

BACHELORS DEGREE ASSIGNMENT SPECIFICATION

Student name:	Louis Dunstan, Ethan Davies, Evan Arthur, Callum Francis-Beck, Luca Gray	Student P number:	2304942, 2305338, 2304605, 2312005, 2304962
Programme:	Foundation Engineering	School:	Engineering
Module:	Integrating Project	Module Level (4, 5, 6):	4
Module code:	ACHA4008	Contribution to Overall Module Assessment (%):	60%
Lecturer:	Richard Sutton	Internal Verifier:	Andrew Noble
Assignment Title:	Project first report	Assessment No (x of x):	1 of 2
Hand Out Date:		Submission deadline:	28 th January 2024

Referencing:	In the main body of your submission you must give credit to authors on whose research your work is based. Append to your submission a reference list that indicates the books, articles, etc. that you have read or quoted in order to complete this assignment (e.g. for books: surname of author and initials, year of publication, <u>title of book</u> , edition, publisher: place of publication).
Disclosure:	I declare that this assignment is all my own work and that I have acknowledged all materials used from the published or unpublished works of other people. All references have been duly cited.

Student's Signature:		Date:	24/01/24
-----------------------------	--	--------------	-----------------

Turnitin: Lecturer to tick to indicate if an electronic version of the assignment must be submitted to Turnitin. Note: the Turnitin version is the primary submission and acts as a receipt for the student. Both electronic and paper versions MUST be submitted by the same deadline. No marks will be released until both submissions are received. Late submission of either the electronic or paper version will result in a late penalty mark. Penalties for late submission: Up to one week late, maximum mark of 40%. Over one week late, Refer. Only Year Tutors and the Programme Director may grant an extension.	YES	
	NO	

Learning Outcomes tested (from module syllabus)	Assessment Criteria To achieve each outcome a student must demonstrate the ability to:
1. To implement an application/design synthesizing their knowledge from a number of modules	· Demonstrate in-depth knowledge of the underlying concepts and principles associated with the topic under research · Employ an appropriate referencing system · Propose objectives and suggest strategies to achieve the outcomes of the study
2. To analyse a well-defined scenario, establish the requirements and develop an appropriate solution	· Propose objectives and suggest strategies to achieve the outcomes of the study

Project Introduction

For this group project we had to research and design a soapbox race car that will be eligible to compete in the Richards Castle Soapbox Race. To do this we had to break down the 'ins and outs' of how to build and design something that not only looks good, but also has the capabilities of winning the event, all while staying within the rules and regulations.

Our group is made up of 5 members meaning that the most efficient way to complete this project is to break it down into several larger topics, these are then assigned to a member or coupled up into pairs. They are as follows:

Materials - Evan Arthur
Cost Analysis - Ethan Davies
Steering - Luca Gray and Ethan Davies
Braking - Louis Dunstan
Chassis - Louis Dunstan and Evan Arthur
Designer/Artist - Callum Francis-Beck
Suspension/Wheels - Evan Arthur
Wheels - Evan Arthur
Main Writing - Louis Dunstan and Ethan Davies

We also split into three separate groups to come up with a base design with a brief analysis, to be put forward to be the final design. We ensured that these three designs were all done with different building methods and designs. Each team was given free reign over their design and inspiration, and after one month we all met up in person to decide on the winning design.

Team 1: Luca Gray
Team 2: Louis Dunstan and Ethan Davies
Team 3: Evan Arthur and Callum Francis-Beck

We held meetings further into the project when the initial designs and ideas had been finished and discussed throughout the group, this had resulted in going forward with design team 3 as our final project.

There were also many smaller and less significant tasks that were delegated out to individuals to make sure the workload on each participant was as equal as possible. We also held meetings as the full group or individual checkups to oversee the work other participants were doing to make sure everybody was kept on track and the work produced was of a high standard.

Design 1 - Mario Kart

For this design, we wanted to have a bit of fun, and decided on a “Mario Kart” theme. The idea of this was to create a soapbox which resembled a go kart from the Mario Kart game series. We wanted to explore whether a design like this would adhere to the rules and regulations, be challenging while fun to design and build, and also be fast on the course without major issues, all while being cost-effective.

For this design, there are 3 main parts which need considering; chassis, steering, and brakes.

With the chassis, there are two possibilities for us to choose with a go kart, designing and building our own chassis, which would be easier for us to modify and fit parts onto, or to buy an already existing kart chassis second-hand. When analysing the basic cost of each option, an existing chassis would cost around £160 (Ebay.co.uk), and the cost of purchasing material for building our own would be £105 (Metals 4u), with 4m of $\frac{1}{2}$ " steel pipe required. Due to the significantly lower price of creating our own chassis, we decided that this would be the better option, as the money saved from this would allow us to buy the more complex components ready-made, and fit the chassis around them.

