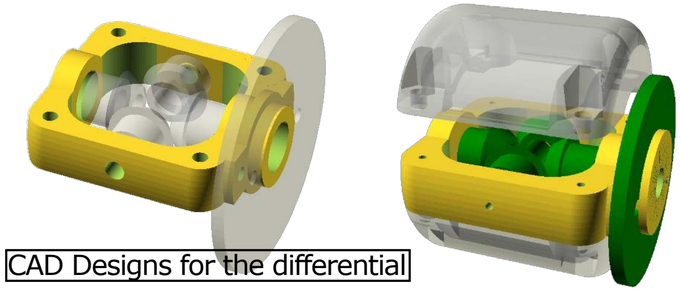
HUMPTY 05

DESIGN AND CONSTRUCTION

The chassis for Humpty 05 is built from lengths of lightweight carbon fiber and aluminium arrow shafts glued together and held with blocks of aluminium with holes drilled in them and grub screws. The body is made from 0.5mm folded PVC plastic taped onto the drink carton that has to be carried.

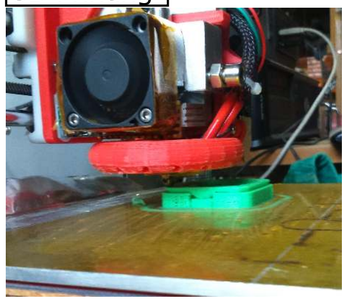
Initial designs were drawn on paper and a model made from the construction toy "Meccano." Scale drawings were then made using a vector drawing program that could be used to make each part. Most of the aluminium parts were solid blocks of aluminium in which I drilled holes using a milling machine. I then put them in a lathe and turned them down to reduce excess weight. The parts were then assembled and adjusted until everything was accurate and friction was low. This took several goes and some parts had to be remade or used elsewhere in a slightly different way than originally intended.

DIFFERENTIAL



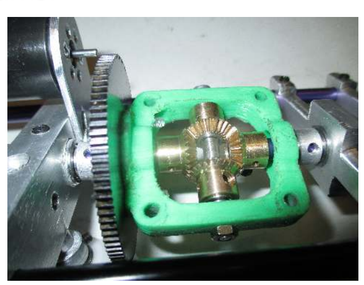
CAD Designs for the differential

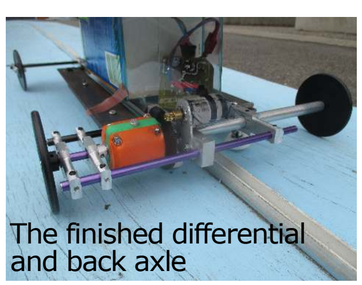
3D Printing



One of the biggest issues with a model solar car is wheel slip on take-off. This can be lessened by fitting a tyre on the driving wheel, although doing this can severely affect the car's rolling resistance. Another alternative is to drive more than one wheel, in this case the whole back axle. The only downside to driving multiple wheels is that when turning a corner, one wheel must do more revolutions than the other wheel.

To allow the wheels to rotate at different speeds while still driving both of them, Humpty 05 uses a differential as found in full size cars. The differential found in Humpty 05 consists of a 3D printed casing with a spur gear driven by the motor mounted on it with four commercial brass bevel gears mounted inside. There were several different versions for each part to be 3D printed and they were all designed with 3D CAD software. Eventually, all of these designs were refined and edited until the final design was made. The 3D printed enclosure had to be machined down to increase accuracy and to keep everything parallel as the 3D printed parts did not print with 100% accuracy. After the design was printed for the first time I realised that I had not left enough material to be machined off accurately in the holes for the bearings and mounting points for the spur gear. This was fixed up in the CAD software and a second part printed. The bevel gears originally came with holes for a 5mm shaft, whereas I needed to use 6mm shafts, so the gears had to be drilled out. Out of curiosity, I weighed the completed differential. It weighs only 45 grams.



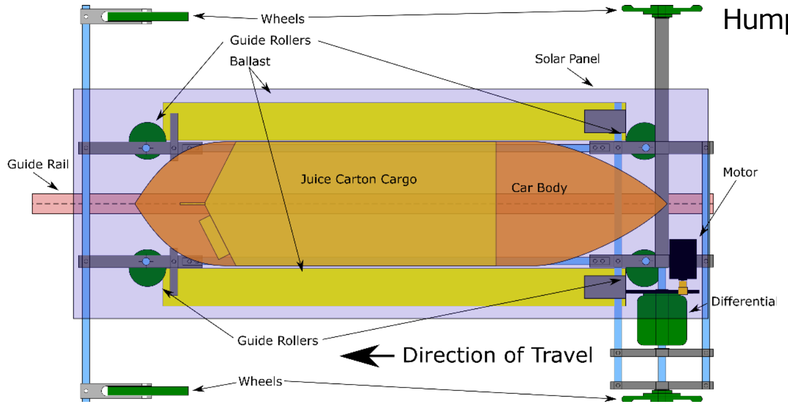


The finished differential and back axle

TESTING

The steering mechanism on the front of the car is mounted offset to the axle to allow it to castor effectively. This has one drawback in that there is a high twisting force on the axle. To make sure that the axle would not break as soon as any load was put on it, a small test was performed by making a mock-up of the front axle and hanging weights where the wheels would go. This proved that the rods were around five times stronger than required.

Humpty 05 was given a test run around the track to check that everything was working properly and to work out what gear ratios to use. It was found that a gear ration of 9:100 was best for low light, 11:100 was best for medium light levels and 14:100 was best for high light levels. On a later test at the track, I found out that some of the screws and nuts holding the differential together came easily undone and stopped the car from running properly. This issue was fixed by doing two nuts up against each other to lock them on the thread.



Humpty 05 From Above

Humpty 05 Test Time For Blue Track

Pinion	Spur Gear	Sun (%)	Lap 1	Lap 2	Lap 3	Lap 4
9	100	20	20.01	16	15.5	
9	100	25 - 30	16.91	12.77	14.45	
9	100	30 - 40	16.1	12.8	11.8	
9	100	50 - 30	15.13	11.45	12.58	
11	100	10	23.96	19.37	17.09	
11	100	18	21.52	16.9	16.58	
11	100	40	15.8	11.8	10.6	
11	100	90	12.23	8.02	7.8	7.8
14	100	95	12	7.8	7.8	
20	100	90	13.2	8.3	7.8	7.7

GREENHOUSE RELEVANCE

Solar Panels are a renewable source of energy and they do not produce any greenhouse gasses once they have been manufactured. However, even though they are a good source of energy, solar panels are only useful when the sun is shining on them. This means that there needs to be some way of storing some of the energy that they produce, for example a battery or as in model solar cars, kinetic energy. Batteries may not be the best option for long term use as they wear out over time and are hard to make and dispose of properly in a way that is ecologically friendly.

References and Acknowledgements

- The Model Solar Car Design Guide.
- Thank you to Mr. Murphy and Richard Palmer for 3D printing the parts for the differential.
- Thank you to my parents for getting me to wherever I needed to be on time.
- Thank you to Box Hill High School for letting me test Humpty 05 on the track.

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