



Prifysgol Cymru
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PROJECT PLANNING

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Management, Innovation and Sustainability

BEng, HND & HNC Automotive, Motorcycle & Motorsport Engineering

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Chapter 1 - Introduction

As part of an Engineering Management project, we have been assigned with evaluating and refining a specific aspect of the Universities BMW E87 N52 engine. The intention of this project is to investigate a particular aspect of the engine, with the ultimate goal of improving the overall performance, reliability, and efficiency.

Having assessed multiple possibilities, our team has chosen to focus on the intake system. Furthermore, the intake is a vital component of the engine's airflow management, affecting flow, fuel mixture, and combustion efficiency. With the current arrangement, the BMW's intake system is predominantly in its original standard, factory restricted form. This is a considerable limitation affects the performance output of the vehicle, creating a scope for development.

This investigation will cover a detailed study of the existing intake design, including its geometry, flow characteristics, and relationship with the engine as a whole.

In addition, Computational Fluid Dynamics (CFD) simulations, flow bench experimentation, and Ricardo Wave modelling will be adopted to collect comprehensive baseline data. This will facilitate the identification of critical airflow limitations, volumetric inefficiencies, and potential limitations in intake airflow.

Building upon these findings, and guided by fundamental research, the team will be able to determine the modifications and design changes necessary to enhance the performance of the intake system. Also, the analysis will focus on maximising airflow, minimising pressure losses, and improving volumetric efficiency, while ensuring that all alterations remain compatible with engine constraints. Additionally, by combining testing, simulation data, and evidence-based design principles, the project aims to deliver a robust, optimised intake system capable of providing measurable gains.

Overall, we aim to gain a deeper understanding of intake system design principles which we can apply to a real-world motorsport application, ultimately resulting in performance improvements.

Chapter 2 - Roles and responsibilities

Table 1: Roles and responsibilities

Robbie Sandford	Isaac Jones	Wesley Ives	Snasloy D'Silva
Project Manager	Modelling	Product Testing & Development	Product Innovation
- Computational Fluid Dynamics - Research & Data Collection	- Computer-Aided Design - Computational Fluid Dynamics	- Ricardo Wave Simulation - Flow Bench Testing	- Research & Data Collection - Data Analysis & Evaluation

Belbin's Team Role is a well-established model that helps me recognise my own strengths and favoured ways of contributing within a team, as well as how I can best work alongside others to enhance team interactions and promote collaborative effort. (Belbin, 2025)

As part of a university study, I recently completed a Belbin assessment, which revealed that I scored particularly high, around 89%, in the 'Plant' and 'Completer Finisher' categories.

The 'Plant' role reflects creativity and problem-solving, whereas the 'Completer Finisher' role demonstrates attention to detail, persistence, and a focus on delivering high-quality outcomes.

Furthermore, these results, combined with my experience as a Rally Co-Driver competing at a high level, have equipped me to perform effectively under high-pressure conditions.

Given this combination of high-scoring Belbin roles and practical experience in pressure-intensive situations, I believe I am well-suited to this role and can contribute effectively to team objectives.

Chapter 3 - Intake group tasks and timings

Table 2: Group tasks

Phase	Task	Start	End	Duration (weeks)	Responsibility
Planning	Define objectives, assign roles, gather background data	13/10/2025	2/11/2025	3	Team Collaboration
Research & Data Collection	Literature review, YouTube research on N52, benchmark studies	13/10/2025	23/11/2025	6	Robbie Sandford + Snasloy D'Silva
Ricardo Wave Simulation	Model valve timing & cam effects	10/11/2025	07/12/2025	4	Wesley Ives
3D Scanning & CAD Modelling	Scan head, model intake & cams	10/11/2025	18/01/2026	6	Isaac Jones
CFD Simulation	Simulate intake airflow and cam effects	19/01/2026	01/02/2026	2	Robbie Sandford + Isaac Jones
Prototype & Flow Bench Testing	Manufacture test parts, validate CFD	02/02/2026	15/02/2026	2	Wesley Ives
Dyno Testing & Validation	Power runs, compare to simulations	16/02/2026	01/03/2026	2	Team Collaboration
Data Analysis & Evaluation	Combine CFD, flow, and dyno data	16/02/2026	08/03/2026	3	Snasloy D'Silva
Reporting & Presentation	Prepare report, viva, and presentation	13/10/2025	08/03/2026	18	Team Collaboration

The initial stage of the project focuses on planning and preparation running from 13th October to 2nd November 2025, lasting three weeks. During this period, the group will determine main objectives, assign roles, and gather essential background data.

Following this, the research and data collection phase is planned to last six weeks, from 13th October to 23rd November 2025. During this stage, myself and Snasloy will carry out an in-depth review of existing literature, explore relevant YouTube resources and study benchmark data to inform later design and simulation work.

