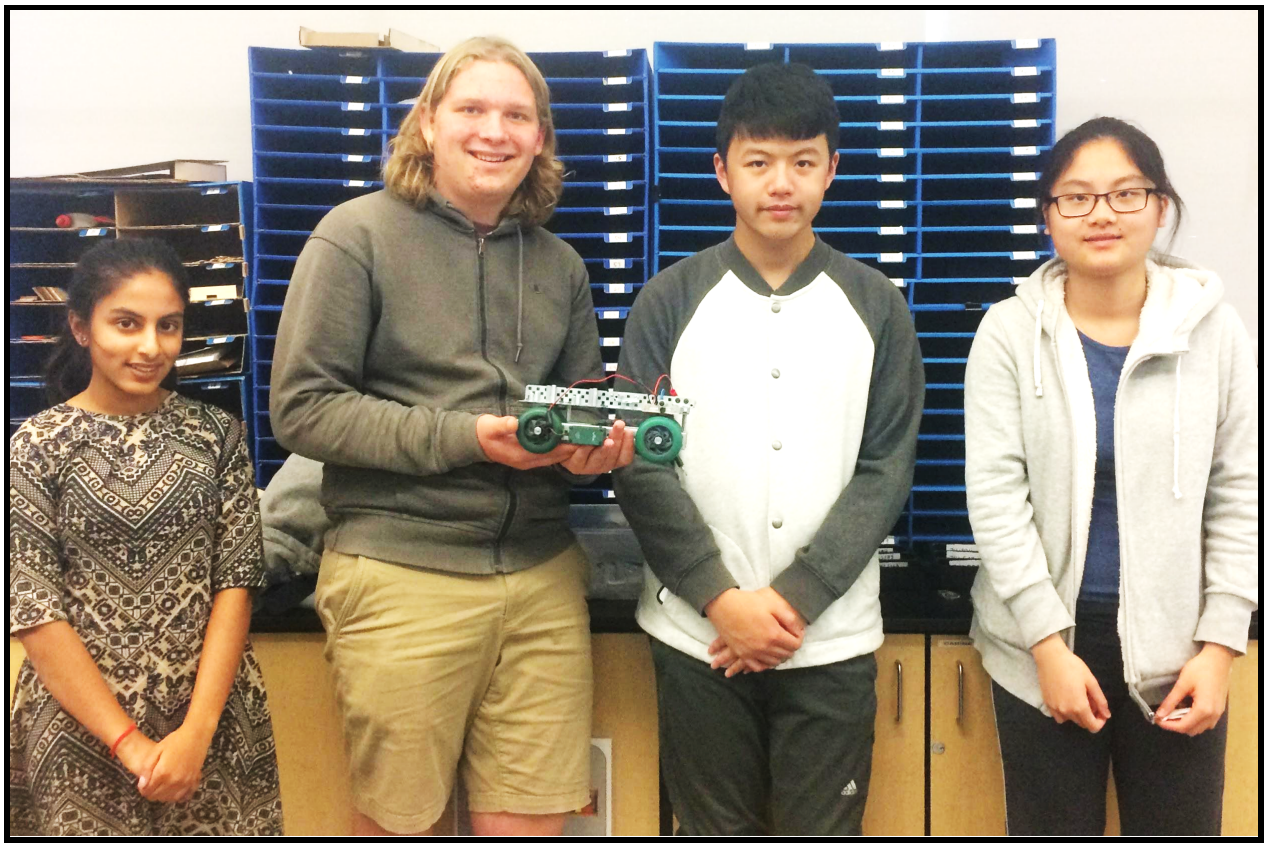
Project 1.3.2

Solar Hydrogen Vehicle



Tesla Model HTW

Connor Meece, Ethan Lau, Khushi Gupta, Antonia Leung

November 1, 2018 to November 16, 2018

Principles of Engineering

Period 7

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Design Brief

Client/Target Consumer: Tesla Incorporated

Designers: Connor Meece, Ethan Lau, Khushi Gupta, Antonia Leung

Problem Statement: There exists a need for a vehicle that can be powered with solar or hydrogen fuel cells.

