

University of Wales Trinity Saint David



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## Soap Box Car Group Project

Integrating Project ACHA4008

Morgan Albrighton

Jacob Jones

Nick Davey

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## 1. Introduction and team composition

### 1.1 Aims

The aim of this report is to research into three possible soap box car plans that can be used in the Richard Castle soap box derby, these plans will also be supported with technical designs for each car also included will be materials required for assembly steering and braking specifications and finally the total cost of each soap box car.

### 1.2 Objectives

The objective of this report is to provide a conclusion on what one of the three soap box car designs are ideal, which will then be carried forward into further study and development.

### 1.3 Team composition

**Morgan Albrighton**- Team Leader.

Work completed: technical drawing 2,

Materials 1,2 and 3,

driveability and braking 1,2 and 3,

Gantt Chart.

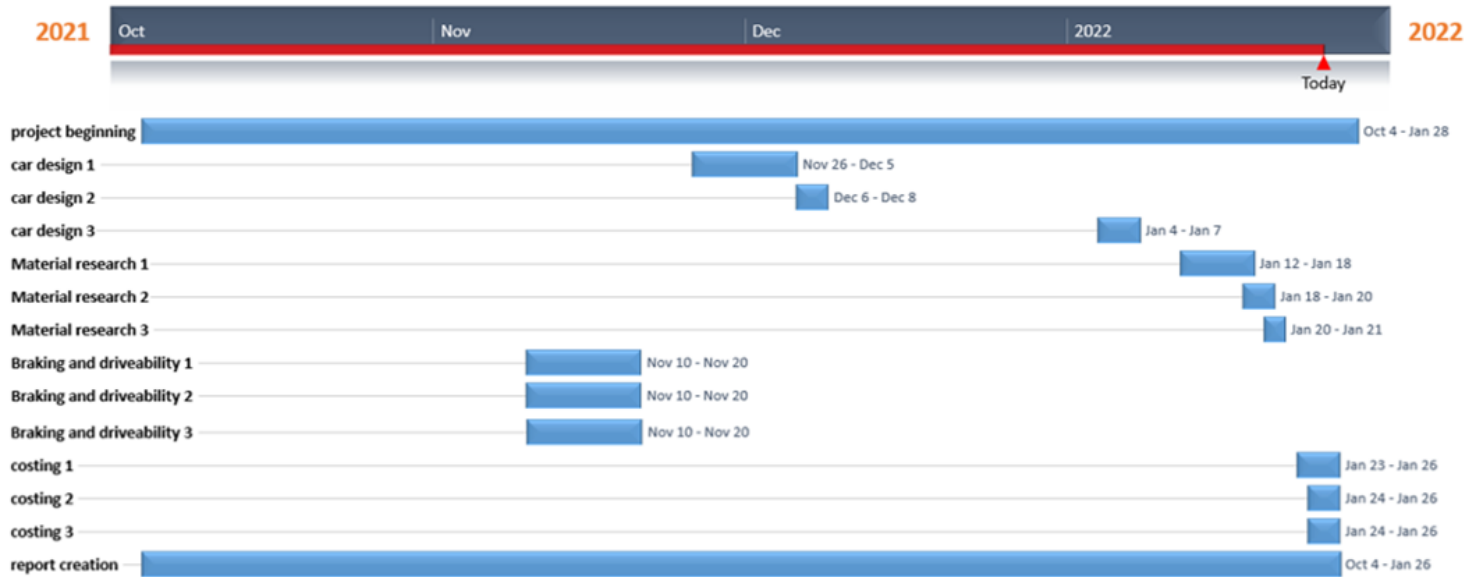
**Jacob Jones**- Vehicle Designer

Vehicle technical drawings 1 and 3

**Nick Davey**- Project Financier

Work completed: Financial and costing 1,2 and 3

## 2. Gantt chart



### 3.1: Low Budget Car

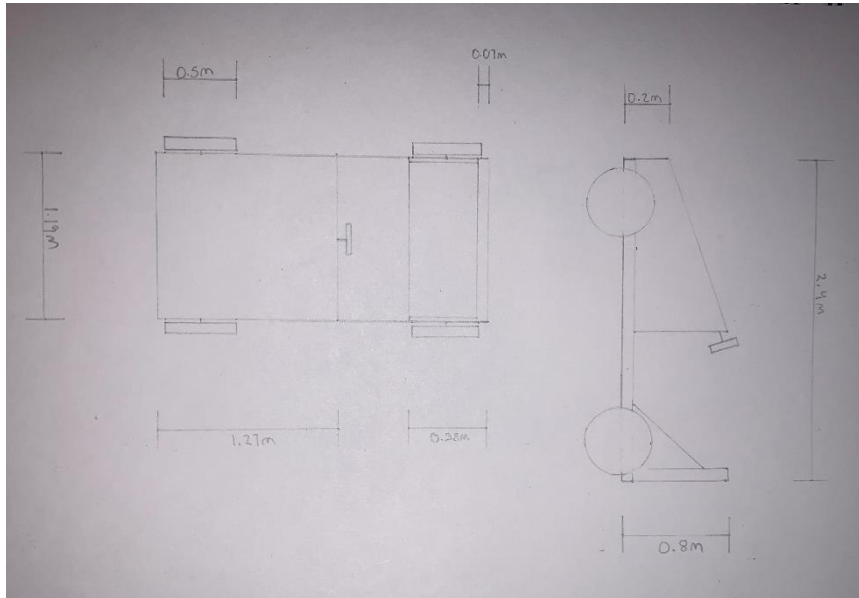


Figure 3.1.1: Technical Drawing for low budget soap box car.

#### Low budget car materials

##### Wood

Firstly, one option to construct the soap box car is to use spruce wood beams, this wood has many advantageous qualities; The first of which are its physical properties. Spruce is a softwood which is both hard and lightweight. Secondly spruce is inexpensive and is readily available to purchase, this allows easy and spontaneous repairs to be possible whenever the need is required. The disadvantage of using spruce as is with most wood is that if it is left untreated the wood would begin to rot due to weather conditions over time. (*Properties of Wood - Composition, Physical, Mechanical and Thermal*, no date)

##### Aluminium

Aluminium was another alternative material I considered using to construct the soap box car. What made this material alluring to pick were the beneficial properties that come from using metal to construct our car. Such beneficial properties include but not limited to: Aluminium is a malleable metal due to its softness this will make it easier to construct our car than most metals. Aluminium is one of the more relatively cheaper metals that are readily available to purchase from local hardware stores. Aluminium is also considerably lighter than alternative metals. The malleability of aluminium can also prove to be a weakness because it means that it is more easily warped. (*Metals & Their Properties: Aluminium | Morecambe Metals*, no date)

##### Steel

Steel was a final option when considering what to construct the soap box car out of, this material comes with desirable properties just like aluminium. The properties of steel consist of its durability as it is denser than aluminium this also proves to be a negative as it means its heavier. Another admirable property of steel is its tensile strength, steel can absorb a high amount of stress before it suffers breakage this also negatively impacts as the material is less malleable due to this and its higher density. (*Properties of Steel | Understanding Material Properties*, no date)

##### Final choice

The material I have decided to chose is my first option, which is the spruce wood. Spruce is a low-cost wood to buy in bulk. Price of the material was a factor in the decision which carried very much weight in my final decision-making process. Spruce still providing adequate strength for the soap box car.

