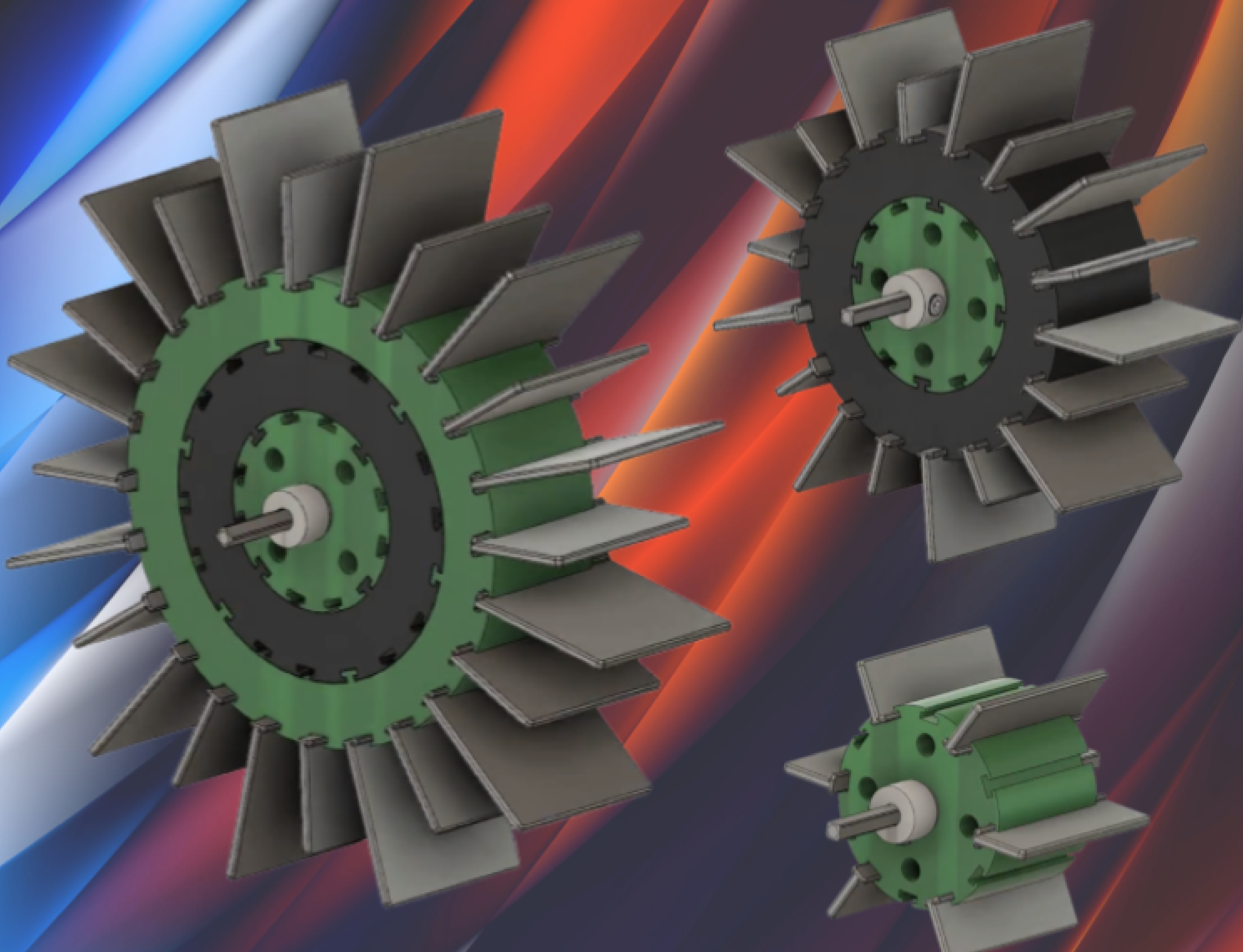
Make It Real

CAD Engineering
Challenge Sponsored by Autodesk

The Onion Roller



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Introduction

Reliable intake systems are essential for competitive VRC teams. They allow robots to quickly collect game pieces, giving teams a major competitive advantage. *A broken intake system would make any team cry!* However, intake mechanisms are currently challenging to build and unreliable. Rollers are a common type of intake mechanism, which includes VEX intake rollers and “custom rollers”. Unfortunately, VEX intake rollers only come in one small size, making them incompatible with larger game pieces. Meanwhile, “custom rollers” made of sprockets, conveyor-belt base links, conveyor-belt inserts, and tank treads are tedious to build and fragile. Conveyor-belt base links and tank treads easily break during assembly or while in use. Due to these issues, our team created the Onion Roller, a three-layered roller that is compatible with VEX conveyor-belt inserts and adjustable in size. The Onion Roller eliminates the need for VEX intake rollers and fragile links, making intake mechanisms simple to construct and reliable.

