GlassTech Inc.

EDSGN100
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Executive Summary

This project outlined by Delphi worked to design something to make automobiles safer, greener, and more connected. If the design can not affect all three of these requirements, it may improve only two without negatively affecting the other. Three different concepts were made after research of recent car innovations. Random people were then surveyed about the three ideas to see which one the general public would want to see the most. After this survey one idea was dropped and then two different ideas were generated from the other two. This left us with four concepts which we used in our decision matrix. We defined customer needs and calculated which idea satisfied the them the most. We concluded that the best idea for this project would be a windshield with new de-icing and tinting technology. This windshield would have a chemical applied to it which would keep ice from forming on it in the winter. It would also have a switch in the car to adjust the tint of it depending on the light conditions.

Introduction

The purpose of this project is to make cars safer, greener, and more connected. Delphi wants innovations that make cars less likely to get into accidents and more safe when in an accident. They also want to see a design that makes cars safer for the environment when they are manufactured or when they are being used. Delphi also wishes to make innovations that make cars able to relay information between each other. A design must be developed for an automobile to fit these three criteria. It is permitted for the design to only improve on two of these criteria while not having a negative effect on the other.

Research

The chemical we would most likely use for this project would be propylene glycol. This added with a thickener to help it stay on the windshield for a long period of time would be able to keep ice from forming because of its low freezing point. NASA came up with this mixture in the late 1990's and it is used on spacecrafts and planes. Automatic tinting is already in use but mostly in offices and businesses. They use PDLC technologies which is applied to windows. PDLC is a thin film of different materials and crystals which control how much light is let in when electricity is applied to it. This technology could be used in cars so it automatically switches the tint of the windshield depending on the brightness.

Calculations

Cost per windshield

$225- average windshield price
$225/3= OEM Cost= $75
$75/2= A + B + C= $37.50

$37.50 - $6.25(Assembly Q&A Labor) - $16.40(NRE)= $14.95*2.34= $33.58

$33.58 = cost of parts for average windshield
Cost of parts for new windshield = $33.58 + $1.00 + $82.40= **$116.98**

Cost of Propylene Glycol- $1000 per metric ton = $1 per kilogram (price per windshield)

Cost of Tinting Technology- $20 per square foot
Square footage of a windshield- 4.1284
$20 * 4.1284= $82.40

New NRE
$28,800(wages) + $200,000(cost to change production line)= $228,000
$228,000/40,000 parts= **$5.70**

Customer Needs

It is necessary to recognize what makes the operators of the vehicle would like to have to make their use both safe and easy. In order to provide this experience for our customers, we created target specifications. In the table below, we have provided the customer needs we focused on, along with their related metrics.

Customer Needs	Metrics
Tinting is quick	Changes to the correct tinting in .5 seconds
De-icing and tinting technologies are effective	Visibility will be at 100% at all times
Energy Efficient	Will reduce energy used for windshield in current cars by 50% (see Final Description to see explanation)
Low maintenance	Chemical needs to be reapplied once every year
Inexpensive	$371.65 , typical cars cost $225
Compact Size (tinting technology)	4 x 4 inch system built into the dashboard
Simple/Intuitive	Driver doesn't have to do anything
Fail-safe options	Defrosting/scraper is a sufficient replacement but it takes longer

Concept Generation

In order to determine which direction we took our design for the project, we surveyed 15 people each on the possible concepts under consideration. We asked questions on their preference in the three different concepts: 1) springs on the bottom of seats to prevent whiplash 2) an automatic tinting windshield and 3) advanced de-icing technology. In the survey, we asked each participant to rate each concept on a scale of 1-5 on whether or not they would purchase the product. The descriptions on the survey are as follows:

- **Springs on the bottom of seats**- Springs are installed under the seats of cars to minimize the "whiplash" felt upon collision. This will decrease injury.
- **De-Icing Technology**- Heat technology, temperature gauges, and programmable computers combine to provide technologies that counteract ice and fog. The car will regulate the temperature inside the car before you enter to verify visibility is 100% before you start driving.
- **Automatic tinting windshield**- Windshield that will tint automatically to help regulate glare and increase visibility.

After collecting our results and tallying the answers, we found the automatic tinting windshield and the de-icing technology were the popular choices. Instead of choosing just one, we decided to combine the two concepts to create a general advanced windshield technology. We named our design GlassTech Inc.

