

University of Wales Trinity Saint David
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Project Planning for Group Project
Management Innovation & Sustainability
(M5X01176)

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1 Abstract

A competitive electric single seater hill climb car to be designed for the British Hill Climb Championship. Areas of work were split into four groups; aerodynamics, chassis, powertrain and simulation. Our group, aerodynamics, was split into smaller sections of design and research which were front wing, floor, sidepods, engine cover and rear wing. This was to provide faster and more efficient workflow. Aerodynamics of the car used to reduce drag and increase lateral grip while cornering at high speeds which is one of the best ways to reduce run times as average speed will increase.

Table 1 - Table to show the goals and objectives of the group.

Goals	Objectives
Efficient aerodynamics package	• Get a lift coefficient value of -1.92 • Get a drag coefficient value of 0.77
Aerodynamic package adjustability	• Allow the aerodynamics package to be adjusted for different tracks • Allow quick adjustments which can be made between runs depending on driver feedback
Cooling	• Small amounts of cooling to be provided to powertrain
Packaging volume	• Allow enough packaging volume for the powertrain • Allow enough packaging volume for the front and rear suspension
Mounting points	• Leave space to accommodate mounting points for the wishbones

2 Group Members

Table 2 - Table showing group members roles and responsibilities.

Team Member	Roles	Responsibilities
Alex Baldwin	• Group leader • Shaper / Complete Finisher	• Design front wing
Duke Asamoah	• Team worker	• Design rear wing
Zhendu Fang	• Complete finisher	• Design floor
Dion Billing	• NA	• Design Side pods and engine cover

2.1 Belbin's Model

Belbin's model was developed by Meredith Belbin to identify key strengths and weaknesses of an individual working in a team. It also shows how they are perceived by colleagues and how their managers can act towards them to make them thrive in the workplace (Aritzeta, Swailes and Senior, 2007).

2.2 Personal Skills

As the leader, I had to inspire the group to work as hard as possible to reach the objectives given to them. Often, they would ask for assistance on CAD and ideas on how to model their sections of the aerodynamics package. This required patience and a good understanding of the software to be able to aid the troubled members. Some members of the group would do minimal work to progress the project onwards, therefore I had to talk to them privately to ensure they advanced on their work.

On the Belbin model test, a very high score of shaper was obtained (23). Shapers are dynamic and highly motivated who have a lot of energy and high need for achievement. Their prime goal is to get things done as quickly as possible. They enjoy challenges and competition, and are also determined to overcome any obstacles to win. Furthermore, shapers enjoy leading and pushing others and do not mind taking unpopular decisions just to get things done. Oppositely, they can neglect others feelings and cause conflict and arguments amongst the team. As they are very invested in the team's success, they show strong emotions when frustrated or disappointed (Belbin, 2019).

A high score of complete finisher was also obtained (8). Complete finishers have an attention to detail and always strive to reach the highest possible standards. They can find mistakes easily which makes them good at quality control. On the other hand, they have tendencies to miss deadlines due to wanting the work to be perfect (Belbin, 2019).

The personality shown on Belbin's model test depicts the way I work in a group very well. These traits have pros and cons while being a group leader, as I can push the team to innovate great things but cause conflict along the way.

3 Tasks

3.1 Group Tasks

Table 3 - Table showing group timings and vivas throughout the project

Task Name	Duration	Start	Finish
Aero research/regulations	126 days	Mon 30/09/19	Mon 23/03/20
CAD concept 1	17 days	Fri 11/10/19	Sat 02/11/19
CFD Concept 1	4 days	Sun 03/11/19	Wed 06/11/19
CAD concept 2	8 days	Thu 07/11/19	Sun 17/11/19
CFD concept 2	2 days	Mon 18/11/19	Tue 19/11/19
CAD concept 3	4 days	Wed 20/11/19	Mon 25/11/19
CFD concept 3	2 days	Tue 26/11/19	Wed 27/11/19
Find best concept combination using CFD	12 days	Thu 28/11/19	Fri 13/12/19
Refine parameters using CFD	5 days	Mon 06/01/20	Fri 10/01/20
Prepare presentation	18 days	Thu 07/11/19	Sun 01/12/19
Present presentation	1 day	Mon 02/12/19	Mon 02/12/19
Manufacture scale model prototype	10 days	Mon 06/01/20	Fri 17/01/20
Test prototype scale model in wind tunnel	3 days	Mon 20/01/20	Wed 22/01/20
Analyse data and compare with CFD	1 day	Thu 23/01/20	Thu 23/01/20
Small improvements to design	10 days	Fri 24/01/20	Thu 06/02/20
Prepare second presentation	32 days	Fri 07/02/20	Sun 22/03/20
Viva 2 - Present presentation	1 day	Mon 23/03/20	Mon 23/03/20
Write final report	80 days	Tue 03/12/19	Mon 23/03/20