## Driveability and Braking

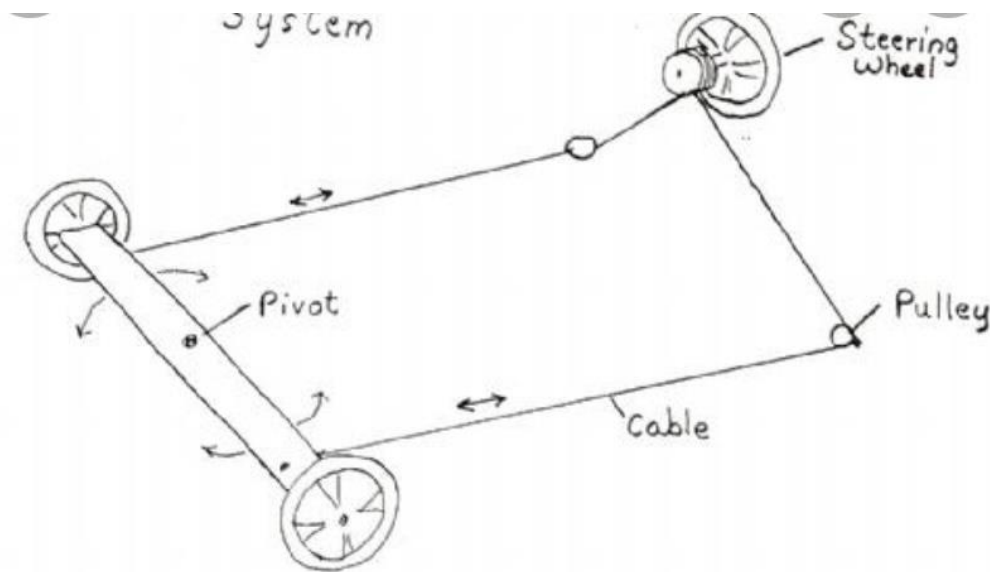


Figure 3:1:2 Diagram showing cable steering system that will be used in low budget soap box car (5Q3LzjrkIIA9xjoHGMUIY81hRQ72gQaFXC1hZkrO6RkpWmXikfVDtGZoFlZW9EiR5fT5Q=s155 (155×85), no date)

Firstly, for the cheapest soapbox I decided the steering system to use is the cable wind system. These steering systems have been around since the beginning of soap-box construction as they are remarkably simple to build and only require a few materials such as a single pivot axle a basic steering wheel and a cable connected to each side of the axle.

Staying on a budget I have decided to equip 16inch wooden wheels these wheels may not have the best traction around corners however they have the strength to make multiple runs in a race. When the driver turns the steering wheel, the cable connected will pull on the axle depending on what side they would like the axle to turn. Due to the sensitivity of the steering method high speeds are difficult, because of the steering system restricting the carts speed, I have decided that a basic wooden lever will act as a handbrake with a thick piece of rubber at the end of it as a result when manually activated the rubber will contact the track. This will then be able to slow the cart down.

# Finance and Costing

## Low Budget Soap Box Car

### The Frame:

The Frame for our Low budget soap box car is going to be made from spruce wood beams (from B&Q), here is the overall price of materials we need to build the frame.

Total length of wooden beams (accounting for extra): 21m

9x (L)2.4m (W)30mm (T)25mm: £35.82 (in total)

(3.98 per 2.4m of spruce timber beams)

This will give us an overall total of 21.6m of Rough sawn whitewood spruce timber to build the frame.

### The Body.

The body panels for our low budget car will be constructed out of Hardwood Plywood Board from B&Q. listed next is the price of making the body of the low budget soap box car.

Total needed of plywood board: 2x Hardwood Plywood Board (L)2.44m (W)1.22m (T)18mm

2x (L)2.44m (W)1.22m (T)18mm: £84

(£42 per board of plywood)

This will give us a Total amount of plywood board which is 5.95m<sup>2</sup>

### Total

The total cost of constructing the car will come to approximately £ 119.82

## 4:1: Medium Budget Car

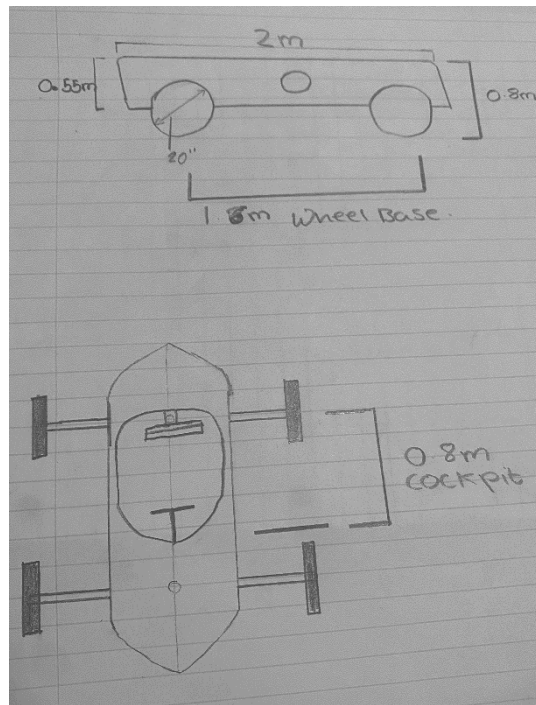


Figure 4:1:1 Technical drawing of middle budget car

### **Aluminium**

The first material option to use for the soap box car is aluminium. Aluminium has a lot of desirable properties; nameable properties include its malleability which lends itself to the lightweight nature of this metal. The aforementioned properties both mean that aluminium is an easier metal than most to work with. One drawback of aluminium is its strength, aluminium by itself is not the strongest metal available. (*Metals & Their Properties: Aluminium* | Morecambe Metals, no date)

