MECHANICAL ENGINEERING DEPARTMENT

MACHINE DESIGN

SEMESTER VI

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Automatic alcoholmeter as controller of the start of the vehicle for passenger safety

THE PERFECT MIX:

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1. Introduction:

We are in the process of designing an innovative solution to enhance road safety and minimize the number of alcohol-related incidents. Our design includes the integration of an alcohol sensor with fast and accurate response time, which will be linked to the car's key insert. This ensures that the driver's alcohol level is assessed before the vehicle is started. If the driver does not meet the predetermined standards for safe driving, the key insert will be disabled, preventing the car from being started. This design will be an effective deterrent to drunk driving, ensuring that drivers stay within the legal limit, and promoting a safer driving environment for all.

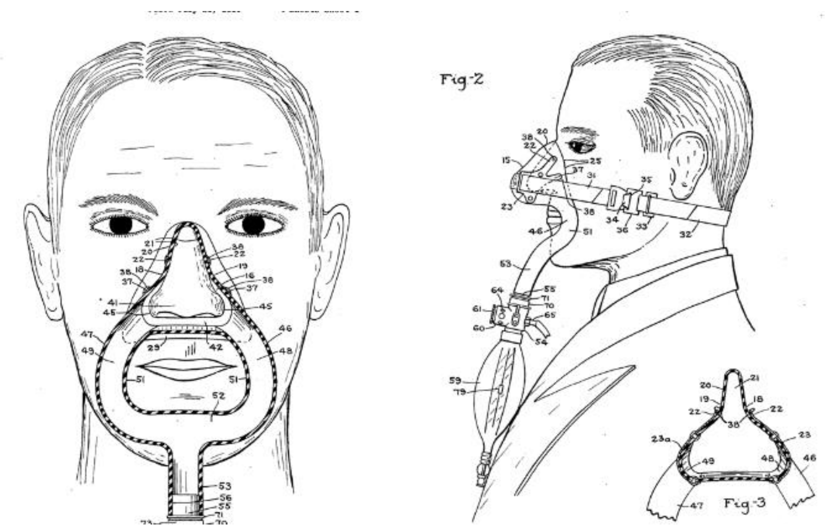

Image 1: Design of the automatic alcoholmeter

2. Problem formulation:

Reducing the number of deaths on the roads due to alcohol is important for several reasons, especially in India where road safety is a major concern. Here are some of the reasons why:

1. Human Loss: Drunk driving results in the loss of precious human lives and leaves many families devastated. Reducing the number of alcohol-related road accidents will help save lives and reduce the number of families affected by this tragedy.
2. Health Care Costs: Alcohol-related road accidents place a heavy burden on the healthcare system, with victims requiring medical treatment and rehabilitation. Reducing the number of alcohol-related accidents will help to reduce healthcare costs and free up resources for other important healthcare needs.
3. Economic Loss: Drunk driving results in a significant loss of productivity and revenue, both for the individual and for society as a whole. Reducing the number of alcohol-related accidents will help to reduce this economic loss and promote economic growth.
4. Improved Road Safety: Alcohol is a major contributor to road accidents and reducing its impact will help to improve road safety for all users.

In India, road safety is a major concern and reducing the number of deaths due to alcohol-related road accidents is a top priority. The country has some of the highest road traffic death rates in the world, with over 150,000 people losing their lives each year. By reducing the number of alcohol-related road accidents, India can take a significant step towards improving road safety and saving lives.

3. Market survey:

According to a study by the World Health Organization (WHO), the estimated cost of road traffic accidents in India was approximately 3% of the country's Gross Domestic Product (GDP) in 2010.

Gross Domestic Product (GDP) of India was approximately $2.9 trillion.

3% of the GDP would be: $2.9 trillion * 0.03 = $87 billion.

Also, we see opportunities in these segments of the market because of:

- The new Traffic and Road Safety Law in the European Union aims to reduce the number of road accidents caused by drunk driving. As a result, the law requires the use of anti-start breathalyzer devices in vehicles. This means that starting a vehicle will be contingent on passing a breathalyzer test. It is expected to be released in May 2023
- Breathalyzer devices in vehicles is already mandatory in some countries, such as France and Belgium, and has been introduced as a pilot project in others, such as Germany. These countries serve as examples of the potential impact and success of such a law.
- The EU market presents a huge opportunity for our anti-start breathalyzer device, and the new Traffic and Road Safety Law further strengthens this opportunity.