Design Statement: We hope to make a vehicle whose power source can easily be changed between both solar and hydrogen fuel cells, to maximize the efficiency of our design.

Criteria and Constraints: We are constrained to the length and width dimensions of 5” By 12” and the building materials offered by the teacher. We have a limited in the amount of time to develop the product, having the dates of November 1, 2018 through November 16, 2018 to work on the project.

Deliverables:
Team: Working Prototype and Report that includes: Title Page, Table of Contents, Design Brief, Initial Vehicle Design Sketch with labels and paragraph, Testing summary tables with calculations, Power Source Evaluation and Testing Summary Paragraph, and a Reference list of sources.

Individual: Design brief notes & team norms, Project Log, Brainstorming sketches, Table of measurements, Calculations, Conclusion questions

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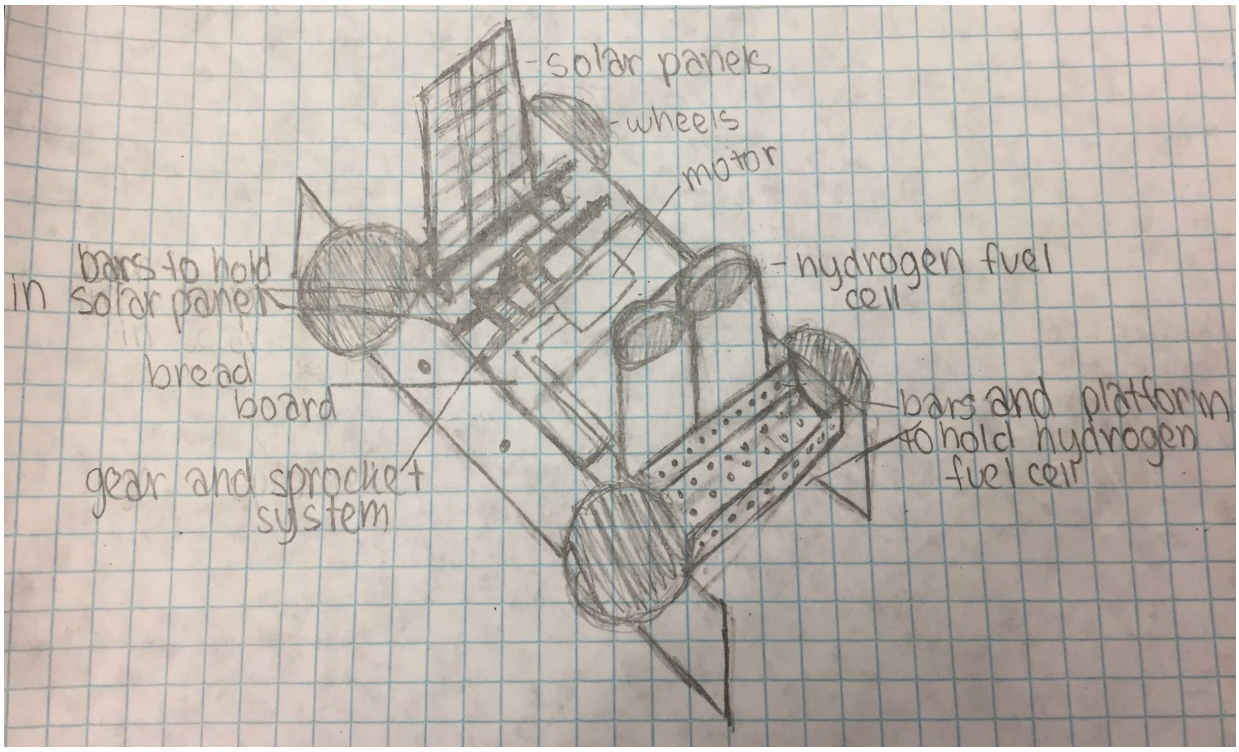
Initial Design Solution



For our initial design solution, we had wanted to create a vehicle with only one level. In that level, the breadboard would rest in the center. On one side would be the mechanical mounts for the hydrogen fuel cell, and on the other side would be the mounts for the solar cells. The breadboard would be wedged in between the space for the solar panels and the hydrogen fuel cells. We had also planned to use four wheel, as well as only a back wheel drive for stability and less gears needed to connect both wheels to the gear and sprocket system, which also allows for less weight and friction. Some modifications we may need to make is most likely adding in a way a second level if everything does not fit on one level. Another modification would be changing the gears ratios to make one smaller or larger on the bottom, which are planned to move the wheels, to something that has less friction if the power sources are unable to provide enough force.