Concept Selection

In the Analytic Hierarchy Process table, we have chosen 10 features we want our design to have. We want the design to be effective, meaning the tinting changes accurately and visibility is perfect. The design needs to work quickly and it has to be energy efficient by cutting back on energy used. The design will require little maintenance, only needed to be changed once a year. The technology has to be a small, compact size to easily fit inside the car and it has to make driving safer. The design needs to be a low cost, along with being simple to use. The fail-safe modes have to be useful and logical, in case the technology stops working. In Table 1.0 below, we ranked each feature depending on its importance to the design.

Table 1.0- AHP matrix, showing relative importance of 10 design features for the advance windshield design

	Effective	Quick	Energy Efficient	Low Maintenance	Inexpensive	Compact Size	Makes Car Safer	Simplicity	Fail-Safe Modes	Intuitive	TOTAL:	weight
Effective	1	1	2	3	3	4	1	2	2	2	21	.165
Quick	0.5	1	0.5	1	2	2	0.5	3	0.33	1	11.83	.093
Energy Efficient	0.5	2	1	3	2	4	1	2	2	2	19.5	.154

Low Maintenance	0.33	1	0.33	1	2	2	0.33	2	1	1	10.99	.086
Inexpensive	0.33	0.5	0.5	0.5	1	1	0.33	2	0.5	1	7.66	.060
Compact Size	0.25	0.5	0.25	0.5	1	1	0.33	1	0.5	1	6.33	.049
Makes Car Safer	1	2	1	3	3	3	1	2	3	2	21	.165
Simplicity	0.5	0.33	0.5	0.5	0.5	1	0.5	1	1	2	7.83	.062
Fail-Safe Modes	0.5	3	0.5	1	2	2	0.33	1	1	2	13.33	.105
Intuitive	0.5	1	0.5	1	1	1	0.5	0.5	0.5	1	7.5	.059
											126.97	

After determining the important features that should be met in our design, we created four possible combinations to decide which concept would work best. For our windshield technology to prevent ice from forming, the two options were 1) installing an electrical system, or 2) apply a chemical. The automatic tinting process, there were similar options. 1) A chemical tints the windshield when light is applied, or 2) a computer system controls the process using electricity. Table 2 below shows the design selection matrix results and conclusion.

Table 2.0- Design Selection Matrix for Windshield De-Icing and Tinting

	AHP weight	Heat (De-icing)	chemical(De-icing)	Electrical (Window tinting)	Chemical (Window tinting)
effective	0.165	4	4	4	4
quick	0.093	2	5	5	2
energy efficient	0.154	3	5	3	5
low maintananc e	0.086	3	3	4	3
inexpensive	0.06	3	4	4	4

compact size	0.05	5	5	5	5
safe	0.165	5	5	4	3
simplicity	0.062	4	4	5	5
fail-safe modes	0.105	4	4	3	3
intuitive	0.059	5	5	4	4
		38(unweighted)	44(unweighted)	41(unweighted)	38(unweighted)
		3.784(weighted)	4.431(weighted)	3.942(weighted)	3.71(weighted)
			winner	winner	

Table 2 is our design selection matrix. In the matrix, we ranked each feature in the possible designs. Then, we added the weight of each feature into the calculation to determine which designs won. The results show we should choose to create a design where we apply a chemical to the windshield surface to prevent ice from forming, combined with an electrical system to automatically tint the windshield.

Final Description

For our final design, we decided to combine the electrical system to tint the windshield with a chemical applied to the windshield to prevent ice from forming. This design meets the project goal, because it will make the cars both safer and greener.

