

University of Wales Trinity Saint David

Wales Institute of Science and Art



Prifysgol Cymru

Y Drindod Dewi Sant

University of Wales

Trinity Saint David

Project Management

Engineering Management (ACHA5012)

Alexander Cook

2104599

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1 Introduction

This project involves the design, development, and prototyping of an active rear wing system for the Morgan Plus Four, a high-performance sports car. The wing is designed to dynamically adjust to optimize downforce and reduce drag, enhancing the car's handling, stability, and driving performance at speed. By addressing aerodynamic challenges, the project aims to refine the Morgan Plus Four's competitive edge while maintaining its iconic style.

As project manager and manufacturing lead, I am responsible for steering the team, managing workflows, and overseeing the production of the prototype. The success of the project relies on effective time management, resource allocation, and leveraging team expertise.

This report details the wing's development process, from initial design to final testing and evaluation. It concludes with an analysis of the prototype's performance and offers recommendations for future iterations, focusing on potential refinements and integration into production models.

1.1 Aims

- Enhance performance: Improve the Morgan Plus Four's aerodynamic efficiency to boost handling and stability.
- Demonstrate good design engineering capabilities: To showcase advanced engineering techniques in design, analysis, and prototyping of an active aerodynamic system.

1.2 Objectives

- Design: Develop a CAD model of the active rear wing that meets aerodynamic requirements.
- Prototype: Manufacture a functional prototype using 3D printing.
- Test: Validate the wing's performance through physical and simulated testing.

2 Team members

2.1 Team roles and responsibilities

Table 1 - Table showing each team member's roles along with the task for each team.

Names	Roles	Responsibilities	
Nathan Evans	Aerodynamics Development	Aerodynamics Development	• Learn ANSYS software to test the Morgan Plus Four.
Oliver Wilson			Provide data on a baseline run of the Morgan Plus Four. • Design a rear wing using research and theoretical knowledge. Producing a CAD model of the Final Design to all departments. • Test iterations/final design of the rear wing in the wind tunnel to ensure CFD is correct • Working with Manufacturing/ prototype department to produce the final concept to test in the wind tunnel • Using the wind tunnel test the wing profile and gather data. • Deliver accurate data to all departments regarding the performance of the rear wing.
Alexander Cook	Project management	Project management	• Managing the project, ensuring all group members are comfortable with their tasks. • Produce a Gantt chart. • Ensuring group moral is always at consistent level. • Risk Management – identify potential risks to the project's success and provide solutions to mitigate. • Consider Costs.
	Manufacturing		• Manage CAD Files of the rear wing and mounting brackets etc. • Produce multiple prototypes for the testing in the wind tunnel. • Produce the final concept assembled.
Mathew Starke	Structural and Materials	Structural and Materials	• 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. 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.
Conor Jenkins	Structural and Materials		

Alexander White	Control Systems and Mechatronics	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.
Scott Holden	Vehicle Dynamics	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.
	Control Systems and Mechatronics		
Dylan Brierley	Vehicle Dynamics	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 Skills and personality of a team manager

Using Belbin's Team Model, a team manager typically benefits from a combination of specific personality traits found in several roles within the model. No single role perfectly embodies the ideal team manager, as effective management often requires the flexibility to adapt traits from multiple roles to suit various team dynamics, challenges, and goals.

2.2.1 Coordinator (Leader)

- **Personality Traits:** Confident, organized, and mature.
- **Why This is Important:** Coordinators are natural leaders who know how to bring people together and ensure that everyone is aligned with the team’s goals. A team manager with this trait can effectively delegate tasks, clarify roles, and facilitate collaboration, ensuring the team operates cohesively.

2.2.2 Shaper (Driver)

- **Personality Traits:** Dynamic, resilient, and results oriented.
- **Why This is Important:** Shapers push the team forward, setting a high pace and keeping members motivated. In the face of challenges, a manager with Shaper traits can maintain

momentum, overcome obstacles, and encourage perseverance. This role also helps a team stay focused on goals and deadlines, making it essential for project-driven environments.

