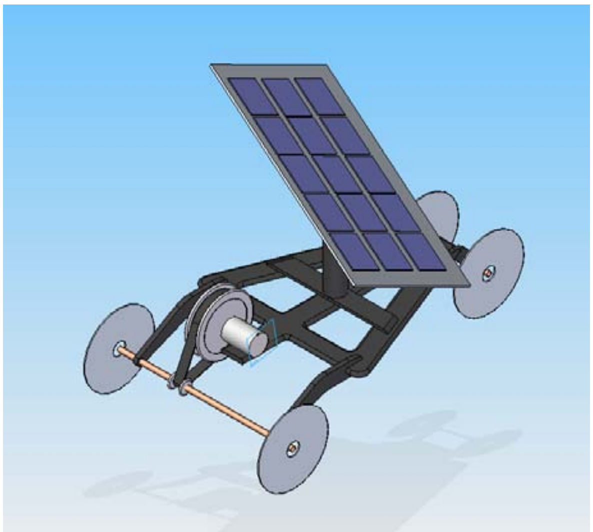
Solar International: SSV Design Report

Introduction

The main objective of this EE4 project is to design and build a small solar car which runs on solar power only and which is able to race against other SSV's. The car is evaluated on speed, originality, and innovation. The main goal in this design is speed, but we try to achieve this speed through design concepts which also are original and innovative. The main focus is the weight of the car. We build it as light as possible (there is a minimum was 750g, and we achieve 870g) while also trying to get the least amount of friction. If we combine this with an optimized gear ratio, we hope to achieve our goal of getting a fast car.

Design Concept



Picture 1 Solar car

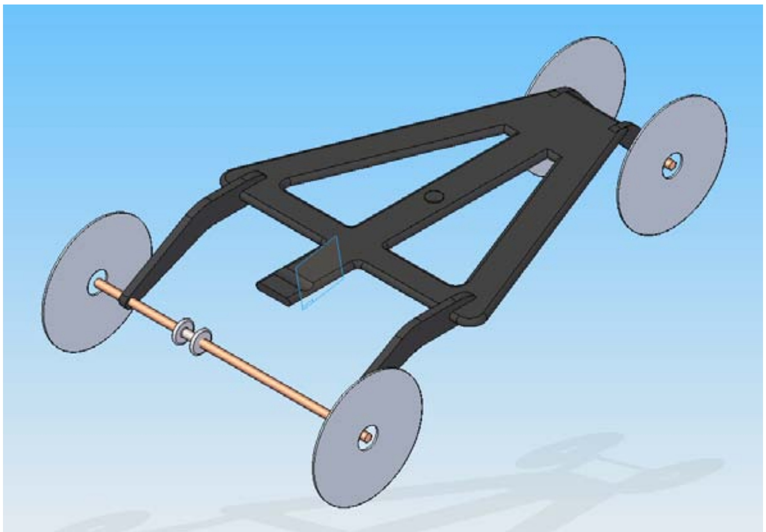
Chassis

In the chassis design we set two goals, first of all the chassis has to be sturdy enough to cope with the weight of the solar panel and the rest of the car. A second goal is to achieve this sturdiness with a design which is also very light.

The material we use is a polymer called polyoxymethylene, also known as Delrin. This material was chosen because it is both rigid and light. It is lighter than plexi-glass, and stronger than wood, which are the two materials you can find at the FABlab.

Another advantage of Delrin is that it's well suited for laser-cutting. This makes it possible to make a very accurate chassis design with the appropriate software and use a laser cutter to get the exact shape we want. It is very important to cut everything exactly because every part has to fit perfectly in the other.

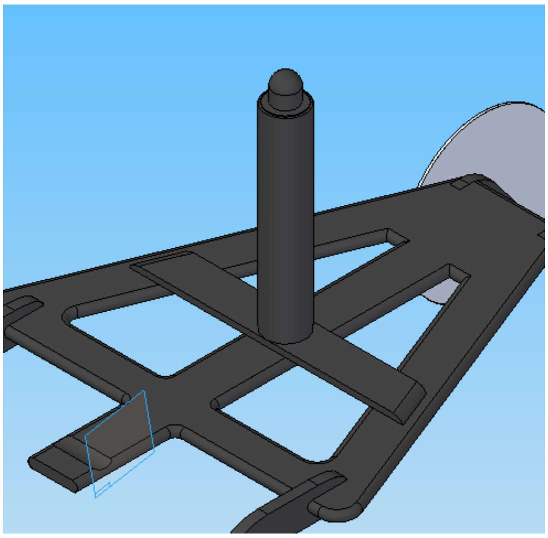
We opted for a triangular chassis, on which 4 wheels are mounted. A triangular chassis will give enough stability for a light car while weighing less than a rectangular chassis.



Picture 2 Chassis

The broadest side of the chassis will be the back side. This is because the motor needs to be attached here and additional space is required for the motor and associated hardware. The front side of the chassis will also be used to mount to wheels, but these wheels will be much closer together and will not be driven.