4. Competition in the market

Honda has started implementing anti-start breathalyzer devices in some of their vehicles. Their device is likely to be similar to other products in the market, in that it measures the alcohol level of the driver before allowing the car to start.

The specific details of Honda's breathalyzer device are not widely known, but it is likely that it uses a similar technology to other devices in the market, such as fuel cell sensors or infrared spectroscopy.

Honda's implementation of anti-start breathalyzers is in line with the growing trend of car.

5. Ideas of the design

Some design ideas for how an automatic breathalyser can exit the driver's cabin in different ways:

1. Retractable Design: Implementing a retractable design, similar to the way in-flight masks are deployed, where the breathalyser can be extended to the driver for use and then retracted when not in use.
2. Wheel-Based Design: Using a wheel-based design, where the breathalyser can roll out from a compartment in the vehicle to the driver's position and then roll back when not in use.
3. Slide-Out Design: Implementing a slide-out design, where the breathalyser can slide out from a compartment in the vehicle to the driver's position and then slide back when not in use.
4. Arm-Based Design: Using an arm-based design, where the breathalyser can extend on an arm from the vehicle to the driver's position and then retract when not in use.
5. Spring-Loaded Design: Implementing a spring-loaded design, where the breathalyser can be extended to the driver with a spring mechanism and then retracted when not in use.

Image 2: Design idea being chosen.

There are several reasons why we have chosen a retractable design for our alcohol breathalyser system. First and foremost, this design provides convenience and ease of use for the driver. By deploying the breathalyser in a similar way to how in-flight masks are deployed, the driver can easily access the device and perform a breath test when needed.

Furthermore, the retractable design is space-efficient and does not take up much room in the car when not in use. This is important for vehicles where space is at a premium, such as smaller cars or vehicles with limited storage space.

In addition, the retractable design protects the device from potential damage or wear and tear that may occur if it were left exposed. By retracting the device when not in use, we can help ensure its longevity and maintain its accuracy over time.

Overall, we believe that the retractable design offers a number of advantages over other options and is the best choice for our alcohol breathalyser system.

6. Hardware Requirements

The following components are required:

1. Microcontroller (ATmega 328)
2. Alcohol Sensor
3. LCD
4. Voltage Regulator
5. Transformer
6. Crystal
7. Push Buttons
8. Buzzer
9. Motor
10. Diodes
11. Arduino