Figure 1. Broken conveyor-belt base links and tank treads.

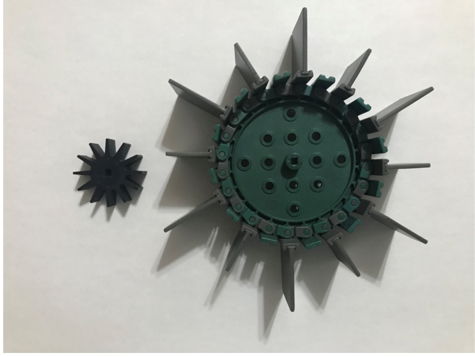

Figure 2. A VEX intake roller (left) and a “custom roller” made using VEX parts (right).

The Design

We finalized our Onion Roller design after 3D printing an initial design and making improvements to it. The final Onion Roller design consists of three cylindrical layers:

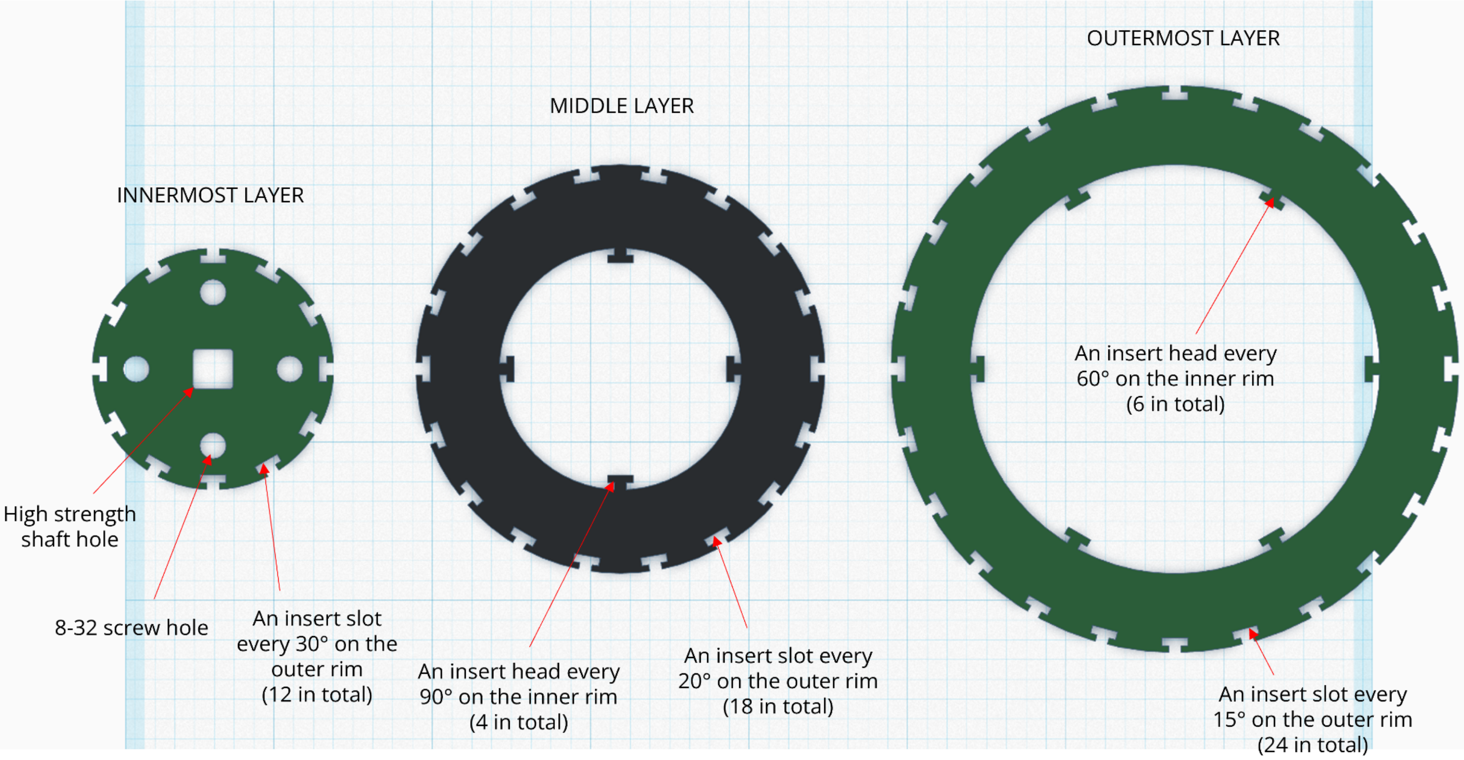

Figure 3. A diagram of the Onion Roller's features.

The innermost layer has a diameter of approximately 1.5 inches. It has one high strength shaft hole, making it compatible with VEX high strength and regular shafts. It has four 8-32 screw holes. There are insert slots on the outer rim at 30° increments. Conveyor-belt inserts can be placed here in any order.

The middle layer has a diameter of approximately 2.6 inches. There are insert slots on the outer rim at 20° increments. There are insert heads on the inner rim at 90° increments. These insert heads fit into the innermost layer's insert slots, allowing the Onion Roller to increase in size.

