

University of Wales Trinity Saint David

Wales Institute of Science & Art



Project Planning

Engineering Management

(ACHA5012)

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1 Introduction

This project focuses on a BMW 1 Series that was originally designed for circuit racing and has since been converted for rally use. The primary objective is to improve the vehicle's suspension travel to better accommodate the demands of rally stages, which typically involve rough and uneven surfaces.

Project Aim

The aim of this project is to research and develop methods to enhance the suspension system of the BMW 1 Series by increasing suspension travel and adapting the setup for mixed-surface rally conditions. Through an analysis of the current suspension kinematics and geometry, potential modifications will be identified and evaluated to improve overall performance.

Objectives

- Increase suspension travel to enhance ride compliance and surface adaptability.
- Improve traction and handling characteristics, particularly on loose and uneven terrain.
- Assess the durability and reliability of proposed suspension modifications under rally conditions.

Additional Input

Following a discussion with Mike, it was noted that the car currently experiences poor traction off the line. Therefore, particular emphasis will be placed on improving traction and handling performance in the revised suspension setup.

2 Roles and team members

The roles were assigned based on each member's strengths and experience, ensuring that the workload was evenly distributed. This helps the group operate more efficiently, as each person focused on task that aligns with their skills.

Iestyn Jones- team leader/project manager

Responsibilities:

- Organises the team
- Allocates tasks
- oversees progress
- Ensures deadlines are met

Daniel Wylie-Morris – researcher

Responsibilities:

- Finds background information
- Gathers technical sources
- Summarises relevant theory
- Supports the team with technical knowledge

Suphakit Pratt – CAD designer.

Responsibilities:

- Produce accurate CAD drawings of the rear suspension assembly
- Assist with interpreting and validating the 3D scan data of the suspension
- Support the development of the WinGeo model by checking geometry inputs and ensuring correct link connections
- Visually verify that the suspension model behaves realistically in WinGeo (e.g., during bump, rebound, and steering simulations)
- Communicate design details, geometry findings, and modelling updates to the rest of the team

2.1 Belbin's model

Table 1 shows the Belbin's model and the students' scores (Table made by student)

Belbin's category	My score	Best fit for role	Variation
implementer	12 (high)	Strong suitability for structured, organised, and practical tasks.	Shows a consistent preference for order and planning; may require more time to initiate tasks but maintains reliable performance once started.
Coordinator	8 (average)	Supports task clarity, team structure, and organised workflow.	Demonstrates moderate coordination skills; does not exhibit the dominant leadership traits associated with high-scoring Coordinators.
Shaper	4 (low)	Limited alignment with high-pressure leadership or forceful driving roles.	Displays lower assertiveness and urgency than typical Shaper profiles, resulting in reduced emphasis on high-intensity task driving.
Plant	7 (average)	Provides creative input during problem-solving stages.	Shows moderate creativity and idea generation; not as strongly original or concept-driven as high-scoring Plant profiles.

Table 2 shows the Belbin's model and the students' scores (Table made by student)

Belbin's category	My score	Best fit for role	Variation
Resource investigator	13 (very high)	High enthusiasm for exploring new ideas, tools, and methods. Useful for research and identifying approaches related to suspension geometry.	Strong exploration tendency, sometimes shifting focus toward idea generation rather than completion.
Monitor evaluator	7 (average)	Supports logical assessment of data, checking measurement accuracy, and verifying model behaviour.	Adequate analytical ability; not as critically detached as a high-scoring Monitor Evaluator.
Team worker	13 (high)	Contributes to group cooperation, communication flow, and coordinated work during measurement and modelling.	Strong collaborative behaviour; may prioritise harmony over critical challenge.
Complete finisher	6 (average)	Helps with accuracy and thoroughness when validating coordinates or reviewing WinGeo entries.	Demonstrates careful checking, but not to the extreme detail-focused level of a high Completer Finisher.

2.2 Belbin's team role analysis

To understand my behavioural strengths within the team, I completed the Belbin Team Role Self-Perception Inventory. My highest scoring roles were Team worker, and Implementer, which together reflect how I naturally contribute to the project.

Team worker (13)

I also scored highly as a Team Worker. I tend to make sure everyone knows what they're doing, and I check in often, so the group doesn't end up confused or working in different directions. When we were measuring suspension points, I helped coordinate who was holding the tools, who was reading the values, and who was recording them. I'm not overly confrontational, so I focus more on keeping the group working smoothly rather than pushing strong opinions.

