Engineering Review

Group 5

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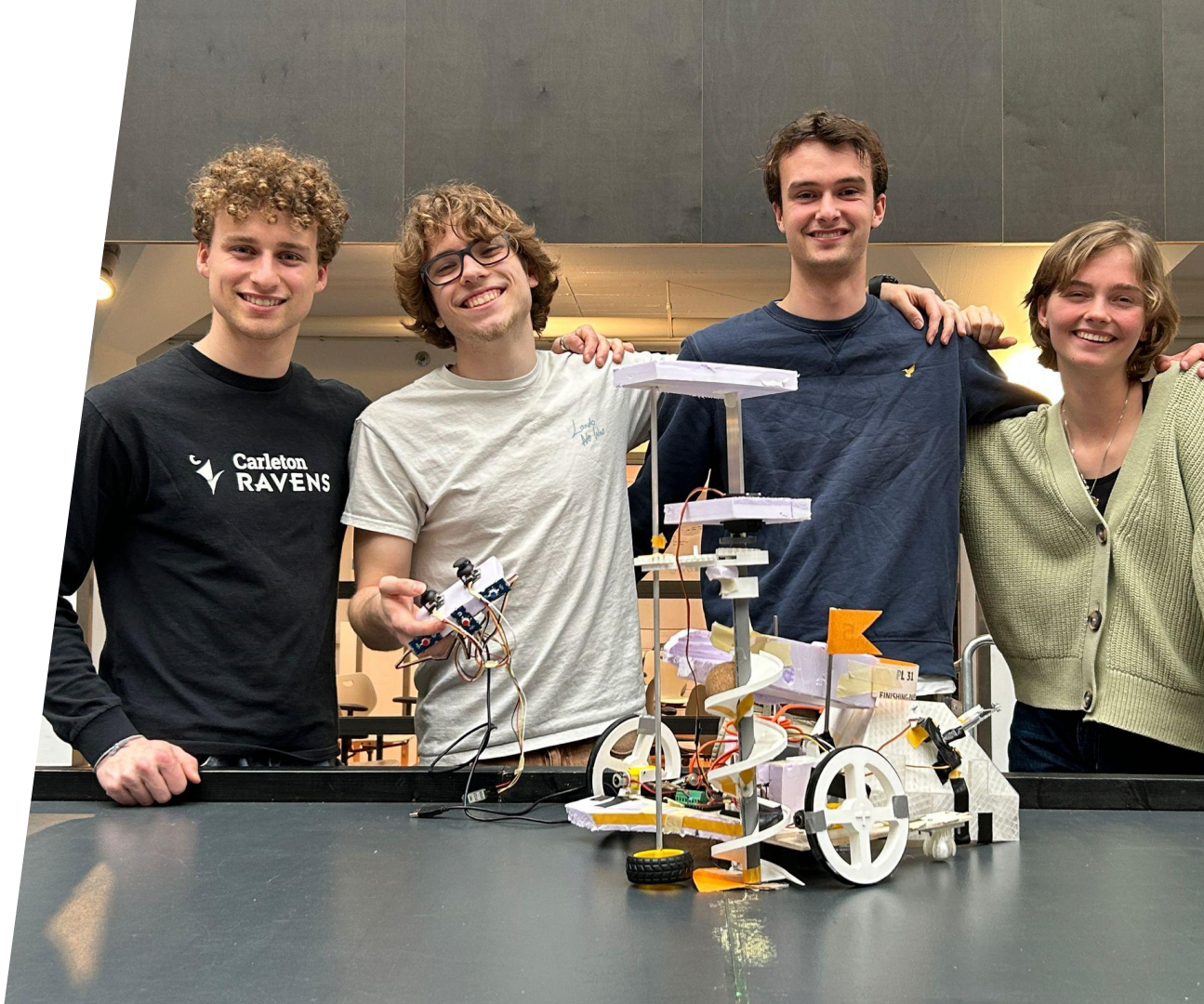
We have reviewed the devices of group 6, group 7 and our own group.

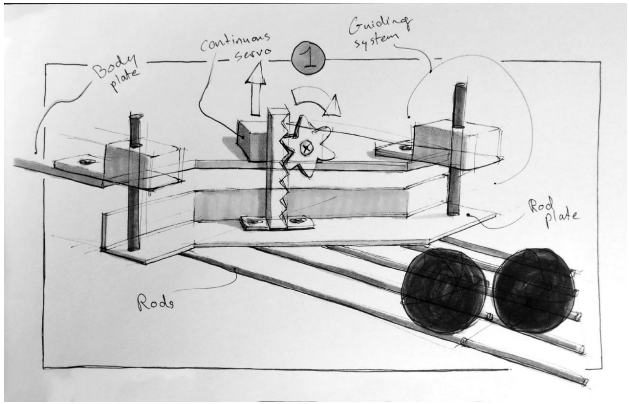


Our Robot's Issues

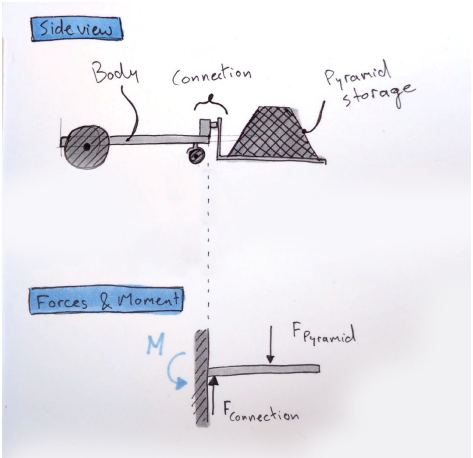
Our robot in a nutshell:
A pyramid-shaped storage, that builds while driving, and places the full pyramid at the end.

