

PROJECT PLANNING

**Engineering Management
(ACHA5012)**

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1. Project Introduction

The group has been given the task of designing an active rear wing for a performance version of a Morgan Plus Four. The wing is intended to both increase the vehicle's downforce and increase its drag under braking to improve deceleration. A successful wing will be one that achieves these characteristics while also improving the vehicle's downforce distribution. Project progress will be monitored by holding weekly meetings between all group members as well as setting clear SMART targets to achieve.

2. Team Member Roles

2.1 Roles & Responsibilities

This project requires our group members to take one of five main roles. These are: Aerodynamic Design & Assessment, Structural Component Design & Analysis, Mechatronics & Control Systems, Vehicle Simulation and finally, Project Management. Below is a table of the stated roles taken by our group members.

Role	Member(s)	Responsibility
Aerodynamic Design & Assessment	Nick Aron	To conduct experimental testing as well as simulated testing to find the wing profile and position that best compliments the Morgan's current downforce distribution.
Structural Component Design & Analysis	Cody	To find the optimal material and mounting method for the wing using stress simulation software to visualise material behaviour under the expected forces.
Mechatronics & Control Systems	Kowsar Jake	To select the most appropriate method of implementing the mechatronics for the wing to be active and to work with the aerodynamics group to optimally integrate this system into the wing.
Vehicle Simulation	Aeron	To simulate the real world benefits and drawbacks of the changes being made to the vehicle's characteristics and advise other roles of possible changes accordingly.
Project Management	Callum	To oversee and support the group wherever it is necessary and to arrange regular meetings to ensure communication across the roles as well as a general understanding every role's ongoing tasks.

Table 1 - Team Roles & Responsibilities

2.2 Skills Required For My Role

As one of the group members that is responsible for aerodynamic design and assessment, I will be conducting much research, testing and development and communicating my findings with my co-worker. I should therefore aim to have:

Knowledge of aerodynamic behaviours – An understanding of thrust, lift, weight and drag which is relied upon to improve and refine performance and safety (Indeed Editorial Team, 2024).

Data Analysis skills – Aerodynamicists regularly use these skills to *“accurately interpret data and make informed decisions”* (Indeed Editorial Team, 2024).

Problem solving skills – An ability to overcome aerodynamic challenges using mathematical knowledge (Indeed Editorial Team, 2024).

Communication skills – The ability to *“share information with their team members and colleagues in other departments and explain complex aerodynamics concepts”* (Indeed Editorial Team, 2024).

As well as these skills, the following personality traits are also desirable whilst working within aerodynamics:

Accountability – *“A willingness to take responsibility for your own actions”* (Birt, 2023) and your individual role.

Organization – Applying structure to your tasks which saves time and keeps processes efficient (Birt, 2023).

Creativity – *“An ability and interest in approaching challenges in new and unique ways”* which drives innovation and development (Birt, 2023).

Flexibility – The ability to adapt to change in a fast paced or dynamic scenario (Birt, 2023).

In order to better understand my current personality traits, I was tasked with completing a self-perception inventory which employed Belbin's model. Belbin's model is a result of Meredith Belbin's research which concluded that high performing teams need to have all nine Belbin Team Roles represented appropriately (Belbin, n.d.). The score of my inventory can be seen in the table below against the average scores which were given within the inventory booklet:

Belbin's Category	Role Description	My Score	Average
Implementer	Organises work that needs completing and turns ideas into actions (Belbin, 2014).	12	10
Coordinator	Effectively delegates tasks and clarifies goals confidently (Belbin, 2014).	11	8.8
Shaper	Overcomes obstacles with determination and thrives under pressure (Belbin, 2014).	10	11.6
Plant	Full of imaginative ideas and isn't fazed by problems. (Belbin, 2014).	3	7.3
Resource Investigator	Enthusiastic to explore opportunities and communicate to create new contacts (Belbin, 2014).	2	7.8
Monitor Evaluator	Strong judgement skills, can lay out all options and strategize (Belbin, 2014).	14	8.2
Team Worker	Listens and co-operates, perceptive not confrontational (Belbin, 2014).	5	10.9
Completer Finisher	Perfectionist, finds errors and polishes. Can be anxious (Belbin, 2014).	13	5.5