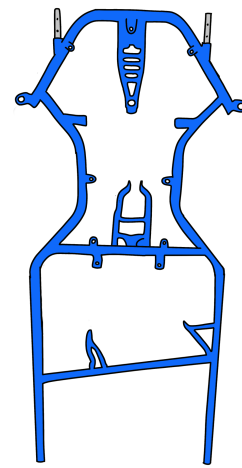


Figure 1.1: A chassis concept inspired by existing ones

One of these components is the steering system. For this, we decided that it would be easier to buy a pre-made system which we could fit onto our chassis. Due to our budget restraints, we decided that an assembly set would be best, and we found that the set available at Maxpeedingrods was the best option due to its cheap price and adjustability, meaning that it would be easier to be able to set up this system on our chassis.

For the brake system, we decided that it would be easier for us to have one brake centrally at the rear axle. This is due to the fact that with only one rotating axle at the rear, a lot of weight is saved, and with only one brake disc, it is easier for us to get the brake system working.

The bodywork for this design is relatively simple, with our best option being to buy used kart bodywork and use spray paint to achieve our desired design. It would resemble Mario's go kart as close as possible, as shown in Figure 1.2. For assembly, we could drill the bodywork into the chassis, so that it is secure and would stay on in the event of a crash.

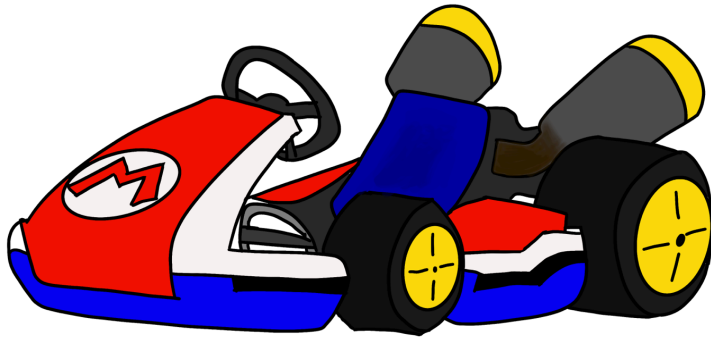


Figure 1.2: A concept drawing to show what we wanted this design to look like

However, there are two reasons why we decided to not go ahead with this design. One of them is the fact that with a go-kart chassis, we would be unable to have a proper suspension system. This is a problem because the surface could be very uneven, creating an uncomfortable ride for the driver and any unexpected impacts would be likely to break the vehicle, as there is no suspension to take in the shock.

The other reason is the need for a substantial roll cage (Article **2.14** in the regulations). Whilst we would be able to construct our own roll cage or roll hoop and have it fully comply with the regulations, we feel that it would intrude on our ideas for the design of the kart too much. If we felt that our main design was not as good as it was, we could have gone ahead with a roll hoop for this design and overlooked how it didn't fit with our overall vision for the kart.

Design 2, F2001 Ferrari F1 Car.

For our second design, we decided to go for an early 2000's Formula 1 car, specifically taking inspiration from Ferraris dominating F2001. When designing an ideal soapbox the centre of gravity needs to be very low, and the design of a Formula 1 car helps this, as the original Formula 1 cars are perfectly designed for speed and cornering abilities.



Figure 2.1 : F2001 Show Car Chassis (Bonhams,2023)

To successfully design a complicated Formula 1 car we decided to not replicate all the minute details and aerodynamics and only focus on a shaved down, simpler version. Bonhams Cars had a F2001 show car in the Abu Dhabi Auctions in November 2023, the images from this car show are the main inspiration, see figure 2.1, to design our car around, due to the quantity of high quality images up close on this car (Bonhams,2023)

To design the rear wing we will simplify it down to a narrow box style wing with two vertical sheets of fibreglass and one concave piece of fibreglass across the middle instead of 3 different wings. We will do this to cut down costs and time.

For the front wing, we came up with 2 different designs, both similar in looks but different when it comes to structural rigidity. The first design will have a solid front nose cone which will be structural and then attach fibreglass copies of the F2001 wings to either side, the design of the Ferrari front wing is a simple 2 wings suspended under the front nose, and attached to 2 complex end plates. We will try to replicate this. This design will protect against frontal impacts, however leaves the sides of the front wing vulnerable to being ripped off in the event of an accident, this then leaves the wheels exposed and increases the potential of losing a front wheel. Similar to what happened to Schumacher in his 1998 f300 car, see figure 2.2



Figure 2.2: Micheal Schumacher, 1998 Belgian gp Accident (Petrić, 2020)

For the second design we would keep the overall design however instead of suspending the wing below the front nose, we would instead attach a structural beam across the width of the car, to protect the wheels and side pods from damage. The front wing would then attach to this. This would throw the overall front design off as the wing will be further forward than it should be, however, we felt that this lack of similarity to the F2001 was necessary to improve overall strength and increase the likelihood of making it to the bottom after an impact. The lack of similarity in the front wing would then give us our own claim on this design being our own and not a copy of the F2001. After discussion over the two front wing designs we came to the conclusion design two is better

The side pods and air intake would be a fibreglass shell attached to the body. It would not only be cosmetic but would also hide our main chassis. For the side pods, we will build a simple metal frame in the shape of the F2001. This will increase the strength of the car as well as reduce the potential damage a side impact will cause. In the event of an accident, only the fibreglass shell would be damaged, and this would not affect our run. For the air intake, we will use this as a cover for the roll hoop, as required in the regulations. Due to our car not needing a real air intake we don't need to make it real and instead, we can just have a black painted part to mimic the intake. This means that the roll hoop does not need to be designed around the car, instead, the car will be designed around it. This increases the safety of our car as we can optimise the design for safety.

