Project 1.3.2 Solar Hydrogen Vehicle

Principles of Engineering, 6th period
Development Cycle - October 31, 2019 - November 18, 2019
By: Oleg Bychenkov, Joey Huang, Sai Kolla, Tyler Trinh

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Design Brief

Client
Tesla Motors

Designers
Oleg Bychenkov, Joey Huang, Sai Kolla, Tyler Trinh

Problem Statement
Vehicles that use gasoline are harmful for the environment because they pollute the air, the energy source is not renewable, and costs a lot of money to harvest.

Design Statement
Design and build a vehicle that is able to hold the solar module or hydrogen fuel cell securely to make a recommendation to Tesla so they gain insight in regards to the capabilities of the two energy sources.

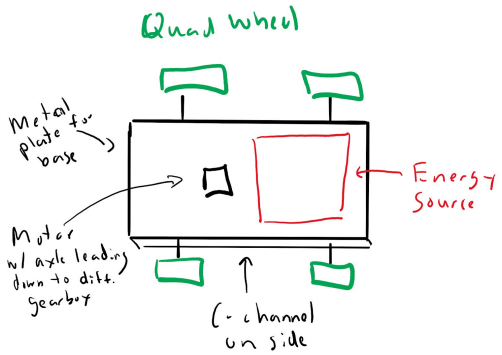
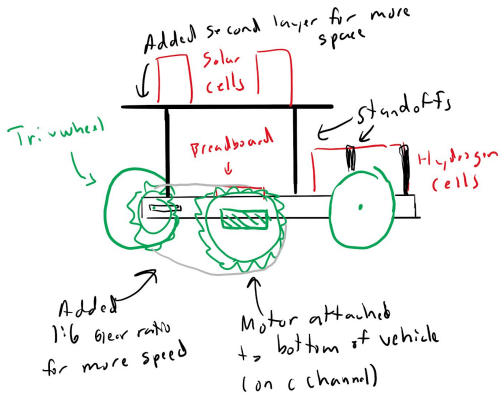
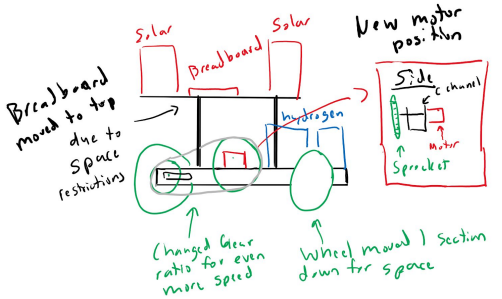
Constraints

- The vehicle needs to be 5x12 inches.
- Only vex or fisher tek parts to build the car. Can only use a vex motor.
- Only allowed to use up to 2 hydrogen cells or up to 2 solar cells at the same time.

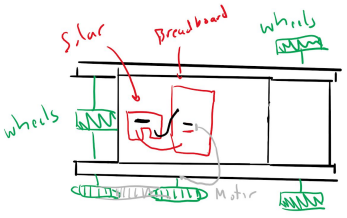
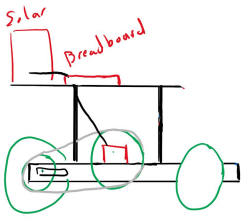
Deliverables

- Working vehicle prototype to demonstrate to the client.
- Electronic document detailing the design process and evaluations.
- Team spreadsheet with team norms, consequences, and responsibilities.

Initial design solution (sketches with signatures)

Date & Electronic signatures	Image	Explanation of change in design
Date: 11/18/19 Electronic Signatures: Sai Kolla Oleg Bychenkov Joey Huang Tyler Trinh		Our initial design was a quad wheel vehicle, with the motor leading down under the base and into a differential gearbox
Date: 11/18/19 Electronic Signatures: Joey Huang Sai Kolla Oleg Bychenkov Tyler Trinh		Our new design featured a tri wheel in order to try and reduce weight. Additionally, due to size constraints, we added a second layer on top in order to allow for more space to mount the cells. Finally, we moved the motor to the side in order to have space for the breadboard
Date: 11/18/19 Electronic Signatures: Joey Huang Oleg Bychenkov Sai Kolla Tyler Trinh		Our final design featured a change in motor position due linear movement of the axle as it was only anchored through 1 point. The additionally c-channel allowed the motor to be anchored through 2 sides and thus have less friction. The breadboard was moved up due to spacing.

