ENGINEERING EXPERIENCE 4

PROCESS REPORT

Team 11 PHOENIX

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Preparing Work

1.We designed Phoenix EE4 Small Solar Vehicle - Team 11 as our logo.

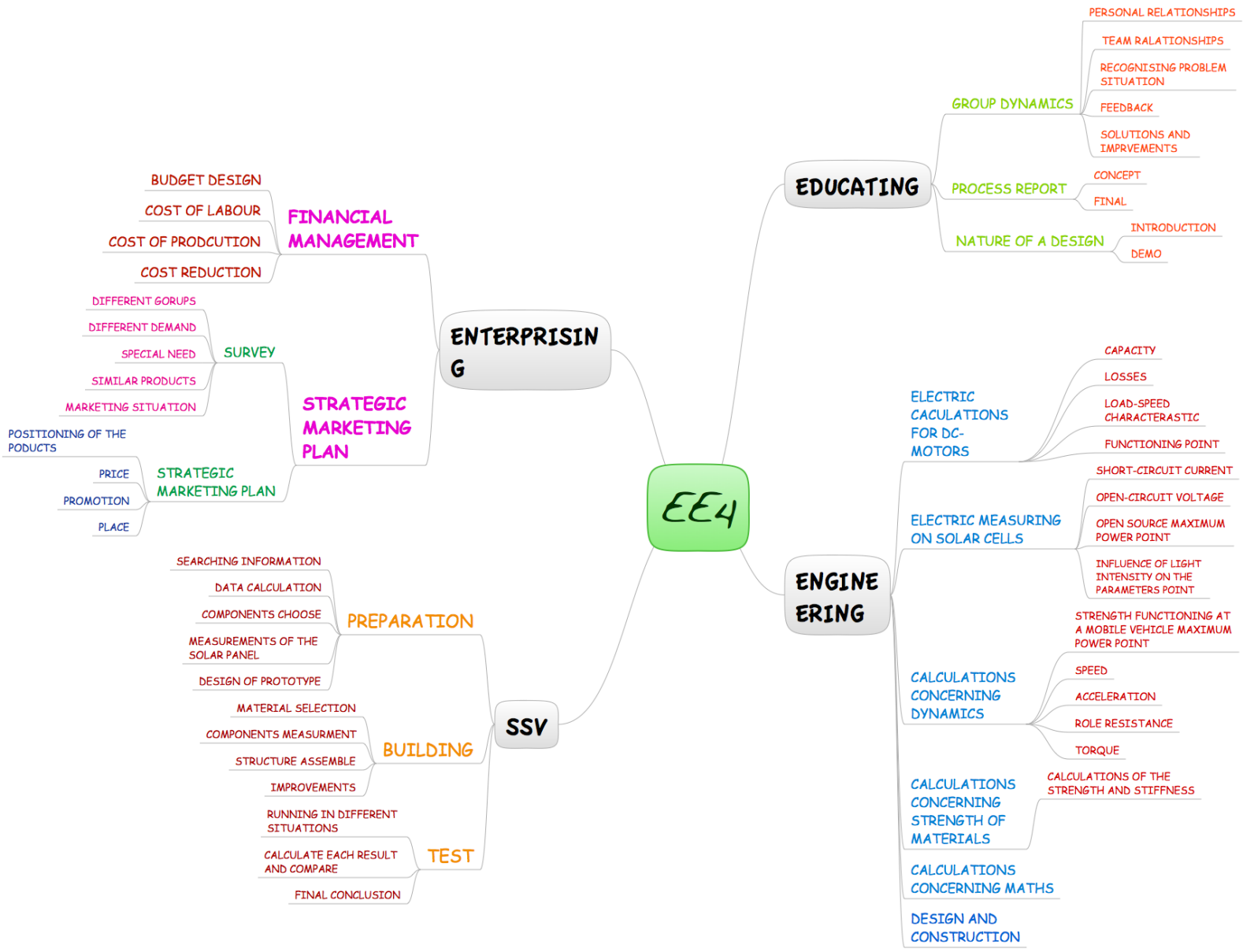
2.Gant Chart

Since the Gant Chart is too large to paste on this page,so we just cut main part of