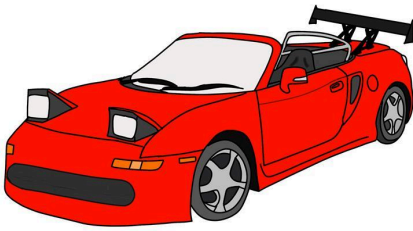
For the design of the cockpit, we will have a custom tubular chassis with a sheet metal floor, we will have a seat attached to two tubes on the base and also attached at the rear to improve seat stability. We will also have a 4-point harness that is attached to the rear beam as well as the same seat mounting points. This will not only be for safety reasons, but also for cosmetics. The steering wheel will be custom to mimic a modern-day Formula 1 wheel. The tubular chassis will have lots of reinforcement around the front nose to protect the driver from impacts.

We will mount the wheels to the chassis via a pushrod suspension, similar to the real thing, however instead of using high-tech custom suspension components, we will get some mountain bike rear suspension components and will custom adapt them to work in this configuration. For steering we will custom-make a system utilising a second hand steering rack from an older vehicle that didn't come with power steering, and build some custom parts to link it to a set of quad bike wheels, with old f1-style grooved tyres.

Chosen Design - Toyota Mix-up

For this design we wanted to do something completely different from the other two designs. We had multiple ideas for what we could do but nothing really came from those. However we then had the idea to put multiple designs together as well as putting our own twist on it. This resulted in 'The Toyota mix-up'.

Body Design:



The Toyota Mix-up - Callum Francis-Beck

Above is the design we have chosen as a group. It is a mix of popular Toyota designs. The rear, front fenders, bonnet and windshield are inspired by the Toyota gt86.



(AutoCar, 2011)

while the mid-section, front bumper and headlights are inspired by Toyota MR2.



(BringATrailer, 2020)

The main reason we have chosen this design is because they are fairly common and are a pretty simple design with no sharp edges or complicated parts that we would not be able to replicate in a real life application such as the design of the Ferrari F1 car we already looked at. There are no complicated Aerodynamic properties that would have to be replicated on the Toyota mix-up.

We also chose this design over the Kart design for the main reasons of adding other safety items such as the roll cage. We are able to successfully add this to the Toyota car design because of its more custom shape and the custom chassis we are adding as its base.

The chassis and all of our steering and braking components should be able to fit nicely in the bodywork since we are basing it off of real life vehicles and since we are using a custom chassis we should be able to keep the package relatively lightweight and compact and we also do not have the restraint of an already made chassis limiting us to what we can and can not have as our bodywork.

Brakes:

As this race is in fact downhill, having good quality brakes is very essential to contribute to our success. Many people who take on the soapbox challenge seem to find themselves in a situation where the soapbox picks up too much downward velocity and their brakes cannot cope causing many collisions and crashes into the barriers. We began researching the best types of brakes that we could use but also keeping in mind that we have to justify them being affordable.

After doing some research we found that the best brakes to use would be mountain bike brakes attached to the rear axle, this is due to them being incredibly light whilst still having substantial stopping power. As stated in the introduction to the Richards Castle Soapbox Derby rule book, there are some parts of the course where speeds of 30-40mph are reached, so we will need brakes that are capable of this. Mountain bike brakes are designed for use at this speed. We feel this will provide adequate braking force due to the rear brake typically being the only one used whilst mountain biking on a downhill descent.

We will position these brake discs internally to not only improve the centre of gravity but also to protect the brakes in case of an accident. By putting them internally we can also use only one per axle instead of one per wheel, which again reduces weight. This is because rule **2.5** states that if an axle has a braked wheel then both wheels on that axle must be braked. So by mounting the brakes centrally, we can brake both wheels with only one brake. In the event of an impact, we will still be able to stop sufficiently as the brakes will not be damaged and will still retain all stopping power.

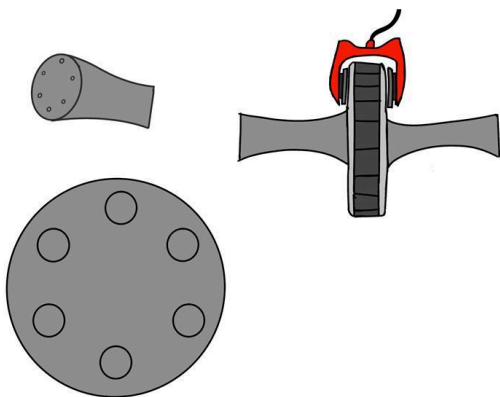


Figure 4.1 shows how we will attach the brake discs to the centre of the rear driveshaft.

