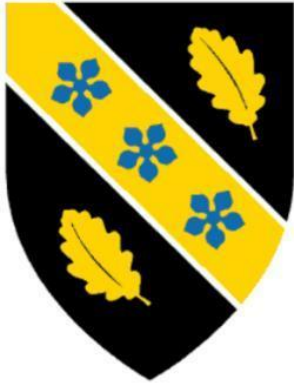


University of Wales Trinity Saint David

Wales Institute of Science & Art



Prifysgol Cymru
Y Drindod Dewi Sant
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Trinity Saint David

Project First Report – The Soap Box

Integrating Project (ACHA4008)

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(01/2025)

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1. Introduction

The Team consists of 5 members, with their roles designated as follows;

Noah Kenneford (2400270) – Designated Group Leader, final

Harry Stark (2404901) – Minute Taking, Design Work, Administration

Jerico Gumapos (2410103) – Dynamics and Driveability Research, Design Work

Harri Brown (2420832) – Materials and Costing Research

Konah Hughes (2415258) – Materials and Costing Research

The Team name is Get Hard or Go Home.

2. Goals, Aims and Methods

The goal of this project is to research, plan and design an entry for the Richard's Castle Soapbox Derby.

Ideally the Soap Box Cart will be competitive - fast down the circuit to achieve a fast time. In order to achieve this a modern technical approach to the design will need to be taken utilising materials and driving systems while maintaining a budget friendly approach. While there is no set cost cap funds for such a project would not be unlimited, therefore a cost-friendly solution must be reached.

This report aims to roughly detail the materials, components and driving systems that could be considered suitable for such a project and give a rough estimate of the cost of these. Included with this will be a small selection of design sketches that show basic concepts drawn up from our research.

To achieve this the team has been assigned different roles. Some people are more heavily involved in the research tasks and others with design and administration; however, everyone has had a part in every aspect of the project.

In order to keep a track of meetings that were held and the time scales of the project minutes have been taken and a GANTT chart assembled which will be submitted alongside this report.

3. Research

3.1. Materials and Costings

The materials selected—wood, mild steel, aluminium, polystyrene, and plastic—have been evaluated for their suitability in terms of structural requirements, weight, and cost-effectiveness. Each material's cost has been calculated based on current market rates from reputable suppliers, with references provided for transparency and verification. The objective of this analysis is to ensure the overall material cost aligns with project constraints while meeting performance and safety standards. This breakdown offers a comprehensive overview of the budget implications and serves as a foundation for informed decision-making during the construction phase.

Wood

Wood is a possibility for use in the chassis and body due to its workability and availability. Depending on the application it has the ability to absorb impact and flex under stress. Plywood offers a balance between strength and weight.

Cost Estimate: The price of plywood varies based on thickness and quality. As of January 2025, standard 18mm hardwood plywood is approximately £30 per 2440mm x 1220mm sheet. For a soapbox car, 2-3 sheets may suffice, totalling £60-£90.

Supplier Reference: Wickes - Hardwood Plywood (Wickes)

Mild Steel

Mild steel is often utilized for structural components like the frame due to its strength and ability to be welded for a strong joint. It is also generally cheaper to source than other metals such as aluminium and stainless steel.

Cost Estimate: Mild steel square tubes (25mm x 25mm) are priced around £15 per 6-meter length. Depending on the frame design, approximately 12 meters may be required, totalling £30.

Supplier Reference: Metal Supermarkets - Mild Steel Square Tube (Metal Supermarkets)

Aluminium

Aluminium is favoured for components where weight reduction is crucial, such as body panels or brackets. It is lighter than steels, however does not come with the same load bearing capabilities, is often considered harder to work with and more expensive than steel.

Cost Estimate: Aluminium sheets (1.5mm thickness) are approximately £50 per 2000mm x 1000mm sheet. One sheet may suffice for necessary components, totalling £50.