Issue 1: Bending, friction and slipping motors. All in one mechanism.
To prevent the balls from rolling while driving around, we came up with a servo-powered rack-and-pinion mechanism that would lift up our pyramid-shaped storage, along with a guiding system (figure A). However, this mechanism would only lift the pyramid from one side. In practice, this ended up being a real problem, because the bending moment in this only connection point between the pyramid and the body was too big (figure B). This resulted in too much friction in the guiding system and ultimately a slipping servo motor.

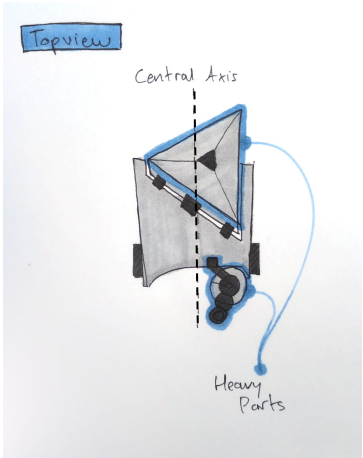
A



B



C



Issue 2: An ignored center of mass.
The center of mass of our robot in its entirety was completely off. The positioning of all parts is based solely on space efficiency; Balance was not taken into account. Because of this, the right side of the robot ended up being way heavier than the left side, meaning that the DC motor powering the right side of the car had to generate a much greater torque than the left one to reach the same rotational speed due to the mechanical resistance (figure C). This made driving straight nearly impossible.

Issue 3: Fragile connections
Due to poor planning, many connections on our robot are made out of tape or hot glue. This lead to some parts having too much/too little friction, too much wiggle room, or very fragile connections. This lack of robustness decreased the overall functionality of many aspects of our robot, like the helix lift, which fell apart multiple times before the match, causing us to take it off last second.

Main Learnings

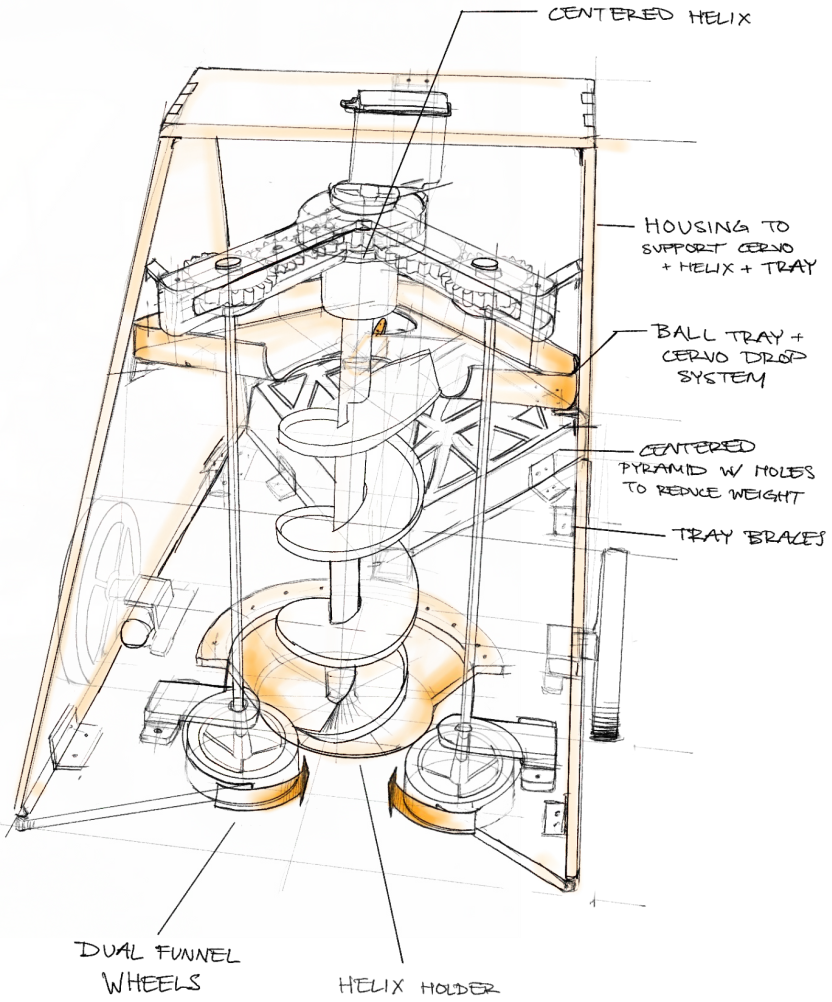
Balance of mass within a product is not to be ignored, especially in robots and mechanical systems. It could cause whole mechanisms to stop functioning due to friction, mechanical resistance or bending moments.

