

University of Wales Trinity Saint David

Wales Institute of Science and Art



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Y Drindod Dewi Sant

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Project Planning

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Engineering Management

Nathan Evans

2204179

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1 Introduction

This assignment focuses on the planning of the Group Design Project. This project entails 8 group members working cohesively to produce an active rear wing for the Morgan Plusfour. This rear wing will aim to enhance the performance of the vehicle around a selected track. Belbin's model test was conducted to see how I would perform within the group. As the Aerodynamicist, I am tasked with ensuring the correct rear wing concept is chosen whilst following the regulations set. Factors considered throughout the planning process are; personal and group tasks, milestones, costs and gateways. Task scheduling, and risk mitigation will be explained in detail for the project.

1.1 Aims

- Develop a comprehensive project plan.
- Outline the roles and responsibilities for each group member and overall group tasks.
- Produce a detailed list of personal tasks throughout the project.
- Identify 2 risks and 1 significant gateway throughout the project.

1.2 Objectives

- Utilise planning tools such as Gantt Charts to outline key tasks and deadlines.
- Discuss roles and responsibilities and categorise each member into their desired role.
- Complete a Belbin's Model Test and Personality test, then compare it to the traits of an aerodynamicist.
- List milestones throughout the project ensuring timelines are listed. Furthermore, include costing and bill of materials required.
- Setting Specific, Measurable, Achievable, Relevant, Time based (SMART Goals)
- Analyse possible failure points for each task and create a risk management plan to address these issues.



Figure 1 Shows a diagram of the project life cycle. This method is typically used to manage projects to ensure a successful outcome (Sketchbubble 2024).

2 Roles and Responsibilities

2.1 Allocated Group roles

Table 1 Shows the group members and their allocated roles.

Names	Roles
Nathan Evans	Aerodynamic Development
Oliver Wilson	
Alexander Cook	Project Management
	Manufacturing
Mathew Starke	Structural and Materials
Conor Jenkins	
Alexander White	Control Systems and Mechatronics
Scott Holden	
Dylan Brierley	Vehicle dynamics and simulation

Table 2 Shows the Roles and associated responsibilities.

Responsibilities	
Aerodynamics Development	- Learn ANSYS software to test the Morgan PlusFour. - Provide data on a baseline run of the Morgan PlusFour. - Design a rear wing using research and theoretical knowledge. - Producing a CAD model of the Final Design to all departments. - Test concepts of the rear wing in the wind tunnel to ensure CFD is correct. - Working with Manufacturing produce the concept to test in the wind tunnel. - Deliver accurate data to all departments regarding the performance of the rear wing.
Project Management and Manufacturing	- Managing the project, ensuring all group members are comfortable with their tasks. - Produce a Gantt chart. - Risk Management – identify potential risks to the project's success and provide solutions to mitigate. - Manage CAD Files of the rear wing and mounting brackets. - Produce multiple prototypes for the testing in the wind tunnel. - Produce the final concept assembled.
Structural and Materials	- Conduct research into materials that can 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. Locate regions of weakness in the design of the rear wing and mounting solutions. - Research into methods to increase any areas of weakness and then apply to design.
Control systems and Mechatronics	- Communicate with all departments to ensure that the mechatronics can be implemented into the design without any major reconstruction of the concept. - Research into the provided mechatronics and decide which is most suitable. - Produce code and circuit allowing for the rear wing to perform outputs.
Vehicle Dynamics	- Determine sufficient electrical systems to differentiate data from sensors. - Create electrical filters, for correct mechatronic movement from data collected. - Research electrical equipment provided to us. - Test chosen equipment for compatibility against our chosen design.
Vehicle simulation	Learn OptimumLap software.

- Use initial data on the Morgan and OptimumLap to do initial sim runs.
- Learn VIGrade software.
- Using the data produced by CFD, test the Morgan Plus Four performance using VIGrade software.
- Produce data on the performance of the vehicle. Use this data to produce code for the control system.
- Analyse data produced from the tests.