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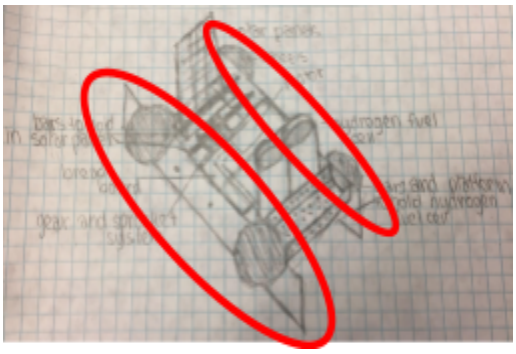
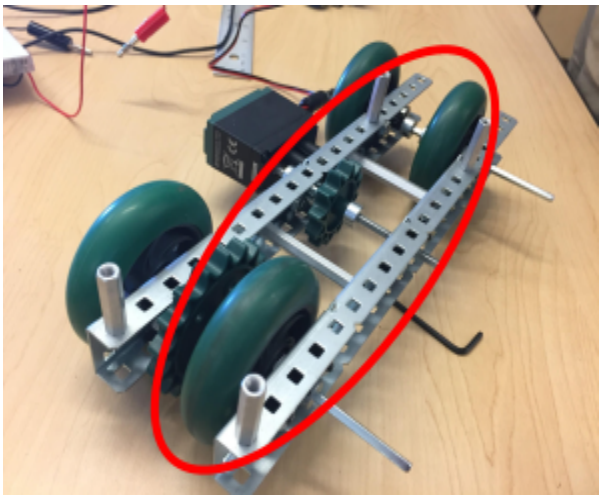
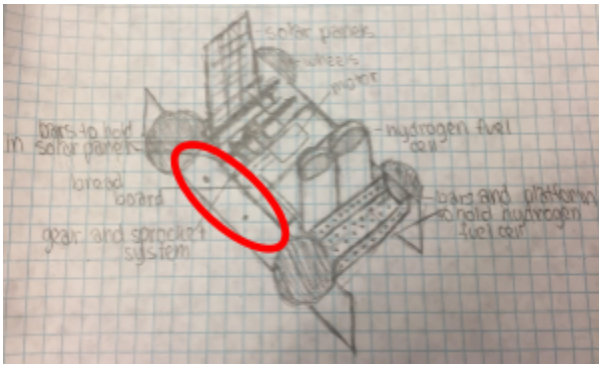
Testing Summary

Modifications

Modification	Explanation
 → 	On the original design, the sets of wheels on either side of the vehicle were to be mounted outside the chassis. However, this left a lot of open space inside and made the design's width more than five inches. An obvious solution was to shift one set inside the chassis.
	In our original design, we intended to mount the various power sources on the same c-channels as the wheels and motor are. However we found that this was not enough space for what needed to be mounted, so we added two pieces of metal above the two bottom channels for mounting space.

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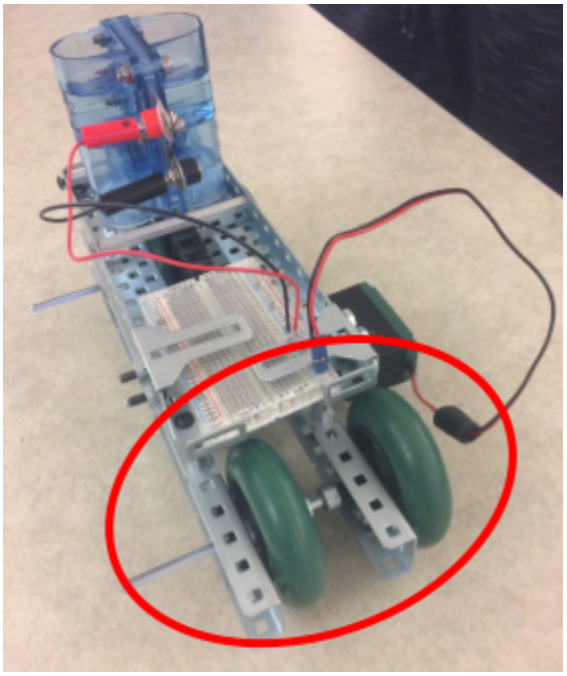
→ 	