Project EE4 Team 11				timeline	work load
jobs	tasks	subtasks	subsubtasks	weeks	hours
1.Assignment Engineering	1.1 Case SSV part I	1.1.1 Design(SSV)	1.1.1.1 logo	1	4
			1.1.1.2 structure	2	24
		1.1.2 Theory Study		2,3	80
		1.1.3 build(SSV)	1.1.3.1 Prepare materials	4	5
			1.1.3.2 Assembling	4,5	25
			1.1.3.3 Reshape Structure	10	5
		1.1.4 optimise(SSV) Sankey-diagram	1.1.4.1 Electric test and measuring for DC-motors	3	4
			1.1.4.2 Electric test and measuring on solar cells	3	4
			1.1.4.3 Calculations	3,4	30
		1.1.4 Test Run		9	16
	1.2 Case Simulink	1.2.1 Matlab-Simulink		4	40
		1.2.2 freely down a ramp. Calculate distance 'x'	1.2.2.1 Mesuring Everything	6	4
			1.2.2.2 Calculations	7	16
		1.3.1 Measure 'x'		7	4
	1.3 Case SSV part 2	1.3.2 Sankey Diagram of Umicar	1.3.2.1 Calculations and drawing	10	8
		1.3.3 Technical drawing of the frame		9	20
2.Assignment Enterprising	2.1 Market position	2.1.1 market research		10	8
		2.1.2 businessplan(4P)		10	10
		2.1.3 Website		10	20
		2.1.4 Engrave logo in the frame		10	24
		2.1.5 Budget control		10	6
3. Assignment Educating	3.1 Create and use a 'wiki			1	20
	3.2 plan of approach			2	3
	3.3 work brake down structure			1	4
	3.4 Gantt chart			1	4
	3.5 Design report			12	20
	3.6 Process report			12,13	26
	3.7 Cooperation contract				2
4. Group Meetings					80
5. Lectures and feedback					128
totaal					644

it.

3.Work Breakdown Structure(WBS)



4.Plan of Approach (POA)

1. Introduction

This POA is made for the course EE4. This document is due Friday week 1. The goal of the POA is to make clear the goals that have to be achieved to the end of the project. In this way the structure of the entire project becomes clear.

1.1 Motivation

As part of EE4, this POA is due Friday of week 1. The goal of EE4 is to create a small solar vehicle. This vehicle will be put in a race against the other teams. The ultimate goal of team phoenix is to win this race.

Projects like this are given to test the skills of engineers in real life. To create a real thing other than pure theory

1.2 Commentary to the structure of the plan.

The following points will contain the part about the project itself and the goals we are willing to achieve. It will also contain some problems that might occur, or why we have any imperfections in the project.

2. Project description

We will build a small solar vehicle. The solar panel and electromotor will be given to us by the coach. Then Team Phoenix will build the solar car. The vehicle will be able to drive for 6 meters before climbing8meters uphill under an angle of 3degrees.. We also have to make a Sankey diagram, this will present what will happen with the energy that is produced by the solar panel: loss in heat, rotation of motor,friction etc.

Case 1 is to design and actually build the SSV. Do calculations about the gear-ratios and resistance. Also a Sankey diagram is required.

Case Simulink a computer program is where we take our calculated design -0to check gear ratios and possible times.

Case 2 is where we do the simulations made above in real life. We also have to make a Sankey diagram of the umicar vehicle. Again we have to make some strength calculations on the axle used in our SSV. Another thing we'll have to do is to make a detailed technical drawing in 2D of our car.

2.1 Principal

The Principal for this project is Groep T, more specific for the course of EE4. The coach that is assigned to us will be our guide in this project.

2.2 Contractors

The contractors consist of a group of 8 people which are from different origins. The team name will be "Phoenix". We democratically chose Xu Weiwei as our team leader.

Name	Phone number	Email
Yan Song	487148280	Song.yan@student.groupt.be
Xu Weiwei	487147725	weiwei.xu@student.groept.be
Yang Tao	488184809	tao.yang@student.groept.be
Zhou Xiao	487148235	xiao.zhou@student.groept.be
Wante Michiel	496180474	michiel.wante@student.groept.be
Govaerts Bram	497291286	bram.govaerts@student.groupt.be
De Beckker Jona	477233764	jonas.debeckker@gmail.com
Spaas Maxime	496415153	maxime.spaas@student.groept.be

Motive

EE4 is an obligated course of BAC 2. All of the contractors are interested in electro-mechanics which made this choice rather evident.