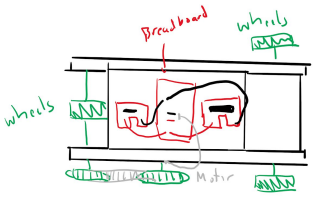
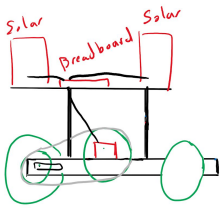
Testing Summary Table (One Solar)

Date & Electronic signatures	Image	Explanation
Date: 11/18/19 *Oleg Bychenkov* *Joey Huang* *Tyler Trinh* *Sai Kolla*	Top Down View 	For one and two solar cells, we had to put the cells on a platform that we built above the car because the "sun" would not be able to hit them in all directions. We also had problems placing them on the base without it touching any of the gears or wheels. Because we put the cells on the top, we also had to place the breadboard there because it would be easier to connect the cells with the motor since we only had short wires.
Date: 11/18/19 *Oleg Bychenkov* *Joey Huang* *Tyler Trinh* *Sai Kolla*	Side View 	Additionally, we placed stand-offs with screws and spacers attached. These would be used to keep the solar panels in place. All you have to do is slide in the solar panel into the raised screw and it's safe to go,

Variable	Value	Calculations
F	0.5 N	N/A
t	4.6 sec	N/A
V	2.8 V	N/A
I	0.18 A	N/A

d	1m	N/A
Speed	0.22 m/sec	Speed = d/t Speed = 1m / 4.6 sec Speed = 0.22 m/sec
w	0.5 J	w = d * F w = 1m * 0.5N w = 0.5 J
P_{out}	0.109 Watts	P_{out}= w / t P_{out}= 0.5 J / 4.6 sec P_{out}=0.109 Watts
P_{in}	0.504 Watts	P_{in}= V * I P_{in}=2.8 V * 0.18 A P_{in}=0.504 Watts
Eff	21.6 %	Eff = (P_{out} / P_{in}) * 100% Eff = (0.109 Watts / 0.504 Watts) * 100% Eff = 21.6%

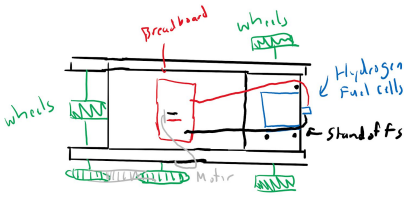
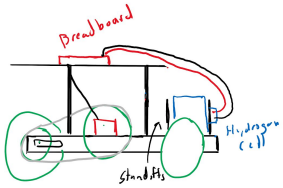
Testing Summary Table (2 Solar in Parallel)

Date & Electronic signatures	Image	Explanation of change in design
Date: 11/18/19 Electronic Signatures: Sai Kolla Oleg Bychenkov Joey Huang Tyler Trinh	Top Down View  	The design is similar to that of the one solar cell design, but there is a second solar cell facing the same direction next to it. This configuration allows the panels to capture more light and produce more energy than one solar cell.
Date: 11/18/19 Electronic Signatures: Sai Kolla Oleg Bychenkov Joey Huang Tyler Trinh	Side View  	Both of these cells would be connected to the breadboard in a parallel circuit. We wanted the voltage to be consistent, which is why we chose to use a parallel circuit compared to a series circuit.

