

University of Wales Trinity Saint David

Wales Institute of Science & Art



Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

Engineering Management

Management, Innovation and Sustainability

ACHA5012

ACMA5007

Rhodri Jones

2305734

08/11/2025

Contents

1	Introduction	1
2	Team members and roles.....	2
2.1	Belbin's Table.....	3
3	Group tasks	4
4	List of personal tasks	5
4.1	Preliminary Bill of materials	6
4.2	Bill of tools and equipment	7
5	Milestones.....	8
5.1	Milestone plan.....	8
5.2	Measurable Performance Criteria	9
5.3	Gateway Performance Criteria	10
6	Risk identification – Areas of concern.....	11
6.1	Risk Assessment.....	11
6.2	Risk 1 - Aerodynamic underperformance.....	11
6.3	Risk 2 - CAD and CFD delays or technical issues.....	12
7	Gantt charts.....	13
8	References.....	14

1 Introduction

The aim of this project is to research, model, test and improve the aerodynamic performance of the 2005 BMW 1-Series while following the Motorsport UK Yearbook 2021 regulations. The purpose of this project is to improve the aerodynamic profile by creating a CAD and CFD file to test the current aerodynamic profile and find the areas that need to be improved. During the project process, a new wing for the rear of the car will be the focus to improve the rally car's grip and downforce, allowing improved cornering and stability.

The underside (floor) of the car can be modified heavily according to the regulations for the championship the rally car is entered into. The car has empty space between the rear wheels and the rear bumper, meaning it acts like an air scoop, not allowing the collected air to escape, therefore increasing drag. By designing a more aerodynamic underside profile, this can remove the air pocket on the rear of the car, allowing it to cut and flow through the air much better.

A rear diffuser will be considered which will also improve the cars general track handling by using the diffusers shape to cut through the air and create an area of low pressure that generates downforce. A rooftop vortex generator will be considered to manipulate airflow over the roof and reduce drag and increasing the cars downforce.

2 Team members and roles

	A	B
1	jobs	names
2	gannt chat	Kairan and Yash
3	concepts/design ideas	Jerremi and Rhodri
4	vortex generator	Kairan and Rhodri
5	finish CAD	Jerremi and Kairan
6	CFD 1st	Yash and Kairan
7	CFD 2nd	Everyone
8	research	Everyone
9	presentation slides	yash(everyone)
10		

Figure 1 Table showing team roles, K Bennet, 2025

This chart shows which team members will be performing each task.

Team member	Role	Responsibilities
Rhodri	Aerodynamic designer	Creates initial design and design research, refines designs once each stage of CFD is completed
Kairan	CFD Analyst	Runs CFD simulations and gathers data
Jeremi	CAD modeller	Creates models of designed components
Yash	Report coordinator	Ensures documentation of the whole project, compiles graphs and data ready for final presentation

Figure 2 Table of team roles, R Jones 2025

2.1 Belbin's Table

Belbin's Category	Implementor	Coordinator	Shaper	Plant	Resource Investigator	Monitor Evaluator	Team worker	Completer finisher
My score	13	5	10	14	8	6	10	4
Best fit for role	Yes	No	Yes	Yes	No	No	Yes	No
Variation	+3	-3.8	-1.6	+6.7	+0.2	-2.2	-0.9	+1.5

Figure 3 Belbin's table displaying scores, R Jones, 2025

My Belbin scores show a proficiency in the implementor, Plant and Resource investigator roles.

Given my role as the aerodynamic design lead, the plant role being 6.7 above the average score is fitting as the plant role excels at generating original ideas and solving problems, making this role a valuable one during the conceptual stages of the project. Individuals who are above average in the plant role tend to work best when they are given creative freedom to think independently and excel in brainstorming new designs and concepts for a project.

I scored +3 above average in the implementor role which shows I am more proficient in turning ideas into practical and workable solutions. The implementor role is responsible for transforming conceptual ideas into applicable plans for a group project. A strong implementor score pairs well with a strong Plant score as they both have creative and idea generation aspects that aid well in a design role.