Implementer (12)

My Implementer score was also high, which reflects how I prefer having a clear, structured plan. Once the group agreed on the measurement method and the coordinate system, I focused on getting everything entered WinGeo properly. I usually break the work down into simple steps and go through them one at a time, which helps me keep things organised. I'm not the fastest to start a task, but once I know the plan, I follow it carefully and make sure the work is accurate.

Shaper (4)

My Shaper score was low, which matches how I work. I don't usually take a forceful leadership role, especially when things get stressful. I don't push people aggressively but instead prefer steady progress and keeping things organised. Even though the Shaper role doesn't really match how I work, the team still benefits from the way I focus on planning, checking details and supporting others, which helps keep things steady when the project gets busy.

Overall, my Belbin profile supports my role as the CAD and Geometry Designer, combining research ability, collaboration, and organised working habits.

3 Task

Table 3 shows the tasks completed by group (Table made by student)

Project Planning Meeting	Agree roles, responsibilities, aims & objectives	22/10/25	25/10/25
Background Research	Research rally suspension setups, travel improvement methods, rules	25/10/25	29/10/25
Define Project Goals and Objectives	Finalising aims, scope, and outcomes	24/10/25	26/10/25
Measurement Planning	Prepare method, checklist, coordinate origin, laser setup	27/10/25	27/10/25
Measuring points	Measure inboard & outboard pickup points	27/10/2025	30/10/25
WinGeo modelling	Enter geometry points into WinGeo and generate model.	6/11/25	15/11/25
3D scan (planned)	Complete scan of rear suspension assembly	Pending	Pending
Kinematic Analysis	Toe, camber, bump, roll-centre analysis in WinGeo	Pending	Pending
Report Writing	Compilation of results, tables, tasks, gateway, milestones	Pending	Pending

3.1 Bill of materials

Table4 shows list of specialised equipment used by group (Table made by student)

Equipment	Purpose	Estimated cost	Lead time
Laser alignment tool	Establish accurate reference lines for inboard/outboard pickup point measurement	£120	1-2 days
Plumb Bob	Establishing vertical alignment for point projection and chassis reference	£10	1 day
3D scanner	Validating measured coordinates against a digital scan	£350	Booking Required
WinGeo	Suspension geometry modelling and kinematic analysis	Provided	Immediate
Computer	Enter data, run WinGeo simulations, prepare diagrams & CAD sketches	£1000	Immediate

4 Detailed task

4.1 Background Research

Hours required: 24 hours

The first stage of our work involved researching rally suspension requirements and the kinematic behaviour of the BMW multilink rear suspension system. We reviewed technical guides, forums and motorsports sources to understand typical travel ranges and methods for increasing suspension movement. We also looked at the BMW rear multi-link layout to identify key pickup points and constraints before carrying out physical measurements.

4.2 Measuring Inboard and Outboard Suspension Points

Hours required: 5 hours

The next step was recording the actual suspension geometry on the car. A laser level, plumb bob and tape measure were used to set up a reference plane and keep everything consistent. Each inboard pickup point—such as the mounts for the upper control arm, camber link, traction strut, semi-trailing arm, toe link, and shock—was measured carefully, usually more than once, to make sure the numbers were reliable.

The outboard points on the hub carrier were then measured. These were harder to access, so they took longer and needed more alignment checks. Getting both the inboard and outboard points right was essential, because even a small mistake would make the model behave differently from the real suspension.

4.3 WinGeo Modelling

Hours required: 40 Hours

Completing the suspension measurements, I transferred all inboard and outboard coordinates into WinGeo to build an accurate digital model of the rear multi-link system. I set the coordinate system to match my measurement datum and entered each pickup point. Once the points were imported, I then ran quick bump and movement checks in WinGeo to confirm that the suspension behaved realistically and that no links were inverted, disconnected, or producing errors.

5 Milestones

The key milestones for this project were identified to ensure structured progress and allow effective tracking throughout the work. Each milestone represents a major stage that directly supports the overall project objectives. They also helped the team organise the workload around weekly meetings, making it easier to monitor progress and recognise areas where additional time, clarification, or support was required.

