VRC "Make It Real" CAD Engineering Challenge

Integrated Adjustable Ratchet

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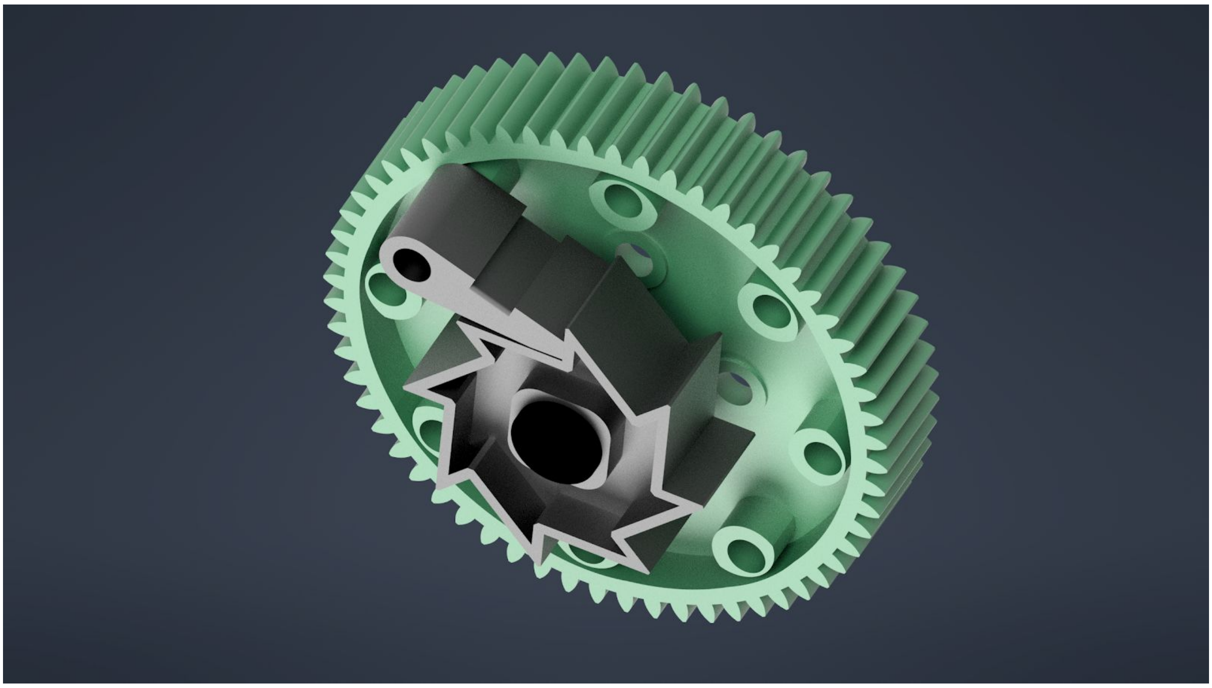
Version: Autodesk Inventor Professional 2021

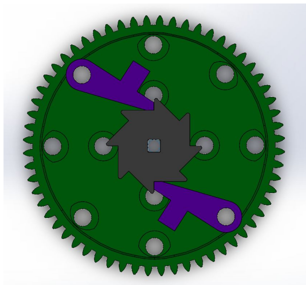
Contents



Introduction

Our first interaction with a ratcheting mechanism developed in VEX IQ Squared Away (2019-2020) whereby members of our team created a "skipping mechanism" found here (timestamped at 6:55).

Moving into VRC we hoped to develop this mechanism further, especially with the use of VEX's Ratchet in the Winch and Pulley Kit. However, upon testing we discovered it was limited, working with only low-strength axles and a lack of adjustment for varying degrees of forces.