Because our soapbox is under a strict budget speed we will use these Formula Cura brakes, ([Brakes](#)), because these have 2 huge 24mm pistons they will provide sufficient stopping power as well as having very long, 165cm, brake hoses they will be able to be compatible with our soapbox. Weighing only 490g for a pair, these

brakes also will not increase our weight to the point of slowing us down. (Marvin, 2021)

To apply the brakes we will have a vertically placed pole to which we will attach the brake handle. See Figure 4.2. It would look something similar to a regular bicycle handlebar, cut in half and rotated vertically. This is the safest and simplest way to mount the brakes. This is due to the other options being positioned further away from the steering wheel and/or having an increased risk of puncture wounds. This mounting method will be incredibly strong, due to the mounting beam being part of the chassis, mountain bike brakes are also designed to be attached to the handlebars, so are already perfectly suited to this mounting method, and will not need adapting.

To mount the disks to the soapbox, we will make custom driveshafts with a central mounting plate see Figure 4.1. We feel that this will not only simplify the braking system but also lower the risk of brake failure. This onboard style of braking will mean that instead of modifying the brake lever to control 2 different brake callipers worth of brake fluid, it only has to control 1. This will in turn mean that the braking lever isn't as hard to pull, due to it moving half the fluid.

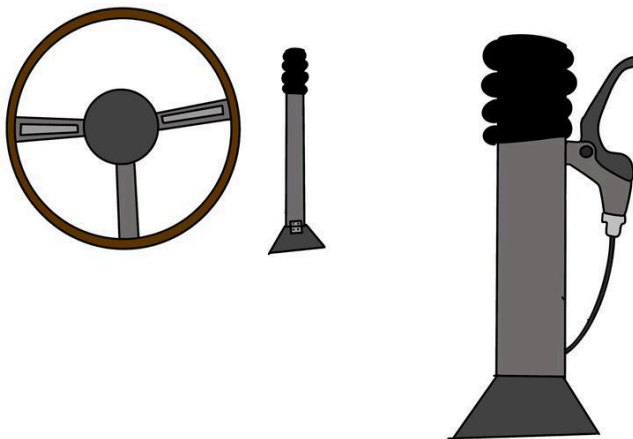


Figure 4.2 shows how we will implement the brake lever into the car's interior.

Steering:

For the steering system, there were two main types of steering assembly which we considered using for our soapbox. One of which is the Rack and Pinion design (Figure 5.1), and the other using simple mechanical linkage (Figure 5.2), which is the most commonly used system in soapboxes, and is much like those used in go-karts. For these two systems, there were three main criteria with which we decided what system to use: ease of production, handling and cost.

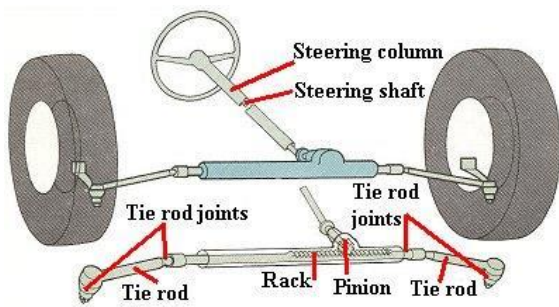


Figure 5.1: A labelled illustration of the Rack and Pinion steering system
(The Motor Ombudsman, 2018)



Figure 5.2: A traditional soapbox steering system
(GordsGarage Blog, 2011)

In our opinion, we feel that a more traditional soapbox steering system beats the rack and pinion design in all three categories. The traditional system has a much simpler design, which allows us to create parts for this ourselves, where we would need to buy an entire system otherwise. This also affects the cost of each, and due to our budget constraints it is much easier for us to find the needed materials to build our own system than to buy an expensive pre-made one. For example, we could use scrap metal which is produced by the University workshops, as the simple design only requires a small amount of material. With the handling of each system, the rack and pinion design requires a lot of steering input by the driver, while the traditional go-kart system turns the same amount as the driver does. With less steering input and attention to this required, the driver is able to be more focussed on following the road, and with this they are much less likely to cause a collision, and damage the soapbox.

There are two main challenges with applying this design to our soapbox. The main one is sourcing the materials required in order to have a fully functioning steering system. Whilst it is possible for us to use scrap pieces produced by the University, we cannot reliably get what we need as the parts are quite specific to the design. This means that we need to buy the materials and parts required ourselves. The only part that we need to buy pre-assembled is the tie rod, due to its relative complexity. For this, we went with the Drivetec steering rod assembly (GSF Car Parts), one for each side. This is due to its low price and ease with connecting to the steering column.

The other challenge is connecting the tie rods to the chassis and wheels. This can be done quite easily, as we can create custom brackets on the ends of the chassis, as shown in Figure 5.3. This is the simplest way to connect the steering system, and can provide a bit of extra strength to the chassis. With the steering rods not being directly connected to the wheels, there is also a smaller chance for them to be damaged in the event of a collision.