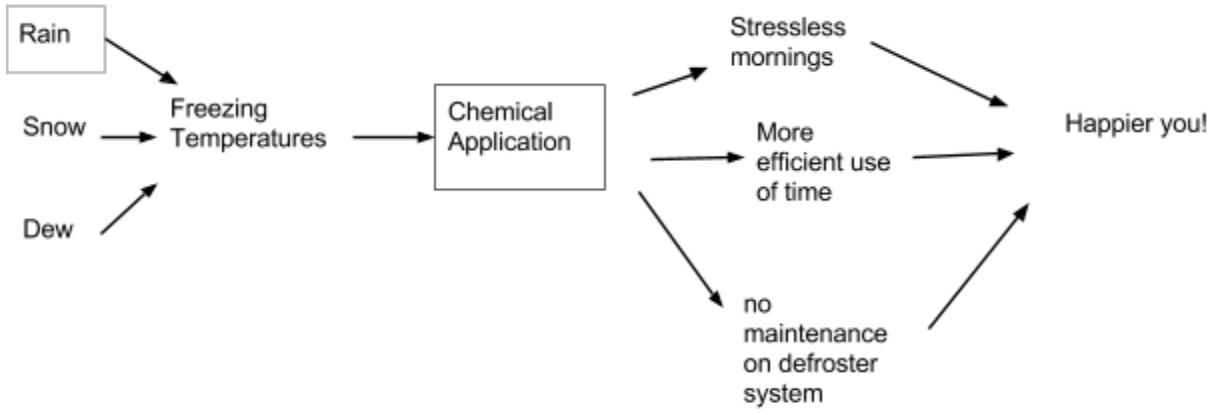
Driving will be safer with our design, because visibility is guaranteed to be 100% at all times. The chemical on the windshield does not allow any ice or debris (snow, rain, etc.) to sit on the windshield. It is repelled off. Also, the tinting process only takes half of a second. So, if the sun is behind the clouds and then it peeks out and hits the windshield, the tint will activate making it easier to see. Also, when drivers are heading directly towards the sun, the windshield will prevent glare from occurring to ensure the driver has 100% clear vision at all times.

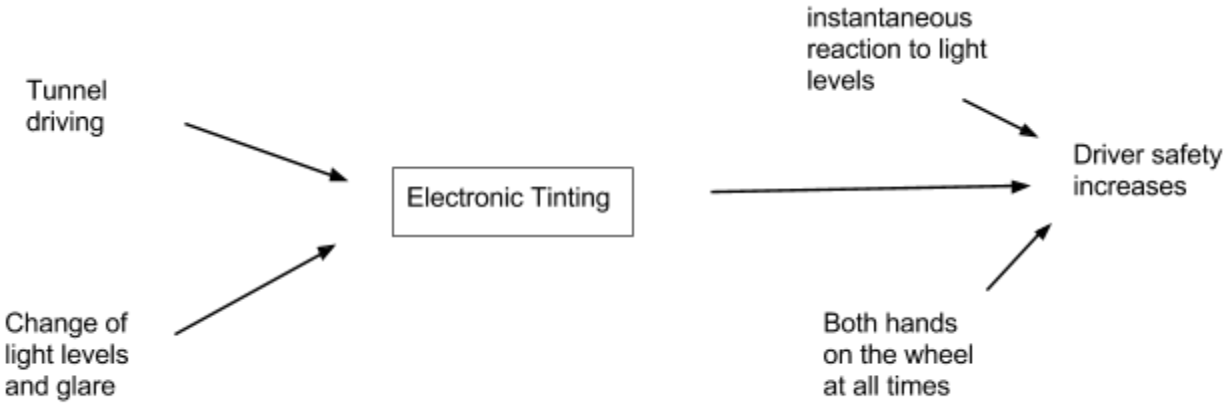
The windshield is also greener than current cars, because it requires less energy. Although adding a computerized electrical system to automate the window tint may seem to require more energy than the average car, it is cancelled out by the lack of energy needed in

the de-icing domain. Normally, the car would have to use forced hot air in order to clear off ice and fog on the windshield. This approach uses significant energy from the car, wasting both gas and battery power, and the time to get from a fogged windshield to a fully-clear windshield can be minutes. However, with the chemical in de-icing the car is not exhausting any energy to complete the same exact task. In summary, our windshield design is actually using less energy than a normal car, while also being more effective. Therefore, it is a greener design.

Along with the goal of the project being completed, our design has features to make it user-friendly. Our advanced windshield design is simple, because the driver is out of the decision loop. They do not even have to know how it works. No button needs to be turned on for the chemical or computer to work. The chemical is working at all times, and the electrical system turns on and off on its own. At night, the tinting system will turn off, because there is no sun affecting the driver's sight, and it conserves energy. The owner does not have to take special care of the windshield. The only maintenance that needs to be done is a reapplying of the de-icing chemical every year. This can be done at the dealership or any local car repair shop. If for any reason the technology stops working, the driver can turn on the defroster and wear sunglasses, and this will sufficiently replace the technology. However, it make take a little more energy. The product is cheaper than an average full windshield replacement. Overall, there is little downside to this product. It is a more effective design to make driving safer and easier.

<u>System Diagrams:</u>





<u>scenarios</u>

The innovative windshield technology will not only be a tremendous asset to normal driving conditions, but also improve the safety for when conditions become less favorable. In scenario A. we will examine the electric automatic tinting of the front windshield.