2.2.3 Monitor Evaluator (Objective Critic)

- **Personality Traits:** Analytical, logical, and discerning.
- **Why This is Important:** Monitor Evaluators provide balanced and objective perspectives, which are crucial for decision-making. A team manager with these traits can weigh options carefully, assess risks, and make informed choices without being influenced by emotion or bias, leading to more sound strategies and effective problem-solving.

2.2.4 Team worker (Supporter)

- **Personality Traits:** Diplomatic, cooperative, and empathetic.
- **Why This is Important:** Team workers prioritize harmony and help smooth over conflicts. A manager with Team worker traits can mediate disagreements, build rapport, and foster a positive environment. This trait is invaluable in team management, as it helps build trust and encourages open communication among team members.

2.2.5 Completer Finisher (Detail-Oriented)

- **Personality Traits:** Meticulous, conscientious, and quality-focused.
- **Why This is Important:** Completer Finishers are detail-oriented and take pride in finishing tasks to high standards. For a manager, these traits ensure that no critical details are overlooked and that the team's output meets or exceeds expectations. This is especially helpful when finalizing projects or ensuring that deliverables are polished and error-free.

2.2.6 Resource Investigator (Networker)

- **Personality Traits:** Outgoing, curious, and adaptable.
- **Why This is Important:** Resource Investigators are valuable for their ability to connect with others, discover new opportunities, and bring fresh ideas to the team. A manager with this trait is proactive in seeking resources, solutions, or partnerships that could benefit the team. They are also often seen as approachable and open to innovation, which can inspire creativity within the team.

2.2.7 Implementer (Practical Organizer)

- **Personality Traits:** Practical, disciplined, and structured.
- **Why This is Important:** Implementers excel at turning plans into action, a vital skill for managing projects. A manager with Implementer traits ensures that strategic plans are executed efficiently and that the team stays on track with timelines and procedures. They

contribute to a structured environment, which can boost productivity and help maintain team discipline.

2.3 Combining Traits for an Effective Team Manager

While each role has specific traits, a successful manager often blends these to balance driving performance, ensuring quality, fostering teamwork, and maintaining a positive, supportive atmosphere. Adaptability is key—effective managers should know when to lean into a particular role based on the team’s current needs or project demands.

(Belbin, 2004)



Figure 1 - Belbin's team roles

3 Groupe tasks and timings

Table 2 - Table incorporating the overall team tasks with their planned duration and estimated start and finish dates

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	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 that need to be completed throughout the project.	8	28/10/24	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

4 Individual tasks

Table 3 - Table showing my personal manufacturing tasks with their associated timings and listed bill of materials, costs and required equipment.

Manufacturing tasks								
Task		Required time (hours)		Estimated time (hours)	Dependencies	Bill of Materials	Estimated cost (GBP)	Specialist equipment
1	Learn how to use slicing software for creating the best 3D printing result of parts	1.5	T(opt)	3.1	-	NA	NA	Chosen slicing software and suitable computer
		3	T(med)					
		5	T(pes)					
2	Research different types of filaments, considering the possibility of testing flexible wing designs	4	T(opt)	7.7	-	PLA Filament	1kg - £11 2kg - £27	NA
		8	T(med)					
		10	T(pes)					
3	Conduct research into assembly and bonding procedures for different types of filaments	5	T(opt)	8.2	Task 2	NA	NA	NA
		8	T(med)					
		12	T(pes)					
4	Agree on a scale with the aerodynamic department that suits the build size of the printers along with the aerodynamic properties and size of the wind tunnel	2	T(opt)	3.5	-	Hobbyist 3D printer with a build size of l 250mm x w 250mm x h 250mm. Prices vary depending on finish quality and machine speed.	£200 - £1100	3D printer and Wind tunnel
		3	T(med)					
		7	T(pes)					
5	Create pressure valves on the wing profiles supplied by the aero team for testing	8	T(opt)	10.7	-	Subscription to Solidworks	"Price on demand"	Solidworks and suitable computer
		10	T(med)					
		16	T(pes)					
6	Using CAD software create stands for the wing profile prototypes to be tested in the wind tunnel	10	T(opt)	14.0	-	Subscription to Solidworks	"Price on demand"	Solidworks and suitable computer
		14	T(med)					
		18	T(pes)					
7	Ensure the CAD files of each part produced by the different departments are	4	T(opt)	8.0	-	Subscription to Solidworks	"Price on demand"	Solidworks and suitable computer
		8	T(med)					
		12	T(pes)					