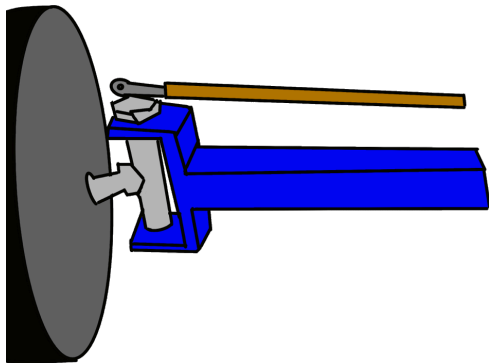


Figure 5.3: Close up of the custom bracket which will be made

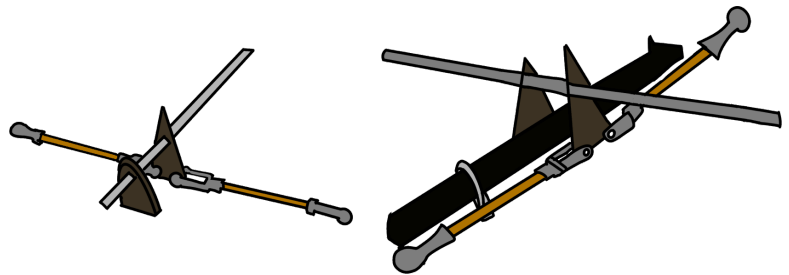


Figure 5.4: Overview of the steering system and how it will be connected with the chassis

Steering Wheel

For the steering wheel we looked at a few options, those being brand new or second hand on ebay or even just getting one from a scrapyard. After searching ebay we came across a brand new aftermarket steering wheel with a relatively low ranged price.



Figure 5.5: The decided steering wheel (eBay, 2024)

Even if a second hand steering wheel would drop the price on this it would not lower the price significantly enough for us to want to take a risk on the wheel being defective, as the wheel is not electric there would be nothing we could do mid race in the soapbox if the wheel were to break or become a problem. Buying brand new also gives us a guarantee that if it is defective we can return it and get another one with no extra cost incurred.

Chassis:

Many soapbox designers use old recycled bits to make the chassis, with the most common sources being pre-existing vehicles. This is due to these products, such as, go-kart bodies, shopping trolleys, and bicycles, being primarily designed for strength in forward motion. This method is also inexpensive compared to having a custom chassis. The main drawback from these recycled chassis is that you have to design the bodywork around the chassis, this can lead to distorted body lines and shapes, if trying to imitate an object with different dimensions.

To make a custom chassis we will have to use some metal square tubing and sheet metal and weld together to make a structural shell. For a start we will make a rectangle that is the desired width of the soapbox and the desired length of the wheelbase, strengthened with an x brace. Atop this we would lay a solid metal sheet which we would bolt the seat and lap belt to. Next we would build a frame around the cockpit to protect the driver, followed by a front and rear crash bar.

A custom made chassis's main positives are it is a lightweight design that is made to fit around the bodywork. Often custom made chassis are faster and more effective, however costly, this is due to the lightweight nature of them. Some soapbox builders use wood to build a chassis however we felt that this would be too fragile for our design, and we decided that the extra weight of metal would be worth the added time as a substitute for extra strength.

The key design to focus on with a custom chassis is having the wheels wide and a flat frame bottom (Ellison 2021). This helps with stability as well as grip round corners. We have to make sure that we don't make our car too wide as this can drastically increase the difficulty of making it through the tight sections of the track. A very wide chassis will also throw off our bodyworks dimensions

If we were to use a recycled chassis we would highly consider that from a ride-on lawnmower as suggested by Joe Ellison via RedBull's 'How to build a winning soapbox racer' (Ellison 2021). This is because it gives us a good rough size that can be easily altered to fit our regulations. Additionally this will ensure our chassis is structurally sound for the mounting of the seat and steering system.

Suspension

The durability of the soapbox is one of the key aspects to making it down the descent. This means it is important that the suspension is both responsive and durable. This can be achieved both internally and externally from the chassis, often using components from commercial bicycles.

Inboard suspension

Figure 6.1 highlights a basic level design of inboard suspension which acts diagonally to the driving surface. A benefit to this design is the opportunity for a wider base and a more central/uniform load to the chassis. The effect this will have on the soapbox is the ability for a much lower centre of mass due to the wider wheelbase which will improve the handling at higher speeds.

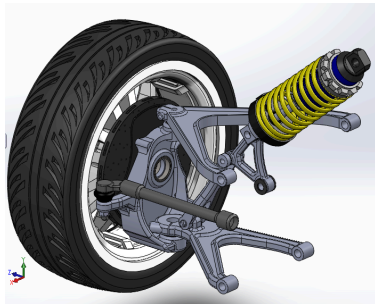


Figure 6.1 - Basic Inboard
(Singh Shekhawat, 2018)



Figure 6.2 - Inboard with push-rod
(Hanlon, 2011)

A variation of inboard suspension, called the push-rod system seen in Figure 6.2, works similarly to the typical inboard design. The damper + springs are both within the central rear structure of the chassis working at a horizontal to the driving surface. Alongside this design allowing for a wider wheelbase, it is also very impactful on how protected the suspension components are which helps the overall durability of the soapbox for going over and around obstacles met on the course.

