Harnessing the Wind

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Element A

Charging any type of battery, whether it be for an electric vehicle or for a battery pack that can be used for camping, can be costly and inconvenient. There is no way to charge a battery when a vehicle is in motion unless the consumer uses an alternator connected to the engine. This, however, is not enough to supply power to battery packs or provide a longer range for an electric vehicle. Additionally, the generators needed to supply power to the electric vehicle chargers put pollution into the environment through the burning of fossil fuels, negatively impacting public health.

Reflective Questions

1. What exactly is the problem?
2. How do I phrase it as an objective problem statement?
3. What is the background, context, or setting of the problem?
4. Who in fact says that this is a problem worth solving and why should anyone believe them?

Problem Statement

The current systems available for electric vehicle charging are highly limited, as the batteries only last for short durations and there is no way to provide long term charging while on the go. There are many potential forms of reusable energy that can be collected from a vehicle as it is driving to provide power to these batteries; however, the applications for such forms of energy have not yet been developed in a way that solves the consumer and environmental issues with electric vehicle charging capabilities.

Background and Statistics

Electric cars use the unit of MPGe to determine their mileage, while regular cars use gallons. 33.7 MPGe's is equal to 1 gallon of gas. Small cars can generally hold up to 12 gallons of gas while the most fuel efficient Tesla has a combined MPGe rating of 132 which is equivalent to slightly under 4 gallons of gas. This means that, even with small cars, it still can hold up to 3 times more fuel then an electric car. Also, as shown by the graph below, the efficiency of batteries goes down over the years, especially when in hot climates like Arizona or if using a DCFC that is considered a level 3 charging station.

Justification

Economics

Currently, California is unable to supply enough energy to meet the demand for electric vehicles. This is in part to the cost of their new clean energy bill. Wind energy from the large windmills simply isn't enough to supply cities power while also charging the super chargers.

Technical Problems

There have been concerns over the longevity of EV batteries for years now. Because these batteries are made of "'wet' lithium-ion batteries [that are] based on liquid electrolytes" they are highly sensitive to temperature, and as a result, battery life is reduced (Crothers, 2021). A study by AAA "quantified the range loss at 20 degrees Fahrenheit to be roughly 40% lower than at 75 degrees for the average EV," showing the severe reduction in battery reserves (Wiesenfelder, 2022). Over the years there have been several recalls for EV batteries from producers such as Chevy, Hyundai, and GM over hazardous batteries. Many of these products have been known to catch fire or malfunction unexpectedly, and it is a known fact that battery life reduces significantly after just a few years, just like a smartphone battery. Recurrent Ceo Scott Case asserts that, "'After five years, it is common to see a 5-10% drop in range'" (Wiesenfelder, 2022). In addition, many consumers find that it is not worthwhile to replace a dying EV battery, as this can often cost the owner more than the car had when they first bought it. There are a few companies, such as QuantumScape, that are working on improving batteries, but there are no existing products yet.

Health and Safety

The burning of fossil fuels such as diesel has been identified as a major cause of climate change and air pollution across the globe. Increased air pollution negatively impacts public health, "[leading] to early death, heart attacks, respiratory disorders, stroke, asthma, and absenteeism at school and work." (Harvard University, 2022)

Experts

I. Azianti Ismail

"Azianti Ismail currently works at the Faculty of Mechanical Engineering, Universiti Teknologi MARA Johor, Pasir Gudang campus. Azianti does research in Quality

Assurance Engineering, Manufacturing Engineering and Industrial Engineering" (ResearchGate). Her area of expertise includes but is not limited to the automotive industry, cars, and industrial engineering. She also has contributed to 36 research papers, where she was either an author or co-author.

II. Robert Yost

Robert Yost is the president of American Wind and inventor of the MicroCube. "American Wind, Inc.[...] has developed the most state-of-the-art micro ducted wind turbine (MDWT) ever brought to market. The technology behind the micro wind turbine is a complete thought change in the wind turbine industry. Instead of bigger turbines farther away from the point of use, power generation can now be used at the point of use" (American Wind, Inc., 2021).

