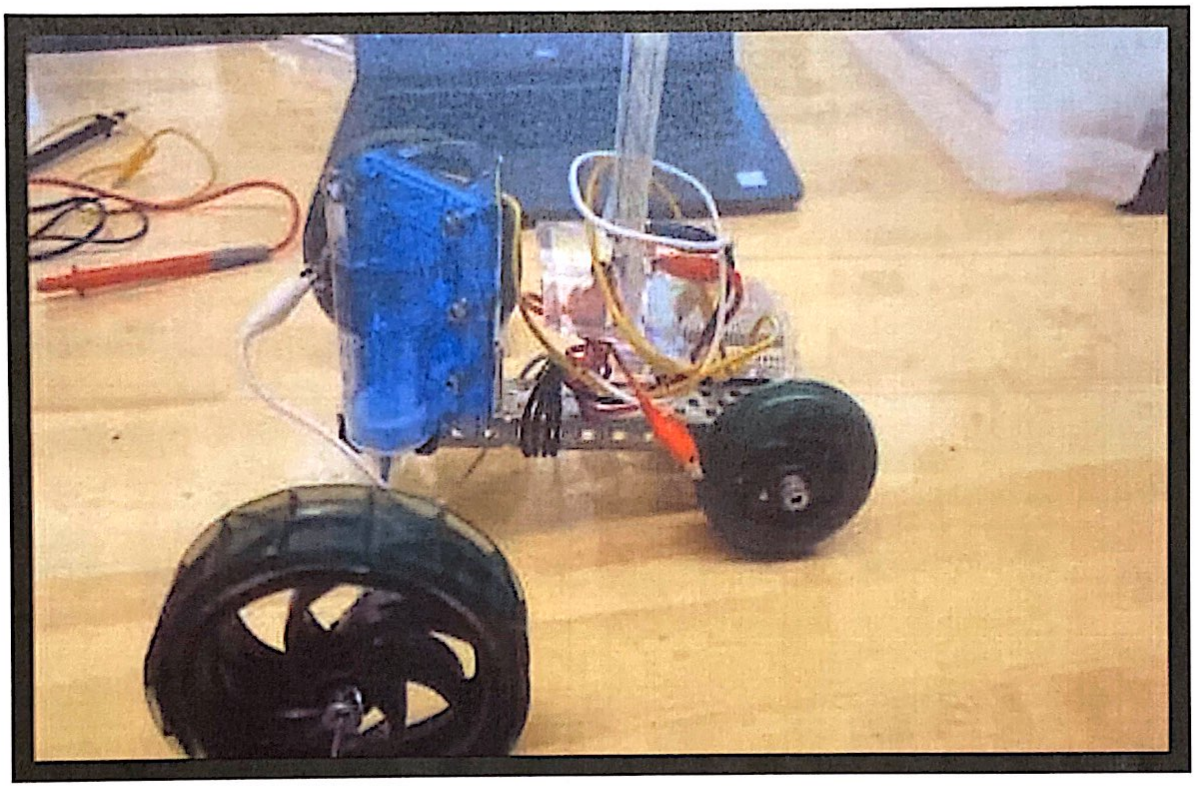
HYDROGEN CELL CAR



Jaidah Morales, Nicole Posada, and Keyur Rana
Principles of Engineering
Passaic County Technical Institute
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Introduction

In this activity, students will comprehend the conversion process of energy in a hydrogen cell car through the utilization of different renewable energy sources to power a Servo motor.

Materials

Quantity	Part Name	Part Number
Assorted	VEX Components	N/A
1	Hydrogen Fuel Cell	Heliocentric reversible
1	Solar Module	Plastic
Assorted	Water	Distilled
Assorted	Wires	22 gauge Wires
1	Multimeter	N/A
2	Batteries	AAA
2	Battery holder	AAA
1	Breadboard	N/A
4	Alligator Jumper Cables	290-1942-ND
2	Standoffs	1" Standoffs
1	Standoff	2" Standoff
2	Screws	⅜" 6-32 Screws
3	Bearing Flats	¼ in. 276-2179
6	Bearing Rivets	¼ in. 276-2215
1	Motor	2 Wire 393
8	Shaft collar	276-2010
1	Shaft	3 in. 276-2011
1	Shaft	12 in. 276-1149