7. Software Specifications

1. Arduino Compiler
2. MC Programming Language: C

8. Electrical design of our circuit

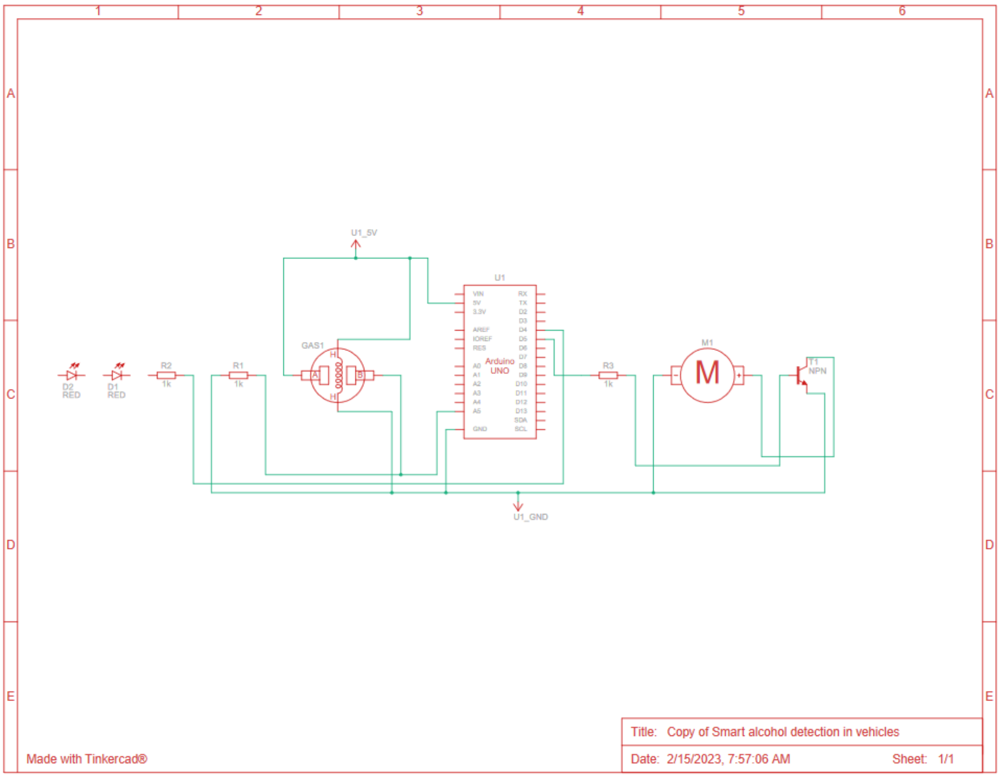

Image 3: Electrical design of our circuit

9. Physical design of our circuit

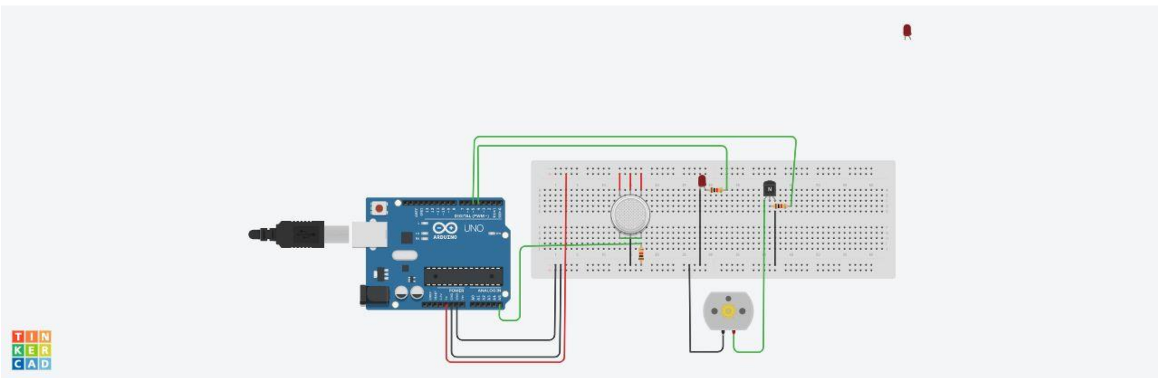

Image 4: Physical representation of our circuit

10. CAD design of our alcohol sensor

To design an alcohol sensor for a driver's mask, it is important to consider the size and form factor of the sensor. The sensor must be small enough to fit comfortably within the confines of the mask while still providing accurate and reliable readings. Additionally, the sensor should be designed to adjust to the specific needs of the driver, such as incorporating features like adjustable straps or adjustable sensor placement to ensure a secure and comfortable fit. Ultimately, a well-designed alcohol sensor that fits seamlessly into a driver's mask can provide an effective and unobtrusive means of monitoring alcohol levels and promoting safe driving practices.

The following CAD designs have been made taking into account those requirements:

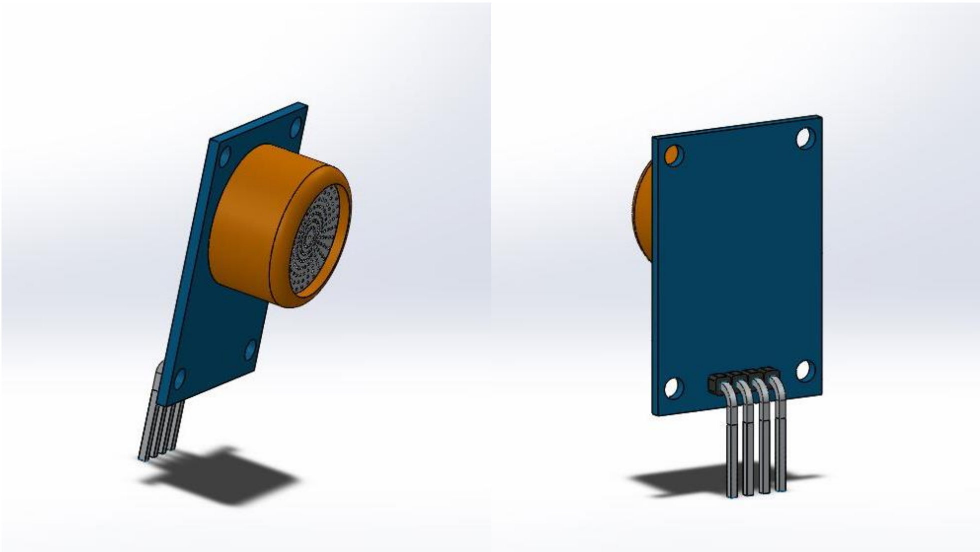

Image 5 and 6: Front and back of our alcohol sensor

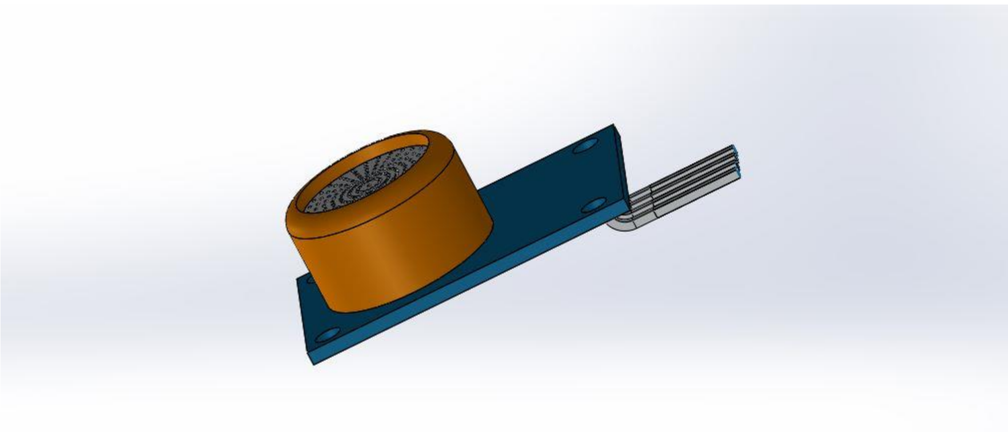

Image 7: Side of our alcohol sensor

11. CAD modelling of the total design

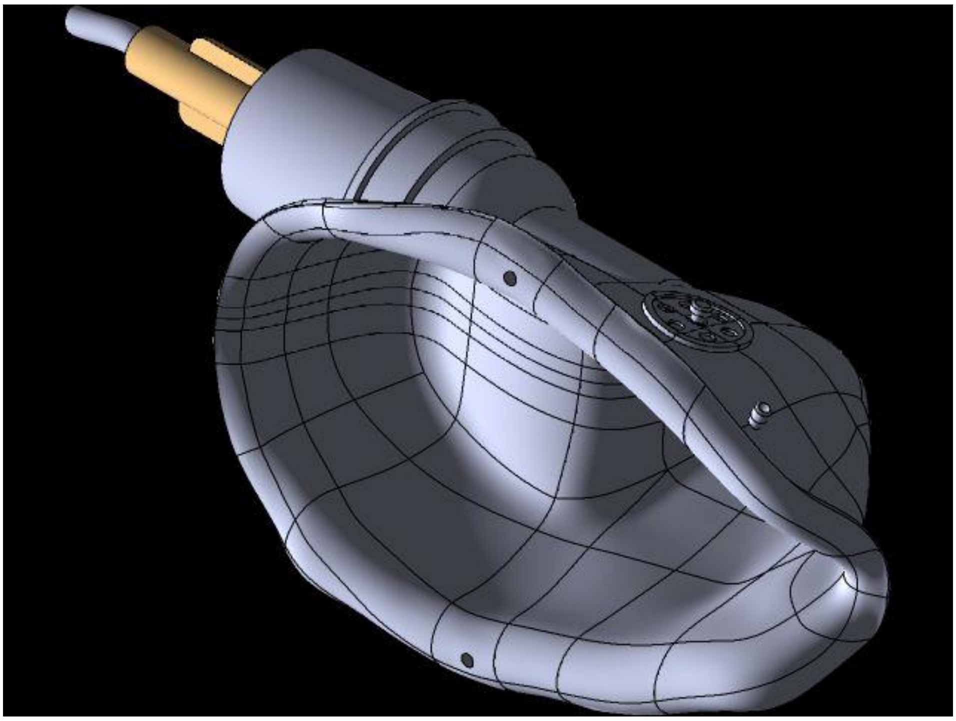

Image 8: Mask that will cover driver´s face.

