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Engineering Management

Project Planning

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Automotive Engineering

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Introduction

This report will look at the planning that has gone into preparation for a group project. The group project in question is to design and test an active rear wing for Morgan for their Morgan +4 road car to increase the performance. This means looking at all aspects of designing a wing including aerodynamics, structural design, control system design, mechatronics and a full vehicle performance assessment including the use of a wind tunnel. The main aim is to maximise the performance benefits of the wing on the car while making sure to keep within the strict technical regulations set by the manufacturer. My personal contribution to the project is on the control systems and mechatronics for the wing, which will allow it to move as an automatic active wing. Success of the project will be measured by percentage increase of overall performance and improvement of lap times on certain racetracks.

Chapter 1: Roles and responsibilities

Below is a list of each of the group project members and their roles and responsibilities within the project.

Role	Group members involved	Responsibility
Group Management	Alex Cook	Managing the project, ensuring all group members are comfortable with their tasks. Produce a Gantt chart. Ensuring group moral is always at consistent level.
Control Systems and Mechatronics	Alex White, Scott Holden	To design the code and electrical wiring/motors required to automatically operate the active rear wing via the motors based on factors such as G-force and speed.
Aerodynamics	Nathan Evans, Ollie Wilson	To provide a base CFD run with appropriate data, to develop the shape of wing and test using CFD, provide accurate data that matches the wind tunnel data.
Simulation and Vehicle Dynamics	Dylan Brierley, Scott Holden	To build an accurate simulation model and run effective simulation tests to evaluate new designs to see the difference in performance.
Structural Design and Manufacturing	Alex Cook, Matthew Starke, Connor Jenkins	Conduct research into materials that can potentially be used to produce the rear wing. Produce a mounting solution for the rear wing to the chassis of the Morgan. Learn FEA procedures to carry out tests on designs. Analyse the rear wing design using FEA.

Ideal skills and personality traits for certain roles in a group project can be identified by using Belbin's self-perception test. Belbin believed the most successful teams are made up of a diverse mix of behaviours (Belbin.com, 2023). However, it is important to ensure that each team member is then correctly assigned a role suiting their personality. My personal results for Belbin's self-perception test can be found in the table below.

Belbin's Self-Perception Test results								
Behavioural types	Implementor	Coordinator	Shaper	Plant	Resource investigator	Monitor evaluator	Team worker	Complete finisher
My score	16	10	7	4	6	6	9	12
Level	High	Average	Low	Low	Low	Average	Average	Very high
Percentage compared to average	66 - 85%	33 - 66%	0 - 33%	0 - 33%	0 - 33%	33 - 66%	33 - 66%	85 - 100%

From the table you can see I scored very high in complete finisher. Being a complete finisher means you reliably see things through to the end, ensuring everything works well. This is a useful trait to have doing control systems and mechatronics as it is important to be thorough and make sure everything is done correctly. This is because code will only do exactly what you tell it to do so if you overlook something or get it wrong, no matter how small, it simply won't work.

Also, from the table you can see I scored high in implementor. Being an implementor means you are well organised and predictable, taking basic ideas and making them work in practice. This again is a useful trait for my role as it is important to be organised while doing coding and electrical wiring because it can quickly become complicated. So, staying on top of this is crucial to ensure you don't make any mistakes which will negatively affect the overall code. However, both traits can mean I can be slow taking my time to do the work. So, although it results in a high level of work which I take pride in, being time consuming can create issues further down the line with meeting deadlines and implementing my work with other group member's work.