2.2 Belbin's Model

Belbin's model is the framework for gaining an understanding on the different roles within a group. Developed by Dr. Meredith Belbin in 1981, she suggests that effective teams are composed of range of different views, strengths and working styles (Roxana-Marcela Zaharia, Barbu et al. 2024). Furthermore, individuals contribute best when their roles align with these strengths. Belbin identified nine distinct team roles which were placed into 3 categories. These categories are; Action, People and Thought.



Figure 2 Shows a diagram of Belbin's model and the individual group member traits associated with the model (Becky Simon 2017).

Table 3 Shows the 9 distinct roles categorised, these were placed into 3 categories. These categories are; Action, People and Thought.

People	Thought	Action
Coordinator	Plant	Shaper
Team Worker	Monitor Evaluator	Implementer
Resource Investigator	Specialist	Complete Finisher

2.3 Belbin Test Results

I completed a Belbin test to see which role I would be when working in a group (Mark Sandford 2024). The test consisted of a series of questions. For these questions I allocated a total of 10 points that I believe best describes myself. I scored highly on; Implementer, Coordinator, Plant, Monitor Evaluator and Complete Finisher.

The Implementer is practical and efficient. They can convert ideas into plans and begin work immediately. Once that is complete, they ensure that the group remains organised. Implementers favour structure and systematic approaches to a task. They are considered reliable in getting tasks done (, The 9 Belbin Team Roles, explained | Models for managers).

Table 4 Shows the results of Belbin's model test. The green shows I scored high (66-85%) and red shows low (0-33%).

	IM	CO	SH	PL	RE	ME	TW	CF
Score	14	12	5	9	2	12	7	9
Average	10	8.8	11.6	7.3	7.8	8.2	10.9	5.5

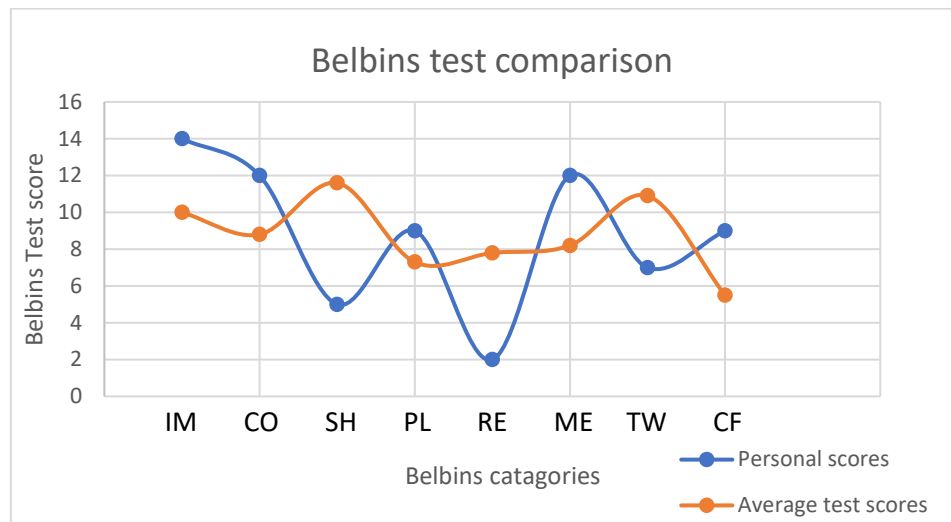


Figure 3 Is a visual representation of the results from Belbin's test results.

2.4 Personality Test Results

Along with a Belbin's test I completed a personality test. With this test, I answered a series of multiple-choice questions that I felt best represent my behaviours and feelings. In this test I found that I am a Type A tendency. Furthermore, I was able to complete another personality test. The results concluded that I was an INTJ (16 Personalities 2024).

Table 5 Shows INTJ and Type A personality traits and weaknesses (Laura Dorwart 2023). All the traits highlighted in green show the correlation between my personality and the role if an aerodynamicist (indeed Editorial Team 2024).

Type A personality traits	Type A Weaknesses	INTJ Architect personality traits	INTJ Weaknesses
Driven	Aggressiveness	Analytical	Overthinker
Rule orientated	Works compulsively	Problem solver	Overly Independent
Competitiveness	Assertive	Honest communicator	Blunt communicator
Perfectionism	Dislike making mistakes	Desire to improve	Pursuit of Perfection
Urgency	Impatient	Efficient	High expectations
Goal-orientated nature	Distressed when goals are not reached	Strategic	Demanding

3 Overall Group Tasks

Table 6 Shows a list of overall group tasks for the project.