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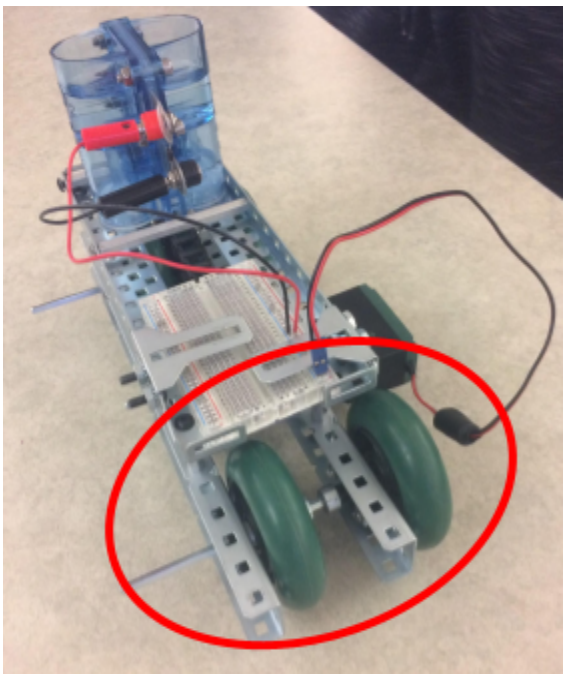

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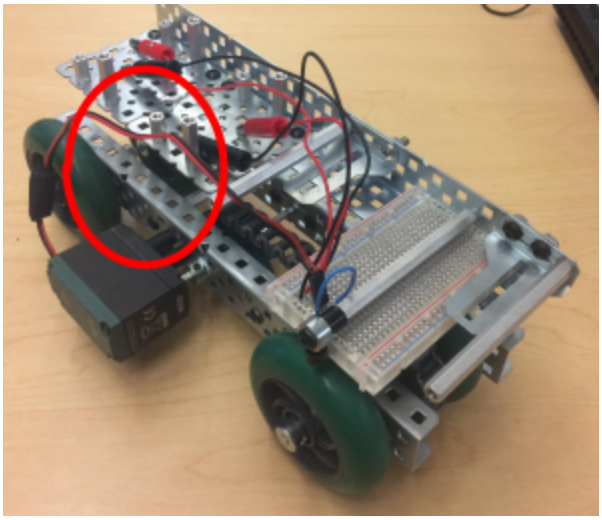

We subtracted the second piece of metal that constituted the second level. This decision was made because the components were wider than the channel created for mounting.

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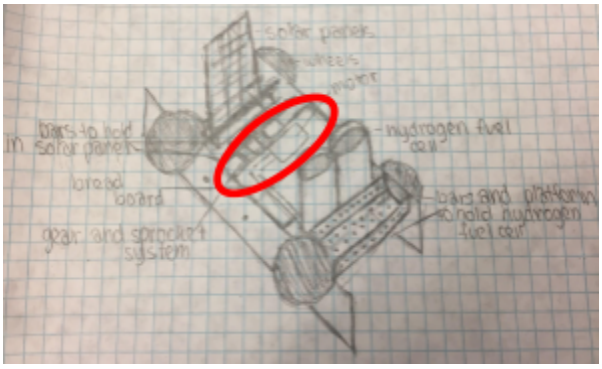