2	Wheels	4 in.
1	Wheel	2.75 in.
1	Nylon Spacer	½ in. x 1 in. 275-1066
2	Zip Ties	8 in.

Design Brief

Client: Skiddles International

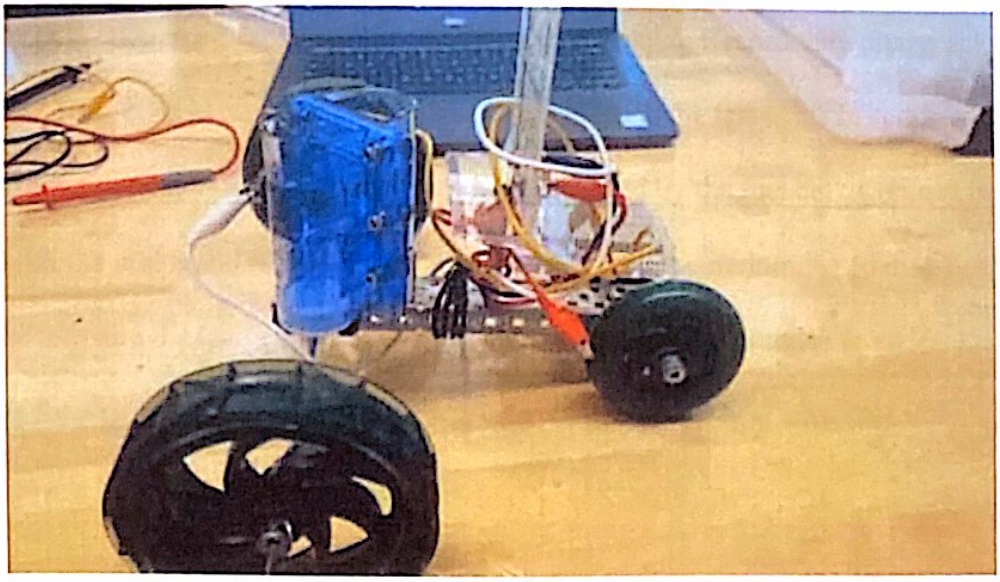
Target Consumer: Car Drivers

Designer(s): Jaidah Morales, Nicole Posada, Keyur Rana

Problem Statement: With the depletion of global resources, other energy sources are needed to power common transportation methods.

Design Statement: Build a model of a Hydrogen Fuel Cell Car utilizing various energy resources to supply power to the car.

Hydrogen Fuel Cell Car



Constraints:

1. Use VEX parts to build the model
2. Use Fuel Cell
3. Include Solar Panel to charge the fuel cell

Procedure:

First, measure the voltage that is produced by the solar panel using a light source 8 inches away. Repeat for the current produced. Find the theoretical power produced if the voltage and the current were to be stable. Next connect the motor directly to the terminals of the solar panel and shine a light source 8 inches away and observe if the vehicle moves. Measure the load voltage of the vehicle using multimeter by connecting test leads to the solar module terminals. Do the same thing to find the current. Calculate the power delivered by the solar module when it is loaded by a motor with wheels off the ground. Charge the fuel cell using the solar panel or a DC power supply. Make sure not to go over 500 mA. Connect the fuel cell to the motor and check if there is enough power to turn the wheels on the ground. Record the voltage value of the fuel cell. Set 10 A current on the multimeter and then connect the test leads in series with the fuel cell. Record the current value. Calculate the power delivered by the fuel cell. Connect two AAA batteries with the motor and record the voltage produced. Set the multimeter to measure 10 A current and measure the load current. Calculate the load power for batteries in series. Do the same thing for a parallel circuit. Measure the load voltage and the load current. Lastly, calculate the Load power for batteries in parallel.

ISSUES:

Difficulties were encountered with the lighting source and insufficient power for the solar panel to power the fuel cell. A power supply was substituted for the solar cell to charge the hydrogen fuel cell to power the motor. Although the directions instructed not to exceed the limit of 500 mA, about two amps were necessary to properly charge the cell. It was acknowledged that the longer the cell was left to charge the more power would be supplied to the motor. Initially, the motor was slow because the cell had only charged for 5 minutes, but when it charged for 10 the wheel spun much faster. Another problem arose with the wiring of the breadboard. One of the wire did not properly connect within the breadboard which severed the connection of the power from the cell to the motor. A replacement wire was needed to secure the connection.