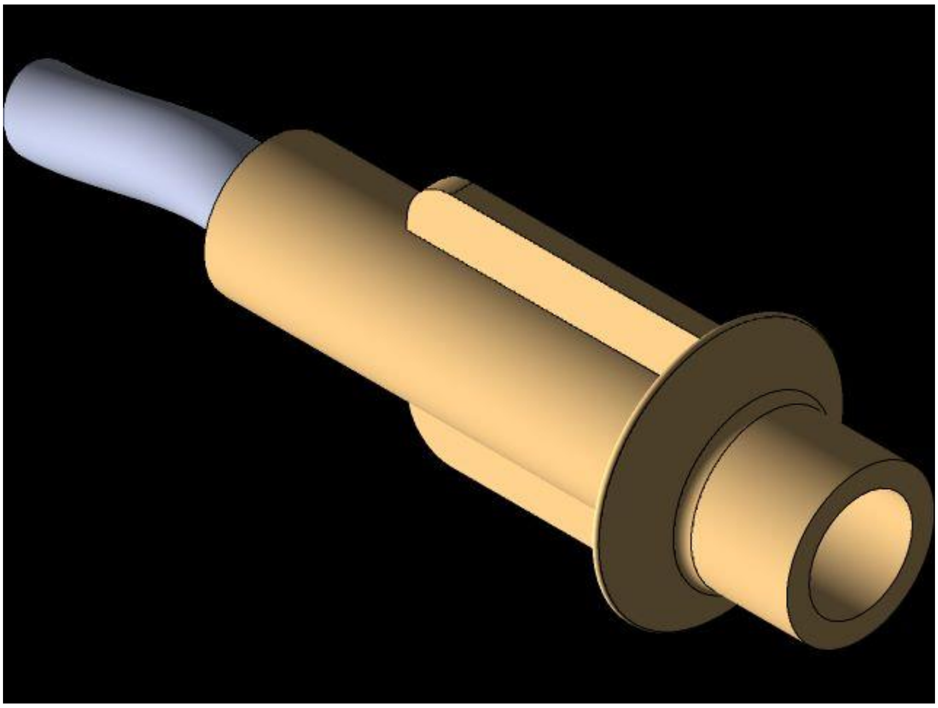

Image 9: Attachment of the mask to the car

12. Mechanism design and kinematic analysis.

The successful deployment of our alcoholmeter will depend on the proper functioning of the cabinet mechanism, which must be designed and analyzed with great attention to detail. Specifically, we need to ensure that the mechanism is designed to operate via gravity and that the kinematic and force analyses are accurate. The cabinet must be able to support the weight of the alcoholmeter while also allowing it to be deployed with minimal effort, all while ensuring that it is stable and secure once in place. Therefore, it is crucial that we carefully consider all aspects of the cabinet mechanism design and conduct a thorough analysis to ensure that it meets all necessary requirements.

A method for performing this investigation is a local stress analysis. Such an analysis is described and its capabilities are demonstrated. The local model is analyzed independently of the global model of the structure.