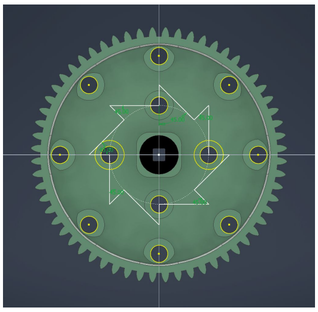
Our initial idea towards developing an integrated ratchet stemmed from one of our robot designs, where we were trying to create a method to passively remove balls from our storage to control the sorting of colours. This robot iteration came from the need to have adaptable yet specific control over the deposition of the balls into goals due to virtual competitions not being developed at this stage. Thus, we adopted a ratchet to deploy when the cycling motor spun in reverse to eject the 'wrong' colour ball out of the robot. The VEX ratchet system was not capable of delivering the adaptive control so we developed our own using polycarbonate.

Robot Integration

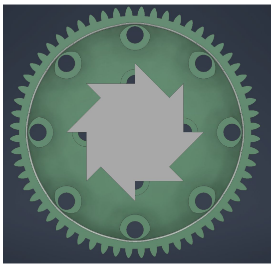
The ratchet can be implemented onto any existing High-Strength (HS) 60- or 84-tooth gears, provided there is enough space for the ratchet gear and clicker to be attached (0.5 inch is required). By placing the ratchet gear onto the same axle as the HS gear and screwing the clicker onto the HS gear, the whole system creates a ratchet; only allowing the HS gear to move in a single direction.

Design and Manufacture Process (Ratchet)

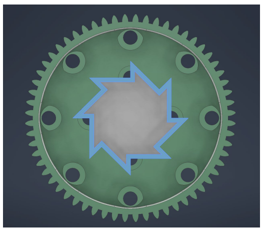
1) We chose a HS 60-tooth gear for the base, over the 84-tooth. This is because it is the smaller gear with at least two sets of screw holes, allowing for a mount point for the 3-part design. The HS 36-tooth gear was also considered, however it lacked mounting points for the clicker. The HS 60-tooth gear also had screw holes that aligned perfectly with those on the HS 84-tooth gear.



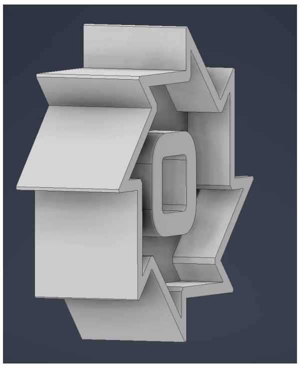
2) We opened a copy of the Inventor part file for the HS 60-tooth gear and created a work plane parallel to the side face of the gear.
3) The holes on the HS gear provided the point for which the slopes would angle out from and determined the number of teeth (8).



4) A circle was made for construction geometry, after which each spoke was joined at 45°. For reference, the screw holes from the gear were projected onto this sketch, allowing easy alignment. This created the overall footprint that the ratchet would take. This was extruded to a thickness of 0.087 inches, identical to that of the high strength gears.