The outermost layer has a diameter of approximately 3.6 inches. There are insert slots on the outer rim at 15° increments. There are insert heads on the inner rim at 60° increments. These insert heads fit into the middle layer's insert slots, allowing the Onion Roller to further increase in size.

Each layer is about 1.1 inches thick, which is ¾ the height of a conveyor-belt insert. The layers alternate from green to black, making them distinguishable and aesthetically pleasing.

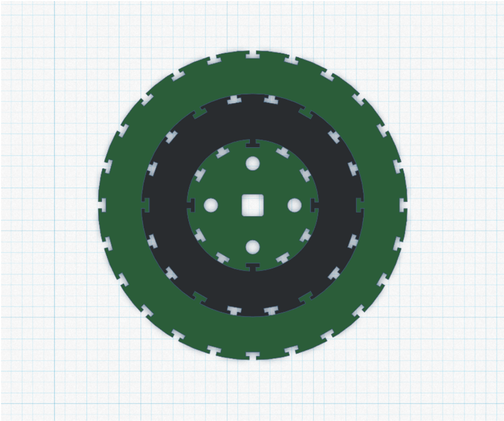

Figure 4. The top view of a maximum sized Onion Roller.

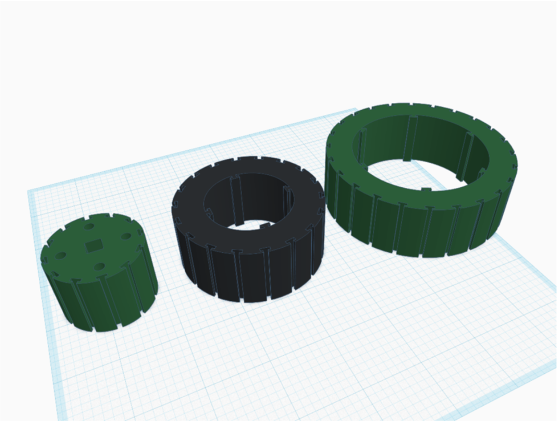

Figure 5. A perspective view of the Onion Roller's different layers.

Using Tinkercad and Fusion 360

We used Tinkercad version 2021_12_14 on Google Chrome version 96.0.4664.110. We completed the final design on December 18th, 2021. We used cylinders as the base for each layer and their sizes matched those of VEX parts.