In the resource investigator role, I scored only 0.2 above the average score, but I feel it applies well to the design and conceptual lead role as the resource investigator takes the role of communication, networking and gathering external information. I feel that gathering external information is an important aspect in design as researching external sources to aid in the design process is vital to ensure the process runs smoothly. In this case, this would include researching race regulations and material costs for the wing.

3 Group tasks

Task	Description	Start	Finish
Aerodynamic research throughout design phase	Gather BMW 1 series aero data and race regulations	Week 1	Week 5
CAD modelling	Create CAD model of wing designs	Week 3	Week 6
CFD testing	Use CAD model to run CFD testing and gather data	Week 4	Week 8
Report and presentation prep	Compile all research, design processes, data and graphs	Week 3	Week 8
Finalise design	Use gathered CFD data to decide on the most effective design	Week 8	Week 9

Figure 4 Table displaying general group tasks and timelines, R Jones, 2025

My task in the group project is to research the rally aerodynamic regulations for the specific championship the car competes in, create concept wing and vortex generator ideas and then once wind tunnel testing has been completed, I will create a final design that the group will eventually create for the car.

Kairan's task is to use the BMW 1 series cad model and to run CFD testing which will test the car model, and once they have been made, the digital models of the car with newly designed aero components fitted, in a digital air tunnel to see how aerodynamically efficient the car is once our designs have been applied.

Jeremi's task is to create the BMW 1 series cad model in SolidWorks and create wheel plinths for the car to be placed and tested on ready for the CFD testing.

Yash's task is to monitor the groups progress, aid other members when possible and to use the work and data that the rest of us complete to prepare the presentation for the finale of the project.

4 List of personal tasks

My role is the aerodynamic design engineer. The purpose of my role is to conceptualise and refine potential rear wing designs for the 1 series rally car. My part of the project connects the conceptual design stages and the prototyping and testing stages of the group project. My designs will be made in CAD to be applied to the CFD testing to determine whether the design improves the aerodynamic performance of the rally car.

Reviewing the race regulations is arguably the most important aspect of the design process because without knowing the regulations, I would not know what I can or cannot design as the design could exceed the dimensions limits, weight limits etc. To understand what can be done while following the regulation limits, I was able to source and analyse the regulations that apply to this specific championship which allows me to the general rear wing designs that are allowed. This task will take around two to three hours.

I have done extensive research to find the appropriate specifications for the aero restrictions. The wing restrictions are as follows:

“For Saloon and Sports Cars such devices must not extend longitudinally from the bodywork by more than 100mm. For Sports Racing Cars such devices must not extend longitudinally from the rear wheel axis by more than 1100mm.” (Motorsport UK. (2021) *Motorsport UK Yearbook 2021: Section J – Competitors: Vehicles.*)

The designs I have researched and conceptualised follow these restrictions so that the final product will be able to be used competitively in the circuit championships. I have researched 7 different existing designs and taken elements from 3 of them that are within the regulations to design a concept that will be created in CAD and then tested in CFD software on a full-scale model of the BMW 1 series. After the virtual testing has been completed, we will be able to see the positive and negative areas of the wing design, which will allow me to redesign certain elements to make the wing perform more efficiently.

4.1 Preliminary Bill of materials

Material or component	Purpose	Estimated cost (£)	Notes
Aluminium sheet for main wing plane	Primary aerodynamic surface for the wing	£90	Cheap and easy to work with
Steel brackets and mounting hardware	To secure the wing to the rear of the car	£40	Includes what is needed to fix the wing to the car
Aluminium end plates	Controls airflow and increases stability	£75	Based on cost of motorsport aluminium end plate kits
Prototyping materials such as plywood, screws, nails, tape and adhesives	Used to build physical prototypes of wing designs for scaling	£65	Plywood sheet and other materials for mock up
Surface finishing materials such as primers, paints, corrosion protection	Prototype finishing and basic surfacing for the final wing	£30	Used to protect the wing from damage
CAD and CFD software	Virtual testing and prototyping	Provided by University, £2151.80/year for SolidWorks and £5341.47/year for Ansys CFD software	These software's are provided for free by the university