Table 2 – Belbin's Team Roles

The self-inventory's results suggest that I will have no problem in keeping my work organized and complete. I will also be quick to judge any new developments and strategize the next steps clearly and accordingly. I will not be phased by setbacks and will take accountability for my work. However, I may struggle to communicate my work to my teammates and come up with creative new designs. I will also need to improve my ability to listen to my teammates' suggestions and find a best fit solution rather than confront ideas that differ to mine.

3. Overall Group Tasks

Task	Start Date	End Date
Aerodynamics		
Discover the Morgan's downforce characteristics	14.10.2024	04.11.2024
Choose/create a wing profile	30.09.2024	02.12.2024
Experimentally test the final selected wing profiles	06.01.2025	03.02.2025
Determine position of wing	03.02.2025	24.02.2025
Print the final profile to scale for the prototype	24.02.2025	17.03.2025
Mechatronics		
On Ramp and self-study completion	14.10.2024	13.12.2024
Creation and finalisation of coded model	28.10.2024	07.02.2025
Creation and finalisation of physical model	28.10.2025	07.02.2025
Creation of finished prototype	08.02.2025	21.03.2025
Project Management		
Allocation of roles and responsibilities	14.10.2024	21.01.2024
Group meetings and meeting minutes	21.10.2024	17.03.2024
Offering assistance to team members	02.11.2024	10.11.2024
Presentation preparation	28.01.2024	30.03.2025
Structural Design		
Investigate materials to identify suitable options	14.10.2024	31.10.2024
Design a wing mount	13.01.2025	10.02.2025
Perform FEA testing to simulate mount behaviour	01.11.2024	10.02.2025
Test the physical materials in the workshop to achieve correlation	31.01.2025	28.02.2025
Vehicle Simulation		
Build car model in OptimumLap	28.10.2024	11.11.2024
Build car and track models in VI Grade	18.11.2024	01.01.2025

Program wing angles and differing coefficients	02.01.2025	09.01.2025
Observe effects around Donington Park	09.01.2025	16.01.2025
Observe experimental tests and correlate with simulated data	17.01.2025	30.03.2025

Table 3 – Overall Group Tasks

4. Individual Tasks

Task	Description	Start Date	End Date	Hours to complete
Discover the Morgan's downforce characteristics				
Follow Workbench video series	Follow Tim Tudor's video series outlining from start to finish how to run a MIRA reference car in Ansys Workbench.	14.10.2024	21.10.2024	8
CFD model the Morgan	Use the knowledge gained to mesh and run the Morgan car model to understand its current downforce distribution.	21.10.2024	04.11.2024	8
Choose/create a wing profile				
Research aerodynamic theory and basics	Read background material to better understand the results given by the CFD software and wind tunnel testing.	30.09.2024	21.10.2024	12
Correlate the NACA 0012 wing profile	Use the results from wind tunnel testing the NACA 0012 wing profile to get correct results out of the Workbench CFD.	14.10.2024	28.10.2024	8
CFD possible wing profiles	Once the CFD is correlated, other wing profiles can be simulated to record the strengths and weaknesses of every profile.	28.10.2024	11.11.2024	12
Determine whether endplates will be used	Testing with and without endplates to help determine whether they will be necessary for the final wing profile.	11.11.2024	18.11.2024	4
Determine the best wing profiles for the Morgan	Using the CFD results, the wings with the lowest drag for acceleration but the highest efficiency for cornering downforce with an achievable stall angle for deacceleration will be selected.	18.11.2024	25.11.2024	4
Explore any further changes to the selected wing profiles	Would the wings benefit from being curved or having a gurney flap added? Explore the changes in	25.11.2024	02.12.2024	4