Wheels:

Small go-kart style wheels remain lightweight and provide sufficient grip on the road for steering and overall stability. These are designed for high speed vehicles and lower, much faster vehicles and require a substantial amount of heat to the rubber to produce good grip which the soapbox will likely not achieve throughout the descent. These cost $\approx$ £250 for 4.

Bicycle wheels are a good, common option in soapbox racing as they are both relatively light and cheap while performing well enough to see the vehicle to the chequered flag in good time. However these have been seen to bend or even snap during small jumps and harsh corners, throwing the overall balance of the soapbox out or even ending the run early. To avoid this a smaller version (such as children's sized wheels) will be considered as these carry all of the benefits of larger scale bicycle wheels in our context, while also having smaller diameter, resulting in better overall strength due to the spokes being closer together on the rim. This gives the opportunity for our soapbox to ride low on the wheels while still meeting the 50mm recommended clearance regulation **2.4**. These cost $\approx$ £25 for 4.

Another sufficient option is wheels from a quad bike as this will provide a good combination of grip and size. This style of wheel is heavier than the other types mentioned, meaning they will have greater rotational inertia which – ideally this will be at a minimum. These cost $\approx$ £100 for 4.

The last option found to be suitable for our soapbox is wheels specifically designed for one. These are commonly found in competition and cost $\approx$ £32 for a set of 4 (eBay, 2024) which is relatively affordable compared to the alternatives. These are lightweight and sized well to fit the vehicle, as well as being durable to harsh impacts. The grip the wheels can produce will be sufficient to allow good overall control of the vehicle and stability on the descent due to the smaller size of wheel. For our design this wheel is most suitable.



Figure 7.1 - eBay Wheels

Materials:

Chassis

Often, the chassis of soapbox cars are made from recycled frames of already functional machines such as ride on lawn mowers. This is to keep the cost and labour down and gives a good foundation to build up from. Sometimes, depending on teams' budgets, the chassis can be custom made out of aluminium piping for its great strength to weight which works as a very applicable base to many different designs. This however is much more expensive than the cheaper alternatives.

In other cases, the chassis is made to fit the rest of the soapbox and is put together by the builders. This is where plywood can be used as it is durable and strong enough to be built off of and withstand some of the obstacles down the soapbox track.

Bodywork

The bodywork on soapbox cars can be seen to be thin wood, of varying types. This is to keep the overall weight of the car down while still allowing creative designs to be implemented with ease. More commonly, cardboard and polystyrene is used as this is lighter and much cheaper than wood while being very easy to form and design on. In some cases, the bodywork is sculpted out of GRP (Glass Reinforced Plastic) or CFRP (Carbon-Fiber Reinforced Polymer) which have very good strength to weight ratios and are very good to form to the shapes required. Similar to the Aluminium, this benefit comes at a significant cost rise which is why the use of this is very minimal in the event. The use of Fiberglass and CFRP will not be permitted for our use due to Safety regulation **3.3 & 3.4**: which does not allow the use of glass or any materials that can shatter and or harm pedestrians/spectators – because of this, cardboard will be used to shape the car as it fits in the specifications, has safe properties for the driver, is lightweight and importantly is very cheap relative to alternative options.

Safety in the bodywork

To ensure the drivers safety, the cockpit of the soapbox is to be fitted with padding. This can be recycled from retired PPE (still usable) and other vehicles to reduce cost while still providing ample protection over the driver. Seatbelts are highly recommended (Technical, Design and Structural Regulation **2.13**) so to ensure the safety of the driver, the vehicle will be fitted with a Lap belt. This option will keep the driver planted incase of a crash while remaining light and affordable, costing around £20 for the whole system. This can be securely mounted onto the chassis as this will be the strongest part of the soapbox.

Cost Analysis:

The financial impact of building and designing a soapbox can make the vital push toward making a winning or losing build. Having no initial budget set we had to keep in mind throughout the whole process that our financials could only stretch us so far. This means that with every purchase we had to evaluate whether it is actually worth having the slightly better parts with increased cost or take a more 'value for money' part and not have that added reliability or perfectly placed part.

However there are a few ways to get around this initial financial block, many groups that have taken on the soapbox challenge before have made use of Ebay. Ebay has been a recommended site to use to be able to cut the costs for the same parts that we could find from first hand sellers (Wilson, M. 2015). Ebay is great as there will be many individuals selling different raw materials, parts and pieces that we could make use of although this comes with the added risk of the items not being of as high as quality, they could be pre-owned and used before, there is more risk of fault, the seller may be selling a quantity of too much or little and it can take a lot more of our time to search the site to find the exact parts we need.

New or Recycled?

After mentioning Ebay we have to also think about whether we want to use new or recycled parts.

New - Brand new store bought parts or unused parts bought from 3rd party sellers

Recycled - Parts that have been used before still in good condition, refurbished parts that are good enough to be able to be used again, parts we have that we can use that will incur no cost, parts that others are willing to just give away for free.