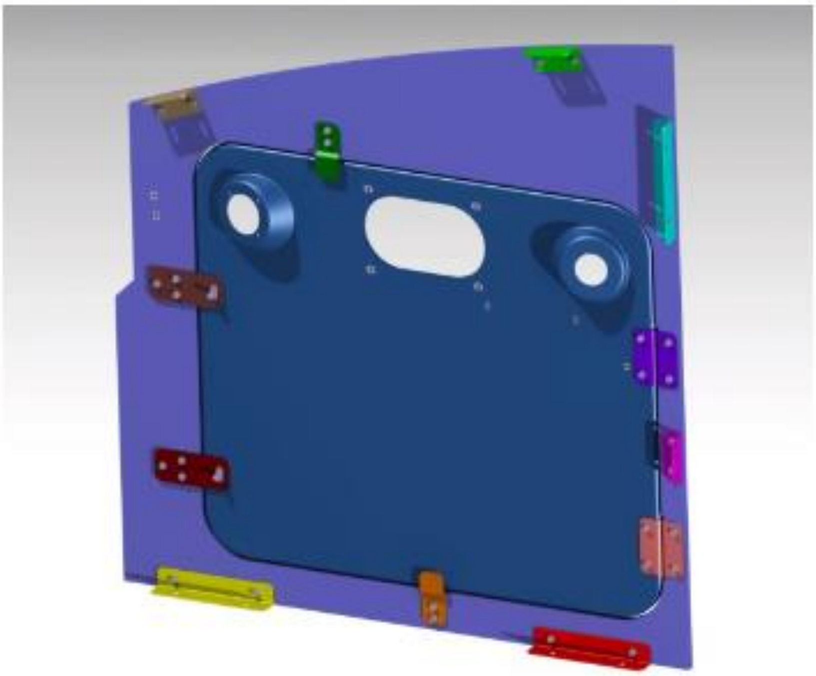

Image 10: CAD design of our cabinet – (view from interior)

Local stress analysis is crucial in evaluating the behaviour of structures and components. It helps to identify potential weaknesses and assess deformation and reactions. If the analysis shows acceptable limits for deformation and reactions, it provides confidence in the structure's performance without needing modifications.

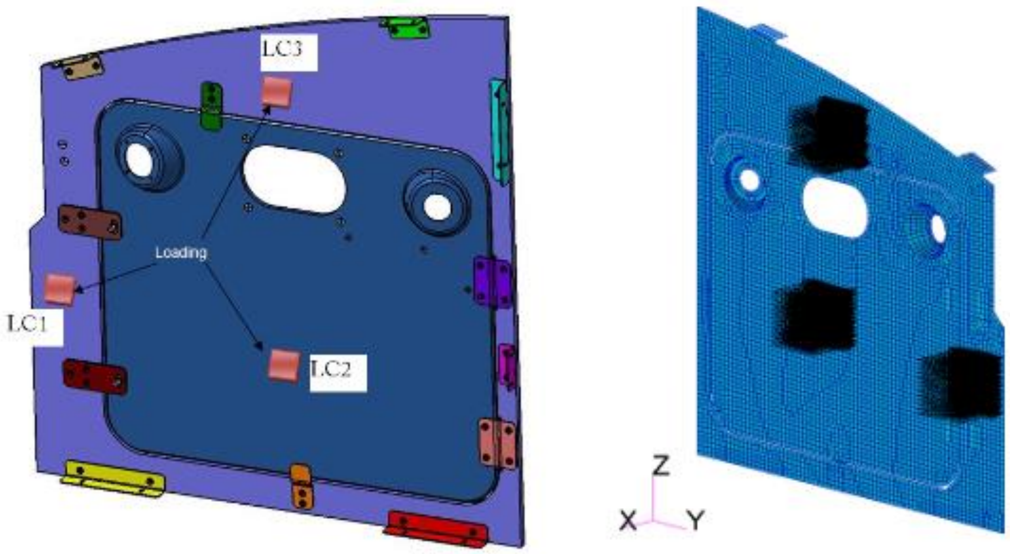

Image 11: CAD design of our cabinet – (view from interior)

3. **Displacements look natural.**
4. **Correct reaction forces**

13. <u>Chosen material for the cabinet.</u>

To determine the best material for the cabinet of our product, we will compare the properties of three different materials: aluminium, carbon fibre, and glass fibre. In Table 1, we have listed the material properties that will be used in the finite element modelling process. By comparing these properties, we will be able to identify which material is best suited for our specific needs. The material with the most favourable properties will provide the best performance, durability, and cost-effectiveness for our product. Careful consideration of the properties of each material is essential in making an informed decision about which material to choose for our product's cabinet.

Property / Type of Material	Aluminium	Carbon Fibre	Glass Fibre
Elastic modulus [MPa]	70000	45000	18000
Poisson's ratio	0.35	0.10	0.11
Shear Modulus [MPa]	26000	28500	28000
Density [t/mm3]	2.70E-09	1.85E-09	1.80E-09
Thickness [mm]	-	0.25	0.125

Table 1: Comparison of the most suitable materials

The aluminium model presents a significant drawback in terms of weight, as it is approximately 10 times heavier than the carbon or glass models. Considering that our product needs to operate via gravity, a lightweight cabinet is essential for proper functioning. Additionally, the aluminium model has a thickness that is considerably higher than that of the other materials, which requires milling of the parts. This additional processing leads to increased production costs, which is a significant disadvantage for a non-structural part of the cabinet intended for automobile use. As such, despite the advantages of aluminium, its weight and manufacturing costs make it a less desirable option for our product's cabinet.