3.2 Personal Tasks

Table 4 - Table showing personal times throughout the project

Task Name	Duration	Start	Finish
Aero research/regulations	12 hrs	Mon 30/09/19	Mon 23/03/20
CAD concept 1	25 hrs	Fri 11/10/19	Sat 02/11/19
CAD concept 2	20 hrs	Thu 07/11/19	Sun 17/11/19
CAD concept 3	20 hrs	Wed 20/11/19	Mon 25/11/19
CFD concept 1	10 hrs	Sun 03/11/19	Wed 06/11/19
CFD concept 2	8 hrs	Mon 18/11/19	Tue 19/11/19
CFD concept 3	8 hrs	Wed 20/11/19	Mon 25/11/19
Find best concept combination for front wing	4 hrs	Thu 28/11/19	Fri 13/12/19
Collection of materials	8 hrs	Wed 01/01/20	Sat 04/01/20
Presentation preparations for vivas 1 and 2	10 hrs	Thu 07/11/19	Mon 23/03/20
Report writing for final submission	20 hrs	Tue 03/12/19	Mon 23/03/20
Manufacturing prototype	30 hrs	Mon 06/01/20	Fri 17/01/20
Testing prototype	25 hrs	Mon 20/01/20	Wed 22/01/20
Total	200 hrs		

Many hours of the project will be spent on designing and testing the concepts. Once best concept is found, manufacturing and testing will take up most of the time as the process is quite tedious.

Table 5 - Table showing bill of materials required for the project

Material	Cost	Purchase lead time
3D printer	£2,808	1 day
3D printer filament	£28.88	1 day
Carbon fibre sheets	£5,000	1 Day
Resin	£161.63	1 Day
Solidworks 2019	£3,100	2 days
Ansys CFD	£4,600	2 days
Total	£15,698.51	

Cost of computer programs for design and testing is a large chunk of the total cost of the project but they are also one of the most useful assets. Labour cost not included.

4 General Plan

4.1 Milestones and Gateway

Table 6 - Table showing milestones for the project

Milestone	Due Date	Comments
First Concept Design	Wed 06/11/2019	This will motivate members to continue making designs
Viva 1 - Presentation	Mon 02/12/2019	Present entire group presentation
Best design combination	Fri 13/12/2019	Main CAD and CFD work finished
Wind tunnel testing	Wed 22/01/2020	Analyse real values and compare with CFD
Viva 2 – Presentation	Mon 23/03/2020	Present entire group presentation
Final report	Mon 23/03/2020	Hand in final group report

One personal gateway of the project is getting the first concept design for the front wing. Regulations would have to be taken into account which were max width ahead of front wheels no larger than 1500mm. This meant that the front wing including the end plates could not be wider than 1500mm. With this information, the design had to be thought of in two different ways; wider end plates but smaller wingspan, or thinner end plates and larger wingspan. Other problems taken into consideration was the airflow downstream after passing the front wing, and how that would affect other areas of the car. Wing adjustability was also a key design implementation as the wing would have to be adjustable to allow changes due to track/weather changes and driver feedback.

There are also a few areas of concern with the design of the front wing. One of those is the airflow downstream to other aerodynamic elements of the car. If the front wing spoils the airflow, the other sections of the car will not get enough clean air. This can be resolved by adding less elements and allowing more clean air to flow to aerodynamic areas, which adds another issue, which is less front downforce. As there is less downforce on the front the centre of pressure can move too far back. A higher value of downforce can be achieved on the front by having more efficient wing profiles and angles of attack.