As we are a group of students living away from home we do not have any spare parts lying around in our accommodations that we could use for this project so we will be unable to make use of that. With that disadvantage being said as being students we have access to wide network of other students that we can put to use to ask for any spare parts for our project, although this in theory may be a good idea it would have a low probability of usefulness to us as we are looking for specific parts and pieces to be able to use and the chances that a person we knew would be able to help with the pieces we are looking for are very low.

The only options left on the table for us to consider now are brand new parts, pre owned/used and refurbished. With our options now laid out we went ahead to start looking for the best prices across different sites while still having to make sure the cost was low enough to be made agreeable.

Average v Actual

This section is displaying the average cost of each section of the soapbox compared with the actual price of the section. The average price in mention relates to an average of a few different sources for the same or similar part/piece that we have chosen for our project. This section will also display a relative price range of the parts that we have searched for on sites such as Ebay and Amazon stating the price range that we deem affordable.

This section will only include the prices of pieces that we deemed we had to buy and could not take from scrap.

Suspension:

Price Range - £130 - £500

Average - £350

Actual - £210

Wheels:

Price Range - £25 - £150

Average - £50

Actual - £32

Steering:

Tie rod (price for 2);

Price Range - £10 - £60

Average - £30

Actual - £30

Steering wheel

Price Range - £15 - £100

Average - £45

Actual - £20

Brakes:

Price Range - £40 - £300

Average - £200

Actual - £150

Other prices

Bodywork & Chassis will be made by us from raw materials hence there will not be an average price

Bodywork

Expanding foam (per can)

Price range - £4 - £10

Actual - £6

We will be buying 3 cans of expanding foam resulting in a price of £18

Cardboard

The rest will be made from cardboard and as cardboard is given out free at supermarkets and stores this will incur no cost.

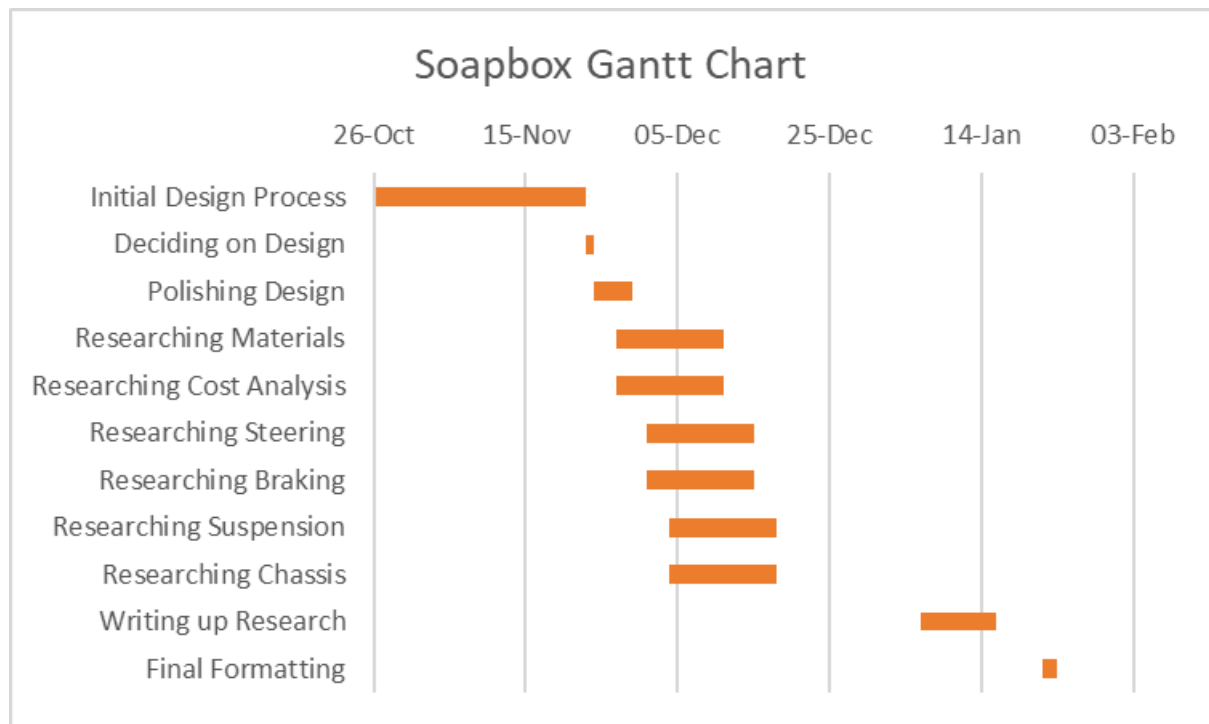
Chassis

Aluminium tubing (15 metres)

£250

The rest of the chassis will most likely feature from recycled parts incurring no extra cost.