Furthermore, over four weeks, scheduled between 10th November and 7th December 2025 Wesley will take responsibility for the Ricardo Wave Simulation, with the primary aim of replicating the BMW N52 engine to establish baseline data for variables such as airflow characteristics and injector performance.

In parallel, Isaac will be tasked with handling 3D Scanning and CAD Modelling, this segment will last six weeks, running from 10th November 2025 to 18th January 2026. It will involve scanning the cylinder head and creating a detailed 3D model of the intake system, generating the geometry needed for computational analysis.

In addition, once CAD data is available, myself and Isaac will collaborate on CFD Simulation work ranging from 19th January to 1st February 2026. Over two weeks, we seek to simulate airflow and assess the performance of the intake system to validate and optimise its design.

The subsequent phase entails flow bench testing, running from 2nd to 15th February 2026 under Wesley's responsibility. This two-week period involves conducting a physical bench test to gain greater detail and ultimately validate the CFD results.

Thereafter, the team will undertake dyno testing and validation between the weeks of 16th February and 1st March 2026, led by the whole team. During this two-week period, we will perform power runs to compare experimental data with simulation outcomes, ensuring consistency between theoretical and practical findings.

In the following stage, Snasloy will manage Data Analysis and Evaluation from 16th February to 8th March 2026. Over the course of three weeks, this phase will include compiling and interpreting CFD, flow bench, and dyno data to form a cohesive evaluation of the project's results.

Finally, Reporting and Presentation will occur throughout the entire project timeline, from 13th October 2025 to 8th March 2026. This ongoing, collaborative task involves preparing the final written report, presentation, and viva materials to effectively communicate the group's findings and technical achievements.

Chapter 4 - My tasks

Table 3: Research and Data Collection

<i>Task Description</i>	<i>Hours Required</i>	<i>Task Duration</i>	<i>Approx. Costs</i>	<i>Lead Times</i>	<i>Specialist Equipment</i>	<i>References</i>
Literature review (academic papers, technical journals)	12 hrs	4 Days	/	/	/	/
Online resource analysis (YouTube tutorials, webinars)	30 hrs	10 Days	/	/	/	/
Benchmark data collation (engine specs, airflow data)	24 hrs	8 Days	/	/	/	/
Preliminary notes & summary for later CAD/CFD work	24 hrs	8 days	/	/	/	/

<i>Description</i>	<i>Total</i>
Total number of weekdays in 6 weeks	30 Days
5 Day Weeks	
Hours Per Day	3
Project Total Days	30
Project Total Hours	90

Table 4: CFD Simulation Work

Task Description	Hours Required	Task Duration	Approx. Costs	Lead Times	Specialist Equipment	References
CAD data preparation and import	8 hrs	2 Days	£2435.00	14 Days	PC + Montier	(Pcspecialist.co.uk, 2025)
			\$4,716.00 - Year	Immediate	SolidWorks	(SolidWorks, 2024)
CFD model setup & simulation	20 hrs	5 Days	£600.00 - Month	Immediate	CFD software	(Autodesk.com, 2021)
			£675.00 - 3 Day Hire	7 Days	Scanner	(Central Scanning, 2018)
Analysis of airflow and performance	8 hrs	2 Days	Included with SolidWorks	Immediate	Post-processing software	/
Documentation of simulation outcomes	4 hrs	1 day	£8.49 - Month	Immediate	Office 365	(Microsoft.com, 2024)

Description	Total
Total number of weekdays in 2 weeks	10 Days
5 Day Weeks	
Hours Per Day	4
Project Total Days	10
Project Total Hours	40

Table 5: Dyno Testing and Validation

Task Description	Hours Required	Task Duration	Approx. Costs	Lead Times	Specialist Equipment	References
Dyno setup & calibration	4 hrs	1 Day	£300	Immediate	Transport Costs Van + Trailer + Fuel	/
			£140.00 + Vat / Hr	14 Days	Dyno facility access	(Northampton Motorsport, 2025)
			£672.00			
Engine power runs and data collection	4 hrs	1 Day	25L - £91.25	7 Days	102 Octane Racing Fuel	(Vital Equipment , 2018)
			£100.00		Vehicle Lubricants	/
Comparison of experimental vs CFD results	16 hrs	4 Days	/	/	/	/
Reporting and documentation	16 hrs	4 Days	/	/	/	/
			/	/	/	/

Description	Total
Total number of weekdays in 2 weeks	10 Days
5 Day Weeks	
Hours Per Day	4
Project Total Days	10
Project Total Hours	40

Research and Data Collection Overview

The research and data-gathering phase laid the groundwork for the project, comprising literature reviews, online technical analysis, and the collation of key benchmark data such. Furthermore, all information sources were immediately accessible, eliminating any dependency on lead times and allowing the team to complete 90 hours of research within the six weeks and no overhead expenses. This stage provided the necessary theoretical background and structured notes required for later CAD preparation and CFD analysis.