Group Tasks	Duration (Hours)	Start Date	Finish Date
Allocating roles and responsibilities to each member.	3	30/09/2024	14/10/2024
Consolidate a communication platform to ensure information is conveyed accurately.	3	30/09/2024	4/10/2024
Familiarise the group with the regulations associated with the project.	4	7/10/2024	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.	8	28/10/24	4/11/2024
Software related to each role (i.e. FEA, VI Grade and ANSYS).	8-15	14/10/2024	4/11/2024-18/11/2024
Reconvene and discuss work and ideas completed by each department. Summarise and discuss further the route 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.	20	17/03/2025	30/03/2025
Total	102		

4 Personal Tasks

Table 7 Shows a PERT Table, this lists all the personal tasks that I have been undertaken for the group project.

Personal Tasks	Duration (hours)	Standard time (hours)	Pessimistic time (hours)	Start Date	End Date	Bill of Materials and list of Equipment
Learn ANSYS software to test the Morgan PlusFour.	T(opt) 15	25	27	07/10/2024	01/11/2024	ANSYS Software - £8000 SolidWorks - £4462
	T(med) 25					
	T(pes) 35					
Conduct research into different wing profiles.	T(opt) 20	27	29	14/10/2024	08/11/2024	Laptop - £800
	T(med) 25					
	T(pes) 40					
Produce desired wing profiles in CAD.	T(opt) 10	12	13	11/11/2024	15/11/2024	SolidWorks
	T(med) 12					
	T(pes) 15					
Using the CAD files import into ANSYS and complete CFD on the concepts.	T(opt) 20	25	26	18/11/2024	29/11/2024	SolidWorks and ANSYS
	T(med) 25					
	T(pes) 30					
Use CFD data to compare wing profiles and identify which one performs best.	T(opt) 15	20	21	02/11/2024	06/12/2024	
	T(med) 20					
	T(pes) 25					
Interim VIVA	N/A			10/12/2024	11/12/2024	
Collaborate with Manufacturing to produce the selected concept for wind tunnel testing.	T(opt) 25	35	37	13/01/2025	24/01/2025	Polylactic Acid (PLA) - £20
	T(med) 35					
	T(pes) 45					
Using the wind tunnel, test the wing profile and gather data.	T(opt) 3	5.5	6	27/01/2025	31/01/2025	Wind Tunnel - £250
	T(med) 5					
	T(pes) 10					
Analyse the data from wing in isolation and ensure it correlates with the CFD results.	T(opt) 10	15	16	03/02/2025	14/02/2025	SolidWorks and ANSYS
	T(med) 15					
	T(pes) 20					
Implement the wing design onto the Morgan PlusFour model.	T(opt) 3	5	5	17/02/2025	21/02/2025	SolidWorks
	T(med) 5					
	T(pes) 7					
Begin CFD tests on Morgan PlusFour with new rear wing concept.	T(opt) 3	7	8	24/02/2025	28/02/2025	ANSYS
	T(med) 7					
	T(pes) 11					
Compile all data and information related aerodynamics in an assignment format.	T(opt) 10	12	13	03/03/2025	21/03/2025	Office 365
	T(med) 12					
	T(pes) 15					
Final Viva/ Finish	N/A			01/04/2025	02/04/2025	
Total		189	200			£13,532.00