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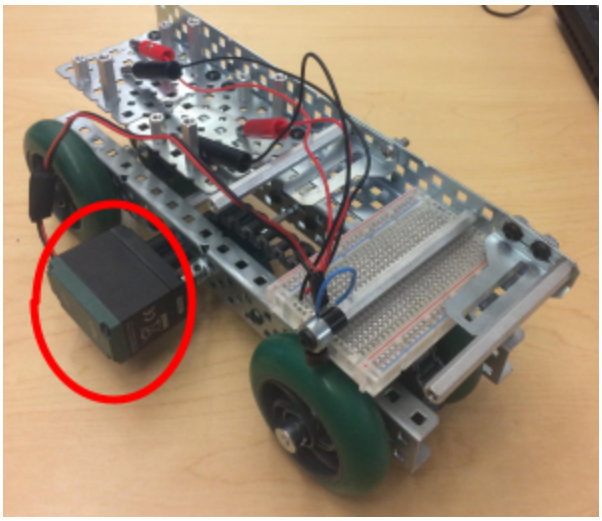

We had changed the location of the motor as in the drawing it is not to scale, making it impractical to put it on the breadboard since it would cover most of it. So we decided to move the motor to the side of the car, and this modification, combined with the other previously mentioned modifications allowed us to make space for the motor and still remain within the 5 inch limit.

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Data Table

	F(N)	d(m)	t(sec)	V(volts)	I(A)	Electric Power	Mechanical Power
1 hydrogen cell	1.25 N	1m	46.28 s	0.74V	0.10A	0.074W	0.027W
2 hydrogen cells (parallel)	1.50 N	1m	54.22 s	0.76V	0.16A	0.1222W	0.028W
1 solar cell	1.20 N	1m	11.87 s	2.56V	.16A	0.4096W	0.1011W
2 solar cells (series)	1.75 N	1m	6.50s	4.67V	.15A	0.7005W	0.2692W

Calculations

Electrical Power:

$P = IV$

$P_{1\,Hydrogen} = IV = 0.10A \times 0.74V = 0.074W$

$P_{2\,Hydrogen} = IV = 0.16A \times 0.76V = .1222W$

$P_{1\,Solar} = IV = 0.16A \times 2.56V = 0.4096W$

$P_{2\,Solar} = IV = 0.15A \times 4.67V = .7005W$

Mechanical Power:

$P = \frac{Fd}{t}$

$P_{1\,Hydrogen} = \frac{Fd}{t} = \frac{(1.25N)(1m)}{46.28s} = 0.027W$

$P_{2\,Hydrogen} = \frac{Fd}{t} = \frac{(1.50N)(1m)}{54.22s} = 0.028W$

$P_{1\,Solar} = \frac{Fd}{t} = \frac{(1.20N)(1m)}{11.87s} = .1011W$

$P_{2\,Solar} = \frac{Fd}{t} = \frac{(1.75N)(1m)}{6.5s} = .2692W$

Weight: 808g

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Speed:

$$Speed = \frac{distance}{time}$$

$$Speed_{1\ Hydrogen} = \frac{distance}{time} = \frac{1m}{46.28s} = .0216\frac{m}{s}$$

$$Speed_{2\ Hydrogen} = \frac{distance}{time} = \frac{1m}{54.22s} = .0184\frac{m}{s}$$

$$Speed_{1\ Solar} = \frac{distance}{time} = \frac{1m}{11.87s} = .0842\frac{m}{s}$$

$$Speed_{2\ Solar} = \frac{distance}{time} = \frac{1m}{6.50s} = .1538\frac{m}{s}$$

Efficiency:

$$Eff = \frac{P_{out}}{P_{in}} \times 100\%$$

$$Eff_{1\ Hydrogen} = \frac{P_{out}}{P_{in}} \times 100\% = \frac{0.027W}{0.074W} \times 100\% = 36.49\%$$

$$Eff_{2\ Hydrogen} = \frac{P_{out}}{P_{in}} \times 100\% = \frac{.028W}{.1222W} \times 100\% = 22.91\%$$

$$Eff_{1\ Solar} = \frac{P_{out}}{P_{in}} \times 100\% = \frac{.1011W}{.4096W} \times 100\% = 24.68\%$$

$$Eff_{2\ Solar} = \frac{P_{out}}{P_{in}} \times 100\% = \frac{.2692W}{.7005W} \times 100\% = 48.49\%$$