When realizing a concept **the devil is in the details**. If a concept is great, but details like dimensions or connection types do not yet make sense, the idea cannot realistically be brought to life.

The Redesign:

Key Elements:

1. Balanced Weight
2. The Ball Storage System
    a. Part replacement, mobility, and solving the rack-and-pinion.
3. More Detailed Part Joinery



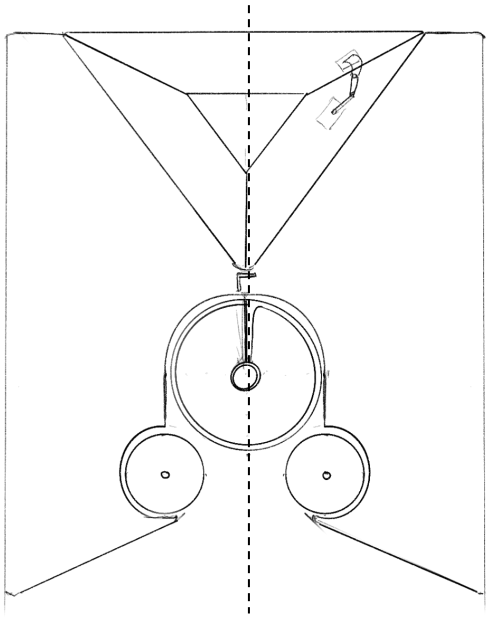
The Redesign: Part 1

Centering the heavy components

The bad weight distribution on our robot caused many driving problems, so with this redesign we center the heaviest components on our robot.

By putting the Helix and pyramid on the central axis, most mass of our robot will lie closer to the actual dimensional center, leading to a more balanced weight distribution and a smaller mass moment of inertia when turning. Ultimately, this will make mechanical stress on the DC motors equal and improve the vehicle handling, which likely makes ball collection easier.

Top View (Simplified)



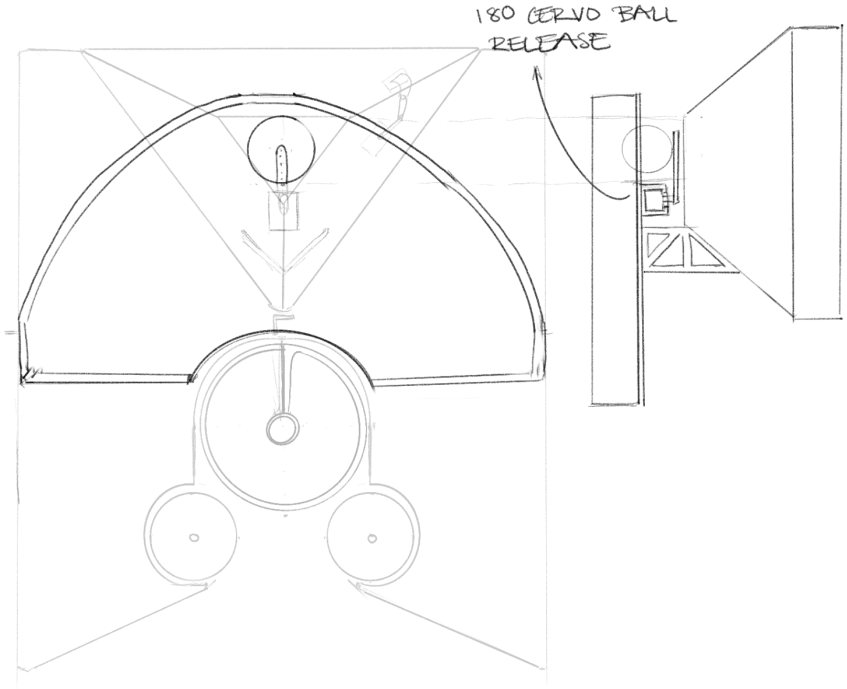
Central Axis

The Redesign: Part 2

Ball Storage-Tray System:

The Pyramid lifting mechanism was very sensitive to problems around friction and bending moment. So, instead of making the lifting system more complicated to fix this problem, we see opportunities in a mechanically simpler system.

With a ball storage system on a higher level, there would no longer be a need for the rack-and-pinion system, as the balls would not need to stack until the final placement. In practice, the first ten balls could be captured and dropped into the system, and then the following ten would be stored in the top compartment until the last moment.



The Redesign: Part 3

Improved Joinery:

Having bad connections was one of our key failure points.

To eliminate problems around fragile and loose connections, we decided to look into improved and more detailed joinery.

The improved design would have a multitude of joints focused around laser cut wood, and 3D printed & metal brackets to stabilize mechanical movements in the robot and improve its robustness.