Variable	Value	Calculations
F	1.5 N	N/A
t	2.82 sec	N/A
V	2.7 V	N/A
I	0.2 A	N/A
d	1m	N/A
Speed	0.35 m/sec	Speed = d/t Speed = 1m / 2.82 sec

		Speed = 0.35 m/sec
w	1.5 J	w = d * F w = 1 m * 1.5 N w = 1.5 J
P_{out}	0.53 watts	P_{out}= w / t P_{out}= 1.5 J / 2.82 sec P_{out}= 0.53 watts
P_{in}	0.54 watts	P_{in}= V * I P_{in}= 2.7 V * 0.2 A P_{in}= 0.54 watts
Eff	98.15%	Eff = (P_{out} / P_{in}) * 100% Eff = (0.53 watts / 0.54 watts) * 100% Eff = 98.15%

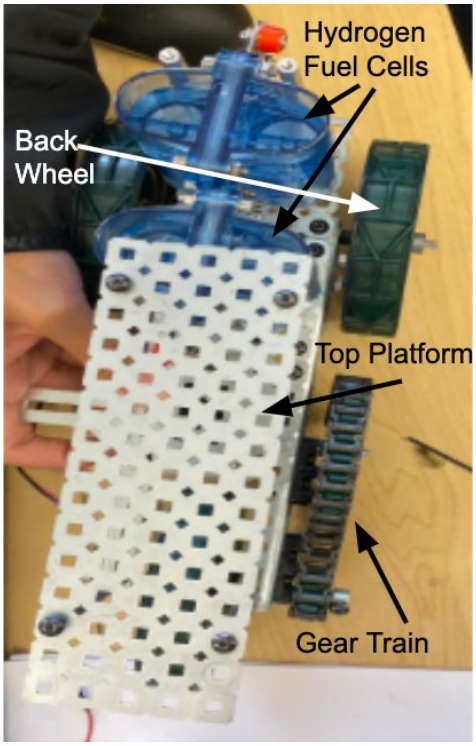
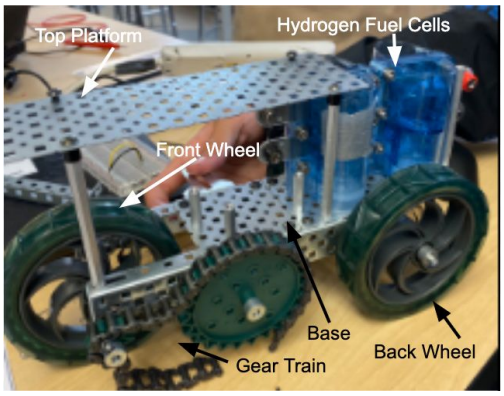
Testing Summary Table (One Hydrogen)

Date & Electronic signatures	Image	Explanation of change in design
Date: 11/18/19 Electronic Signatures: Sai Kolla Oleg Bychenkov Joey Huang Tyler Trinh	Top Down View  	The platform is not used while running on hydrogen cells because there is enough space to put them on the base. The Breadboard will also be on the base so we can use shorter wires to connect the hydrogen cells with the motor.
Date: 11/18/19 Electronic Signatures: Sai Kolla Oleg Bychenkov Joey Huang Tyler Trinh	Side View  	One modification was adding stand-offs to keep the cells in place. This made it so that it would not only slide off, but also not touch the wheels, making the car move slower.

Variable	Value	Calculations
F	0.25 N	N/A
t	8.9 sec	N/A
V	0.7 V	N/A
I	0.147 A	N/A
d	1m	N/A
Speed	0.112 m/s	Speed = d/t Speed = 1m / 8.9 sec Speed = 0.112 m/s

w	0.25J	w = d * F w = 1m * 0.25N w = 0.25J
P_{out}	0.0281 watts	P_{out}= w / t P_{out}= 0.25 J / 8.9 Sec P_{out}= 0.0281 watts
P_{in}	0.1029 watts	P_{in}= V * I P_{in}=0.7V * 0.147A P_{in}=0.1029 watts
Eff	27.31 %	Eff = (P_{out} / P_{in}) * 100% Eff= (0.0281 watts / 0.1029 watts) * 100% Eff = 27.31%