### **Steel**

One alternative option for a material is steel. Steel has many qualities which could benefit the soap box car such as its strength. Steel is a very strong metal and is capable of dealing with a high amount of stress. Another advantage of steel is that to purchase, steel is often cheaper than aluminium whilst still providing more than adequate workability. One negative of steel is its weight its heavier than aluminium which can prove detrimental in a number of applications. (*Properties of Steel* | Understanding Material Properties, no date)

### **Carbon fibre**

The third and final option, be it a more optimistic choice is carbon fibre. Carbon fibre provides a vast multitude of effective qualities such as its unparalleled strength. When analysing the weight/strength ratio, carbon fibre out competes all other materials in its class. Other functions that carbon fibre excels at are its vibration dampening and its low coefficient of thermal expansion. However, the one over shadowing disadvantage of carbon fibre is its considerably high cost of manufacture and purchase. (Bhatt and Goe, 2017)

### **Final choice**

In conclusion although carbon fibre provides unmatched advantages, for this particular design aluminium has been decided to be the material we will carry forward as the final choice to use on this car. The reasoning for this choice includes its medium price point and the ease of acquisition.

## 4:2: Driveability and Braking

For the middle-priced soapbox, I decided to use a more accurate and durable steering system. I wanted a system that was able to perform well under higher speed and would be more stable around corners as a result I decided to use a pitman style drive system. This system converts torque from the steering gear and is then turned into mechanical force which can steer the wheels.

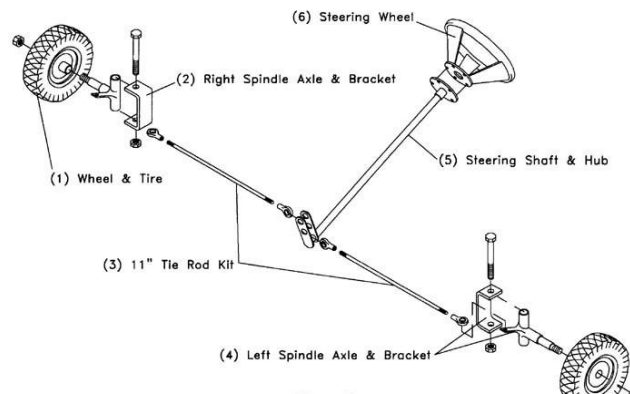


*Figure 4:2:1 diagram showing example of steering linkage used on middle budget car (Pin on chekeson, no date)*

Looking at *figure 4:2:1* we will require basic components such as 20-inch wheels, a steering wheel with a hub and shaft system. Other key requirements are a tie rod kit, splined axles, and a pitman bracket.

The braking system I have decided to use is a simplistic and cheap standard bicycle system specifically a design called a scissor design. This system requires few components such as a brake lever which will be situated within reach of the driver. A cable is also used as a pulley which pulls the back levers fitted with brake pads then causing friction to occur between the wheels and brake pads. This will allow the soap box to slow down.

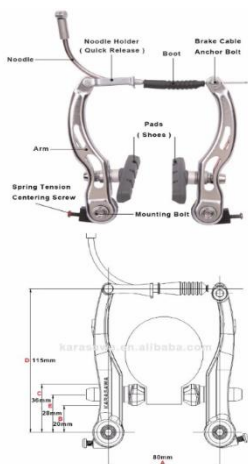


*Figure 4:2:2 example of braking system used on middle budget car (shimano v brake parts, no date)*

# Finance and Costing

## Medium Budget Soap Box Car

### The Frame:

The Frame for our Medium budget soap box car is going to be made from aluminium square tubing (from B&Q), here is the overall price of materials we need to build the frame.

Total length of aluminium tubing (accounting for extra): 18m

9x (L)2m (W)20mm (T)1.5mm: £150.30 (in total)

(16.70 per 2m of box tubing)

This will give us an overall total of 18m of aluminium box tubing to build the frame.