Market Research

A recent study from 2018 compared the average costs to fuel both electric and gas-powered cars, finding the cost of electric vehicles to be roughly $485 annually while gas costs amounted to an average of $1,117 per year. An additional study in 2020 found the difference in cost between electric and gas vehicles to be nearly 60% (Courtney, 2022). Based on current rates and the average household from June 2022, it would cost about $59 per month to charge an electric car at a rate of 15 cents per kWh, whereas the average price of gas is at $3.70 per gallon and needs two to three refuels a month (Kurczewski, 2022).

Scholarly Articles

I. An economic analysis of the production of hydrogen from wind-generated electricity for use in transport applications

This article documents the results of the HyFrance 3 experiment, investigating the "storage of wind-generated electricity in the form of hydrogen." The study found that "storing electricity in the form of hydrogen is not an economically worthwhile method of compensating for intermittent power generation," since the process is too costly and overall does not benefit the economy. However, future applications of wind energy that are not related to hydrogen generation may prove promising for the production of general fuel.

II. ### Charging-Related State Prediction for Electric Vehicles Using the Deep Learning Model

This article predicts the state of vehicle charging in the future and shows that users will have to charge their vehicles far more frequently due to the long duration and limited driving range.

III. ### Challenges and recent developments in supply and value chains of electric vehicle batteries: A sustainability perspective

LIBs are the future of eclectic cars. LIBs have had a greater demand since the practical uses have increased from power components for portable electronic devices like phones and tablets to electro mobility and grid energy storage. While there may be many risks like mining and OEM’s, the benefits and possibilities far outway them.

Overview of Existing Products

MicroCube™ Wind Turbine

The MicroCube wind turbine, due to its size, is designed to capture 98% of wind energy's potential, instead of just 3% like large wind turbines. It generates 2,800 watts per hour to keep the lithium-ion battery charged. The product currently costs $2,850 per windwall.

Element B

The first wind turbine in history was built by Charles F. Brush. Over time, there have been major improvements in wind turbines in both their effectiveness and their applications. In the modern era, wind turbines are expensive and are limited to harnessing the Earth's wind currents. Currently, however, there exists technology that can make these turbines operate efficiently on a much smaller scale. In order to harness the ability to innovate and overcome the challenges of electricity, our team needs to design a mechanism that will effectively turn wind energy into electric vehicle energy. The team began by conducting research using Google Patents, discovering 4 patents and 4 products that are closely related to the topic. While the patents provide viable solutions to our issue, the technology used is relatively new and leaves a lot of room for potential improvements. In addition, a limited number of products on the market show that the applications of these technologies are very limited to the public. Further examining the designs will provide our team with insight on how these technologies work and allow the team to discover potential solutions and improvements.

Reflective Questions

1. What are all of the methods, products, or actions that are being used or have been developed to try to solve this problem? Exactly why doesn’t each of them actually solve the problem?
2. How do I/we prove to others that I/we have done an extensive search for possible current solution attempts?
3. Who has helped me/us identify and state the shortcomings of the solution attempts found and why should anyone believe them?Justification

Existing Patents

Modular Micro Wind Turbine—US9062654B2

Inventor: Robert D. Yost

Publication Date: 2012-03-26

This invention was designed to generate electricity on the localized level. The turbine consists of several airfoil blades connected by a central hub to a drive shaft and an electric generator. As the wind turns the blades, the turning of the drive shaft generates electricity by rotating around magnetic coils. This allows individual users to generate power from high-wind conditions. A secondary patent listed below provides information on the generator used in the internal assembly.

This invention provides the basis for generating wind energy from vehicles by creating a smaller version of the larger wind turbines that are commonly used in energy production. This smaller replica can be more easily attached to a vehicle to allow the user to generate passive energy as they drive. In fact, the inventor of this patent has used this technology in electric vehicle applications, attaching a grouping of panels to the top of the car to harness the potential wind energy.

Improved Magnetic Generator for Modular Micro Wind Turbine—US9331534B2

Inventor: Robert D. Yost

Publication Date: 2016-05-03

This invention is similar to an electric generator since it consists of a drive shaft with a configuration of alternating stators and rotors. The first and second main rotor use axially aligned magnet pockets to generate energy as the drive shaft rotates. Alternatively, the invention is also similar to an improved magnetic generator core, utilizing a circular rotor with radially arranged magnet pockets. The drive shaft extends through the interior of the central housing, harnessing the opposite polarity of the magnets to generate energy.