Images Describing Our Design

Views Describing Power Configurations
Hydrogen Fuel Cells

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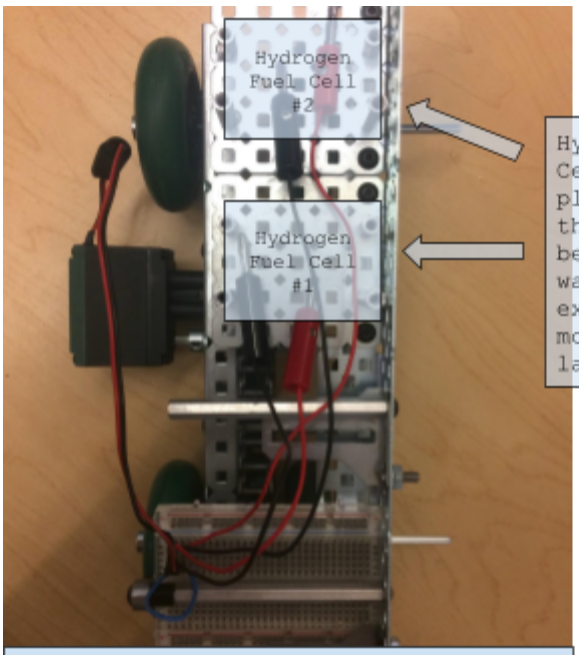
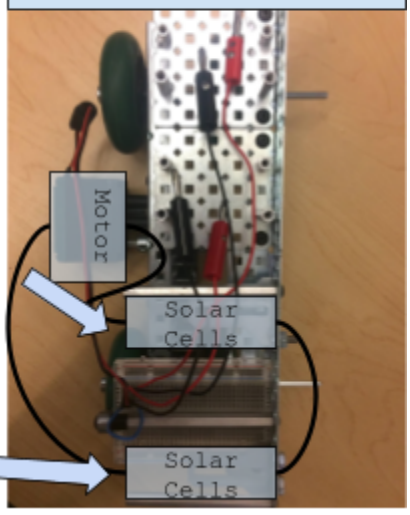


Parallel

Solar Cells

The Solar Panels are placed where they are because the large area towards the back of the vehicle was occupied by hydrogen fuel cells, and we wanted to not worry about installing and uninstalling different mounts. Additionally, they are mounted facing opposite each other so that they did not interfere with the amount of mock-sunlight the other received.