	suitable for 3D printing							
8	Using slicing software prepare the prototypes for print	3	T(opt)	6.0	Task 1; Task 2; Task 7	Hobbyist 3D printer with a build size of l 250mm x w 250mm x h 250mm.	£200 - £1100	3D printer
		6	T(med)					
		9	T(pes)					
9	Prep the prototype wing profile for the wind tunnel tests	9	T(opt)	14.8	Task 2; Task 3; Task 5; Task 8	Tools can be designed and 3D printed	Negligeable	Sanding and polishing tools.
		15	T(med)					
		20	T(pes)					
10	Check the CAD files of each part and prepare them using slicing software for printing	5	T(opt)	8.7	Task1	NA	NA	Solidworks, slicing software and suitable computer
		9	T(med)					
		11	T(pes)					
11	Print the final wing design to scale	5	T(opt)	8.3	Task 7; Task 10	Hobbyist 3D printer with a build size of l 250mm x w 250mm x h 250mm.	£200 - £1100	3D printer
		8	T(med)					
		13	T(pes)					
12	Print the wing supports to scale	5.5	T(opt)	7.3	Task 7; Task 10	Hobbyist 3D printer with a build size of l 250mm x w 250mm x h 250mm.	£200 - £1100	3D printer
		7	T(med)					
		10.5	T(pes)					
13	Print any extra required parts and activation links	5.5	T(opt)	8.6	Task 7; Task 10	Hobbyist 3D printer with a build size of l 250mm x w 250mm x h 250mm.	£200 - £1100	3D printer
		8	T(med)					
		14	T(pes)					
14	Prepare all parts before assembly	5	T(opt)	8.5	Task 11; Task 12; Task 13	Tools can be designed and 3D printed	Negligeable	Sanding and polishing tools.
		8	T(med)					
		14	T(pes)					
15	Assemble the final scale model of the wing assembly including all the mechatronics	6	T(opt)	10.3	Task 11; Task 12; Task 13; Task 14	NA	NA	NA
		10	T(med)					
		16	T(pes)					
16	Complete test runs to ensure the assembly is functional	2	T(opt)	5.2	Task 15	NA	NA	NA
		5	T(med)					
		9	T(pes)					
		Total time		132.8				

Table 4 - Table showing my personal tasks as project manager with their estimated required hours

Project manager tasks								
Task		Required time (hours)		Estimated time (hours)	Dependencies	Bill of Materials	Estimated cost (GBP)	Specialist equipment
1	Managing the overall performance of the group, ensuring all members are on track and understand their tasks	Consistent throughout the whole project without a particular associated time			-	NA	NA	NA
2	Overseeing the team development throughout the whole project				-	NA	NA	NA
3	Ensure group moral is high and consitent and that the team is working efficiently				-	NA	NA	NA
4	Identify potential risks within the team environment and in the work of each department	8	T(opt)	12.3	Task 2	NA	NA	NA
		12	T(med)					
		18	T(pes)					
5	Conduct research and provide solutions for potential risks	4	T(opt)	8.3	Task 5	NA	NA	NA
		8	T(med)					
		14	T(pes)					
6	Aid in the costings of each team to ensure the project remains within budget	3	T(opt)	5.2	-	NA	NA	NA
		5	T(med)					
		8	T(pes)					
7	Regularly update myself on the regulation specifics in order to check that the team is working within the set constraints and to ensure the project stays on track without encountering any extra costs or unnecessary tasks	3	T(opt)	5.2	-	NA	NA	NA
		5	T(med)					
		8	T(pes)					
8		14	T(opt)	18.5	-	NA	NA	NA

	Manage the layout of the project report	18	T(med)					
		25	T(pes)					
9	Create the Interim and Final VIVA presentation slides and support documents	10	T(opt)	16.0	-	NA	NA	NA
		16	T(med)					
		22	T(pes)					
10	Produce an overall flow chart for the project	3	T(opt)	5.2	-	NA	NA	NA
		5	T(med)					
		8	T(pes)					
11	Create and update the group Gantt chart	4	T(opt)	6.7	-	NA	NA	NA
		6	T(med)					
		12	T(pes)					
		Total time:		77.3				

The combined time for all my tasks exceeded the base allocation of 200 hours, with a total estimated workload of 210.1 hours. These timings, however, are based on estimates and should consider pessimistic projections for better planning.