### The Body.

The body panels for our middle budget car will be constructed out of silver effect aluminium embossed sheet from B&Q. listed next is the price of making the body of the middle budget soap box car.

Total needed of aluminium sheet: 9x Silver effect aluminium embossed sheet (H)1000mm (W)500mm (T)0.5mm

9x (H)1000mm (W)500mm (T)0.5mm: £222.30

(£24.70 per sheet of aluminium)

This will give us a Total amount of aluminium sheeting which is 4.5m<sup>2</sup>

### Total

The total cost of constructing the car will come to approximately £ 372.60

## 5:1: High budget car

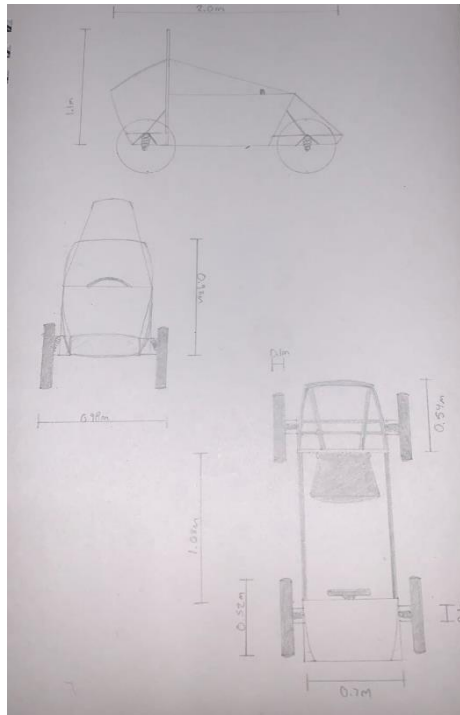


Figure 5:1:1 Technical drawing of high budget car

### High budget car materials.

#### Carbon fibre

The first option that has been selected to be used on the high budget soap box car is carbon fibre. Carbon fibre provides various highly desirable qualities, some of which being its exceptional tensile strength. High tensile strength usually come at the cost of high weight, however in the case of carbon fibre due to its unique composition carbon fibre remains substantially more lightweight than its competitors. Carbon fibre is corrosion resistant and chemically stable which will be advantageous in the future when considering the longevity of the car's lifespan. (Bhatt and Goe, 2017)

#### Aluminium

The second option that is open for use is aluminium. Aluminium is a desirable material to use in construction of our car as it is easily acquired at an acceptable price point. It is malleable which makes it excellent for shaping and benchwork. However, compared to alternative metals, it is not as strong. Aluminium is one of the lighter metals out there which would lend itself well to the performance of the soap box car and the ease of transporting it to the event. (*Metals & Their Properties: Aluminium* | Morecambe Metals, no date)

#### Carbon Steel

The final alternative material choice for this high budget soap box car is a carbon steel composite. Carbon steel is incredibly strong, whilst still remaining malleable and ductile, which means it will still be relatively easy to shape this composite into our desired shape for the car. However just like carbon fibre and a lot of composites, carbon steel is still very expensive to purchase, and is heavy in terms of its weight. (*Carbon Steel: Properties, Examples and Applications - Matmatch*, no date)

#### Final Choice

The material which is selected to be used is carbon fibre as it provides the most beneficial properties such as its incredibly high weight/strength ratio. Thanks to the high budget for this car the price of purchase for carbon fibre is not as substantial of a factor to subvert our choice of using it.

## Driveability and Braking

For the final soap box, I decided to use a rack and pinion steering system. This system is commonly used on motor vehicles however I intend to use a small lightweight one designed for go-karts. This steering system is incredible capable of keeping control at high speeds while also excelling at cornering also while being exceptionally reliable. The rack and pinion design does consist of multiple components such as the rack and pinion, tie rods, steering knuckle, and spined axles. I will accompany this steering system with 20-inch carbon fibre wheels with racing compound tyres fitted to each wheel.