2.3 Goals

Engineering:

For this project we have to make 3 cases. These cases are: SSV case 1. This case handles the design building and optimisation of the small solar vehicle. Case 2 is the Simulink case. Here we optimize our SSV by looking at simulation software. The use of this software will be learned during the seminars. Case 3 is the SSV case 2. Here we measure distance x. We also do a critical analysis of the stresses in the driven shaft. We have to make a Sankey Diagram of the Umicar and draw a technical drawing of the frame. We have to do all of this to make sure our ssv as faster as possible.

Enterprising:

Market research
Business plan (4P)
Create a website to promote the SSV
Engrave logo in the frame. This can be done at the fab-lab
Control the budget so we don't exceed the limit of 200 euro

Education:

Create a Wiki page.
Plan of approach, Work Breakdown Structure, Gantt Chart.
Keep a blog up to date.
Write a design report and a process report

2.4 Problems

Problems will occur during this project. We'll need to keep the deadlines in mind, and make sure we don't miss any of them.. When a problem occurs there will be an appropriate solution.

As team members we can remind each other about peer assessments.

Other deadlines are looked after by the team leader.

It is possible that we cannot come to a proper solution for a certain problem. If this occurs, the team leader will intervene and will try to come to a consensus where every team member feels comfortable in. The team leader will take the lead when discussions occur and will make the final call when important decisions are there to be made.

If a team member doesn't feel comfortable in the group, it is his duty let the team know, in order to fix the problem that lies underneath that uncomfortable feeling.

2.5 Expected results

Engineering:

3 cases:

- Case SSV part 1: design a SSV and build it. Calculate a transmission so there is a sufficient transfer of energy to the wheels. This transfer of energy will be put in a Sankey diagram. This diagram will show what happens with the energy received from the sun?.

Finally we will race our SSV against other EM teams.

- Case Simulink: simulate what will happen when our SSV rolls freely down a ramp. And then calculate what the distance x will be.

- Case SSV part 2: we will measure the real x of our SSV. We will make a sankey diagram of the umicar. We will analyze the critical stresses in the drive shaft of the SSV. And we will make a drawing of the frame

- Finish first in the race against the other teams.

- Create an innovative SSV.

Enterprising:

What will be the market position of a miniature model of the Umicar?

We will do a market research about the need of a solar vehicle.
Our business plan will be based on the four P's.
We'll create a website to promote the SSV, especially our ssv.
We'll engrave our team logo in the frame. This can be done at the fab-lab in Heverlee.And finally we'll control the total budget so we don't exceed the limit of 200 euros.

Education:

Create and use a Wiki page, Upload imformations onto it at least once a week.Plan of approach, Work Breakdown Structure and a Gantt Chart.

We will have to keep a blog up to date as a personal logbook for all teammembers.We will write a design and process report about our SSV

3. Management aspects

3.1 Timing

The team leader will keep an eye on the deadlines to make sure that we don't miss any. The team has made an agreement to join together frequently and have meetings to divide tasks. With frequently we mean surely weekly during the ee4 hours in our schedule and also at another moment to divide new tasks or to bring different parts togherer. If it's not possible, due to different class schedules of the team members, meetings will be hold in smaller groups.

5.Other Preparings

A.We built a website for promoting the SSV,and during the whole process,we keep update the it.

http://thephoenixssv.wordpress.com

B.We built a blog,which is for the Phoenix project.

http://users.telenet.be/jonas.de.beckker/phoenix/news.html

ENGINEERING PART

A.Basic characterastics

1. Our motor is "218799",and we looked for detailed information of our motor on MAXON MOTOR website.

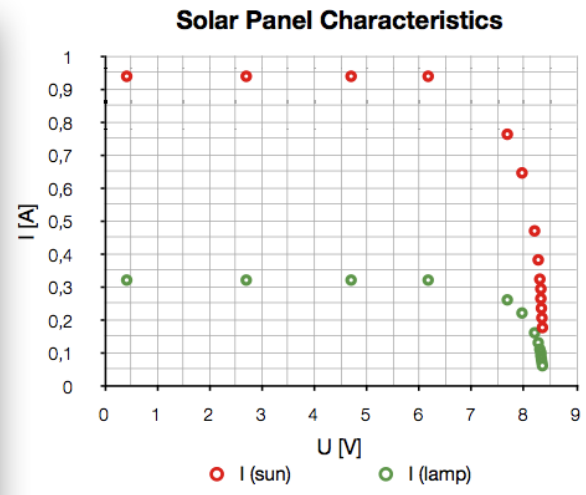
http://shop.maxonmotor.com/ishop/article/article/218799.xml

Here is part of the data of our motor.