Chapter 2: Group Tasks

Group Tasks	Duration (Hours)	Start Date	Finish Date
Allocating roles and responsibilities to each group member.	3	30/09/2024	14/10/2024
Consolidate a communication platform to ensure all information associated with the project is conveyed accurately.	3	30/09/2024	04/10/2024
Familiarising the group with the regulations associated with the project.	4	07/10/2024	21/10/2024
Begin the initiation phase of the project. Using initial ideas begin producing a plan for different wing concepts and mounting solutions.	8	21/10/2024	25/10/2024
All departments begin listing tasks involved with each specific role that need to be completed throughout the project.	8	28/10/2024	04/11/2024
Software related to each role (i.e. FEA, VI Grade and ANSYS). Begin the initiation process by generating ideas for each role.	8-15	14/10/2024	04/11/2024-18/11/2024
Reconvene and discuss work and ideas completed by each department. Ensure that all ideas are considered. Summarise and discuss further the route/idea the group wants to develop towards.	8	18/11/2024	22/11/2024
Each department produces work to be organised into a presentation for the interim VIVA.	20	25/11/2024	10/12/2024
Evaluate and review all work completed prior to assignment and VIVA submission.	20	10/03/2025	28/03/2025
Pre-presentation meetings to ensure all aspects of the project are understood before the final VIVA and all departments have work presented.	20	17/03/2025	30/03/2025

Chapter 3: Individual tasks

Task	Task Duration	Hours Required	Estimated Duration (hours)	Specialist Equipment Required
Learn how to effectively use the software Simulink and MATLAB to create the code required, done by using Simulink and MATLAB onramps provided by the software and practice.	14 days	T(opt): 13	16	Laptop
	14 th – 28 th October	T(med): 16		Simulink/MATLAB software
		T(pes): 19		
Create first code using an Arduino and Simulink to control a basic motor by using a switch.	1 day	T(opt) 1.5	2.25	Laptop
	29 th October	T(med): 2		Arduino UNO Rev3
		T(pes): 4		Stemedu FT90R digital servo motor Connector board PA-O7 Precision Wire strippers Hook up wire spool set Control switch Simulink
Learn how to convert pulse width modulation (PWM) into a variable voltage and learn circuit simulation.	5 days	T(opt): 5	6	Laptop
	29 th - 4 th October - November	T(med): 6		Simulink/MATLAB software
		T(pes): 7		
Learn general control systems and how to control an Arduino with Simulink. Both can be done by using Onramps provided by Simulink/MATLAB website.	6 days	T(opt): 6	8	Laptop
	4 th - 10 th November	T(med): 8		Arduino UNO Rev3
		T(pes): 10		Simulink/MATLAB
Decide on what mechatronics design will be	12 days	T(opt): 8	10.333	Laptop

used for first ever set up, look at potentially using vertical actuators or hydraulic pistons and how they will be implemented.	10 th – 22 nd November	T(opt): 10		
		T(pes): 14		
Create basic idea of what code will look like to make the mechatronics function.	9 days	T(opt): 7	9.666	Laptop
	22 nd – 31 st November	T(med): 10		Simulink/MATLAB
		T(pes): 11		
Produce presentation and what I will talk about for VIVA. (Due 8 th December).	7 days	T(opt): 5	8	Laptop
	31 st – 8 th November - December	T(med): 8		
		T(pes): 11		
Create first prototype code for wing angle based on G values and speed given by simulation group members.	14 days	T(opt): 10	13.666	Laptop
	10 th – 24 th January	T(med): 14		Simulink/MATLAB
		T(pes): 16		
Create prototype code which takes into consideration G values, steering input, speed and GPS location based on simulation data.	12 days	T(opt): 10	12.333	Laptop
	24 th – 5 th January – February	T(med): 12		Simulink/MATLAB
		T(pes): 16		
With the aero and structural teams consider how the mechatronics will be implemented into the wing itself.	6 days	T(opt): 4	6	Laptop
	5 th – 11 th February	T(med): 6		
		T(pes): 8		
Create code that takes all values into consideration for wing angle and include automatic vertical wing height adjustment based on speed.	11 days	T(opt): 10	12.166	Laptop
	11 th – 22 nd February	T(med): 12		Simulink/MATLAB
		T(pes): 15		
Create electrical wiring set up including either electric motors, vertical actuators or hydraulic pistons to go along with code.	18 days	T(opt): 19	22	Arduino Mega 2560 Rev3
	22 nd – 12 th February - March	T(med): 22		BOJACK 12 values 120 Pcs IC
		T(pes): 25		