Testing Summary Table (2 Hydrogen in Series)

Date & Electronic signatures	Image	Explanation of change in design
Date: Electronic Signatures: Sai Kolla Oleg Bychenkov Joey Huang Tyler Trinh	Top Down View 	This design is very similar to the one hydrogen in series, but with an additional hydrogen fuel cell on the base. Also, when we are configuring it on the breadboard we used a series circuit, which is different from the parallel circuit that we incorporated while using the two solar cell configuration.
Date: Electronic Signatures: Sai Kolla Oleg Bychenkov Joey Huang Tyler Trinh	Side View 	As you can see from the image, the cells are facing different ways. This is to optimize space, so that they don't face each other. If they faced each other, we would have to space them further apart. This positioning allowed us to minimize the amount of materials on our build, while also allowing use to use 2 cells at once.

Variable	Value	Calculations
F	0.6 N	N/A
t	5.5 sec	N/A
V	1.7V	N/A
I	0.145A	N/A
d	1m	N/A
Speed	0.182 m/s	Speed = d/t Speed = 1m/5.5 sec Speed = 0.182 m/s
w	0.6 J	w = d * F w = 1m * 0.6N w = 0.6J
P_{out}	0.1091 watts	P_{out}= w / t P_{out}= 0.6J / 5.5 sec P_{out}= 0.1091 watts
P_{in}	0.2465 watts	P_{in}= V * I P_{in}= 1.7V * 0.145A P_{in}= 0.2465 watts
Eff	44.3%	Eff = (P_{out} / P_{in}) * 100% Eff = (0.1091 watts / 0.2465 watts) * 100% Eff = 44.3%

Power Source Evaluation + Summary Paragraph

In relation to both force and distance, a configuration with two solar panels powered through a parallel circuit is superior to the other options. The configuration was able to output 1.5 newtons of force, and travelled a one meter distance in 2.82 seconds, and performs at an astonishing 98.15% efficiency when supplied 0.54 watts of power. Efficiency is crucial in determining the best energy source because it is a measure of how well the energy source is able to output power compared to the power input given. Two hydrogen cells placed in a series circuit travelled a one meter distance at the relatively similar locations, meaning the friction and other outside factors were similar, in 5.5 seconds, double the time it took two solar panels, and output only 0.6 newtons of force. One solar panel and one hydrogen cell perform worse than their counterparts because they simply do not output enough power to be efficient. A parallel circuit is also better in this scenario because it ensures equal power flow to both of the solar panels, which allows both of them to achieve their full potential, while a series circuit would cause one panel to receive more power than the other. This circuit also makes the car safer and more consistent, because if one solar panel were to break, then the other will continue receiving power which allows the car to continue moving, even if it is at a slower pace it is still better than the car completely shutting down.

An issue with solar panels is that they rely heavily on the angle the light hits them. The results of the tests are caused by direct impact of rays on the panel, and it is unrealistic to assume that that will always be the case in the real world. Because of this, solar panels may be less consistent depending on various circumstances such as location or time of the day, which is not an issue with hydrogen cells since they do not rely on an external power source. Nevertheless, solar panels can be small, and still achieve a significant impact, which means that they are far easier to install onto a vehicle than the large hydrogen cells, and will not slow the vehicle down. Solar panels are often installed on the roofs of houses, and this same concept can be applied to cars with ease. Despite the solar panels being exposed on the roof of the car, they are usually water and weatherproof, so there's no danger to them being located in this position.

We tried our best to minimize our errors by performing the tests in the same location using the same general configuration. Nevertheless, there are still errors present because a 98.15% efficiency is possible, but is highly unlikely. We also compared two solar panels that are in parallel versus two hydrogen panels that are in series, which is not a completely fair comparison due to the benefits of the parallel configuration. With all the errors in mind, two solar panels in a parallel circuit are still the most beneficial because they are easy to implement while allowing a vehicle to achieve a significant speed with a decent force output.