4.1 Aerodynamics Flow Chart

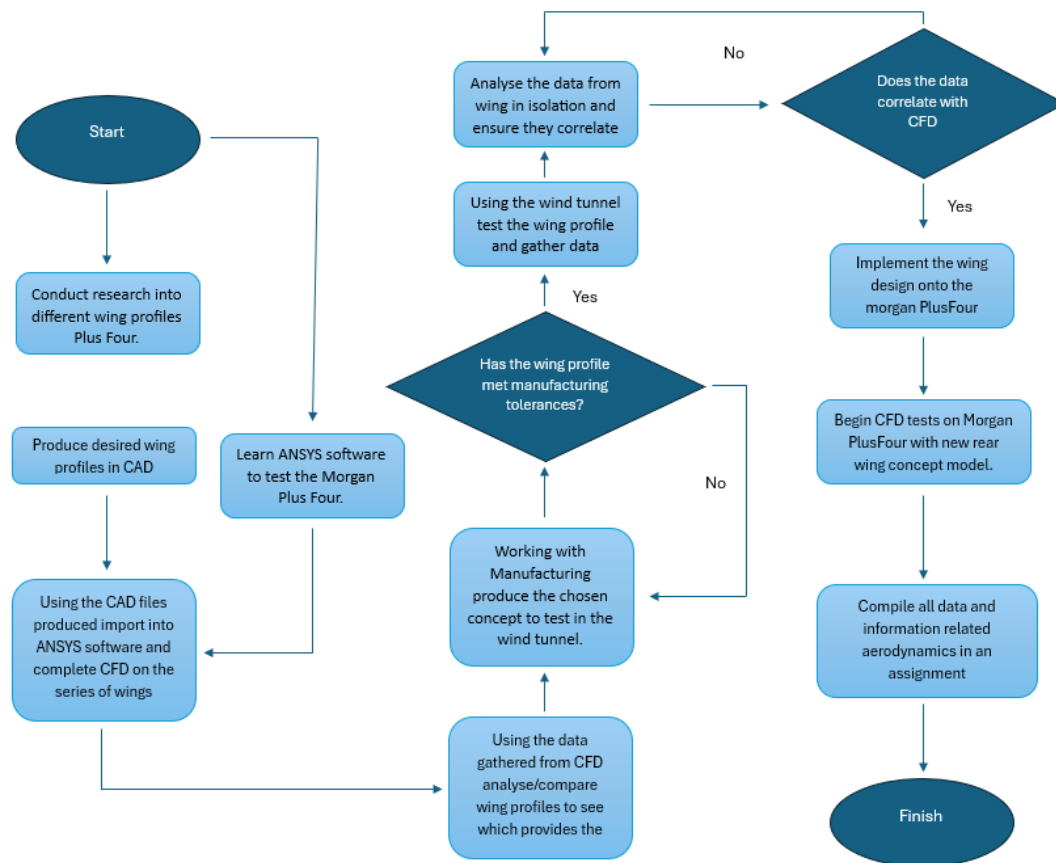


Figure 4 Shows a flow diagram of my personal tasks throughout the project.

4.2 SMART Goals

Table 8 Shows a select few SMART Goals that have been set for the project.

Task	Specific	Measurable	Achievable	Relevant	Time
Learning ANSYS for CFD Analysis	Understand the skills required to simulate aerodynamic performance in CFD.	Complete video tutorials to analyse two wing profiles within two weeks.	2 hours daily to ANSYS practice.	Essential for accurately simulating the aerodynamic performance of the Morgan PlusFour's rear wing.	4 weeks
Researching wing profiles	Identify and evaluate 3-4 wing profiles suitable for the Morgan PlusFour.	Compile a table of aerodynamic properties (e.g., downforce and drag coefficients) for each profile.	3 research sessions of 3 hours over the allotted period.	Critical for selecting the most efficient and compatible wing design.	4 weeks

5 Project Milestones

Milestones are measurable points within a project timeline that represent the completion of major phases. Milestones act as markers that demonstrate progress toward the project's ultimate objectives. Achieving milestones gives the team clear progress markers, providing a sense of achievement. Milestones are used to track timelines, ensuring the project remains on schedule and identifying if adjustments are needed. When linked to gateways, milestones help identify risks early. If a milestone isn't reached as planned, it triggers a review to address the issue.

Table 9 Shows a list of the milestones with allocated deadlines for the project.