Supplier Reference: Aluminium Warehouse - Aluminium Sheet (Aluminium Warehouse)

Polystyrene

Polystyrene is typically used for creating moulds or aerodynamic features due to its lightweight and ease of shaping, however, can become a strong and durable material if built up. Where high loads are not expected it can be used, or to fill out the body for aerodynamic purposes.

Cost Estimate: Expanded polystyrene sheets (50mm thickness) are around £10 per 2400mm x 1200mm sheet. Depending on design requirements, 1-2 sheets may be needed, totalling £10-£20.

Supplier Reference: Insulation Superstore - Expanded Polystyrene Sheets (Insulation Superstore)

Plastic

Plastics, such as acrylic or polycarbonate, are used for windshields or other lightweight components such as body panels.

Cost Estimate: Clear acrylic sheets (5mm thickness) are approximately £40 per 2000mm x 1000mm sheet. One sheet is likely sufficient, totalling £40.

Supplier Reference: The Plastic People - Clear Acrylic Sheet (The Plastic People)

Total Estimated Material Cost: Summing the upper estimates: £90 (wood) + £30 (mild steel) + £50 (aluminium) + £20 (polystyrene) + £40 (plastic) = £230.

Considerations:

- **Regulatory Compliance:** Ensure all materials and the overall design comply with the Richard's Castle Soapbox Derby regulations.
- **Supplier Variability:** Prices can vary between suppliers and may be subject to change.
- **Additional Costs:** This is not accounting for ancillary materials (e.g., fasteners, adhesives), components for steering/braking and tools, which would add to the overall cost.

The total estimated material cost of £230 aligns well with the project constraints, leaving room to address potential additional expenses such as fasteners, adhesives, or unforeseen requirements. The referenced suppliers and pricing data offer transparency and serve as a guide for procurement. This cost analysis not only supports budget management but also lays the groundwork for achieving a high-quality and competitive soapbox car design.