A. A driver is cruising along the highway when he approaches a tunnel. The tunnel is dimly lit and lets very little light in. In most cases, the driver would need to remove his sunglasses, therefore removing one hand fro the wheel, decreasing his control over the vehicle, while increasing the risk for an accident. With electronic tinting, this.5 second response time will allow the driver to remain in control of his vehicle for the duration of the ride. This applies when exiting the tunnel as well and any other situation where change in visibility brightness or sheerness comes into effect.

The second part of our fully functional windshield technology is its ability to resist and repel water, frost, and ice. As proven in scenario B., this innovation will be extremely useful.

B. An unsuspecting driver rushes out of his house in the morning to make it to work on time only to find a layer of frost on his windshield. He turns on his defroster and the ice slowly melts. This common occurrence could be avoided. With the chemically treated windshield, water will be repelled the instant it becomes in contact with the glass, therefore there is no chance for ice or frost to even form in the first place.

<u>total cost analysis</u>

$225.00 per windshield divided by 3 = DEM cost
$225.00/3= $75.00
$75.00/2= (A+B+C)= $37.50

$37.50 - $6.25 (Assembly and QA labor)= $31.35

$31.35 - $16.40 (NRE) = $14.95

$14.95 x 2.34 = $33.58 (Cost of parts for windshield)

- Per Car:

$82.40 per windshield (tinting cost)
$1.00 Propylene Glycol per kilogram (1 kilo. per car)

- Cost of new windshield:

($33.58 + $1 + $82.4) / 2.34 = $116.98

$116.98 / 2.34 = $49.99

$49.99 + $6.25 (Assembly and QA labor) + $5.70 (NRE) = $61.94

$61.94 x 2 = $123.88 (DEM)

$123.88 x 3 = **$371.65 (Assembly Cost)**

- NRE:

$28,000 (wages) + $200,000 (cost to change production line) = $228,000

$228 / 40,000 (distribution spread out over cars: estimated 2 year span) = $5.70

life cycle analysis

As you can see in the Figure 1 below, glass (windshields) are nearly 100% recyclable. This drastically decreases the amount of pollution and solid waste that is created and discarded throughout the lifespan of the project.

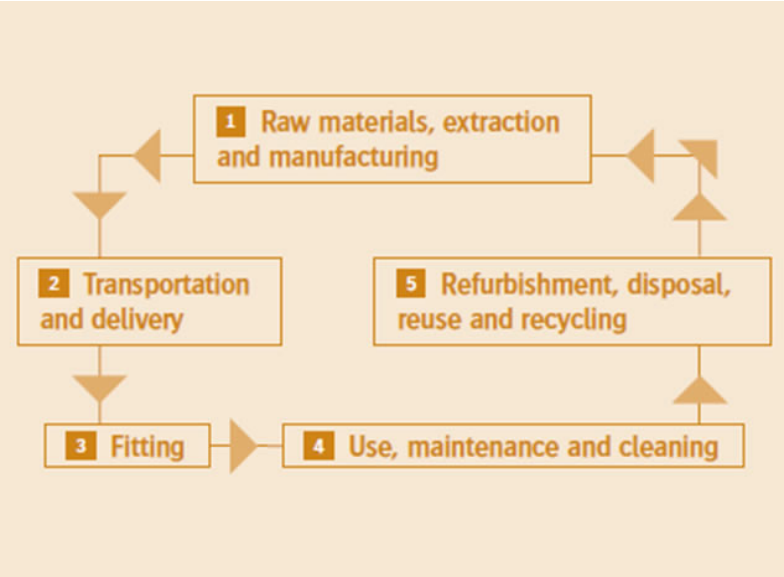


Figure 1

Conclusion

This project gave our team the opportunity as engineers to design a real solution for an actual company that wanted to design a new product. We came up with many possible solutions as a group, narrowed our ideas down to one by evaluating the effectiveness and public opinion, and designed a prototype. Our design was chosen because we felt that it best solved two of Delphi's design goals of being safe and green while not negatively affecting it being more connected. It also was the idea that was favored most by the people that we surveyed. We did extensive research to come up with the best way to design our idea and how much it would cost. We pitched our design to the other groups in the class to gain their approval. This project really benefited our understanding of what an engineer goes through to come up with a design that would best suit the needs of a company.

Appendix

- **Propylene Glycol**- Organic compound consisting of carbon, hydrogen, and oxygen. It is a viscous colorless liquid with a very low freezing point.
- **PDLC technology**- a film composed of PET and ITO film, polymer and liquid crystal molecules

References

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