Motor Data													
	Values at nominal voltage												
1	Nominal voltage	V	6.0	9.0	9.0	12.0	12.0	15.0	18.0	24.0	30.0	36.0	48.0	48.0
2	No load speed	rpm	9640	9980	8770	10400	9410	10300	9970	10700	10800	9800	9290	8380
3	No load current	mA	29.6	20.9	16.9	16.9	14.2	13.1	10.4	8.83	7.20	5.07	3.48	2.94
4	Nominal speed	rpm	7480	7350	6150	7820	6760	7620	7310	8060	8160	7090	6520	5620
5	Nominal torque (max. continuous torque)	mNm	4.81	6.33	6.42	6.36	6.31	6.29	6.25	6.23	6.18	6.15	6.03	6.10
6	Nominal current (max. continuous current)	A	0.840	0.757	0.673	0.597	0.533	0.465	0.374	0.301	0.241	0.181	0.126	0.115
7	Stall torque	mNm	21.5	24.1	21.5	25.5	22.5	24.5	23.5	25.2	25.1	22.3	20.3	18.6
8	Starting current	A	3.65	2.81	2.21	2.34	1.86	1.77	1.37	1.19	0.957	0.641	0.414	0.343
9	Max. efficiency	%	83	84	84	84	84	84	84	84	84	83	83	83
	Characteristics													
10	Terminal resistance	Ω	1.64	3.20	4.07	5.13	6.46	8.48	13.1	20.2	31.3	56.2	116	140
11	Terminal inductance	mH	0.106	0.222	0.288	0.362	0.445	0.584	0.890	1.37	2.10	3.68	7.29	8.95
12	Torque constant	mNm / A	5.90	8.55	9.73	10.9	12.1	13.9	17.1	21.2	26.2	34.8	48.9	54.3
13	Speed constant	rpm / V	1620	1120	981	875	790	689	558	450	364	274	195	176
14	Speed / torque gradient	rpm / mNm	452	418	410	412	422	422	428	429	435	443	462	454
15	Mechanical time constant	ms	19.1	18.8	18.7	18.7	18.7	18.7	18.7	18.8	18.8	18.9	19.1	19.0
16	Rotor inertia	gcm²	4.04	4.29	4.35	4.33	4.24	4.24	4.18	4.18	4.14	4.07	3.95	3.99

2.We measured the characteristics of the solar panel,and calculated data based on it.

	Measurements		Transformed to the expected sun rays
	U [V]	I [A]	0,88/I [A]
1	0,42	0,32	0,9387
2	2,7	0,32	0,9387
3	4,7	0,32	0,9387
4	6,17	0,32	0,9387
5	7,68	0,26	0,7627
6	7,96	0,22	0,6453
7	8,20	0,16	0,4693
8	8,27	0,13	0,3813
9	8,30	0,11	0,3227
10	8,32	0,10	0,2933
11	8,32	0,09	0,2640
12	8,33	0,08	0,2347
13	8,34	0,07	0,2053
14	8,35	0,06	0,1760



3.calculated data

Coefficient of rolling:0.015

Gear ratio :8.53

Surface area (look from font):0.05m^2

Drag coefficient :0.5

Power from the sun:800w/m^2

Quality factor N of solar panel:1.256

Short-circuit current Isc:0.94A

Open-circuit current Ioc:0.56V

Density of air:1.29kg/m^3

Gravity:9.81N/kg

Total travel time(by simulink):5.3s

Slide down time (by simulink):2.7s

(The calculation of all the characterastics is detailed included in the calculation report.)

