

ACHA4008

Integrating Project

Soap Box Design Concepts
Group E

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Introduction

This projects intention was to design a soap box for the Richards Castle Soap Box race. We decided to focus purely on the performance of the soap box, the intention being of course to win.

Considerations

To develop out initial design concept, we first decided to research 3 key areas. These are Rules for the soapbox, Track lay out/data and finally similar vehicles. What we found for each are as follows.

Rules The only rules which we decided would impact the decision-making process would be the overall dimensions, the need to clear the starting ramp and the addition of a protective structure.

Track lay out. The exact location of the track we could not establish from the event organisers, however from knowing the general location, looking at photos and some onboard footage we established the track is the road in fig.1 As shown it has 3 right hand bends as well as a single left-hand bend. Using the terrain function, we estimated the track would drop by 230m throughout its duration with the steepest section between turns 1 and 2. The course is paved single lane road which from watching videos of previous years had some severe bumps, potholes, and loose gravel; especially on the run to the first corner.

Similar Vehicles The first item of interest is what we believe to be the winner of a previous year. Here you can see he has used a streamliner type body and what appear to be about 16"x0.75" tyres, similar to those of a bicycle. We then looked at other projects including Guy Martins attempt which utilised a similar body shape and enclosed cockpit. Many other examples were found all with commonalities, an emphasis on low frontal areas, streamlined shapes and typically a 4-wheel configuration. This gave us enough information to begin an initial design.

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Fig. 1 – track lay out



Fig. 2 – Previous winner



Initial design.

For the initial design this is as far as we deemed reasonable to take it. Some key decisions were made with this design, such as having both front and rear suspension, front wheel steering and disc brakes. The features that were to be kept and the reasons why are as follows, Front disc Brakes are an essential part of this design. The exact componentry is to be specified later however discs and callipers used for downhill mountain bikes would be the most obvious solution and used other vehicles as well. Mountain bike brakes offer a wide range of choice in terms of componentry, larger or smaller diameter discs are available as well as callipers with between 1 and 4 piston arrangements. Due to this range, it is reasonably easy to find components off the shelf (which saves time and likely money in not developing our own) As well as having a large range of budgets to accommodate for. The only item not available would be a foot operated master cylinder, however with some modification a bicycle or motorcycle unit could be used. A steel tubular chassis was chosen for 2 main reasons. It has a good compromise between weight and rigidity, in this case we decided that some weight saving could be made by removing the two tubes that run the length and replacing it with a single tube and "u" bent vertical supports. the mounting points for the wishbones could also be brought in, however this is to accommodate a Integrating Project more Aerodynamic body. The second reason we used a steel tubular chassis is due to the ease and cost of manufacturing as well as ease of modification and repair should any need to be made. Compared with monocoque fiberglass or carbon fibre designs. The wishbones in this design would be changed or modified to be longer in order to fit the re designed chassis as well as the addition of aerodynamic profiles being added. Weight we considered a factor at this stage. The ideal mass of the vehicle including rider we decided we could calculate if we were able to get mor track information. We decided we wanted to also have the chassis/driver combination less then the maximum ideal weight so we could adjust ballast to suit as well as have adjustment in terms of centre of gravity (horizontally front to back as opposed to vertically. We also decide more could be done at this stage to limit frontal area, i.e. decreasing the size of the chassis. Suspension we decided would be essential to a fast time, our decision was based on the videos of previous attempts which would show unsprung vehicles behave erratically over the rough surface, leading to lack of control and time wasted. Mountain bike rear dampers were again a good choice. Whilst again we would have to spec these depending on budget, they offer in the high-end units several features which are advantageous to us. Firstly, they have a variety of spring rates which can be fitted, secondly, they offer the ability to control compression and rebound damping and in some cases in both high and low velocity damping. Finally, the shape and weight are well suited due to being both light and reasonably compact. Initially the thought was to mount them between the lower wishbone and frame however it was decided an improvement in aerodynamics could be made by moving them inboard and having them actuated by a linkage. This would also give us another point of adjustment should it be needed.

Further development.

Several areas could benefit from further development.

Firstly is the area of suspension, specifically in terms of geometry. In order to control the amount of camber with suspension travel the wishbone lengths can be changed. With our ideal ride height being as low as possible, regulations and ground clearance depending, the upper wishbones could benefit by being shorter to decrease the amount of positive camber which in the first design was an issue; 10 degrees or so at the given ride height.

The ball joints also affected the camber in this instance and lower profile replacement, or alternative would be desirable.

The second area of development would be with the suspension linkage. As stated above, inboard shocks were considered a good solution. The linkage used therefore is very important.

To tune the geometry to our needs and specified components software such as WinGeo or similar could be used. Seeing as our overall dimensions are fixed, ride height, wheel travel and our final chassis is to be as narrow as possible we can adjust our wishbones and linkage within these programs to give us a good idea of the exact measurements, we may need to have the correct camber as well as ensure the shocks are operating within their set parameters.

To develop an understanding of what geometry may be required, resources such as Racing Chassis and Suspension Design by Carrol Smith could be used.

The chassis and bodywork would be then next to develop. With a full model made on solid works finite element analysis could be used in order to test designs to ensure they will not fail or flex, this way the chassis design could be tuned to be as light and strong as required.

CFD simulations could be used in order to adjust the bodywork.

Production and cost.

Since the design has mostly been created with computer aids there is only a limited need for prototyping. This keeps the cost of production lower and timeframe short.

The bodywork and suspension are the two largest costs.

The cost of the bodywork if made in fibreglass would be at a minimum £250 as the moulds would also have to be built and then the panels made. Fibreglass kits are available for £40 for 5kg resin and the appropriate amount of the glass fibre. To know quantities required the thickness and area of the body would need to be decided upon.

Price for the suspension units vary. The high-end components are in the area of £500 – Fox dpx2 Rear shock. 4 of these would be required of course. Shocks can be found for as little as £30 each and then most prices in between.

The estimated overall cost for a mid-level specification would be between £1000 and £2000 depending on the exact design. This is of course excluding labour rates of any fabricators that may need to be used.