This product exists to ensure the most efficient energy collection possible in an urban, low cost environment. Many of the components of the invention can be manufactured using laser sintering or 3D stereolithography printing, making the technology faster and more cost-effective to manufacture than other products. The invention allows for a variety of applications, including the ability to link multiple turbines and harness other forms of reusable energy such as hydropower. The smaller design makes it possible to utilize 97% of wind energy, since less wind escapes compared to the larger wind turbines.

Wind-driven turbine cells and arrays - US20100001532A1

Inventor: Mihai Grumazescu

Publication Date: 2006-06-12

An array of cells are arranged to generate electricity from incoming wind. The wind enters through a mouth in which the turbine is connected to a brushless DC generator. The top deflector is shaped to receive upwardly moving air and redirects it horizontally to flow over the surface structure. With this arrangement, each cell can generate a few tens of watts to be made available.

This product exists to create energy from wind and turn it into electricity while also having a mobile element that allows the product to move in response to the movement of the wind. This product can easily be attached to any surface and would also have no effect on the aerodynamics of the vehicle because it creates a negative space that allows the wind to merge back with the moving wind. Although the product generates a small amount of energy that is made up for by adding an array of these fans onto a surface. The small and seamless design makes it easy to attach to a vehicle while also being unnoticed.

Regenerative braking system for motor vehicles - US7458650B2

Inventor: Hiromitsu Toyota, Masaru Konishi, Tomonaga Sugimoto, Yoichi Isono

Publication Date: 2008-12-02

A regenerative braking system is created by attaching a generator to one or more wheels of a vehicle to generate electricity through toque. In addition, a series of calculation methods are utilized to determine wheel speed and road grip variation to compensate for the amount of energy generated. This energy is used in electric vehicles to recharge lithium ion batteries.

This patent provides an overview of alternative forms of reusable energy that are currently being applied in the automotive industry. While regenerative braking can be used to generate a substantial amount of passive energy, the technology cannot always be used in cases where the vehicle is traveling too slow. A faster speed is necessary to create enough torque and in turn generate energy.

Existing Products

MicroCube™ Micro Wind Turbine

Price: $2,850

Summary: An encased micro wind turbine designed to be smaller than traditional wind turbines. Reduces the amount of air lost between the turbine blades—a common problem with larger wind turbines—allowing the turbine to capture 98% of the wind's potential.

Strengths:

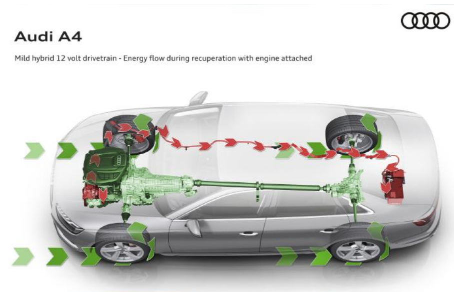
- Enables at use power generation
- A single unit can produce 1kW of energy
- Highly versatile
- Very quiet
- Lightweight
- Smaller than standard wind turbines
- Increases efficiency of wind power generation

Weaknesses:

- Measures 9 by 9 by 13 inches, which is not aerodynamic for a car add-on
- Costly

- Must connect more units together to provide adequate energy
- Ideal range of 35-40mph, which means that traveling at faster speeds would not produce optimal energy
- High wind (over 300mph) causes the unit to overheat and explode

Regenerative Braking System



Price: $199 - $699

Summary: A mechanism that uses the kinetic energy of a vehicle's wheels and turns it into electricity that can be used or stored for other purposes.

Strengths:

- Used to top off the battery on electric or hybrid vehicles.
- When used with hybrid vehicles, the user does not need to plug in.
- Harnesses kinetic energy that would otherwise be wasted.
- Reduces thermal energy created from braking.
- Slows the vehicle down without the driver having to use conventional braking systems.

Weaknesses:

- More costly
- Adds weight to the vehicle, requiring more energy to get it moving again.
- Amount of energy generated depends on the driving style
  - Maintaining too high or low speeds will not generate energy
  - Slow braking generates more energy, while fast braking wastes kinetic energy

Lithium-Ion Batteries

Price: $2,000 - $10,000

Summary: A type of battery used in most electric vehicles because of its high energy efficiency, low self-discharge and extended battery life.