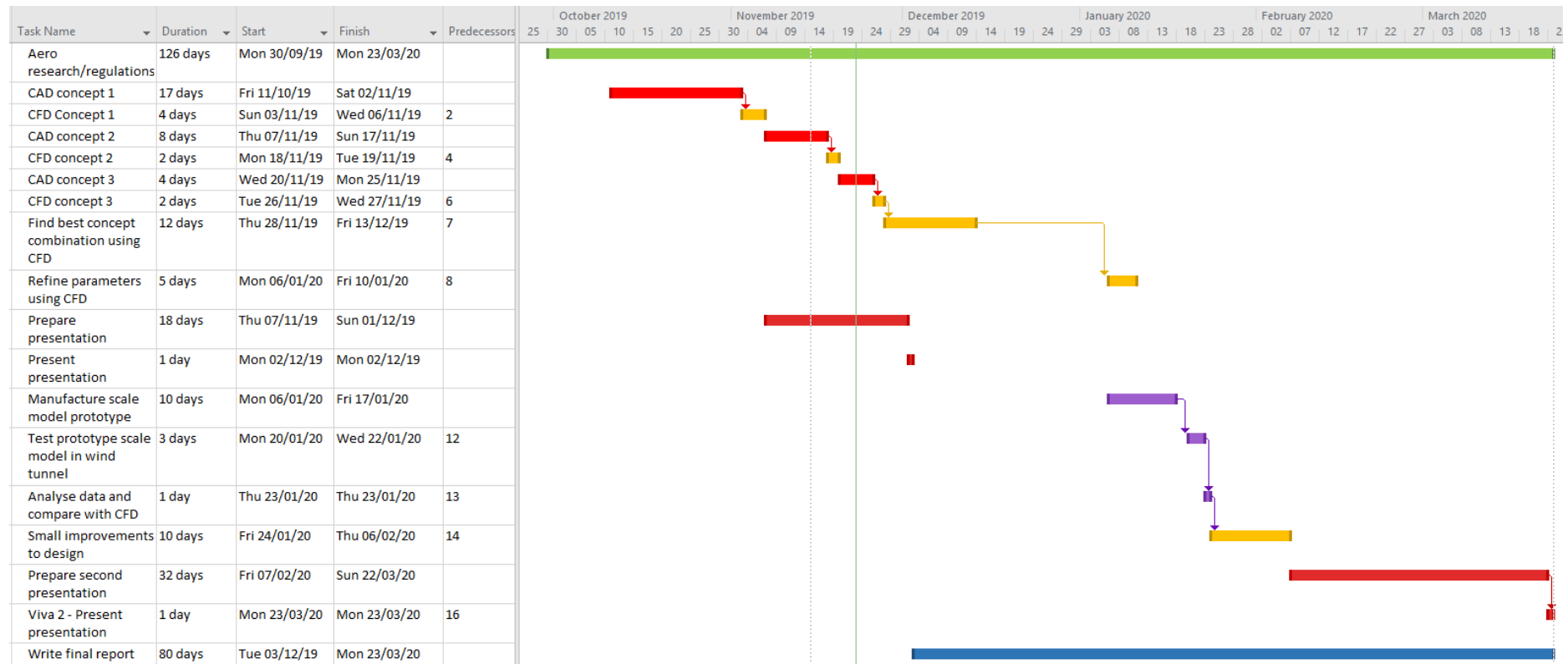


Figure 1 - Gantt chart for entire group

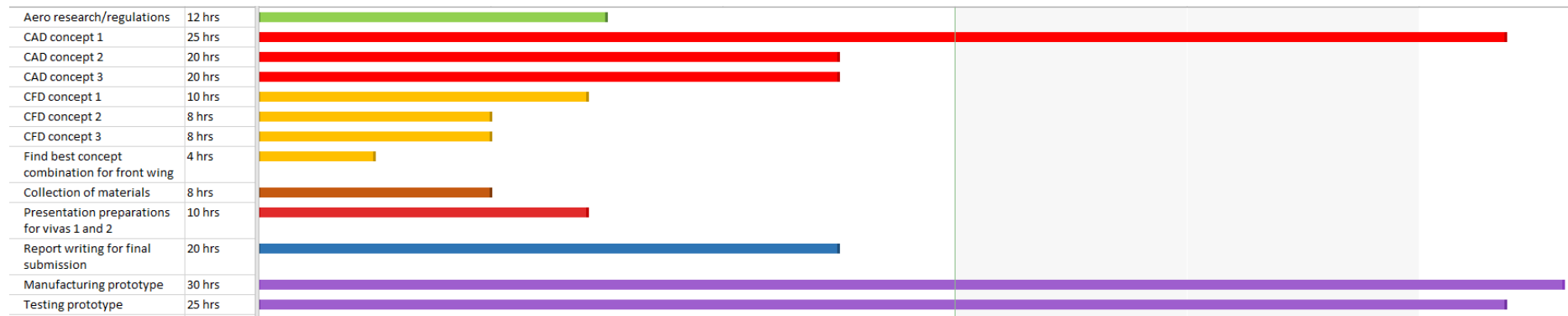


Figure 2 - Personal Gantt chart

5 Conclusion

The final aerodynamics package will be high downforce and low drag. It will allow changes to angle of attacks of wings so it can be versatile for multiple tracks and drivers.

6 Evaluation

The group so far has worked diligently to meet key dates which therefore keeps us on track for future deadlines. This has made the project move smoothly and if the team stays at this pace, it will remain smooth until the final deadline.

References

Aritzeta, A., Swailes, S. and Senior, B. (2007) 'Belbin's Team Role Model: Development, Validity and Applications for Team Building', *Journal of Management Studies*. John Wiley & Sons, Ltd (10.1111), 44(1), pp. 96–118. doi: 10.1111/j.1467-6486.2007.00666.x.

Belbin (2019) *Belbin | High Performing Teams*. Available at: <https://www.belbin.com/> (Accessed: 19 November 2019).