Figure 5 Table showing all materials needed, R Jones 2025

4.2 Bill of tools and equipment

Tool/Equipment	Purpose	Source/Cost
Bandsaw	Used for cutting plywood for prototype	Provided by University
Drill and drill bits	Cutting holes in wing	Provided by University
Angle grinder	Shaping edges of the aluminium wing	Provided by University
Measuring tools (digital callipers, tape measure, meter stick)	To measure the dimensions as accurately as possible	Provided by University
Electric sander	To smooth the edges of the prototype wing and the final build	Provided by University
PPE Equipment (eye protection, gloves, mask while sanding)	Protect the user while working with tools and materials	Provided by University

Figure 6 Table showing all tools and equipment needed, R Jones 2025

5 Milestones

5.1 Milestone plan

The following milestones outline the stages of the project. By using these milestones, it will allow us to monitor progress and make our goals clearer between the design and concept stages, the CAD, the CFD and the reporting.

- Week 1: Project Start
Discuss roles, create teams channel
- Week 2: Identifying areas of potential aerodynamic improvement
Analyse the BMW to decide which areas to focus on
- Week 2: Action plan
Decide responsibilities, team jobs and create project schedule
- Week 2: Initial design and sketching phase
Create concept designs
- Week 3: CAD modelling
Create wing design to be attached to premade BMW 1 series model to create CFD ready model
- Week 3-4: CFD testing
Run CFD testing and collect drag, lift and downforce values
- Week 4-5: Redesign
Redesign areas of wing model that require work
- Week 4-5: Continue research
- Week 6: Final design
- Week 6-7: Final CAD model
- Week 6-7: CFD testing with final design
- Week 7: Risk assessment
Evaluate risks affecting aero design development and potential project delays
- Week 8: Real life feasibility
Check manufacturability, regulations, cost etc
- Week 9: Finalise
Create report of project process explained with graphics

5.2 Measurable Performance Criteria

Goal	Type	Aim	Method
Decide team roles	Team organisation	To figure out which jobs each team member will have	Have a group team meeting and assign roles
Conduct initial design research	Research	To collect baseline aerodynamic figures and data about the 1 series and rally regulations	Online research, reading rally regulations
Produce baseline CAD model of the 1 series	Technical design	To generate a scale and dimension accurate 3D model ready for CFD testing	Use SolidWorks to create an accurate model using the vehicles dimensions
Complete first rear wing design	Technical design	To create the first functional rear wing design ready to be tested	Sketching and CAD modelling
Create CFD ready rear wing to attach to main car body	Testing preparation	To create and fit the virtual model ready for aerodynamic simulation testing	Carefully combine both CAD parts making sure there are no gaps, then convert to CFD software
Once testing is complete, analyse first iteration of CFD data	Analysis	To identify areas of improvement in the wing design and redesign necessary areas	Analyse post CFD testing data
Create improved wing design based on the CFD data and retest	Improving the design	To optimise the wings performance in CFD and reduce drag by atleast 5%	Update the CAD model and rerun test simulations until final design is agreed upon
Create preliminary bill of materials	Cost and material analysis	To estimate material types, costs and production times	Market and material cost research and gather price estimates
Finalise design and data collection ready for presentation	Reporting	To gather all data and process notes to prepare a presentation	Write a report to use to create a presentation using data, tables and diagrams gathered from CFD

Figure 7 Table showing measurable performance criteria, goals of the project to aim for, R Jones, 2025

5.3 Gateway Performance Criteria

Criteria	Target value	Reason	Pass/Fail condition
Downforce increase	>10% increase to downforce	Increases the performance and handling of the car	Pass if $\geq 10\%$ Fail if $< 10\%$
Drag increase	<5% increase	If the drag increase is too high, the positive effects will be negated	Pass if $\leq 5\%$ Fail if $> 5\%$
Manufacturing and research costs	<£400 total cost	Matches Bill of materials expectation	Pass if $\leq \text{£}400$ Fail if $> \text{£}400$

Figure 8 A Table showing error limits, R Jones, 2025

This gateway helps guide progression and design limitations from the design stage. If any of the criteria fail, the design must return to either CAD modification or the initial design concept phase before further CFD testing is performed. This ensures the group does not waste time refining or testing a design that exceeds the limitations.