Strengths:

- Good high-temperature performance
- High power-to-weight ratio
- Energy efficient
- Long battery life

Weaknesses:

- Costly
- Nearly impossible to recycle
- Manufacturing is not eco-friendly
- Long charging time

Tesla Model S

Price: $96,950

Summary: The Tesla Model S is one of the most widely known electric vehicles available on the market. It is designed with eco-friendliness in mind, meaning that it provides incredible speed, endurance, and range while also protecting the environment from the production of fossil fuels. Tesla uses principles of aerodynamics to create a sleek design that provides the user with a more responsive performance.

Strengths:

- 0-60 mph in 1.99s
- Eco-Friendly
- 1,020 hp
- Very aerodynamic
- Utilizes regenerative braking and other forms of renewable energy.

Weaknesses:

- Has less range compared to gas powered cars
- Quite long and harder to park
- Costly
- Reliant on energy stations for charging

Element C

Before beginning the design process it is important to identify the constraints and necessities behind the product. Such parameters have been determined through research on the subsequent topic to evaluate the pitfalls of existing products and the specific problem that will need to be addressed. Additionally, project deadlines and available resources played a large role in determining constraints. The following list of design specifications had been ordered in terms of importance to the development of the product.

Reflective Questions

1. Now that I know what the problem statement is and why current solutions are not solving the problem well enough, what are the measurable things a new design would have to accomplish (in order of importance) to be seen as a real solution?
2. How did I/we determine each of these design requirements?
3. If the product or system that your team develops is successful, how will you know? Brainstorm a list of benchmarks, against which you can compare your solution, that represent performance expectations that your solution must meet to successfully solve the problem. Benchmarks must be measurable. Sometimes a benchmark is a simple pass/fail assessment. Other times a success rate or percentage of success is the goal.

Design Specifications (In Order of Importance)

I. Performance

Ideally, our solution should act similarly to a regenerative braking system, harnessing kinetic energy from the vehicle as it drives to recharge the EV battery. The product must be able to provide a voltage of 14.4 to 14.6 volts to recharge the lithium ion batteries utilized by electric vehicles.

II. Size and Weight

The current smallest wind turbine available on the market measures 9x9x13 inches. Application of this technology in automotives often requires the installation of a few of these devices to provide ample power output. Our goal is to develop a product that is smaller than these dimensions and does not require the use of several linked systems. In addition, we need to minimize weight as much as possible, since an increased weight would increase air resistance and drag as well as require more energy to get the vehicle moving again from a stop.

III. Operating Environment

Temperature: Since the vehicle will be operating in various environments, it will need to be kept cold so when it heats up due to friction from high winds, it doesn't overheat and explode.

Corrosion Potential: Have a metal like stainless steel or another metal with anti-rusting properties.

Dust/Dirt: Must be able to withstand moderate levels of dust and dirt up to the amount generated by minor dust storms.

Vibration: The wind turbine must have a strong connection to the vehicle so the wind doesn't cause it to vibrate to the point of falling off.

Noise: Quiet—The amount of sound generated by the wind turbines should not exceed the amount of noise generated by a standard gas engine.

Degree of Abuse: Grade 3—The NAAA Vehicle Condition Grading Scale rates vehicles from 0 to 5, with 5 representing a vehicle in excellent condition and 0 representing an inoperable vehicle. Grade 3 car damage is used for normal wear and tear, where the frame and mechanical elements of the vehicle are structurally sound, but some parts may need replacement or maintenance to function properly.

Wind Speeds: Up to 100mph

IV. Ergonomics

The device will need to be integrated into the vehicle in an area that is optimized for wind generation, but does not interfere with the aerodynamics of the vehicle. Our team will need to look at wind patterns for vehicles as they are driving to identify the best place to install the product. Ideally, the product should be installed in a spot that is not directly visible to the user, such as inside a truck bed or in the grill of a car, where a lot of wind energy can be generated.