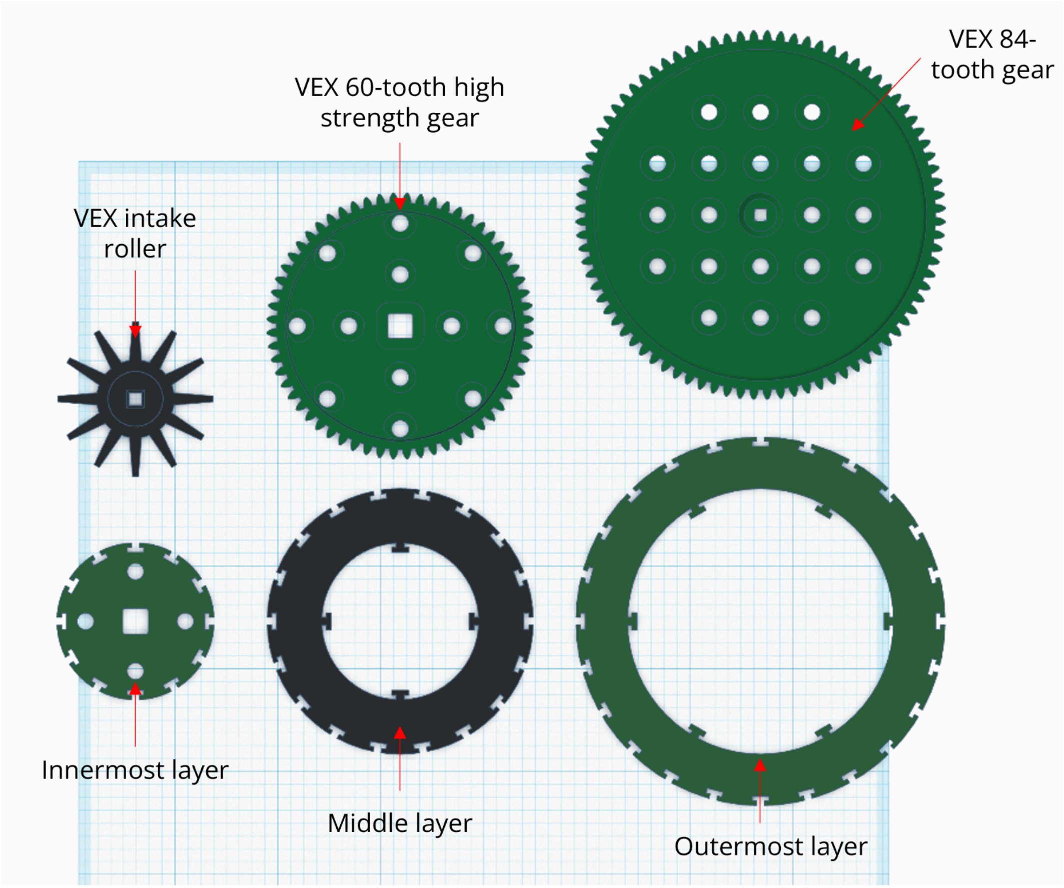

Figure 6. How the sizes of the Onion Roller's layers were determined using .stl files of VEX parts.

For the insert slots, we used holes in the shape of conveyor-belt base link slots. We positioned two holes opposite from each other, then aligned, rotated, and grouped them with each cylinder. We also used the hole and group functions for the shaft and screw holes. We used the innermost and middle layers as holes for their next consecutive layer. To ensure the layers would connect, we added a small amount of clearance between each layer. Tinkercad's hole, group, align, and rotation functions helped with modeling. The fit view to selected shapes and orthographic view functions helped with editing details.