Figure 5:3:1 example of wheels used for high budget car (Rin Trasero Italika Ft180, Rt180, Ft200, Ft250 2.15x18 | Meses sin intereses, no date)

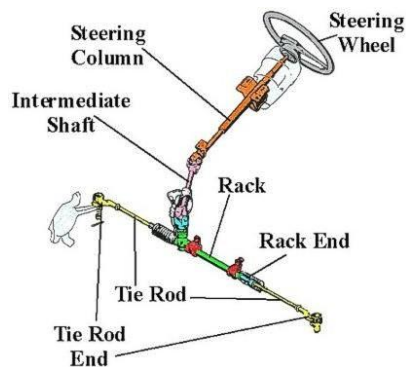


Figure 5:3:2 diagram showing steering system for high priced car (What are the materials which are used for manufacturing steering rack? - Quora, no date)

The tyres I have chosen, have a tyre tread which is specifically designed to provided optimal grip at high speeds while also having excellent traction around corners. These tyres are very lightweight and durable providing an excellent choice for the soap box.



Figure 5:3:3 image of ideal racing compound tyres for the highly priced soap box car

As the soap box will be able to achieve higher speeds the vehicle requires an improved braking system. I have decided to use a hydraulic disc brake system which is used on high end mountain bikes. Once the brake lever is pulled hydraulic fluid flows through a series of hoses before reaching the piston inside the calliper. The piston is forced by the fluid to move causing the pads to contact the brake disc. I am going to use a steel brake disc with an aluminium centre. The brake discs I have chosen are designed to allow heat to dissipate while the brakes are under operation

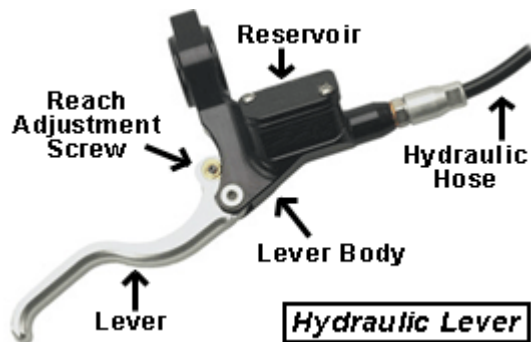


Figure 5:3:4 example of braking lever (Disc Brakes 101! - Bicycle Habitat NYC, no date)



Figure 5:3:5 aluminium and steel brake disc image (Brakes | Balfe's Bikes, no date)



Figure 5:3:6 diagram showing how the soap box cars brake assembly works (Bicycle Disc Brakes, no date)

## Financial and Costing

### **High budget car**

#### The Body

The body for our high budget car will be constructed out of double-sided high strength carbon fibre sheet. Listed next is the price of making the body of the high budget soap box car.

Total needed of carbon sheet: 18x double sided high strength carbon fibre sheet

18x 0.34m<sup>2</sup> (T) 3mm

(£228.50 per 0.34m<sup>2</sup> of carbon fibre)

This will give us a Total amount of carbon fibre which is 6.1m<sup>2</sup>

#### Total

The total cost of constructing the car will come to approximately £ 4113.00

# Conclusion and Reflections

In conclusion this report has laid out three possible options to pursue for the design of our soap box car. Each car contains factual information such as material properties and pricing as well as a detailed and annotated technical drawing for each design finally each design also has a well detailed driving and braking document containing all necessary information needed for driveability and braking of each soap box car. Reflecting on this project I believe the designs we produced are good quality and are well-constructed designs that could potentially be used in Richards Castle soap box derby.

## References

*(Carbon Steel: Properties, Examples and Applications - Matmatch, no date)*

Carbon fibre production-Bhatt and Goe, 2017)

*(Properties of Steel | Understanding Material Properties, no date)*

*(Properties of Wood - Composition, Physical, Mechanical and Thermal, no date)*

*(Metals & Their Properties: Aluminium | Morecambe Metals, no date)*

*(Bicycle Disc Brakes, no date)*

*(Brakes | Balfe's Bikes, no date)*

*(Disc Brakes 101! - Bicycle Habitat NYC, no date)*

*(Vittoria Rally tubular tire – Retrogression, no date)*

*(What are the materials which are used for manufacturing steering rack? - Quora, no date)*

*(Rin Trasero Italika Ft180, Rt180, Ft200, Ft250 2.15x18 | Meses sin intereses, no date)*

*(shimano v brake parts, no date)*

*(5Q3LzjrklIA9xjoHGMUiY81hRQ72gQaFXC1hZkrO6RkpWmXikfVDtGZoFlZW9EiR5fT5Q=s155 (155x85), no date)*

*(Pin on chekeson, no date)*