	characteristics these changes make.			
Experimentally test the final selected wing profiles				
Select the best tested CFD profiles	Select the most promising two/three wing profiles from CFD testing for printing.	06.01.2025	13.01.2025	4
Print wind tunnel scale profiles	Make the changes required to facilitate the mechatronics components and allow space for pressure taps to be added and send off the profiles to be printed to a wind tunnel scale.	13.01.2025	20.01.2025	4
Test printed wing profiles	Test the printed wing profiles and ensure the CFD was indeed correlated.	20.01.2025	03.02.2025	8
Determine position of wing				
CFD wing positions on the model	Once the wing itself has been finalised, its height and distance relative to the car roof must also be determined with CFD testing featuring a model of the car and the wing.	03.02.2025	17.02.2025	8
Determine the best position for the wing	Conduct tests at a variety of heights and distances until the optimal position is found. This position should then be forwarded to the structural component member for their wing mount design.	17.02.2025	24.02.2025	4
Print the final profile to scale for the prototype				
Select the best experimentally tested wing profile	Continue with the wing profile that had both the best experimental and simulated results for the final prototype.	24.02.2025	03.03.2025	4
Alter the model for component additions	Make any final changes to allow for wing mounts or control system components.	03.03.2025	10.03.2025	4
Print the final prototype	Send off the final prototype model to be printed for presentation in the final viva.	10.03.2025	17.03.2025	4
4 hours a week allocated for group meetings and supervisor sessions = 80 hours				
1 hour a week allocated to the preparation of VIVAs and Final Report = 20 hours				

Table 4 - Individual Tasks

4.1 Bill of Materials

PLA Filament – PLA will be used for printing the wing profiles for experimental testing. A kilogram of 1.75mm diameter PLA filament will cost £26.99 and take a day at most to arrive once ordered (Filamentive, n.d.).

4.2 Specialist Equipment Required

Wind Tunnel – The wind tunnel is available for use with the knowledge or supervision of a lecturer or workshop technician.

3D Printers – The 3D printers aren't directly available to students; models set to be printed must be sent to workshop technicians who will then have the models printed.

SolidWorks 2023 – SolidWorks software is available for use on campus within the project room and is available for download to personal computers.

Ansys Workbench 16.2 – Workbench is available for use in the project room only, it cannot be downloaded to personal computers.

5. Significant Milestones for the Project

5.1 Group Milestones

Milestone	Date
First Group Meeting	14.10.2024
Group Roles Allocated	21.10.2024
Interim VIVA Slides Started	04.11.2024
Interim VIVA Slides Complete	06.12.2024
Rehearse Interim VIVA	07.12.2024
Interim VIVA	08.12.2024
Final Report Started	06.01.2025
Printed Wing Prototype	03.02.2025
Physical Mechatronics Model	07.02.2025
Final Materials Selected	10.02.2025
Final Scale Prototype Printed	17.03.2025
Final VIVA Slides Started	18.03.2025
Final VIVA Slides Complete	28.03.2025
Rehearse Final VIVA	29.03.2025
Final Report Completed	29.03.2025
Report & Final VIVA	30.03.2025

Table 5 - Group Milestones

5.2 Gateway Objective

It is of great importance that the final wing's efficiency isn't undermined by excessive drag, which is why a gateway objective of mine for this project is to ensure the drag force generated by the wing doesn't exceed 20N at 0° angle of attack. This can be calculated by using the below formula:

$$\text{Drag Force} = C_D \times \frac{1}{2} \rho V^2 \times A$$

However, I do not have the drag coefficient (C_D) as I have not yet selected a wing profile. Therefore, the equation will have to be rearranged as follows:

$$C_D = \frac{\text{Drag Force}}{\frac{1}{2} \times \rho V^2 \times A}$$

With this formula, the drag force limit of 20N can be substituted in along with air density (1.223 kg/m^3) for ρ , 240kph for V and 0.65 m^2 for the wing's area. The selected speed is the Morgan's top speed (Morgan Motor Company, 2024) at which the wing will generate the highest drag force. In a similar vein, the area has been calculated by scaling the NACA 0012 wing profile model used in the university wind tunnel to have its span match the Morgan's width, which is 1650mm (Morgan Motor Company, 2024). The wing's chord length has also been scaled accordingly. This equation can now be used to calculate the highest possible coefficient of drag that falls below the 20N drag force limit.