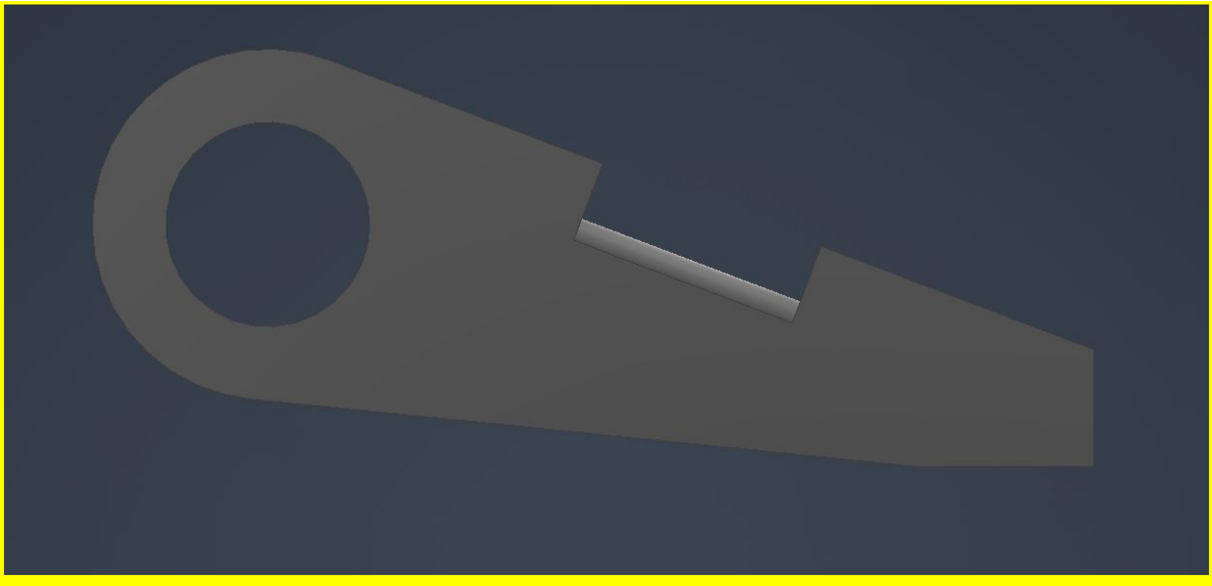


5) The supporting elements were made by copying the external footprint into a new sketch on the surface of the ratchet, using the offset function to create an internal border with a thickness of 0.05 inches and extruding that sketch on one side by 0.207 inches (identical to that of the high strength gears). After creating a plane that was centred to the first extrusion, we used the mirror feature to replicate the same border extrusion on the other side, resulting in the ratchet being an overall thickness of 0.5 inches, the same as a high-strength gear.
6) Our next concern was safety, so we chamfered the sharp teeth edges by 0.02 inches.
7) To allow a high-strength axle to fit and accommodate inserts to convert between high and low strength, we used the original gear to project its axle hole onto the central plane and extrude this geometry by 0.384 inches symmetrically so that an insert could fit in both ends like a high-strength gear. Finally, we removed the axle hole, before using another extrusion to remove the original gear out.