Series



Side View

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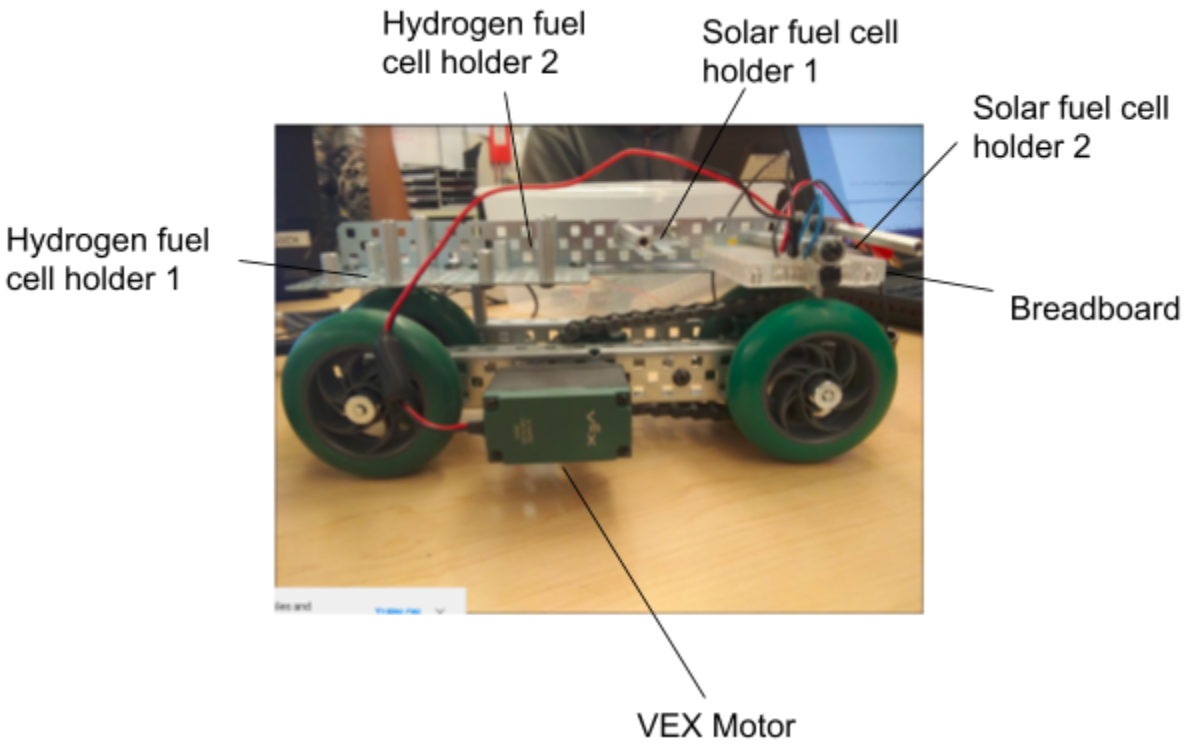
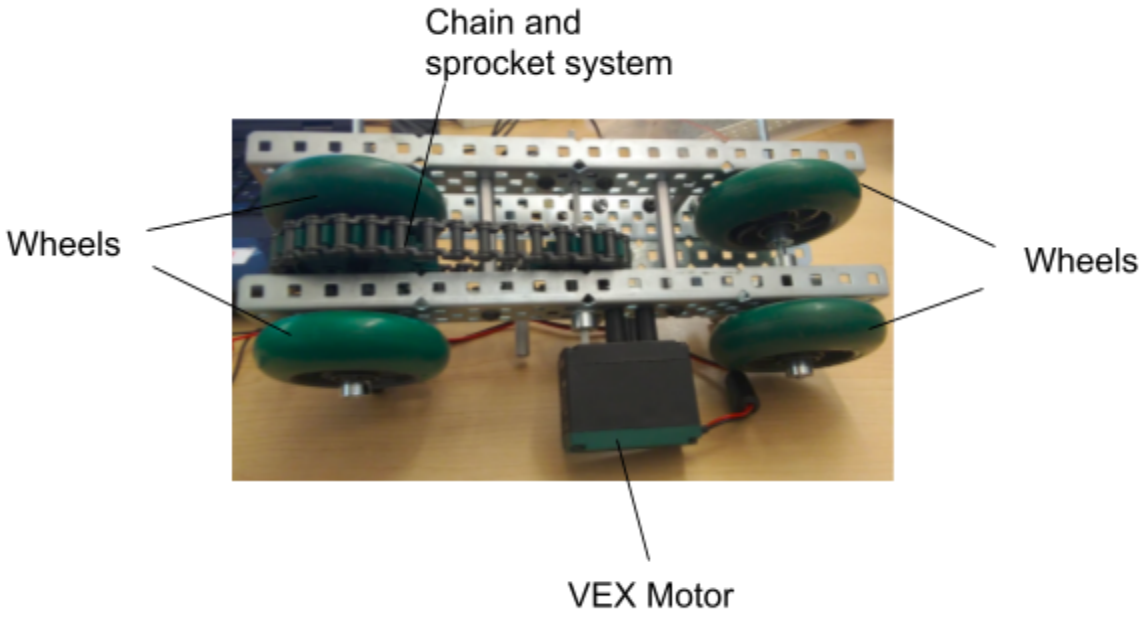


Bottom View



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Power Source Evaluation

After conducting four tests (one with 1 hydrogen fuel cell, one with 2 hydrogen fuel cell placed in a parallel circuit, one with 1 solar fuel cell and one with 2 solar fuel cell placed in series), the results proved that the best way to power a vehicle would be two solar cells placed in series to power the motor. The configuration provides both the greatest speed as well as the greatest efficiency for the vehicle, obtaining values of 0.1538 m/s and 48.49% respectively. The efficiency for two solar cells is 12% greater than our second best highest efficiency, being the one hydrogen fuel cell, making it largely greater. Solar panels can be placed on top of the vehicle as the roof in a scaled-up version of the vehicle. However, there is also the problem of needing power even when there is no sunlight, such as when it is night time. This would require the car to have a battery which stores solar energy obtained from daytime, so the vehicle would still be able to run at night.

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