4.Weight and size of components

Total weigt:800g

Motor:52.23g

Solar panel:360g

Wheels(CDs):4*6.4g

Bearings:4*4.5g

Axes:5.14g

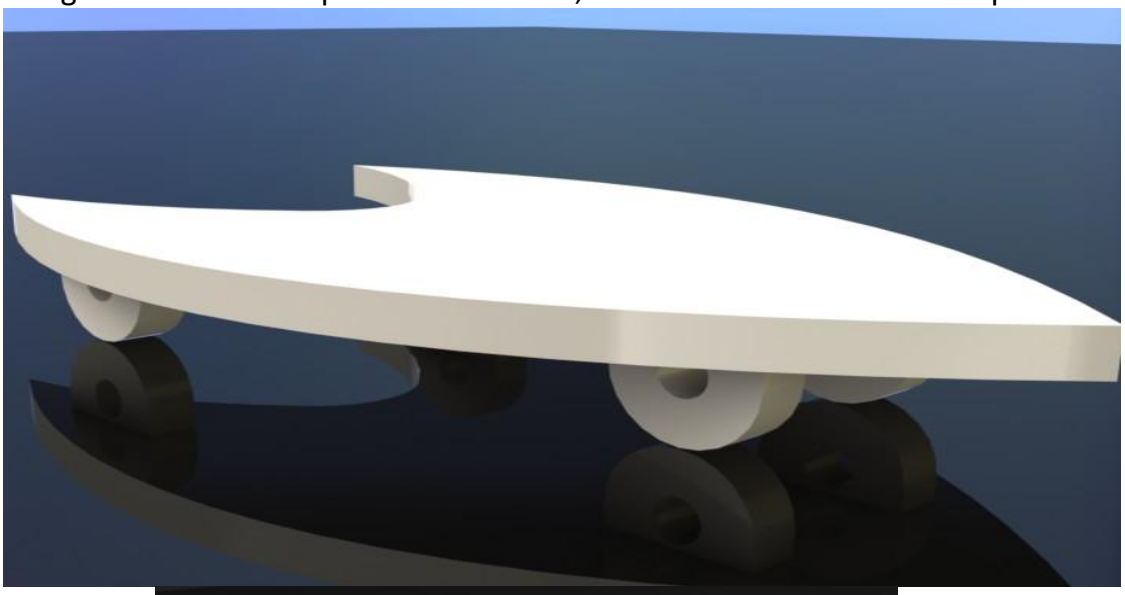
Wheels:10g

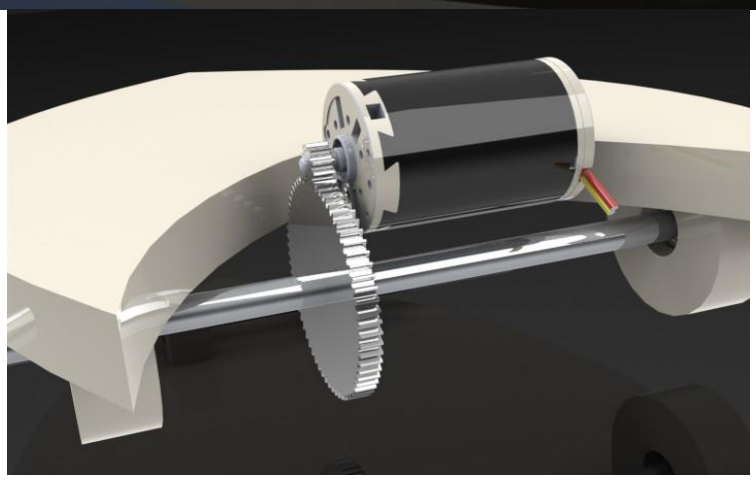
Aluminum round tube: Φ=5 mm length= 305 mm

Bearing: innerΦ=5 mm outerΦ= 11 mm

B.Designs

We designed the basic shape of the solar car,and made all our effort to improve it.