Milestones	Duration (hours)	Start Date	Finish Date
Completed Baseline CFD simulation on the Morgan to gain data for vehicle simulation.	8	07/09/24	12/09/24
Completed vehicle simulation test of the Morgan on a track to attain baseline performance.	4	21/09/24	04/11/24
Complete CFD of the chosen wing profile	15	03/02/2025	14/02/2025
Winter VIVA	1	10/12/2024	11/12/24
Complete FEA on mounting system	20	03/02/2025	21/02/2025
Produce a prototype to test in the wind tunnel.	35	13/01/2025	24/01/2025
Attain results of the chosen wing profile on the Morgan Plus four.	7	24/02/2025	28/02/2025
Complete a wind tunnel test of the rear wing concept. Use the data gathered from the test and compare against CFD results.	20.5	27/01/2025	31/01/2025
Finalise control system	10	12/03/2025	19/03/2025
Upload final write up document		14/09/2024	30/03/2025
Final VIVA	1	01/04/2025	02/04/2025

6 Gateways - Analysis on rear wing concepts

To ensure effective planning of a project gateways and milestones must be outlined. This method is used to assess progress and determine whether the project should continue to the next phase. Each gateway allows for the members to review the project's progress, performance, and alignment with objectives, ensuring that the criteria is met before advancing.

The Aerodynamic Analysis Gateway is designed to evaluate aerodynamic concepts for an active rear wing. This stage ensures that the most aerodynamically effective concepts move forward, helping to refine the design by identifying any options that may not meet performance requirements.

6.1 Scope

This gateway includes initial Computational Fluid Dynamics (CFD) simulations to measure downforce, drag, and airflow patterns. At this stage, detailed structural analysis/ FEA are reserved for later gateways. This task will include an angle of attack study which will take a large portion of time to complete.

6.2 Evaluation Criteria and Metrics

Each concept must meet a minimum threshold of aerodynamic lift, with at least a 40% increase in lift over the baseline. Additionally, designs must not exceed specified drag limits to ensure they do not compromise the vehicle's speed and fuel efficiency etc.

6.3 Activities and Processes

ANSYS is used to conduct CFD simulations allowing the department to analyse airflow and measure aerodynamic properties of each concept. Mesh quality and boundary conditions were standardized across designs to ensure consistent results, with simulations run at various angles of attack to assess the wing's performance under different driving conditions.

6.4 Documentation and Reporting

All findings were documented in a preliminary report, detailing the simulation setup, boundary conditions, and each concept's performance metrics. This documentation allows for easy reference in subsequent gateways and ensures that design decisions are well-justified.

7 Risk Management

Risk management is essential in project planning, as it focuses on identifying, and addressing potential risks and uncertainties that could impact project success. The process involves recognising and evaluating risks whilst understanding both individual and collective implications. Measures need to be implemented to reduce risks setting aside appropriate contingencies to handle unforeseen issues.

Failure to test a series of wing concepts

In a project where aerodynamics plays a central role, failing to test multiple wing concepts poses a significant risk. The aerodynamic profile of a wing directly influences overall vehicle performance, as all other departments rely on the Aerodynamicists to deliver optimized designs. Without thorough testing and validation of wing concepts, there's a risk of selecting suboptimal designs that could compromise downforce, increase drag, or reduce vehicle stability. This oversight could lead to performance deficits, increased costs, and delays due to the need for redesigns.



Figure 5 Shows a diagram of the processes involved in risk management (Nicky Clarke 2022).

7.1.1 Aims

- **Maximise downforce without generating excessive drag:** One of the primary objectives in wing concept testing is to achieve maximum downforce, which enhances grip and stability, without generating excessive aerodynamic drag. Balancing these two factors is crucial, as increased drag reduces top speed and overall efficiency. The risk involves developing a wing profile that either compromises downforce or introduces too much drag, leading to decreased vehicle performance.
- **Conduct Comprehensive Research and Development (R&D):** R&D is essential to identify all possible aerodynamic improvements and innovative design approaches. Exploring all areas that could boost performance ensures that the final design incorporates the best possible features. The risk of incomplete R&D means potentially missing opportunities for performance enhancements, which could be detrimental in a competitive environment. Therefore, it's important to investigate various wing profiles, test in simulated and real-world conditions, and analyse the results thoroughly.