Table 5 shows the milestones for the project (Table made by student)

Milestone	Milestone description	Purpose
Project Setup and Initial Planning	Start of project, team roles assigned	Ensures clarity of responsibilities and prevents duplicated work
Research Complete	Background research finalised	Provide technical foundation and reduce risk of incorrect assumptions.
Inboard/Outboard Measurements Complete	All pickup points physically measured	Important dataset for geometry modelling
3D Scan Completed and Cross-Checked	Scan compared with measured points	Validates measurement accuracy
WinGeo Model Fully Built	All coordinates entered, links created	Foundation for all kinematic analysis
WinGeo Model Verified (Gateway Passed)	Model behaves correctly and passes performance criteria	Confirms the geometry is correct before analysis
Kinematic Analysis Completed	Analysed the suspension behaviour	Allows evaluation of current suspension performance for rally conditions
Full Draft Report Completed	Draft of entire report written and compiled	Enables internal review and corrections before final submission
Final Submission	Proofread and submit report	Complete final assessed work

6 Gateway

The gateway for this section of the project takes place after inputting all the suspension coordinates into WinGeo and building the initial model. At this point, the main goal is to make sure that the model is accurate, functional, and ready for kinematic analysis. This means checking that all the points have been entered correctly and that the suspension moves in a smooth and believable way during the test movements. Completing this gateway ensures the geometry has been interpreted correctly and that there are no major errors- such as incorrect points or inverted axes. Once the model works as expected, the project can move on to detailed analysis, and the results from that stage will support the later parts of the report.

6.1 Performance Criteria

Table 6 summarises the measurable performance criteria used to evaluate the WinGeo Model (Table made by student)

Criteria	Target	Passing Conditions
Link integrity	100% connected	Ensures all suspension links and joints are connected properly, with no missing, duplicated, or broken links. This is essential for preventing unrealistic movement or instability in the model.
Axis orientation	Correct X/Y/Z $0^\circ \pm 0.5^\circ$	Confirms that the coordinate system is aligned with the measurement origin. Any mirrored or misaligned axis would cause incorrect suspension motion and invalidate the results.
Movement stability	Smooth and realistic movement	The model must behave predictably during bump and rebound. Smooth motion indicates that pivot locations and link lengths have been entered correctly.
Joint behaviour	Correct rotational axes (100%)	Each joint must rotate around the correct axis to match real-world behaviour. Incorrect joint definitions can cause physically impossible motion.

7 Risk assessment

The main risk in this project relates to the accuracy of the WinGeo model and the integrity of the measurement and modelling data. The table outlines the risk, their likelihood and impact and the mitigation measures used to reduce their effect on the project

Table 7 shows the Risk and Their mitigation strategy (Table made by student)

Risk	Likelihood	Impact	Mitigation Strategy
WinGeo Model Errors (incorrect link connections, wrong axis orientation, incorrect points)	Medium	High	Double-check link alignment, verify axis direction, compare link lengths to measured values, run small bump sweeps to identify spikes, correct geometry before analysis.
Data loss or corrupted file	Low	High	Save multiple versions, back up files to cloud storage, export GEM files after each major update, keep a master measurement file protected.

Risk 1 – WinGeo Model Errors

Mistakes like putting a joint in the wrong place or having an axis flipped can make the suspension move in ways that do not make sense, which would make the analysis unreliable. Since multi-link suspensions are sensitive to small geometric changes, this risk has a high potential impact. Mitigation involves verifying each link, checking for visual alignment issues, and running preliminary bump tests to detect instability.

Risk 2 – Data Loss or Corruption

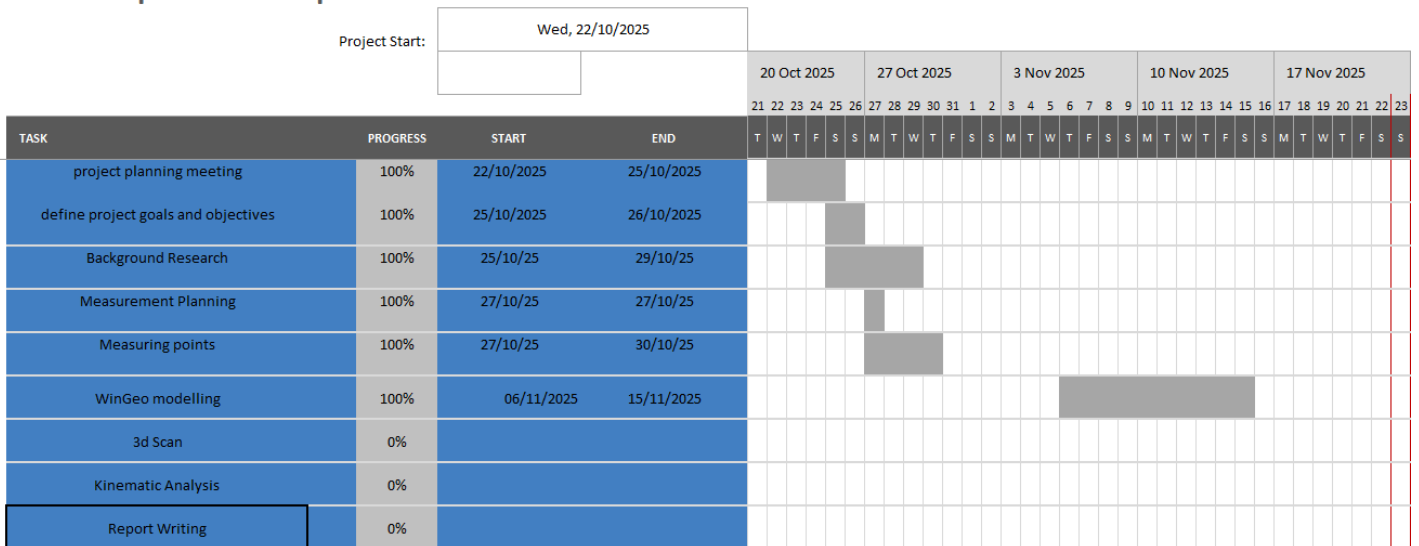
Losing coordinate data, measurement logs, or WinGeo files could delay the project significantly. Although the likelihood is low, the impact is high because rebuilding the model would take time. This risk can be managed by keeping multiple backups and storing files on cloud.