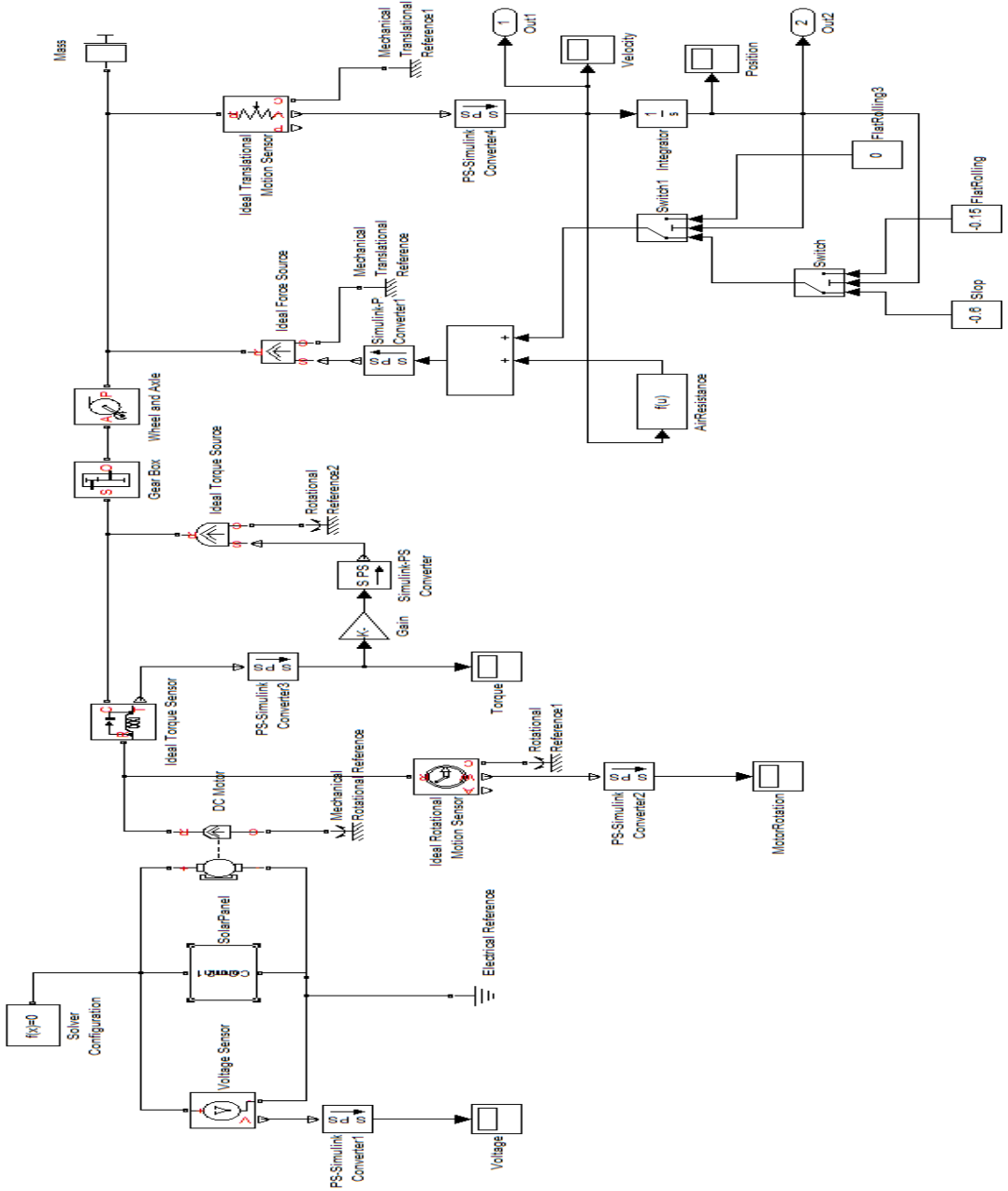




gears and motors

C.Simulink

Based on calculated data,we used simulink to simulate the race situation.



After simulation,we get the total travel time is 5.3s and the slide down time is 2.7s.Compared with the race time we get (5.4s and 2.9s),it is very accurate.

D.Problems and Adjustment

1.At very beginning,we considered the shape of the body to be square or rectangular. In this way,we would use four wheels and two of them would be motivated. At the same time,another formal came up. The shape also could be triangle,in this way,three wheels would be in need. One is in the front of the body and the others would be at the bottom.

This triangle shape is lighter and easier to be set on the track. However,it is hard to fix wheels on the body.