6 Risk identification – Areas of concern

6.1 Risk Assessment

Risk assessment is an important aspect of every engineering project as many things can go wrong in each area from design, to testing to production. By picking out which possible risks could occur in each stage of the project, the engineering team can be aware and prepare to make sure these risks do not happen or the chances of them happening are as low as possible

6.2 Risk 1 - Aerodynamic underperformance

There is a risk that the initial wing design may not perform to the required targets. Incorrect measurements, inaccurate design shaping or not enough research could potentially cause the design to fail the criteria targets, requiring a redesign of the rear wing.

Impact on project:

- Delays to the whole project caused by redesigning
- CFD tester cannot run simulations by milestone deadlines
- Project schedule is pushed back for the testing section
- The final design could potentially fail to meet any project specifications

Strategy to succeed

- Conduct thorough research into all required areas before beginning CAD section
- Create multiple early-stage designs that can be tested concurrently so if one fails, there are others that can be tested while the failure is redesigned
- Implement time into the schedule for potential redesigns

6.3 Risk 2 - CAD and CFD delays or technical issues

While creating the aerodynamic models of the wing designs, the risk arises of the modelling process taking longer than planned due to technical or design issues. This could be caused by incorrect measurements, incorrect modelling or the corruption of files.

Impact on project:

- The CFD simulations will be delayed, pushing the entire project back
- The group will struggle to meet design deadlines
- There will be less time for design refining and retesting
- There will be increased pressure on the group to meet deadlines and get the project complete on time

Strategy to succeed:

- Begin the CAD process early
- Save incremental versions of files often to prevent mass loss of time and work
- Use templates and reference images/models when possible
- Schedule in time to account for redesign and possible file rebuilding incase of corruption etc

7 Gantt charts

Gantt charts are an effective way of ensuring the aerodynamic development of the BMW 1 series rally car progresses efficiently and does not fall behind schedule. Gantt charts are used to help visualise the timeline of projects and aid in completing milestones for the project.

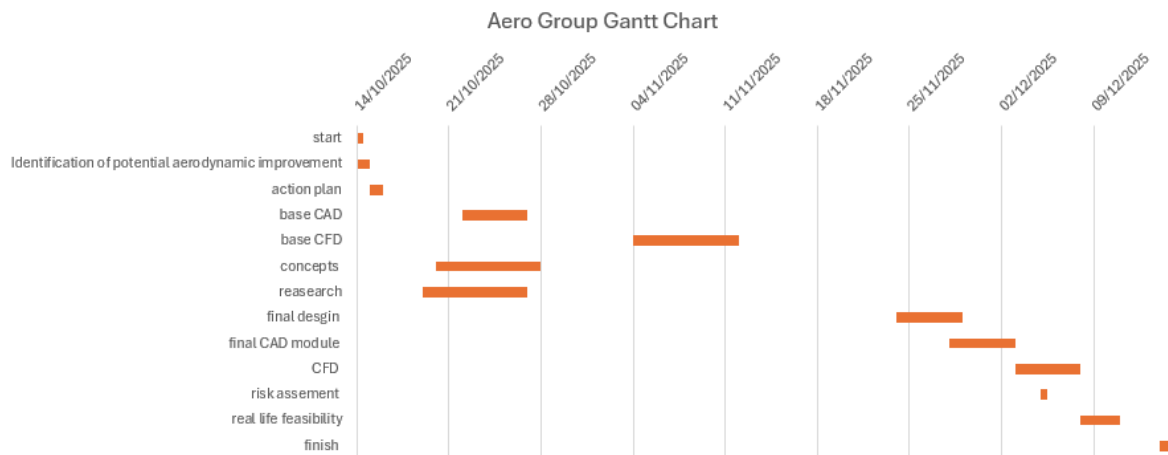


Figure 9 A Gantt chart showing the overall project schedule (R Jones, K Bennet, 2025)

The Gantt chart above shows all major stages of the entire group project from the start to the end. The chart identifies significant milestones such as the completion of initial research, the final CAD model and the final design completion.