14. Final cost evaluation

Given that the main market for our alcoholmeter is in the USA and EU, it makes sense to consider the cost of production and manufacturing in these regions. The cost of production and manufacturing can vary significantly depending on the location, as labour costs and material costs can vary widely between different regions. By taking into account the cost of production and manufacturing in these regions, we can ensure that our product remains cost-effective and competitive in these markets. Additionally, producing our product in these regions can help to reduce transportation costs and lead times, which can further improve the efficiency of our supply chain. Therefore, it is important to carefully evaluate the cost of production and manufacturing in the USA and EU and to choose suppliers and service providers that can offer cost-effective solutions without compromising on quality or reliability.

The average price of these components is:

5. Microcontroller (ATmega 328): $2-3
6. Alcohol Sensor: $10-20
7. LCD: $5-10
8. Voltage Regulator: $0.5-1
9. Transformer: $2-5
10. Crystal: $0.5-1

11. Push Buttons: $0.1-0.5
12. Buzzer: $0.5-1
13. Motor: $2-5
14. Diodes: $0.1-0.5
15. Arduino: $20-30
16. 20x20 fiber glass cabinet can vary depending on several factors such as the thickness, quality of the material, and the manufacturing process used. Roughly speaking, the cost of a fiber glass cabinet of this size can range from $10-30.

Taking the maximum price for the components:

17. Total cost for electronic components: $77
18. Cost of fiberglass cabinet: $30
19. **Total cost of production: $107**

Manufacturing and transportation cost:

20. In terms of production and manufacturing, the cost can also vary depending on several factors such as the production volume, labor costs, and location of the manufacturing facility. Assuming a moderate production volume and a manufacturing facility in a location with moderate labor costs, the cost of production can range from $5-10 per unit.
21. Transportation costs can also vary depending on several factors such as the distance between the manufacturing facility and the destination, the mode of transportation used, and the quantity being transported. Assuming the transportation is within a reasonable distance and by ground shipping, the cost can range from $1-3 per unit.

Summing everything:

- **Total cost per unit: $113-$120**

To estimate the potential profit from selling the alcoholmeter in the USA and EU, we first need to make some assumptions about the market size and demand. Let's assume that the total number of cars sold in the USA and EU combined is around 40 million units per year, and that we can capture 1% of the market share for our alcoholmeter. This means that we can potentially sell around 400,000 units per year in the USA and EU combined.

Based on our previous estimation, the profit margin per unit would be around $80-$87. Multiplying this profit margin by the estimated sales volume of 400,000 units per year, we can estimate the total profit to be:

Profit = (Profit Margin per Unit) x (Estimated Sales Volume)

Using the range of profit margin per unit ($80-$87), the total profit can be estimated to be:

Profit = ($80-$87) x (400,000) = $32 million - $34.8 million/year

Therefore, if we assume that the alcoholmeter is legalized and made mandatory in the USA and EU, and we are able to capture 1% of the market share, the potential profit could be around $32 million - $34.8 million per year.

It is important to note that this is just an estimation, and the actual profit may vary based on several factors such as market demand, competition, and other market conditions. Additionally, the estimation does not take into account other potential costs such as research and development, regulatory compliance, and intellectual property protection, which can also affect the overall profitability of the product.

15. Conclusion

In conclusion, our research has shown that an automatic alcoholmeter can bring significant benefits to society by improving road safety and reducing the number of accidents caused by drunk driving. We have also estimated that the potential market for this product is significant, and that we can potentially capture a 1% market share in the USA and EU, which would result in a profit of $32 million to $34.8 million per year.

Considering the benefits to society and the potential revenue, we believe that manufacturing the automatic alcoholmeter is a great decision. However, we also recognize that there are several challenges to overcome, such as regulatory compliance, production costs, and intellectual property protection. We must carefully navigate these challenges to ensure that our product is safe, effective, and profitable.

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