3.2. Dynamics and Driveability

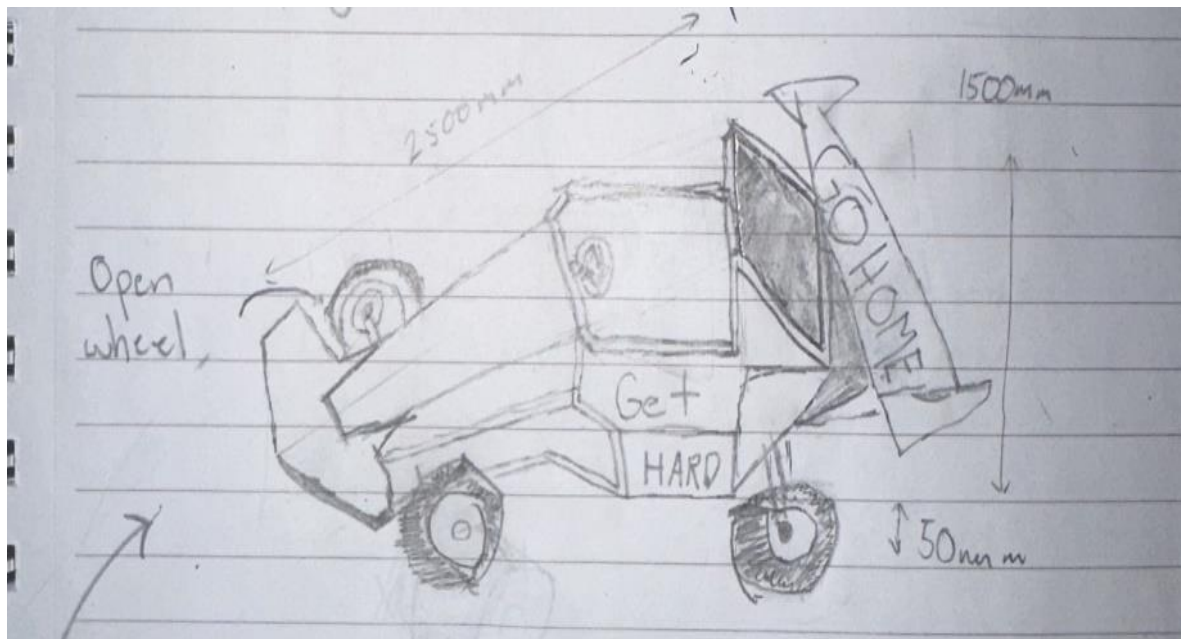


Figure 1 - Dynamics and Driveability Initial Sketch

For stability purposes it has been decided to use the maximum allowed width of 1500mm and length of 2500mm. The main reason for this is by using a wider soapbox it allows the kart to achieve phenomenal speeds when taking corners, due to a lower weight transfer (Motorsport Engineer 2020) meaning less prone for the cart to roll over. Performance wise this enables the kart to have an increase grip in the outer wheels, however due to the normal forces of gravity the inner wheels will still lose a bit of grip. In addition to this it has been decided to make use of an aerodynamic wing. This enables the kart to have an increased downforce and provides the kart with stability as air passes around it (Francks 2024)

The desired ride height for this design is the lowest it can possible be which is 50mm, by having a low ride height this enables the kart to achieve a lower centre of gravity making it less vulnerable to weight shifts when turning a corner or experiencing harsh braking (Springrates Team 2022)

This sketch has been designed to have an open wheel design, this design reduces the use of materials. A beneficial factor of this is, the cart becomes lighter weight in result of less body panels being used and could obtain a balanced weight distribution between the front and rear axle, which can significantly enhance handling by having the same grip percentage on all four wheels (Racing Car Technology 2020).

Braking system

The braking system that the soapbox will incorporate is the disc brakes. They will be pedal operated, mimicking the same ones on a modern car but on a smaller scale. This system consists of a master cylinder filled with brake fluids connecting to both callipers with brake lines, then when the pedals are depressed the brake pads would clamp onto the disc brake via pistons. Disc brakes provide a longer lifespan due to its ability to dissipate heat at a rapid rate compared to other braking systems (Dexter Group 2023). Alternative braking systems that have deemed to be inferior in comparison to the disc brakes are the drum brake systems, due to the systems enclose environment, they tend to accumulate thermal heat at a rapid rate thus leading to brake fade (Andy 2021).

Steering system

This soapbox will be using the rack and pinion steering system, this steering type is one of the most used system in modern vehicles because of its compact, efficient light weight design. Due to the design having less parts it is much more accurate compared to the older steering systems for e.g. the recirculating ball steering. An alternative steering system that is more suitable for a soapbox kart is the direct linkage steering, it may not have the same attributes as the rack and pinion such as, precision and efficient steering inputs. But nevertheless, it is a more primitive and a simple invention that is still capable to steer in the desired direction. This type of steering requires more attention in terms of maintenance because of mechanical wears on components such as linkages and joints.