7.1 Gantt chart

The Gantt chart was produced to show the timing and sequence of the project activities. The first chart outlines the overall project timeline, while the second shows a detailed plan of the tasks for my section of the project. Both parts show milestones and the gateway points.

Figure 1 overall Group Gantt Chart (made by student In Excell)

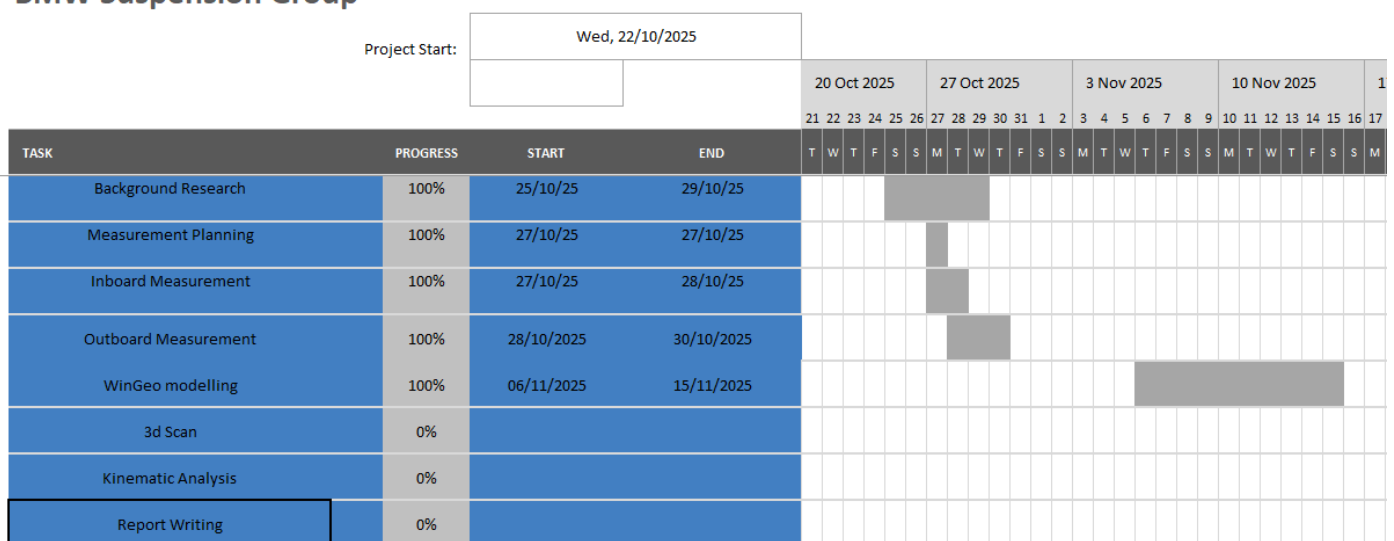
BMW Suspension Group



7.2 Personal Gantt chart

Figure 2 Personal Gantt Chart (made by student In Excell)

BMW Suspension Group



8 Reference

Belbin. (n.d.) *Belbin Team Roles*. Available at: <https://www.belbin.com/about/belbin-team-roles>

(Accessed: 24 March 2025).