CFD Simulation Work Overview

The CFD simulation phase entailed preparing CAD models, configuring simulation parameters, and evaluating airflow performance over a total of 40 hours. Additionally, the bulk of the expenditure was linked to the workstation hardware and required software packages, all of which were available for instant download aside from the PC's 14-day delivery period. This stage provided the opportunity to deliver projected operational outcomes, which formed the analytical basis for comparison against real dyno data.

Dyno Testing and Validation Overview

Dyno testing offered the practical verification of the intake design, covering equipment setup, calibration, and controlled power runs. Moreover, costs were primarily linked to dyno facility hire (£672), transport requirements (£300), and consumables such as fuel and lubricants. Lead times included a seven-day fuel delivery period, while dyno access had to be booked 2 weeks in advance. Over the two-week period, the team collected experimental data, compared it against CFD predictions, and prepared the reports needed to conclude the validation phase.

Total Costing

The research phase will require 90 hours of work with no associated cost (£0). Furthermore, the CFD stage is estimated at £7,323.49 and will take 40 hours, while the dyno testing phase will cost £1,163.25 and also require 40 hours.

In total, the project will demand **170 hours** of work and incur an overall cost of **£8,486.74**

Chapter 5 - Project Milestones

Table 6: Milestones

Milestones	How It Can Be Achieved
1. Within a 4-week period, we will become proficient in using Ricardo Wave software. We will measure my progress by successfully building and running a sample engine model of the N52 engine by the end of the 4 weeks.	Initial Training: Begin with structured tutorials and online training modules to understand the fundamentals of Ricardo Wave's user interface, model setup, and simulation workflow. Practical Application: Develop a simplified single-cylinder model to explore parameters such as valve timing, intake/exhaust duration, and pressure wave interactions. Progressive Complexity: Gradually increase model complexity by introducing real-world boundary conditions and intake geometry data obtained from CAD/3D scans. Performance Validation: Compare Ricardo Wave simulation outputs with known engine data to ensure understanding and accuracy. Documentation: Record all learning outcomes and challenges to establish a technical reference for future simulations.
2. within a 2-week period, we will learn to use Computational Fluid Dynamics (CFD) tools to analyse intake flow characteristics. We will measure progress by successfully analysing the flow characteristics of the N52 engine by the end of the 2 weeks.	Software Integration: Understand how CFD data complements Ricardo Wave by providing detailed local flow insights for intake systems. Geometry Preparation: Import 3D-scanned intake port geometries into the CFD software, ensuring proper meshing and surface refinement for accurate airflow modelling. Simulation Execution: Run steady-state and transient flow simulations to study velocity profiles, pressure drops, and turbulence within the intake ports. Result Correlation: Use Ricardo Wave to simulate global engine parameters (mass airflow, volumetric efficiency, torque) and correlate them with CFD results for validation. Iterative Optimisation: Refine geometry and boundary conditions based on comparison outcomes, developing a stronger technical understanding of airflow optimisation.
3. Within a 3 week-period, we will successfully create an accurate digital copy of the intake ports using the 3D scanner. We will measure progress by successfully developing fully processed 3D model that can be used for further analysis or CAD work by the end of the 3 weeks.	Preparation & Setup: Clean and prepare the BMW N52 cylinder head to ensure accurate scanning surfaces; calibrate the 3D scanner to achieve precision within ± 0.05 mm. Scanning Process: Conduct multiple scans from different angles to capture full port geometry, eliminating blind spots or distortions. Data Processing: Use post-processing software, such as SolidWorks to align, merge, and clean the point cloud data. CAD Conversion: Generate a solid CAD model of the intake ports suitable for simulation and CFD meshing. - Verification: Compare the scanned model against OEM data or manual measurements to validate dimensional accuracy. Integration: Export the final model into Ricardo Wave and CFD software for simulation and performance analysis.

Dyno Testing Gateway Objective

The objective of the dyno testing gateway is to validate the real-world performance of the intake system by conducting a rolling road test programme, this will ensure that the prototype delivers measurable improvements over the vehicle's baseline output. During this phase, activities include the correct installation of the intake system and calibration of all rolling road sensors, followed by warm-up cycles, then full-load acceleration pulls to capture torque, power, airflow, and temperature data. Furthermore, fundamental vehicle parameters such as mass air flow (MAF), ignition timing, and throttle position, are monitored to ensure accurate context for performance assessment. Additionally, project costs associated with rolling road hire, transport, and consumables are recorded to maintain alignment with the resource plan.