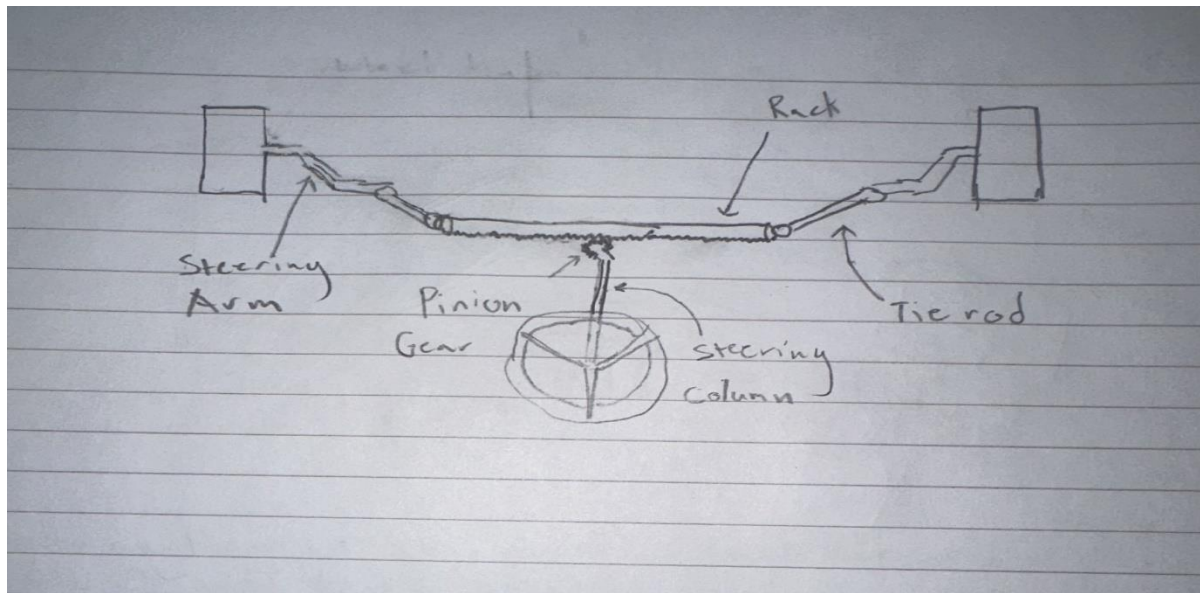


Figure 2 - Steering system Sketch

4. Conclusions

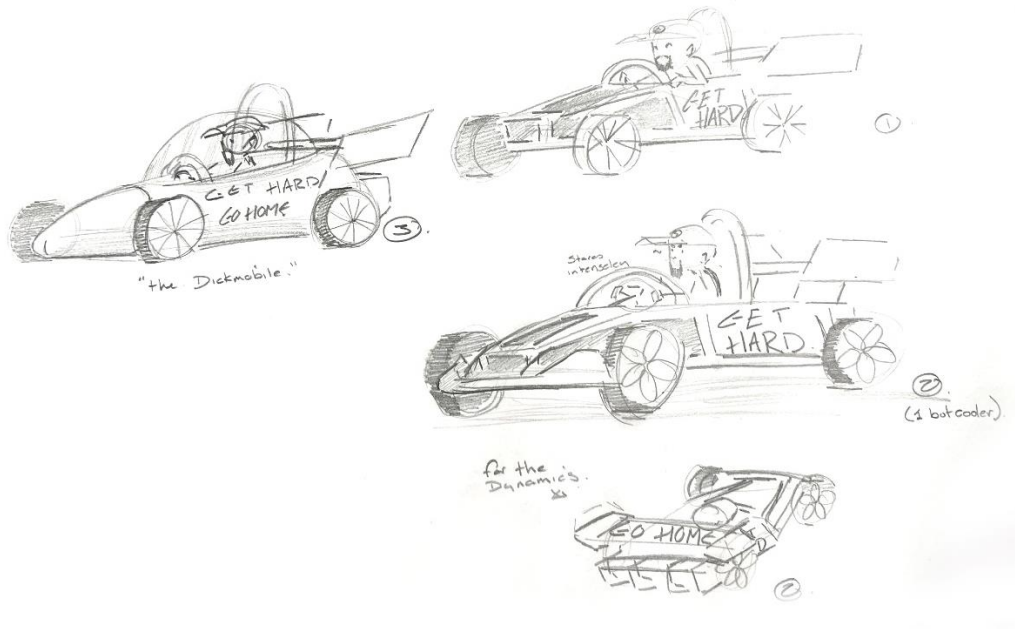


Figure 3 - Design Sketches

Figure 3 illustrates some final design sketches the group has come up with.

While materials that have been used are not explicitly visible on the drawings, there are some points to note with driveability and dynamics.

The idea of having the Soapbox low to the ground and being of the maximum length and width can be seen in the open wheeler design, and the aerodynamic concepts to make the cart be faster in a straight line while having downforce provided from wings are also visible.

The regulations set by Richard's Castle Soap Box Derby state that the cart must have roll bars for safety purposes – one above the head of the driver and one above the steering wheel. These are visible in the design drawings also.

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