7.1.2 Risk Mitigation Strategies

1. **Establish Testing Protocols:** Develop a structured approach to test multiple wing concepts under various conditions. This can include using CFD simulations and wind tunnel tests to evaluate the aerodynamic characteristics of each design.
2. **Allocate Sufficient Time and Resources:** Ensure the project timeline includes adequate time for concept testing and refinement. Budget for necessary resources, such as simulation software, wind tunnel access, and testing personnel.
3. **Collaborate Across Departments:** Work closely with other departments, such as structural engineering and performance analysis, to ensure that the selected wing concept integrates seamlessly with other systems.
4. **Document Findings and Iterations:** Maintain detailed records of each concept tested, including test conditions, results, and feedback. This allows for informed decision-making and the ability to revisit prior concepts if new information becomes available.
5. **Encourage Creative Exploration in R&D:** Foster an environment where the group members are encouraged to explore innovative wing designs that could unlock additional performance.

7.2 Inaccurate data provided to other departments

Inaccurate data within the project presents a significant risk as it impacts the outcomes of all dependent departments. In this project, the accuracy of data is critical, as other departments rely on it to make informed decisions about structural integrity, performance, and overall vehicle dynamics. Errors in data, whether related to downforce, drag coefficients, or airflow characteristics, could lead to faulty designs, compromised safety, increased costs, and project delays due to rework and adjustments.

7.2.1 Aims

- **Ensure Data Precision and Reliability:** Provide accurate, consistent, and validated aerodynamic data to other departments. Precise data allows each team to make decisions with confidence, leading to optimal design choices that improve vehicle performance and safety.
- **Enhance Cross-Departmental Communication and Data Verification:** Establishing effective communication and data verification processes between departments ensures that information is accurately conveyed. Minimizing misunderstandings and the risk of using incorrect data. Regular feedback and reviews help ensure accuracy in shared data.

7.2.2 Risk Mitigation

1. **Implement Data Verification and Validation Protocols:** All data generated by the Aerodynamics team should confirm the accuracy.
2. **Develop Clear Documentation Standards:** Standardise the format and process for documenting and sharing data to reduce errors. Each data set should be accompanied by context, units, and any limitations.
3. **Regular Meetings:** Schedule meetings to review and discuss data inputs. This ensures that any concerns are identified allowing for a resolution before the data is used in downstream decisions.
4. **Data Review Responsibilities:** Designate two members to complete data analysis, the role is to check data outputs before they are shared with other departments. This increases accountability and quality control.
5. **Real-Time Data Sharing Platforms:** Implement a communication platform for data sharing and version control, which allows all departments to access current data, reducing the risk of outdated or inaccurate information being used.

8 Gantt Chart

8.1 Personal Gantt Chart

Project Planner

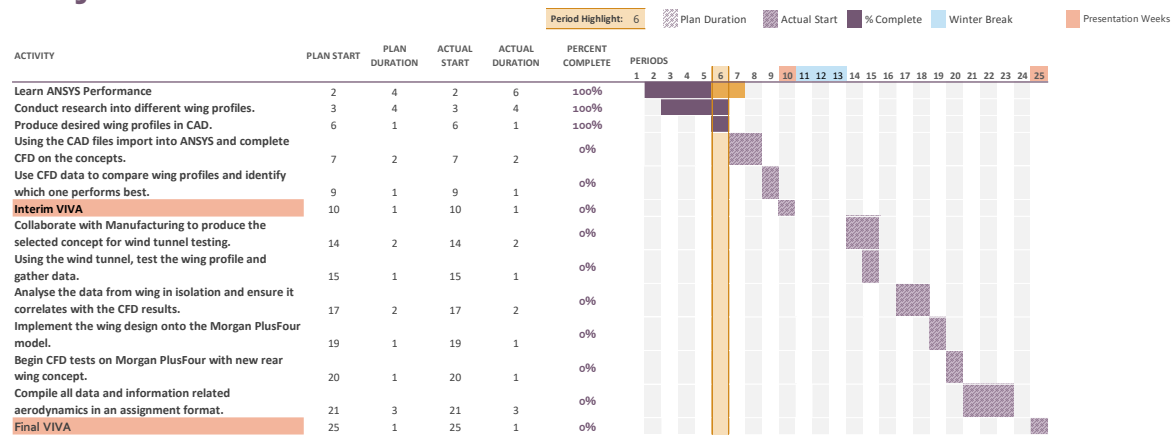


Figure 6 Shows my personal Gantt Chart for the group project.