Conclusion:

1. **Using the measurements you made, compare and relate the four options you explored. Was the car best powered by a single fuel cell, a single solar module, two AAA batteries in series, or two AAA batteries in parallel?**

- The car was best powered by the AAA batteries in series because there was more voltage being supplied to the motor. When using the solar module and the single fuel cell there was either not enough light or power to produce a fast-moving motor. When the AAA batteries were used, there was an immediate secure connection that allowed more voltage and speed.

2. **Did voltage, current, or power best describe the suitability of a power source?**

- Power best described the suitability of the power source. Here voltage represents the pressure that generates current to flow. Current is dependent on the voltage and does not describe the amount of time the power source will last or its efficiency. The amount of work that was necessary for the expected outcome was encompassed in the values of power.

3. **If you had many solar modules, how many of them would be needed to get the same performance from the car as the performance observed with two AAA batteries? Describe or sketch how you would connect the solar modules in terms of parallel and series circuits.**

- If we had many solar modules and were to create the circuit in series to perform same as with two AAA batteries, we would need about 12 solar modules. This could be derived from calculating the power of the solar module and the batteries. Then dividing the power of batteries by the solar module. If wired in parallel we would need about two solar panels at most.

4. **If you had many fuel cells, how many of them would be needed to get the same performance from the car as the performance observed with two AAA batteries? Describe or sketch how you would connect the fuel cells in terms of parallel and series circuits.**

- If we had many fuel cells, we would need about 8-9 solar panels in parallel to make it perform same as the two AAA batteries. In series, we would need 2-3 fuel cells to make because they last longer and are bit powerful.

5. **Describe and defend a system that you believe would best use a solar hydrogen system to meet the needs of an average driver.**

- An average driver would require an abundant amount of fuel to power their car due to daily commutes and long trips. A solar hydrogen system in a car would be efficient if the solar panel is placed at the top or back of the car where the most sunlight can be stored. The energy from this sunlight can be stored in the car battery for nights of days without sunlight. The fuel cell could be placed on the bottom of the car to ensure the water produced does not interfere with any of the motor or wires internally.

6. **How does a photovoltaic cell work? Record the source of your information.**

- A photovoltaic cell works through being made of semiconductor materials such as Silicon and having a wafer of this material used as an electric field. As light reaches the cell, electrons are knocked loose from the atoms in the material. If conductors are attached to both the positive and negative sides of the cell, an electric circuit forms. Thus allowing for electrons to be captured as current, forming electricity.
- https://science.nasa.gov/science-news/science-at-nasa/2002/solarcells

7. **Detail how electrolysis separates hydrogen and oxygen. How is electricity produced as the fuel cell allows the hydrogen to reunite in a bond with oxygen? Record the source of your information.**

- Water molecules consist of two positive hydrogen atoms and one negative oxygen atom. Electrolysis splits this water molecules into separate molecules with the use of current. The electricity produced by the current causes positive anodes to attach to negative oxygen atoms and negative cathodes will attach to positive hydrogen atoms. In a

hydrogen fuel cell, hydrogen enters through the first membrane and is charged through electricity as oxygen enters through the other membrane and is charged. The charging process that occurs between the cell allows the hydrogen atoms to seek out the oxygen atoms and bond, two hydrogens to each oxygen. The product is H_20 which is water. The visual representation is seen through the water being filtered to the top part of the cell as the current charges the water as seen in the bubbles produced during the process.

- https://www.hydrogenics.com/technology-resources/hydrogen-technology/fuel-cells/

Calculations

5.

$$Maximum\ Theoretical\ Power = V_{OC} * I_{SC} = 2.43\ V * 3.4\ mA = 8.26\ W$$

9.

$$P = Load\ Power = IV = 0.096\ mA * 0.95\ V = 0.091\ W$$

14.

$$P = Load\ Power = IV = 0.134\ mA\ x\ 1.13\ V = 151\ mW$$

18.

$$P = Load\ Power = IV = 0.32\ mA\ x\ 3.12\ V = 1.06\ W$$

22.

$$P = Load\ Power = IV = 0.13\ mA\ x\ 1.53\ V = 199\ mW$$