Finalise code and electrical wiring ironing out any issues.	7 days 12 th – 19 th March	T(opt): 6	10	Opamp timer Darlington
		T(med): 10		Youmile 4-channel driver module
		T(pes): 14		Gear Motor GA12-N20 DC 12V
Write up final project assignment (Due March 30 th)	7 days 19 th – 26 th March	T(opt): 8	11.666	Hook up wire spool set
		T(med): 12		BOJACK 6 values double sided PC8 board
		T(pes): 14		PA-O7 Precision Wire strippers
				Laptop
				Simulink/MATLAB
				Bestgle Soldering Iron Tips
				Weller WESD51
				KY040 Rotary Encoder Module
				MPU6050 Accelerometer and Gyroscope Sensor
				COLM Power Adapter Charger 9V

Create final presentation for final VIVA with group (Due April 1 st)	6 days	T(opt): 6	8	Laptop
	26 th - 1 st	T(med): 8		
	March - April	T(pes): 10		
Meetings for project with group	Once to twice a week	T(opt):35	40	Laptop
		T(med): 40		
		T(pes): 45		
Total Estimated Time (hours): 196.08				

List of Specialist Equipment	Cost (£)
Laptop	600
Simulink/MATLAB subscription	77 (per year)
Arduino UNO rev3	20
Arduino Mega 2560 Rev3	40
BOJACK 12 values 120 Pcs IC Opamp timer Darlington (pack of 120)	10
Youmile 4-channel driver module	7
Stemedu FT90R digital servo motor	20
Gear Motor GA12-N20 DC 12V	2
Hook up wire spool set (for 25ft)	12
BOJACK 6 values double sided PC8 board	2
PA-O7 Precision Wire strippers	24
Bestgle Soldering Iron Tips (Pack of 5)	8
Weller WESD51	200
KY040 Rotary Encoder Module	4.50
MPU6050 Accelerometer and Gyroscope Sensor	15
COLM Power Adapter Charger 9V	9
Electric Linear Actuator 100mm Stroke 1000N Linear Actuator 24V	46
Festo Pneumatic Piston Rod Cylinder 50mm stroke	54
Total cost: 1150.50	
Average delivery time: 2 - 3 days	

Chapter 4: Significant Milestones

Milestone	Date
Completed Baseline CFD simulation on the Morgan to gain data for vehicle simulation.	08/10/24
Completed vehicle simulation test of the Morgan on a track to attain baseline performance.	27/10/24
Finished Finalised rear wing concept designed on CAD.	17/11/2024
Complete CFD of the chosen wing profile.	24/11/2024
Run FEA on the chosen wing profile and mounts.	01/12/2024
Interim VIVA.	10/12/2024
Produce a prototype to test in the wind tunnel.	09/02/2025
Complete a wind tunnel test of the rear wing concept. Use the data gathered from the test and compare against CFD results.	16/02/2025
Finalise control system.	27/02/2025
Develop prototype and manufacture using additive manufacturing processes.	16/03/2025
Final VIVA.	01/04/2025

Chapter 5: Gateway objective

An important gateway for my area of the project is ensuring the wing on the car is able to get to the new position required, when for example under heavy braking for a slow corner, within the time specified by the simulation team. As this is a performance wing, drivers using the car will want rapid response to heavy braking, therefore the wing needs to activate immediately or even before the driver has got to 100% braking. So, for example by the time they have applied full braking the wing is already in the correct position slowing down the car. This needs to be completed before we can finalise the control systems, an important milestone for completing the group project, which should be done by 27/02/2025. There are few considerations I need to take to make sure this is possible. This includes:

- What is the RPM of the motors.
- What is the mm/s of the vertical actuators and hydraulic pistons
- Which of the 3 will be the most effective at adjusting the angle and height of the wing.
- What kind of voltage is required to power the chosen type of motor.
- How will the code written ensure the wing is as efficient as possible at getting to its new position .
- That all factors like G-force, GPS location and speed are taken into consideration by the code when the wing is adjusting.
- The mechatronics won't fail under constant movement, which needs to be rapid to respond to the driver's inputs.
- What forces the mechatronics and wing will go under when moving at high speeds.
- What is the ideal point for the wing to begin moving when the driver starts to input heavy braking.
- How long does it take for the wing to move into the correct position to provide downforce and braking.