V. Customer Needs

The lack of EV charging capabilities poses a significant problem for consumers. A home charger, or level 1 charger, can take up to 40 hours to charge a vehicle, while a level 2 charger in places like work or even in the home can charge the vehicle overnight or during the typical work day. A level 3 charger that runs off of DC power, such as those utilized in public charging stations, can charge the vehicle in as little as 30 minutes. However, many public charging stations are spread great distances away from one another, making it difficult for the user to keep ample charge in the battery. The customer needs a system or design that will produce energy as the vehicle is in motion, reducing the amount of time that the consumer will have to spend charging the vehicle at a charging station or in the home.

VI. Materials

The system will need to utilize light materials, such as aluminum, that will minimize the impact on the overall weight of the vehicle. Materials will need to be tested for durability and strength to ensure that the product will hold up against the environmental conditions that the operator drives in.

VII. Global Environment

The wind turbine blades utilized will need to be made biodegradable or recyclable. The current blades used in large wind turbines utilize non-biodegradable materials, and as a result, many of these blades are buried in landfills since there is simply no other way to dispose of the materials. In addition, the product will not include any toxic or dangerous substances.

VIII. Durability and Maintenance

The wind turbine blades, engine/generator, lithium ion battery and the regenerative braking system must have easy access for maintenance. Routine maintenance should occur every 12,000 miles or 12 months, whichever comes first. No special tools will be required for maintenance; however, replacement wind turbine blades will be required.

IX. Service Life

The product should have a service life of at least 15 years or equivalent to the car life.

X. Aesthetics

In terms of aesthetics, the product should:

1. Be provided in a variety of colors and should be optional for people who want a different color.
2. Be aerodynamic and fit within the design of the vehicle.
3. Should not be too heavy, since heavier materials will increase drag.
4. Surface treatment should be smooth and provide no jagged edges or textures that could negatively impact air resistance.

XI. Safety and Legal Issues

Inexperienced drivers pose a threat to safety while on the road, so these systems need to be made suitable for all users and provide a user-friendly environment. Additionally, the current micro wind turbines overheat and explode in wind speeds over 300mph since they are not designed for such high-friction environments. To make this solution more practical for applications in high-speed environments—such as the wind speeds generated while driving—a modification to the design of the turbines may be necessary.

XII. Target Cost

The MicroCube technology costs $3,000 per system, so our product should aim to be comparable to or less than this price to be competitive on the market.

XIII. Product life

The product should last 10-20 years.

Validation from Primary Stakeholders

I. Stakeholder #1: Robert Yost

Contact Information: dan.yost@americanwindinc.com or 256-217-5892

Qualifications: CEO of American Wind and the creator of the MicroCube wind turbine.

II. Stakeholder #2: Elon Musk

Contact Information: nasales@teslamotors.com or 1-888-518-3752

Qualifications: CEO of Tesla

III. Stakeholder #3: Mr. Baxley

Contact Information: donald.baxley@dvusd.org

Qualifications: BCHS engineering teacher and overseer of the projects in the Engineering Design and Development class.

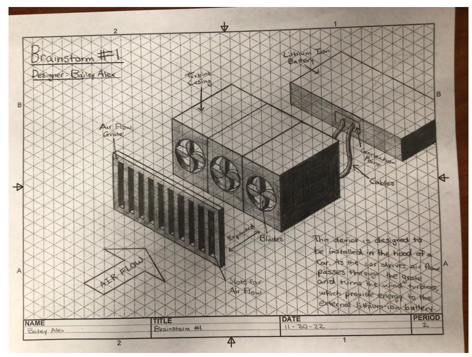
Element D

During the brainstorming process, we found that we had pretty similar ideas on how to solve the problem. We all incorporated a system in which the air flow created through driving passes through wind turbines, which in turn generated electricity that is stored in a backup lithium-ion battery. The main differences in designs is where this system is located on the car itself. While we will still need to conduct more research to determine the aerodynamics of the vehicle and where the system will produce the most energy, we will judge the designs based on prospective energy generation, aesthetics, and efficiency.