8.2 Group Gantt Chart

Project Planner

Morgan Plus Four active rear wing project

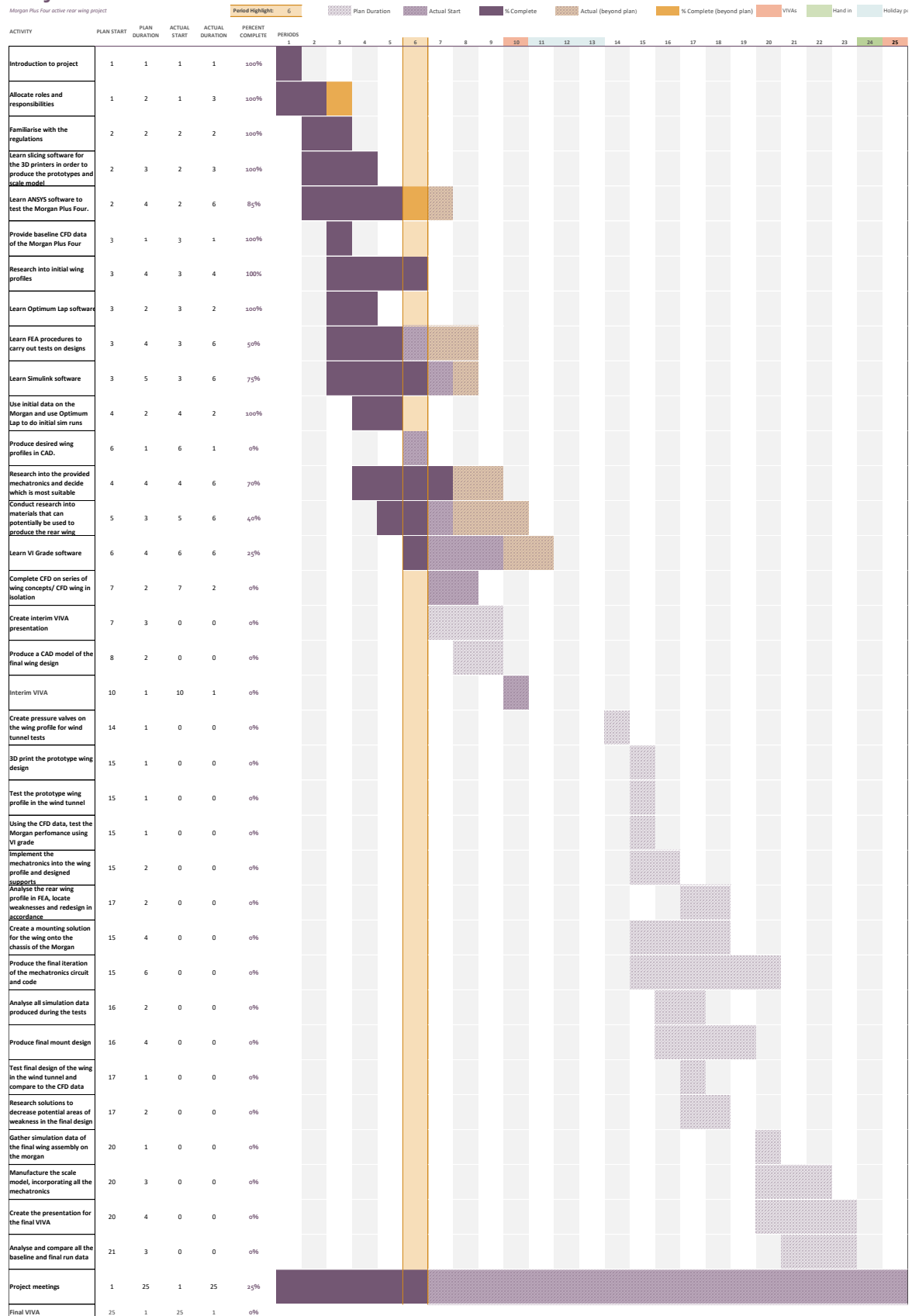


Figure 7 Shows the group Gantt chart for the project.

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