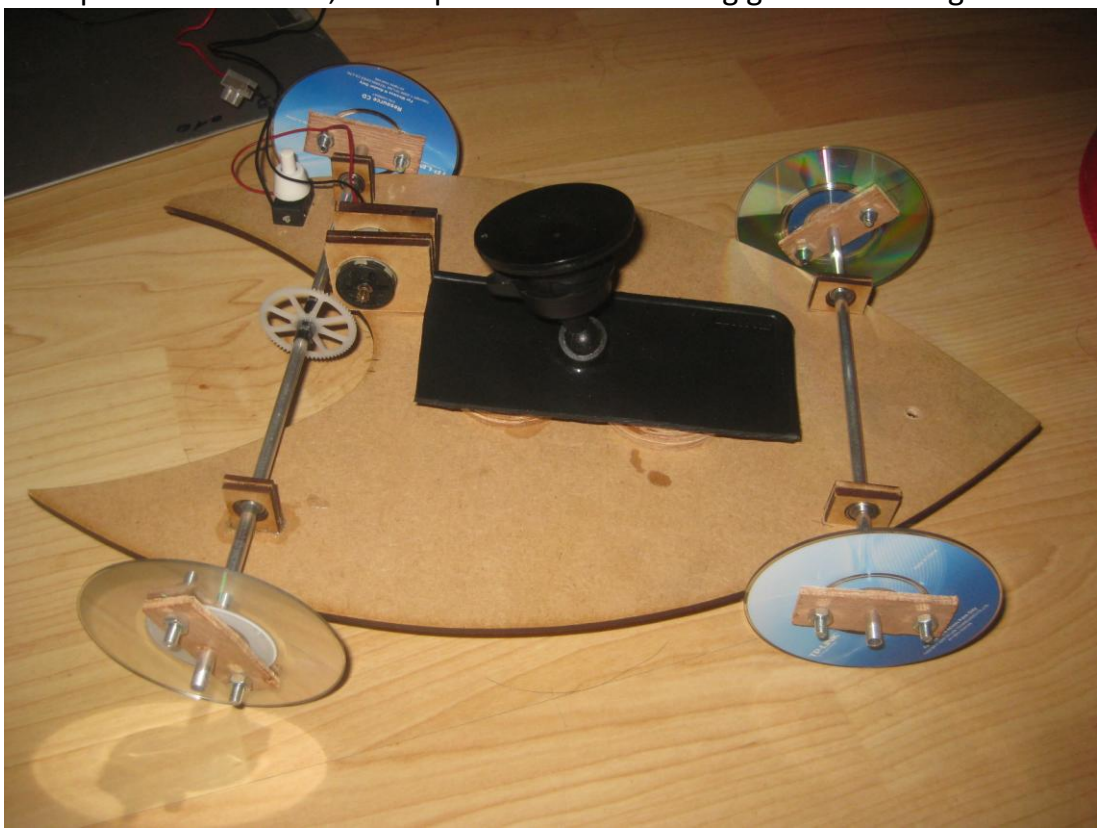
Finally,we choose a streamline shape,which is based on the triangle one. This one has less friction. We changed the three-wheel design into six-wheel. Two wheels are at the front , two are at the bottom ,and we add two guiding wheels in the middle.

2.In order to decrease the weight and friction,we use small CDs instead of traditional rubber wheels. Each CD is 6.4g,it is much lighter.

3.We were trying to find a way to get more sunlight,for instance,using a mirror to help the solar panel absorb more sunlight,but it was too complex to realize and the additional weight was a big problem,so we had to give up this trial. Finally we use a column to support the solar panel. They are connected with a rotating semicircle. So the panel can be easily adjusted to be against the sun,and more sunlight can be gathered.

4.In order to lose weight,we are now trying to make a wooden frame instead of the plastic or steel frame. We are also looking for some components made of aluminum to lose weight.

1. When we first calculated the gear ratio,the “n” value was around 4. That was much smaller than the reference value. We had to do it again. Finally,with the help of maple,we got to the “n”=8.53. It seemed to be alright. Now,the point is to design suitable gears. When we take the new value 8.53 into consideration,problems come up again. If we use a bigger small gear,the big gear is too big to attach to the solar car,while if we use a smaller gear,the big gear seems can function well,but the small gear is too tiny. Finally,we put the base of the solar car upside-down. Thus,more space is left for the big gear. The two gears do function well.



2. When we first put the Phoenix car on the track,we found that without the guiding wheels,it could not travel in a straight line but it traveled at a high speed.If there is guiding wheels,the friction between wheels and the track is too big,under this circumstance,it even could not climb the slope.Though it took us long time to set the guiding wheels,we had to give it up to ensure the speed.

7.In the whole process,we tried our best to make the solar car lighter,but it was even lighter than the limited light.Before the race,we had to truss a box of screws to make it over the limited weight.

SUCCESSES AND PITIES

Pities:

1. We failed with very tiny difference.
2. We did not take the temperature into consideration.During the race,the temperature of the solar panel raised and the resistance of the solar panel raised.So,in the second round,the speed decreased.We did not find a way to make it cool down.
3. During the racing,the angle of the sunlight changed a lot,we did not have any experiment to find out the best angle the solar panel should be.