Brainstorming Designs

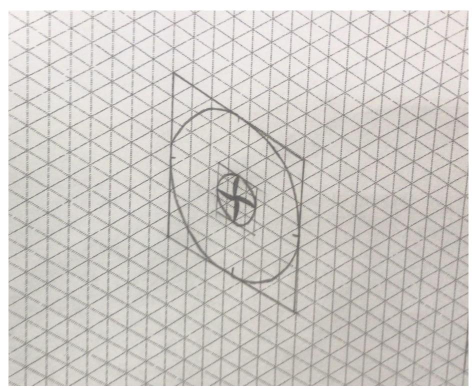
I. Bailey's Design

This device is designed to be installed in the hood of an electric vehicle. As the car drives, air flow passes through the grate and turns the wind turbines, which provide electricity to the external lithium-ion battery.



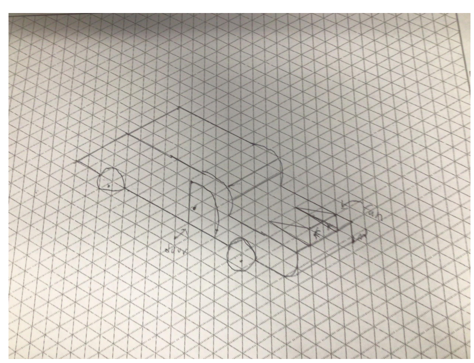
II. Luis' Design

This design uses a system of fans attached to the wheels of a car to produce energy from the wind, that is then sent to a battery.



III. Isaac's Design

An electric car doesn't need an engine so instead of leaving that space empty, fans will be placed there to charge the battery. The position of it in the front keeps it always able to get air, unless one drives in reverse.



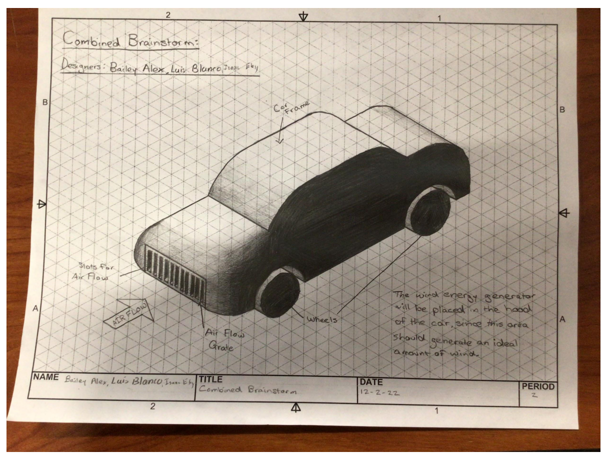
Decision Matrix

Scale: 1-5 (5 is best, 1 is worst)

Design	Function	Efficiency	Aesthetics	Energy Generation	Size	**TOTAL**
Bailey's Design	5	3	5	4	3	**20**
Luis' Design	3	2	5	2	1	**13**
Isaac's Design	4	2	1	3	3	**13**

Final Solution

We decided to incorporate Bailey's and Isaac's ideas into a design that shows both the system used and the location of this system on the vehicle. We believe that the front of the car will most likely generate the most wind, so we decided to place the wind turbines inside of the hood of the car. Electric vehicles do ot have engines, so this decision does not have any negative impacts upon the existing frame of the car. In addition, this design maximizes the aerodynamics of the vehicle and does not create any blocky designs that would prevent air flow.



Materials Research

Plastic:

Pros:	**Cons:**
Cheap	Non-Biodegradable
PLA filament	Harms wildlife

High strength to weight ratio	Microplastics

Metal:

Pros:	**Cons:**
Good electric conductor	Have to weld
Strong and durable	Rusts
Heat resistance	Heavy

Ply-Wood:

Pros:	**Cons:**
High impact resistance	Burns easy
Chemical resistance	Expensive
Light	Decomposes

Element E

In the design of a wind energy generation system for use in the field of automotives, several principles of aerodynamics will need to be utilized. These principles outline the laws of physics that the design will have to abide by. A list of field experts, mainly from the fields of wind energy and mechanical engineering, are listed as potential resources to confirm calculations and ensure that all of the designs are mathematically sound.

Reflective Questions

1. How do we show that our design ideas were not just guesses and that my/our ideas and each of the proposed design attributes really is based on sound logic and subject-related knowledge?
2. Why does this proposed solution have merit to try?

Potential Principles and Concepts

I. Law of Aerodynamics

Aerodynamics relies on the principles of weight, lift, drag, and thrust. Although these principles are mainly applicable to aircraft design, they are still utilized in the design of automobiles.