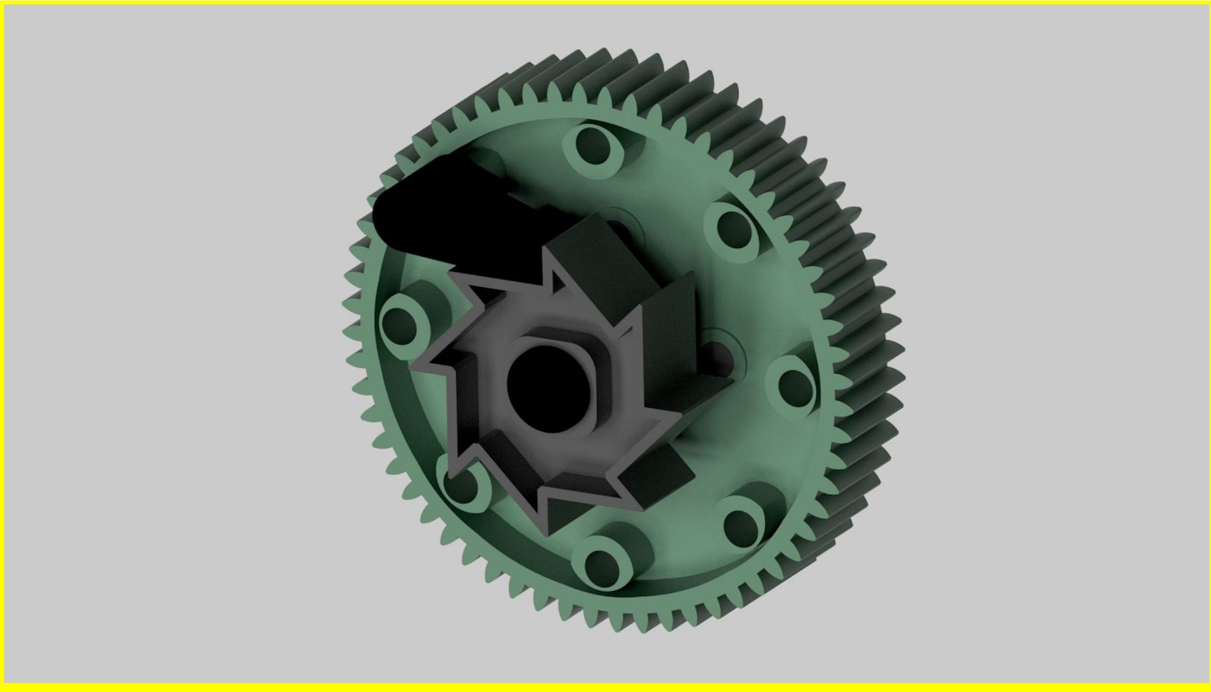


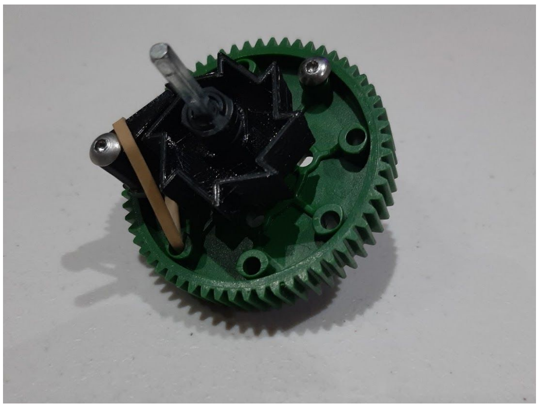
Design and Manufacture Process (Pawl)

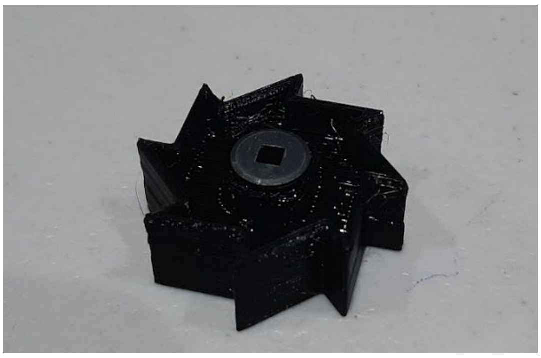
1) Created a sketch in the ratchet file that outlined the pawl shape.
2) Copied the sketch into a new part file, extruding the piece to a depth of 0.5 inches to match the ratchet.
3) The rubber band groove was filleted to avoid elastic snapping.



Final Product







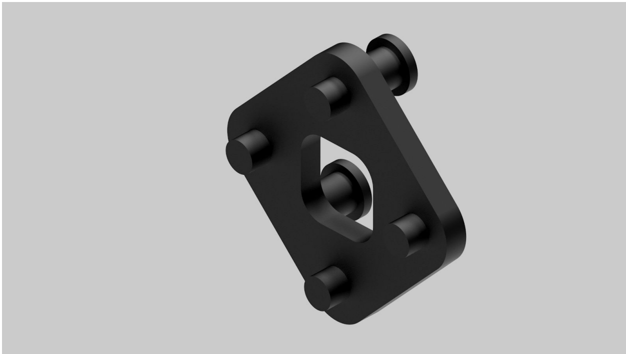
Conclusion and Evaluation

Overall, this project was successful in creating a working ratchet gear which would have solved the problem we faced.

We learnt how we could use Inventor to help create a solution to an actual problem and how this could be a far more efficient solution than more traditional methods, especially if this was a real world problem.

After creating our part, we were able to test the physical model quickly, only having to wait a few hours for 3D printer production. This was quicker than alternative methods of manufacturing available to us, efficiently finding flaws in the original design and rapidly moving through the design process.

One such flaw was the inability to adjust the tension in the rubber band, so we developed a backplate for the rubber band to attach onto. This provided 8 levels of tension in the rubber band which is great for tuning. The backplate connects directly into the gear and allows the rubber band to be hooked behind to be very compact.



Using Inventor to CAD is useful to our team in designing our robot before it is built; we can quickly see how everything fits together and works without the laborious work of building it. We also realised how useful Inventor is in rapid modelling and the creation of custom parts, giving us a competitive edge in VEXU in the future, where we are allowed to use 3D printed parts of a variety of materials.

CAD would definitely help every individual of our team - looking further down the line, most of us aspire to become engineers or involved in STEM, and CAD would help us realise our design ideas.