Upon completion of testing, the collected data is transformed into performance curves and compared against CFD predictions to evaluate how closely the real-world behaviour matches the simulation. However, If the rolling road results demonstrate little to no improvement compared to expectations, this gateway becomes a major point of decision, highlighting the need for a redesign and further development or additional CFD refinement.

Overall, the successful completion of this gateway consequently relies on safe, consistent testing and the production of clear validation data that either confirms genuine performance gains or justifies necessary redesign.

Chapter 6 – Risk Management

Areas Of Concern

Technical and Financial Concern

An important aspect of concern for the project relates to the potential risk of mechanical or electrical failure during the dyno testing phase. This poses both technical and financial challenges, as the dyno facility is expensive to hire, therefore, any form of downtime would result in wasted time. Furthermore, the high hourly cost, fused with the logistical effort of transporting the vehicle and preparing the test setup, could severely impact the project's schedule and budget if any issues occur.

To minimise this risk, a comprehensive pre-dyno inspection will be conducted, this will include checks on fluids, sensors, mounts, and the cooling system to ensure that the car is fully prepared for testing. However, In the occurrence of a major failure, the team would prioritise analysing the simulation data already gathered and compare it to any partial dyno results available.

Lack of Motivation and Uneven Contribution

Uneven work output and involvement among certain team members have slowed project progress. Furthermore, certain team members have demonstrated limited involvement and a relaxed attitude toward deadlines, ultimately risking delays.

To rectify the situation, weekly progress meetings will require clear evidence of completed work. Additionally, progress will be monitored and validated through the Gantt chart to support accountability. However, should progress continue to fall short, tasks may be reassigned, with all changes documented to ensure fairness and maintain project momentum

Chapter 7 - Overall Summary

Table 7: Group Gantt Chart

	13th Oct	20th Oct	27th Oct	3rd Nov	10th Nov	17th Nov	24th Nov	1st Dec	8th Dec	15th Dec	22nd Dec	29th Dec	5th Jan	12th Jan	19th Jan	26th Jan	2nd Feb	9th Feb	16th Feb	23rd Feb	2nd Mar	9th Mar	16th Mar
Planning																							
Research & Data Collection																							
3D Scanning																							
Ricardo Wave Simulation																							
Initial CAD Modelling																							
CFD Simulation																							
Prototype & Flow Bench Testing																							
Final CAD model																							
Dyno Testing & Validation																							
Data Analysis & Evaluation																							
Reporting & Presentation																							

Table 8: Personal Gantt Chart

	13th Oct	20th Oct	27th Oct	3rd Nov	10th Nov	17th Nov	24th Nov	1st Dec	8th Dec	15th Dec	22nd Dec	29th Dec	5th Jan	12th Jan	19th Jan	26th Jan	2nd Feb	9th Feb	16th Feb	23rd Feb	2nd Mar	9th Mar	16th Mar
Data collection and testing																							
Research and Data Collection																							
CFD Simulation - Current Design																							
CFD Simulation - Initial Design																							
Dyno Testing and Validation																							
Planning of project																							
Rehearsing Presentation																							
Report Creation																							
Presentation Initiation																							
Weekly Status Meeting																							

Key
Planned target
Completed targets
Holidays
VIVA

Group Gantt Chart

The group Gantt chart has been constructed with the intention of being clear and easy to follow, this is achieved by only including the main project tasks. This will help ensure everyone can understand the timeline and key milestones. Furthermore, each section from initial planning and research to testing and final reporting, is clearly visible to provide an overview of the project's progression. This chart illustrates a collaborative effort among all team members, with each person contributing to different phases of the work. Also, it serves as a vital tool for maintaining accountability, and ensuring that deadlines are met efficiently. Therefore, by visualising the tasks in a structured timeline, the Gantt chart helps us manage our workload effectively. Overall, it supports the group in staying organised and focused, ensuring that the project remains on schedule.

Personal Gantt Chart

A personal Gantt chart has also been created as well as a joint chart, the advantage of having a bespoke Gantt chart is that it's bespoke and tailored to my role as project manager, focusing on the two key areas I'm responsible for; Project Planning and Data Collection/testing. Furthermore, the chart projects a clear visual timeline of my individual contributions and responsibilities. The chart will enable me to effectively monitor progress, ensuring that all planned activities are completed on schedule. Tasks can be systematically recorded upon completion, helping maintain motivation and a sense of accomplishment. To add, the chart is designed to be constantly updated to reflect any changes in priorities or timelines. Finally, this approach ensures that I can manage my workload efficiently, while also staying aligned with the group's overall objectives.

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