II. Conservation of Mass

The Law of Conservation of Mass requires that the mass of a system must remain constant over time if the system is designated as "closed." A closed system does not allow for the transfer of mass or energy. However, mass can be rearranged within the system as long as it does not constitute a change in the total mass of the system.

III. Conservation of Momentum

The Law of Conservation of Momentum states that the total momentum of an object is constant so long as external forces with weight are not applied.

IV. Conservation of Energy

The Law of Conservation of Energy explains that energy cannot be added or lost within an isolated system. However, energy can be converted to other forms, such as how kinetic energy is transferred into thermal energy through friction.

V. Navier-Stokes Equations

The Navier-Stokes equations describe the motion of viscous fluids. They utilize the three laws of conservation listed above for application in aerodynamics.

VI. Euler Equations

The Euler equations are a series of conservation equations that ignore viscosity (the measure of a liquid's resistance to deformation) and can be used in situations where viscosity has a minor impact on the overall system.

VII. Bernoulli's Equation

Bernoulli's equation is a one-dimensional approach to momentum and energy conservation equations.

VIII. Air Resistance

Air resistance is the force caused by air on things that are moving through it.

Primary Field Experts

I. Field Expert #1: Jimmy Simpson

Contact Information: (623) 687-4270

Qualifications: Works in the field of wind energy.

II. Field Expert #2: Azianti Ismail, PhD.

Contact Information: uitm.edu.my or azianti@gmail.com

Qualifications: Works in the Faculty of Mechanical Engineering at Universiti Teknologi MARA, where she conducts research in Quality Assurance Engineering, Manufacturing Engineering and Industrial Engineering.

III. Field Expert #3: Hiromitsu Toyota

Contact Information: N/A

Qualifications: Designer of the patent for the regenerative braking system utilized in many electric vehicles.

Programs and Equipment

Wind Tunnel

The design group will use the wind tunnel located in the engineering room to simulate the high-wind environments that are present while driving and analyze the aerodynamics of the vehicle to determine where to install the system.

Autodesk Inventor

This program will be used to design and model the necessary parts that will be manufactured using 3D printing technology.

3D Printer

3D printing technology will be used to manufacture parts to create a scale model of the car and wind energy generation system.

Ultimaker Cura

This program is used for slicing stereolithography files into g-codes that can be used in 3D printing.

Element F

Before creating a design for a prospective product, it is important to consider the factors that will affect its viability. This includes, but is not limited to, competitive products, demand for solutions, manufacturing, and distribution needs. By evaluating these aspects, it can be decided whether or not the product will be fully justified.

Reflective Questions

1. How do we show evidence that the proposed design has merit beyond the classroom or lab as a real solution?
2. How can we show evidence that the design could realistically get into the hands of the people the design is trying to help in a sustainable way?
3. What evidence would we have to offer to honestly ask a family to invest their life savings in this idea?

Market Analysis

Competitive Products

Currently, the most competitive product on the market is the MicroCube™ wind turbine. Manufactured by American Wind, Inc., these systems can cost upwards of $2,850 for a single system. The product provides a solution that can effectively harness wind energy on a local level. However, the product has not been optimized for use in the field of automotives, and while a few applications exist, they are not utilized in a way that favors aerodynamics. Our product aims to design a solution that is more practical for use in this field and can be used to generate passive electricity as the vehicle drives.

Demand for Solutions

While there may not be much need for a solution in gas-powered vehicles, the applications of such technology in electric vehicles can provide substantial benefits to the user. EV batteries have been known to last for only short periods of time and pose a challenge to the user in terms of charging. Our solution aims to reduce challenges in EV charging and provide greater ease for the user.

Manufacturing and Distribution

A scale model of our product will be manufactured at school with the available 3D printers. Once the design is past the prototyping phase and enters the market, the product will need to be manufactured in a factory using more sturdy materials and precision machinery.

Conclusion

Although problems may present themselves as things that need solving, the solution may not always be feasible. Even if the greater population believes that the problem is worth solving, this does not mean that the market return will justify the expenses involved in the creation of a solution. However, the team's proposed problem of automotive wind energy generation poses the ability for a valid and justifiable solution to be created.

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