The main goal of this gateway is to make sure the mechanics on the wing are strong and quick enough before we finalise the coding and mechatronics design. The simulation team will give us a number of how fast they want the wing to be in its new position by, for example 300ms. As the mechatronics team, we will make sure that is possible with the motors and mechanism being used. And then see if we can get the wing to do that in maybe 250ms, making it even faster than needed at a 20% improvement to what simulation want. This would be good as the faster the wing can adjust its position the more its performance benefits increase. However, I will need to ensure the mechatronics won't fail while making this rapid movement constantly when the car is being driven hard on the track or on the road. And I will also need to consider the possibility of the wing overshooting its position and how we will prevent that from happening.

Chapter 6: Areas of Concern

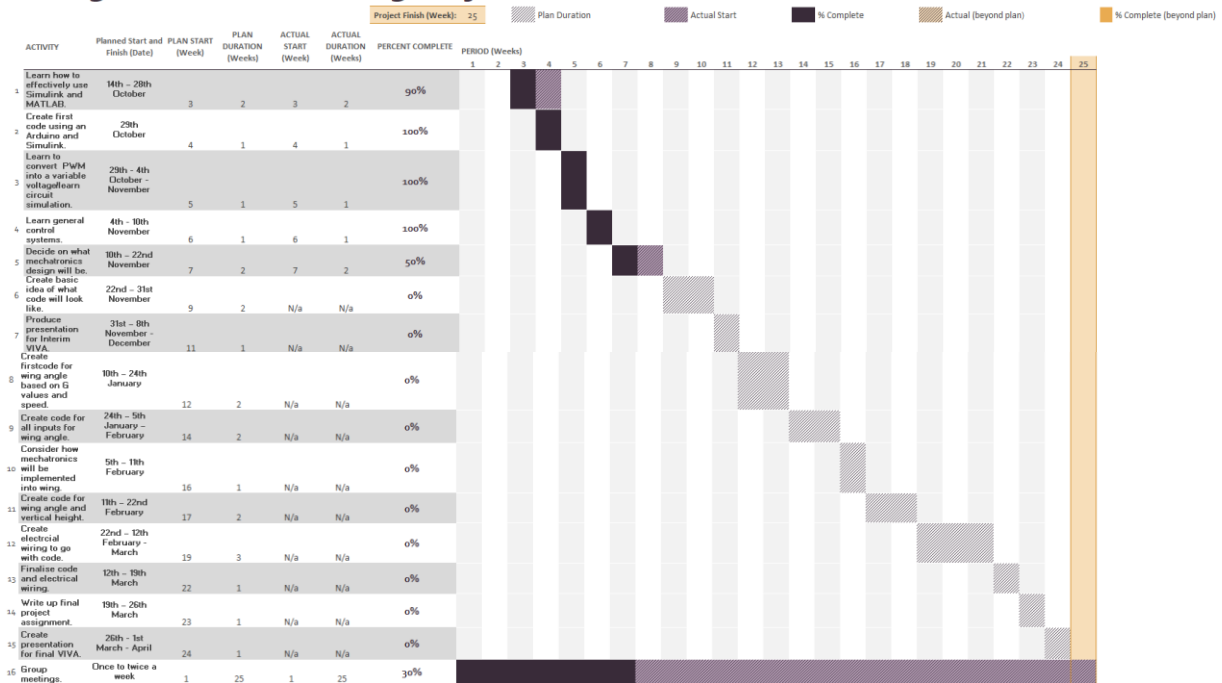
One area of concern for my project is implementing the simulation data into the code for variables which will change the position of the wing. The data will be crucial for creating and finalizing the code in time for the deadlines. To mitigate this risk, there will need to be good communication and teamwork between the simulation team and the control systems team. This includes ensuring the simulation team knows what information we need to create the code and when we need it by. This can be done by setting deadlines and regular meetings with structured tables of what information we need.

Another problem is that the mechatronics may not be strong enough. The wing will undergo large amounts of force when fully extended, and we need to be sure it won't break under heavy load. The use of weak RC motors may not be the best choice because we will need gearing which will take up valuable space in the wing mounts and may become too complex. Therefore, we may look at using hydraulic pistons or vertical actuators which will be stronger and easier to implement mitigating the risk of a mechatronics failure. We will then also be able to use mechanical leverage to make a small piston make large movements while still being strong lowering the risk that wing will break under heavy loads. This also means the mechatronics are less likely to get in the way of the structural and aero teams meeting their milestones.