Meeting minutes and Gantt Chart



First meeting - 26/10/2023

- 11:00 - Meeting began
- 11:05 - Discussion regarding designs
- 11:10 - Design teams formed
- 11:20 - All tasks for design teams set
- 11:30 - Initial research began
- 12:00 - Meeting ends

Second meeting - 23/11/2023

- 12:30 - Meeting began
- 12:35 - Talks about the main design
- 12:50 - Main design chosen
- 13:00 - Tasks for final design
- 13:00 - Research begins for final design

Third meeting - 05/12/2023

- 16:00 - Meeting began
- 16:10 - Talks about how research is getting on
- 16:25 - Talks about how to improve efficiency in researching
- 16:40 - Talks about reassigning certain smaller tasks to best fit other tasks
- 16:50 - Talks about how we can put all research together
- 17:15 - Meeting ends

Final meeting - 25/01/2024

13:00 - Meeting began

13:05 - Discussion about final formatting and layout

13:15 - Polishing of the whole document began

13:40 - Polishing finished with everyone happy with their own sections

13:45 - Every group member deciding which minor tasks were going to be delegated

14:00 - Group meeting ends as every member begins to finish off the document

Bibliography

AutoCar (2011), Toyota GT86 First Drive, Available at: [Toyota GT86 Japanese first drive \(autocar.co.uk\)](https://www.autocar.co.uk/story/toyota-gt86-japanese-first-drive)

BringATrailer (2020), One-Family-Owned 35k-Mile 1991 Toyota MR2 Turbo 5-Speed, Available at: [One-Family-Owned 35k-Mile 1991 Toyota MR2 Turbo 5-Speed for sale on BaT Auctions - sold for \\$21,100 on March 11, 2020 \(Lot #28,928\) | Bring a Trailer](https://www.bringatrailer.com/one-family-owned-35k-mile-1991-toyota-mr2-turbo-5-speed-for-sale-on-bat-auctions-sold-for-21100-on-march-11-2020-lot-28928-bring-a-trailer)

Bonhams Cars (2023) *2001 Ferrari F2001 Authorized 'Michael Schumacher' Formula 1 Show Car*, Available at: <https://cars.bonhams.com/auction/28793/lot/18/2001-ferrari-f2001-authorized-michael-schumacher-formula-1-show-car-chassis-no-52/#photos>

eBay (2024) *Four (4) Soap Box Wheels 12" / 300mm Mag Front Scooter Wheels White Cage Bearing*, Available at: <https://www.ebay.co.uk/itm/203199440689>

eBay (2024) *Gillard TG14 Rotax Max Senior Go Kart Chassis Straight Chassis*, Available at: <https://www.ebay.co.uk/itm/225954561020>

eBay (2024) *PU Leather Sport Racing Alloy Aftermarket Steering Wheel 350mm Silver*, Available at: <https://www.ebay.co.uk/itm/364258871889>

Ellison, J. (2021) How to build a winning Red Bull Soapbox racer, Available at <https://www.redbull.com/gb-en/how-to-build-a-soapbox-car>

GordsGarage (2011) *hAckermann Geometry*, Available at: <https://gordsgarage.wordpress.com/2011/07/25/hackermann-geometry/>

GSF Car Parts (2024) *Drivetec Steering Rod Assembly*, Available at: <https://www.gsfcarparts.com/dtsitr0161l>
<https://www.gsfcarparts.com/dtsitr0161r>

Marvin, T. (2021) *Formula Cura disc brake review*, Available at: <https://www.bikeradar.com/reviews/components/brakes/disc-brake-systems/formula-cura-disc-brake-review>

MaXpeedingRods (2024) *Universal 110cc Go Kart Steering Wheel Parts Assembly Set Adjustable Shaft*, Available at: <https://www.maxpeedingrods.co.uk/product/steering-wheel-part-assembly-kit-for-110cc-go-kart-tie-rod-rack-adjustable-shaft.html>

Metals 4u (2024) *1/2" (15mm) NB Mild Steel Pipe Galvanized*, Available at:
<https://www.metals4u.co.uk/materials/mild-steel/mild-steel-pipe/pipe-galvanized/8680-p>

Hanlon, M. (2011) Lamborghini introduces pushrod suspension to series production, Available at: (Accessed on 28/01/24)
<https://newatlas.com/lamborghini-introduces-pushrod-suspension-to-series-production/17666/>

Petrić, D. (2020) *1998 Belgian GP - Massive accident at the start, Schumacher crashes into Coulthard*, Available at:
<https://maxf1.net/en/1998-belgian-gp-massive-accident-at-the-start-schumacher-crashes-into-coulthard/>

Singh Shekhawat, R. (2018) Dual wishbone front suspension with push rod, Available at: (Accessed on 28/01/24)
<https://grabcad.com/library/dual-wish-bone-front-suspension-with-push-rod-1>

The Motor Ombudsman (2018) *Getting to know rack and pinion steering*, Available at:
<https://www.themotorombudsman.org/useful-information/motoring-advice/getting-to-know-rack-and-pinion-steering>

Wilson, M. (2015). *Get on your soapbox: how to build a gravity racer*, Available at:
<https://www.stuff.tv/features/get-your-soapbox-how-build-gravity-racer/>