To aid in completing the project within the time scale, a redistribution of tasks can be implemented. Specifically, the manufacturing tasks related to the final assembly can be shared among multiple team members.

(Sandford, 2024)

5 Milestones and gateway

5.1 Group milestones, gateways and associated timings

Table 5 - Table incorporating the group milestones with their allocated gateways and estimated completion dates

Gateways	Milestones	Associated planned completion dates
	Given the technical brief on the assigned project	30/09/2024
	Assignment of all roles within the project	07/10/2024
Familiarise group members with ANSYS software	Completed Baseline CFD simulation on the Morgan to gain data for vehicle simulation.	10/10/2024
Familiarise group members with VIGrade and OptimumLap software	Completed vehicle simulation test of the Morgan on a track to attain baseline performance.	27/10/24
Produce a series of rear wing concepts on CAD through research and analysis. Complete CFD analysis.	Finalised rear wing concept designed on CAD	17/11/2024
Analyse the performance of the rear wing concepts and conclude which concept provides the best confidence	Complete CFD of the chosen wing profile	24/11/2024
Produce PowerPoint consisting of the required research and work conducted throughout the project	Interim VIVA	10/12/2024 or 11/12/2024
Discuss mounting solutions/ concepts. Using FEA determine which produces the greatest strength to weight ratio.	Run FEA on the chosen wing profile and mounts	01/12/2025
Implement the final concept of the rear wing onto the Morgan model and complete CFD to gain data on the aerodynamic performance.	Attain data/ results of the chosen wing profile on the Morgan Plus Four.	30/01/2025
Using CAD files produced	Produce a prototype to test in the wind tunnel	09/02/2025
Decide on what mechatronics will be used and how they will be implemented.	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
Implementing simulation data into the control system coding	Finalise control system	27/02/2025
Using the CAD files produced, convert the files to STL file and import into 3D printing software ready for printing.	Develop prototype and manufacture using additive manufacturing processes.	16/03/2025
Produce PowerPoint summarising the research and work completed throughout the project.	Final VIVA	01/04/2025 or 02/04/2025
	Upload final write up document	30/03/2025 @ 10pm

5.2 Manufacturing gateway

The main gateway for the manufacturing section of the project is the successful production of an accurate scale prototype of the active rear wing using 3D printing techniques. This prototype will be required to be a precise scale model to be tested in the wind tunnel environment to evaluate its aerodynamic performance. The testing will focus on validating key metrics such as downforce generation, coefficient of drag and overall aerodynamic performance providing precise data to develop the design to maximise its efficiency. Successfully passing this gateway confirms the feasibility and performance of the concept, demonstrating a critical alignment between manufacturing precision and aerodynamic objectives.

6 Risks

6.1 Creating a Precise Scale Model for Accurate Wind Tunnel Testing

My first risk I may encounter would be producing a scale model that accurately represents the wing profile for obtaining reliable wind tunnel data. Any inaccuracies in the model's geometry or surface finish could compromise the test results, leading to incorrect aerodynamic conclusions.

Mitigation strategy:

- Implement a rigorous quality control process during 3D printing and post-processing stages to ensure the scale model adheres to the CAD design.
- Conduct dimensional checks using callipers or a coordinate measuring machine (CMM) to confirm the prototype's accuracy before wind tunnel testing.
- Use high-quality materials and advanced 3D printing techniques (e.g., SLA or SLS) to achieve finer detail and smoother surfaces.

(International Research Journal of Engineering and technology, 2020)

6.2 Ensuring the Team Sticks to the Project Timeline

If the project encounters delay in design, manufacturing, or testing this could impact the project's success, resulting in rushed processes or incomplete deliverables.