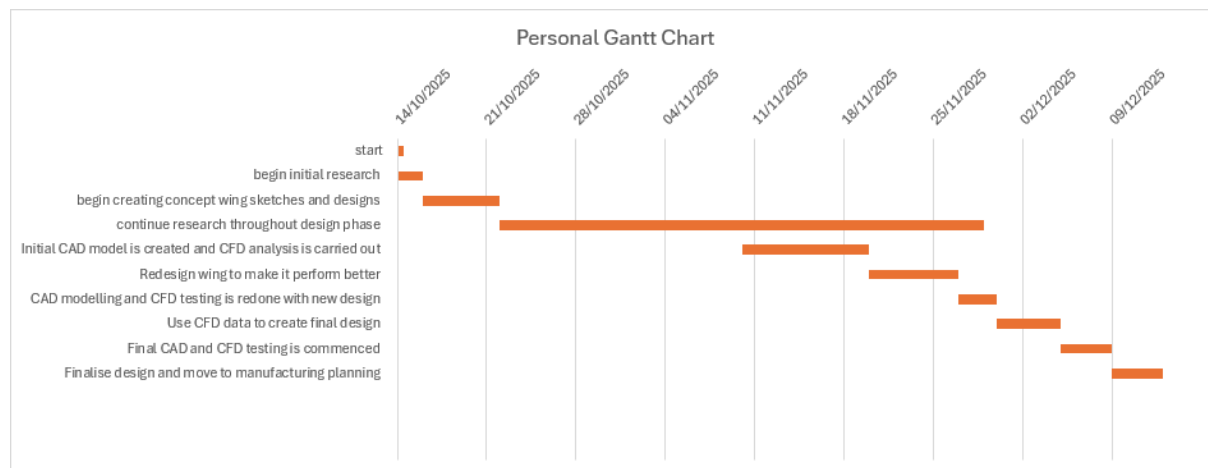


Figure 10 Personal Gantt chart for group project, R Jones, 2025

This Gantt chart of my personal progress schedule shows the steps I will be taking as the aerodynamic designer to create the designs needed and that I will use data taken from the CFD testing to refine my designs for them to be perform better in retesting.

8 References

Motorsport UK (2021) *Motorsport UK Yearbook 2021: Section J – Competitors: Vehicles*. Available at: <https://www.motorsportuk.org/wp-content/uploads/2021/08/2021-09-02-motorsport-uk-yearbook-2021.pdf> (Accessed: 12/11/2025)

Bennet, K. (2025) Team roles table. Figure 1 in: Engineering Management, Innovation and Sustainability Report.

Jones, R. (2025a) Table of team roles. Figure 2 in: Engineering Management, Innovation and Sustainability Report.

Jones, R. (2025b) Belbin's table displaying scores. Figure 3 in: Engineering Management, Innovation and Sustainability Report.

Jones, R. (2025c) Group tasks and timelines table. Figure 4 in: Engineering Management, Innovation and Sustainability Report.

Jones, R. (2025d) Preliminary Bill of Materials table. Figure 5 in: Engineering Management, Innovation and Sustainability Report.

Jones, R. (2025e) Tools and equipment table. Figure 6 in: Engineering Management, Innovation and Sustainability Report.

Jones, R. (2025f) Measurable performance criteria table. Figure 7 in: Engineering Management, Innovation and Sustainability Report.

Jones, R. (2025g) Gateway performance criteria table. Figure 8 in: Engineering Management, Innovation and Sustainability Report.

Jones, R. and Bennet, K. (2025) Overall project Gantt chart. Figure 9 in: Engineering Management, Innovation and Sustainability Report.

Jones, R. (2025h) Personal Gantt chart. Figure 10 in: Engineering Management, Innovation and Sustainability Report.

For Bill of Materials:

Mamba Motorsport (2025) *Motorsport Rear Wing Carbon Fibre – MM183CF-S*. Available at:
<https://www.mambamotorsport.co.uk/p/motorsport-rear-wing-carbon-fibre-mm183cf-s/> (Accessed:
14/11/2025)

Reverie Ltd (2025) *Carbon Fibre Rear Wings for Road and Race*. Available at:
https://www.reverie.ltd.uk/product_list.php?group=A+RWING (Accessed: 14/11/2025)

CarbonXtreme (2025) *Steel, Aluminium or Carbon Fibre: Which Is Best for Racing?* Available at:
<https://carbonxtrem.com/blogs/post/steel-aluminum-or-carbon-fiber-which-is-best-for-racing>
(Accessed: 14/11/2025)