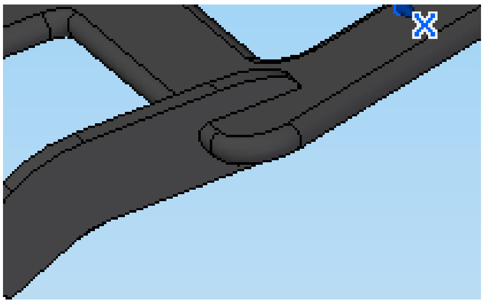
The solar panel is mounted somewhere in the middle of the chassis and is positioned in a way that there is equal weight distribution on all four wheels.
The mounting of the panel will be discussed later on.



Picture 3 vertical beam

Wheel holders and wheels

Four wheel holders are used to attach the wheels to the chassis. These wheel holders have slots which match slots that are made in the chassis. This way the wheel holders can be easily slid into place and then be glued to the chassis. The slots are also laser cut so we can position the wheels exactly where we want them. The holders are also made out of Delrin.



Picture 4 Slots

The wheels are attached to an axle made of steel. We do this because it is important that the wheelbase is strong enough. First, the idea was that the axle would rotate in the holes we made in the Delrin wheel holders because Delrin is known for its low friction coefficient with steel. However, comparing the values with the friction coefficient of bearings we realize that this friction coefficient is lower.

The friction coefficients of Delrin on steel are non-lubricated, but we assumed that we are not able to lubricate these enough to get a lower friction than the bearings.

Coefficient of friction in bearings	
	Coefficient of friction [-]
Slide bearing, hydrodynamic	0.003...0.04
Slide bearing, sinter bronze, oil lubricated	0.04...0.07
Slide bearings, solid bronze, grease lub	0.07...0.12
Polymer slide bearing, polyamide, dry	0.2...0.3
Polymer bearing, composite, dry	0.05...0.15
Ball bearings	0.001...0.0015
Roller bearings	0.0018
Needle bearings	0.0045
Air bearings, pressurized	0.0
Hydrostatic bearings	0.001...0.002, ref viscous s

Table 2 Coefficient of friction in bearings

Coefficient of Friction*	Static	Dynamic
Delrin on Steel		
Delrin 100, 500, 900	0.20	0.35
Delrin 500CL	0.10	0.20
Delrin AF	0.08	0.14
Delrin on Delrin		
Delrin 500/Delrin 500	0.30	0.40
Delrin on Zytel		
Delrin 500/Zytel 101	0.10	0.20

*Thrust Washer test, nonlubricated, 23°C (73°F); P, 2.1 MPa (300 psi); V, 3 m/min (10 ft/min).

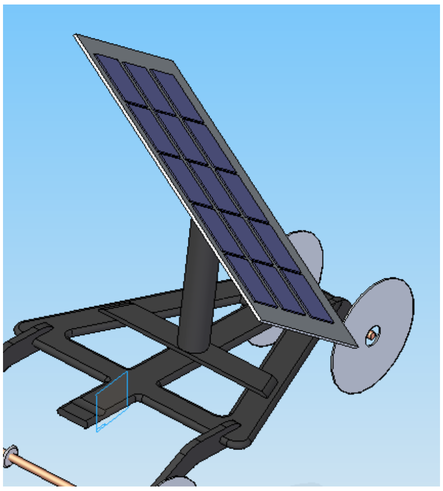
Table 1 Coefficient of friction with Delrin

The wheels themselves are minidiscs. We use minidiscs because they are very narrow, light and easy to find. The narrowness helps us to achieve the least amount of rolling friction. To attach these minidiscs we wired the steel axles and then we used nuts and washers to attach them.

Solar Panel

In the middle of the chassis there is a support beam on which the solar panel is mounted. This is made of wood because that is strong and also very light. The first idea was to use a steel holder to make sure the beam was strong enough. However, the steel holder weighted too much.

Since we need to be able to rotate the solar panel towards the sun, we use a ball joint. This allows us to locate the right angle and lock it in place with a clamp. The ball joint is made of plastic and therefore very light.



Picture 5 Solar Panel

Motor and Transmission

To mount the motor on the chassis we've extended the perpendicular beam on the chassis, it looks like an extra protrusion tailing at the back of the chassis. The motor rests on this extension in such a way the axis of rotation is laid parallel with the axis of the back wheels. This way we can easily apply a simple belt transmission with the appropriate gear ratio between the motor and the wheel axis. The belt and the two gears came from a VCR-player.

Guiding system

The guiding system we use are two small plastic ball bearings that are attached on two nails. This way there is almost no friction between the rail and the bearings. The system itself is placed on the front of the car, between the 2 front wheels. The reason it is positioned in the front is because when the front side of the car stands correctly, the back will follow automatically. Another advantage is that when this is positioned properly, the front wheels automatically stand correct.

The Car

Because a visualization is worth “a thousand words”, this is the car we actually built:

Picture 6 Car