Mitigation Strategy:

- Develop a detailed project timeline with clear milestones and deadlines for each stage of the project (e.g., design finalization, prototype manufacturing, and testing).
- Hold regular progress meetings to monitor the team's adherence to the timeline, address issues early, and adjust plans if necessary.
- Utilize project management tools, such as Gantt charts or software like Trello or Asana, to track tasks and responsibilities effectively.
- Assign contingency time for critical stages, such as prototype production and testing, to accommodate unforeseen delays.

7 Summary and Gantt chart

7.1 Personal Gantt Chart

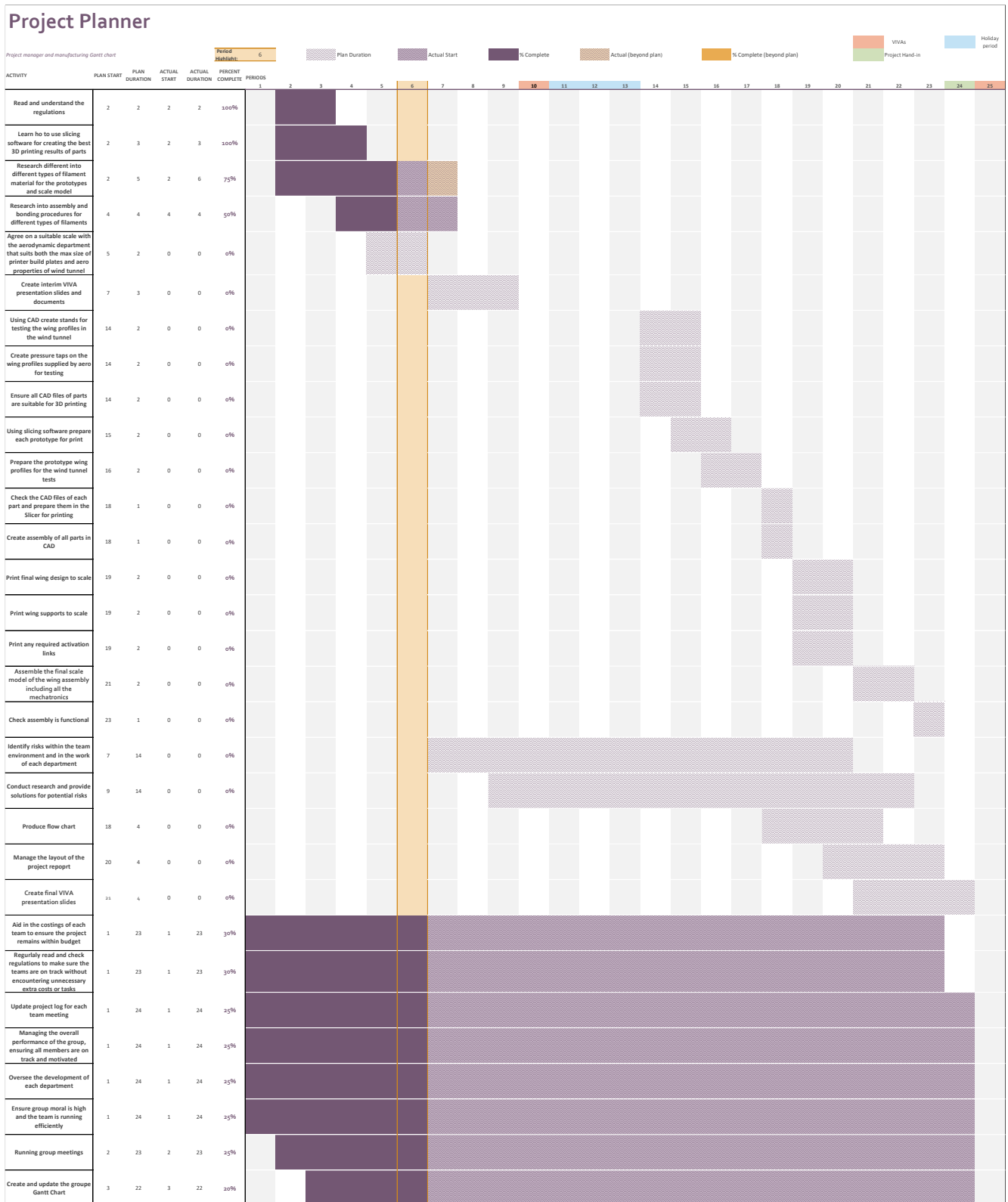


Figure 2 - Personal Gantt chart

7.2 Group Gantt Chart

Project Planner

Morgan Plus Four active rear wing project

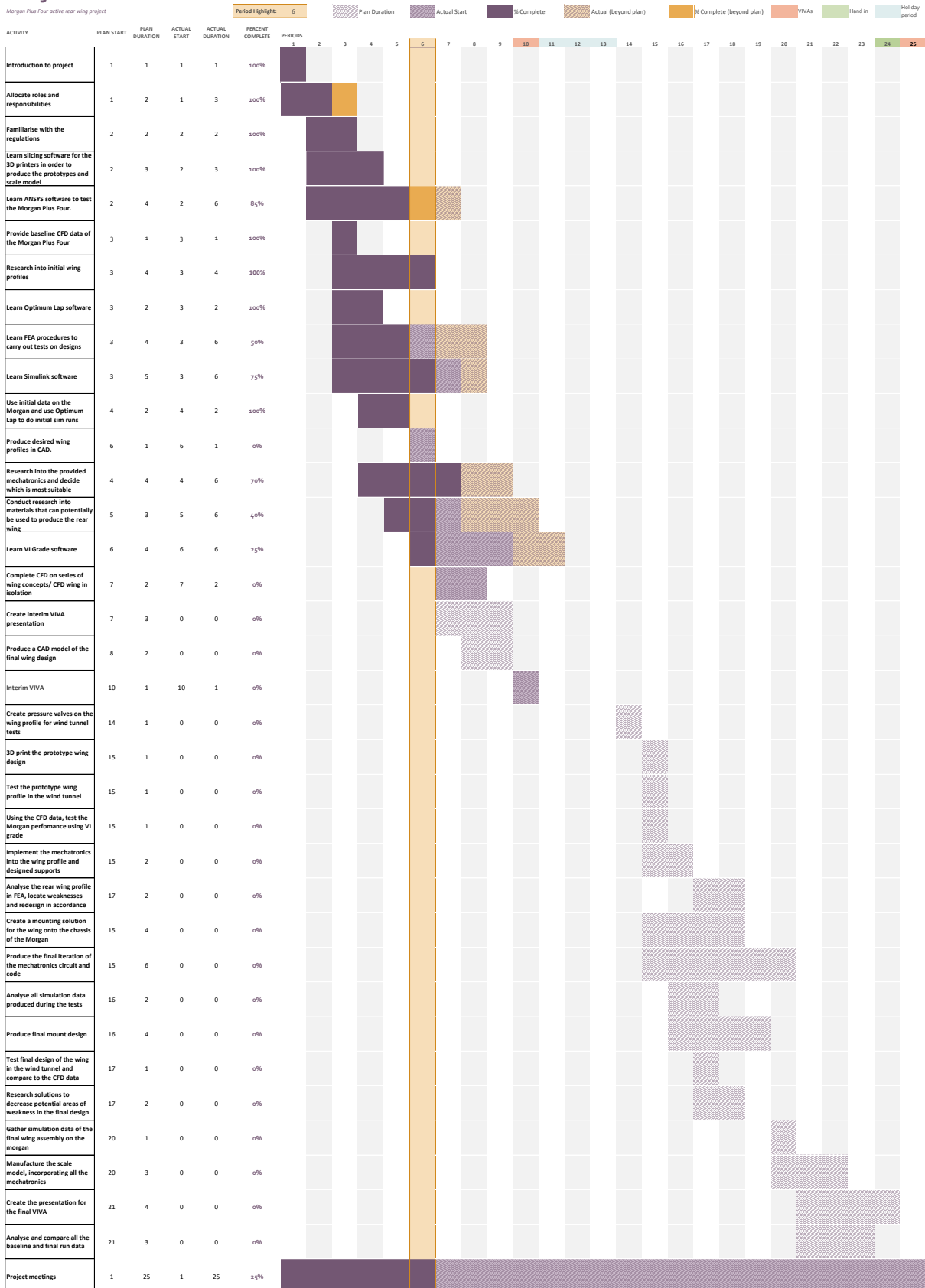


Figure 3 - Group Gantt chart

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