Success:

The best result we got is 5.4s. Since the simulated time is 5.3s. This tiny error shows that we did very accurate calculations.

We were satisfied with the result and the whole project,though we did not get champion.

In the whole project,everyone enjoys their work and the cooperation. We have a very capable leader,he contributed all tasks depending on members' interests and abilities. Although someone did more jobs while someone did less,everyone did devote himself to the work.

Bram mainly handles the all technical drawings with Solid Work,for instance,the gears,the wheels and the solar car in 3D and 2D.

Maxime mainly is responsible for the construction of the solar car.

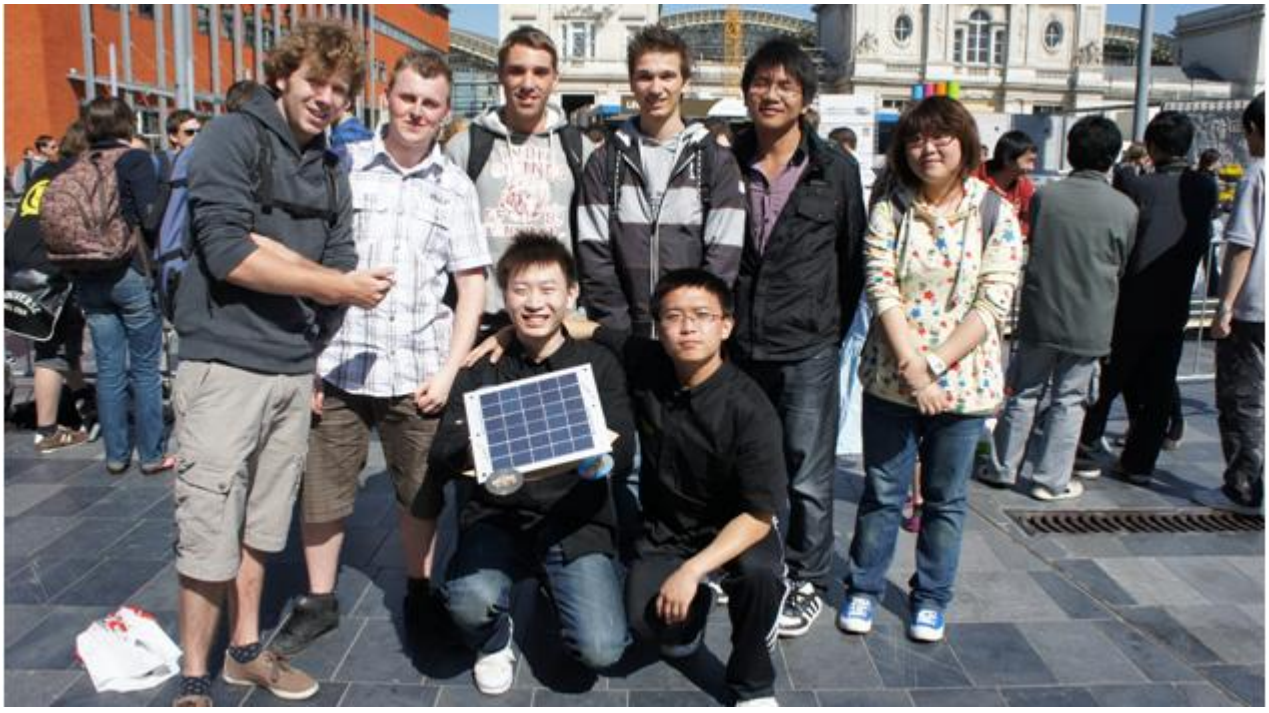
Jonas keeps renewing the website and the blog.He is also responsible for most of the calculations.

Michiel helps a lot with the graph works,like sankey diagram and graphs of forces.He also checks all the reports and the websites.

Xu Weiwei,as the leader,he divides all tasks and arranges the process.He is mainly responsible for the simulink part.

Yang Tao assistes the calculations,like the gear ratio and the critical analysis of the stress in the driven shaft.

Yan Song assistes paper works,sankey diagram and market search.



Zhou Xiao is responsible for WBS and paper works.

With the help of our coach--Tan Ye,we completed the project in an efficient way. Many pieces of advice were raised,and these did help us a lot. Besides,many mistakes were corrected immediately,thus, we had more time to realise our further ideas.