$$C_D = \frac{20N}{\frac{1}{2} \times 1.223 \text{kg/m}^3 \times \left(\frac{240 \times 1000}{60 \times 60} \right)^2 \times 0.56 \text{m}^2}$$

$$C_D = 0.7548$$

This coefficient of drag value will be how I measure whether the gateway objective is being achieved. If my CFD results display a higher coefficient of drag than 0.7548, then I will know that drag reduction must occur in order to keep myself on track for the maximum of 20N of drag force.

6. Areas of Concern

Insufficient understanding – My ability to analyse test results may be compromised by my current lack of understanding of aerodynamics. This could lead to incorrect conclusions being made leading to an ill-advised development path. This risk can be mitigated by further reading or engaging with specialised literature (Indeed Editorial Team, 2024). Handing my work to my aerodynamics teammate for constructive feedback (Indeed Editorial Team, 2024) will also reduce the risk of a flawed conclusion negatively impacting the development process.

Incorrect CFD Results – Taking incorrect CFD loads and forces as fact and giving the rest of the roles this data would be catastrophic for the project. Therefore, it's imperative that I decide on "the most compatible and optimal factors such as mesh density and geometry" (Mechartes, 2024) after familiarising myself with the software. I will also make sure to analyse CFD results which is essential for re-tracing my steps to find where an incorrect result originated as well as to see what was done correctly in an accurate result (Mechartes, 2024).

7. Summary

7.1 Group Gantt Chart

Below is a visualisation of the previously listed group tasks in the form of a Gantt chart. The overall tasks for my role can be found in blue.

The group Gantt chart can be seen in greater detail [here](#).

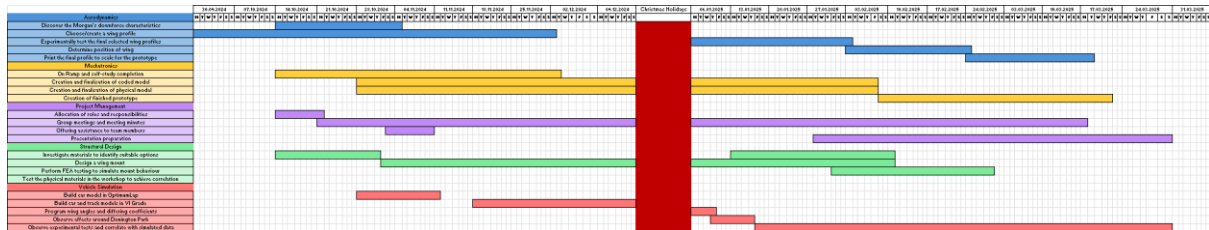


Figure 1 - Group Gantt Chart

7.2 Individual Gantt Chart

Visualised in the Gantt chart below are my individual sub-tasks as well as their relation to the group milestones (coloured orange) and my gateway objective (coloured green). The duration bars are coloured in relation to the overall task they contribute towards.

My individual Gantt chart can be seen in greater detail [here](#).

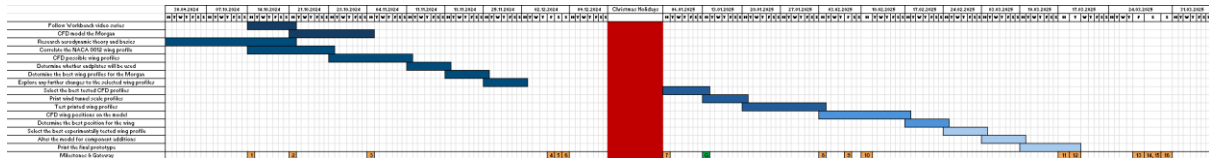


Figure 2 - Individual Gantt Chart

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