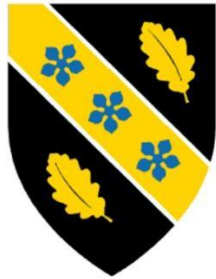


University of Wales Trinity Saint David
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Assessment 1 - Report

Engineering Projects
(ACHA4034)

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1. Introduction

This project involved the design, construction and testing of a tabletop rubber-band car. This was to analyse core principles within the field of mechanical engineering and physics. The primary objective was to convert potential energy stored in an elastic band under tension, into rotational motion of the driven wheels, to propel the car. Throughout the timeframe we had for this project, our group examined and studied the different variables, such as wheel diameter, mass, and friction, and how they influence the vehicles overall performance.

The design process followed a “less is more” mindset, considering we were only set out on this task, with limited materials and resources available. The planning and prototyping phase of producing this car was quite short-lived, which turned out to be rather successful. We ended up hitting the nail on the head by thinking in a simplified manner, with exactly what we needed the outcome to be.

We ended up settling on a simple pull-back design, inspired by commonly found toy cars. These toys tend to use a gear mechanism, however with the resources given, we ended up figuring out a very similar mechanism with the use of rubber bands.

By applying teamwork to our efforts, we were able to not only come up with a very simple but effective design but also iron out any issue we found in the process. This project not only allowed us to confirm/debunk any theories we had regarding the design and development of this car, but also provided adequate practical experience, which in turn allowed us to demonstrate any theories or ideas with something physical to show for it.

2. Design Development

Our group's initial design concept was mainly focussed on producing a basic, rubber-band powered car, which had a lightweight structure, with a setlist of materials we were allowed to use. The design was constructed using wooden lollypop sticks as the frame, with wooden dowels wrapped in modified bamboo straws, allowing the wheels to move freely whilst having the ability to mount the frame to the axles.

The adhesive provided to mount each component was hot glue, which was used mainly to construct the frame, attach the frame to the floating axles (bamboo straws), and secure the wheels to the axles themselves (wooden dowels).

The frame was triangular shaped, like top-heavy dragsters, one to avoid excess material usage, but to also avoid the vehicles trajectory going off-centre once moving. A shorter front wheelbase, upon testing, resulted in a much more stable direction of travel.

During the phase of ironing out any issues with the vehicle, we discovered that on the carpet flooring, we had ample grip to travel the distances achieved without wheelspin. However, on smooth surfaces, for example a wooden table, we had excessive wheelspin which consistently resulted in a heavy decrease in distance travelled.

To combat the issues regarding the lack of grip on smoother surfaces, we utilised the plethora of different sized rubber bands, and made makeshift tyres after finding a size that would fit the wheel in such a tolerance where the wheel wouldn't spin inside the rubber band.

Once discovering, and ironing out this issue, we went back to test on the carpet and smooth surfaces for good measure, to discover that this change did not result in a decrease in distance travelled.

To propel the vehicle, per the assignment brief, it had to be powered using rubber bands.

Considering we had already come up with a floating axle design; it made sense to incorporate this.

By separating our bamboo straws, and in the centre of the axle making a tab that allows us to hook a rubber band.

Upon pulling the car back, the rubber band now wraps around the axle, giving the car its tension before release.

Our next issue with the rubber band that we encountered, was the fact that we at this point had to hold the rubber band in place, then with the vehicle push it back, and then let go.

We didn't want this; we wanted the rubber band to be secured to the vehicle allowing for faster reset time, and no human interference with the pull-back mechanism itself.

To combat these issues, halfway between the front and rear axles, we put a crossbeam made from lollypop stick trimmed down to size and attached a claw-shaped construction to the beam. This, in conjunction with a low tolerance in the claw's gap, allowed us to always keep the rubber band with the car, ensuring it doesn't fly off upon launch, whilst keeping enough of a gap to replace the rubber band in the event it snaps.

3. Strengths and Weaknesses

For the strengths of our design, the vehicle was quick to re-use and could be launched theoretically an infinite number of times, only limited by breakage of the rubber band. The vehicle was very lightweight, and its construction was easy to understand, which allowed us to dismantle the vehicle with ease in the event of it ever breaking. Ours travelled further than vehicles other groups designed, within the first hour of the concept being functional. The vehicle also travelled at an exceptional pace, with a high level of torque upon releasing the rubber band's tension.

Upon testing, admittedly accidentally, we had underestimated how quickly the car got up to pace, and how far it'd go, to which we ended up having an involuntary crash test. However, despite this, that was where we made the discovery that the vehicle's structural integrity wasn't an issue. The vehicle took no damage in our "crash test", with no bending throughout the chassis, along with no parts coming loose, or detaching. This also proved that the method of adhesion was structurally sound and was working as intended.

As for our weaknesses, the vehicle isn't the most visually appealing, as our focus was function over form.

Due to the lightweight characteristics of the vehicle, it was a possibility of the vehicle being prone to bending the chassis, however during extensive testing, we didn't find this to be a problem.

We could've spent more time ensuring the alignment of the chassis was perfect to dial in the trajectory of the vehicle, along with its stability during travel, however we found the results were more than adequate upon testing.

There was an issue with the elastic band getting caught in the floating axle, so we had to trim the modified bamboo sticks (our floating axles) to allow the rubber band more room to wrap around the axle.

Another weakness of our design was that when reattaching the rubber band onto the rear axle to go for another launch, the rear axle must be positioned in such a way that the tab is facing vertically, as there's no other way to hook the band on. This was overlooked during the development stage of the project due to time limitations.

If we had more options for material choice, or a wider timeframe for this project, combatting this issue would've been on the list of issues to iron out.

3.1 Weaknesses Within the Group

Our group had some weaknesses, these showed up when it came to not only attendance, but effort from a select few. Even directly from the start, we had multiple members either not attend the lectures or not engage with any ideas/interest towards the project. These members have still had no response when prompted with messages. The vehicle was disassembled as we had ideas for improvement, however our time management to implement these ideas was not efficient enough, thus resulting in group members having to reassemble the vehicle outside of lectures.

3.2 Possible Improvements

To improve the design, we could have possibly added more weight solely for the purpose of increasing structural integrity and impact resistance. Other members in the group proposed extra weight as an idea for providing extra grip on launch, however this theory was not tested.

We had an idea to invert the pullback design on the front axle, allowing both axles to sit under tension, as a basic form of all-wheel drive. We believed the AWD concept could result in a further distance travelled at a quicker pace.

We discussed the idea of adding our rubber band tyre concept to the front wheels; however, this was mainly in conjunction with the idea of an AWD system. This idea was ruled out after the AWD concept was not in the timeframe to be achieved, so the extra grip on the front wheels was not required.

4. Conclusion

To conclude, our group efforts in reaching the criteria, despite internal setbacks, were to such a point where we ended up with a working rubber band car. The car featured a lightweight frame, travelled to adequate distance at exceptional speed, whilst maintaining rigidity and grip.

We were impressed by how our design turned out, whilst taking note of any improvements we could've made.

Said improvements made can be continued towards any future projects along the same lines, or just as gained knowledge within the subject.