Chapter 7: Gantt Charts

My personal Gantt Chart for my tasks:

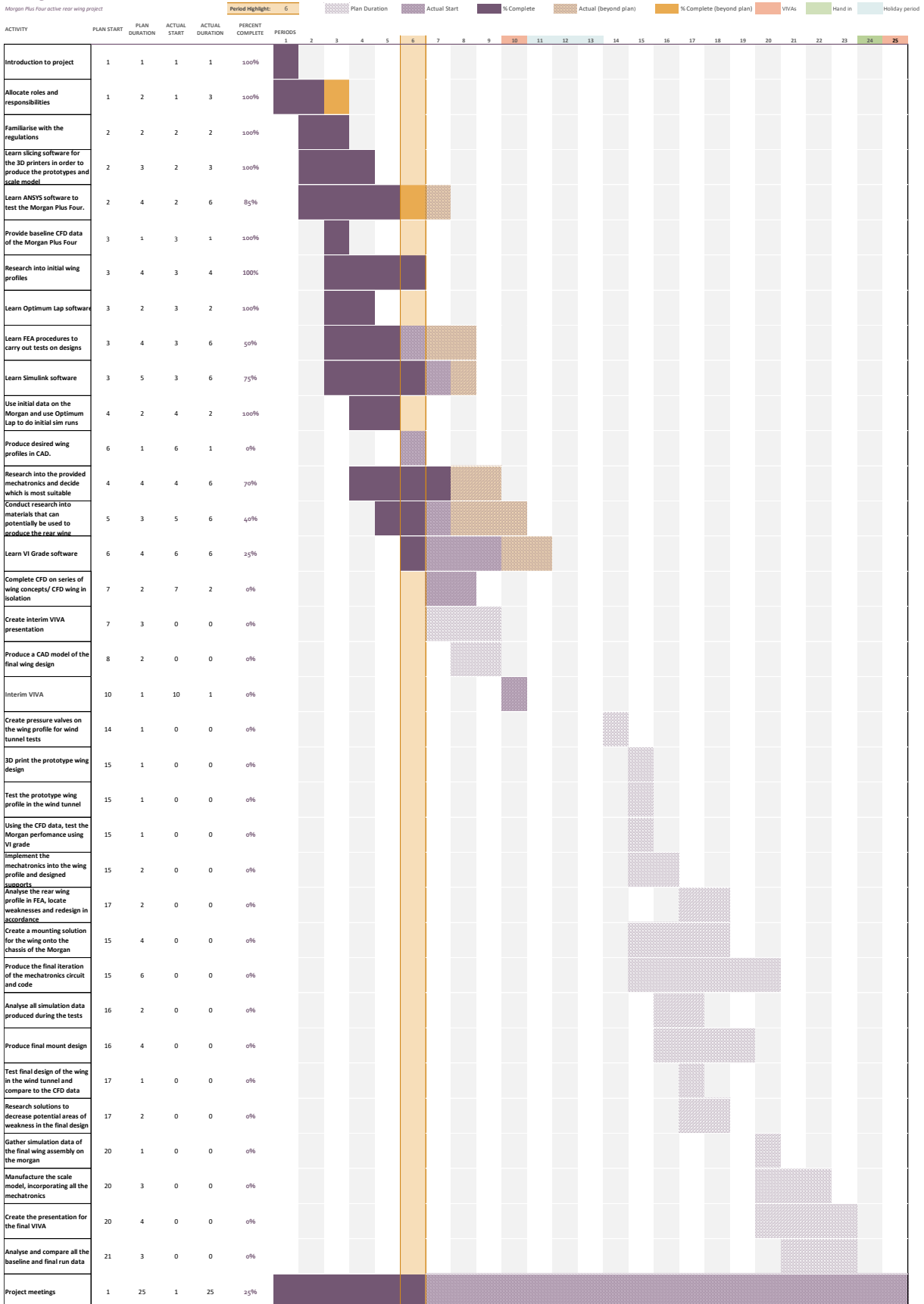
Morgan Active Aero Wing Project



Group Gantt Chart for overall tasks:

Project Planner

Morgan Plus Four active rear wing project



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