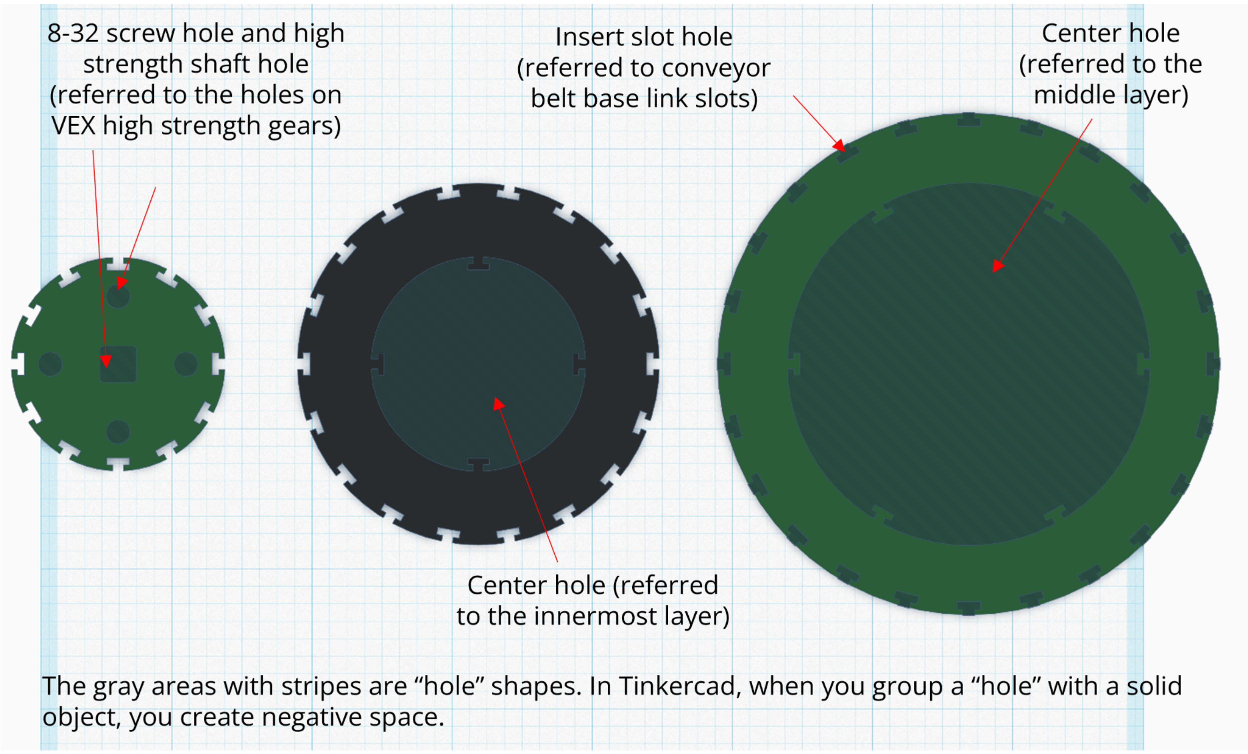

Figure 7. How the hole and group functions were used in Tinkercad to create negative space.

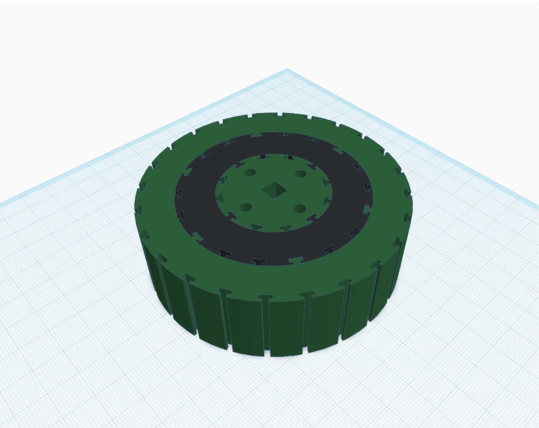

Figure 8. A perspective view of a maximum sized Onion Roller in Tinkercad.

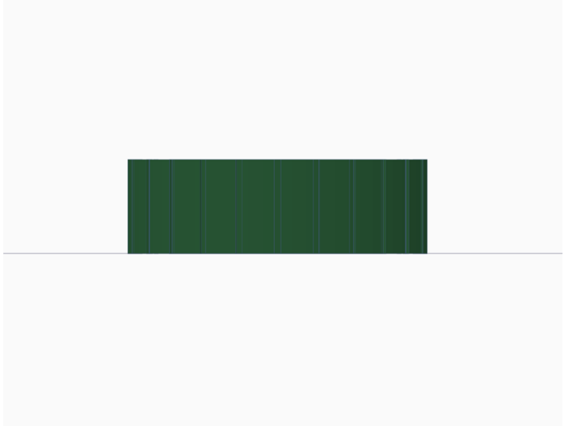

Figure 9. The side view of the Onion Roller in Tinkercad.

We used Tinkercad because it is beginner-friendly and offers live collaborative editing. After modeling our part, we wanted to animate it to visualize how it would work. However, we discovered that Tinkercad has no animation features, so we tried Fusion 360.

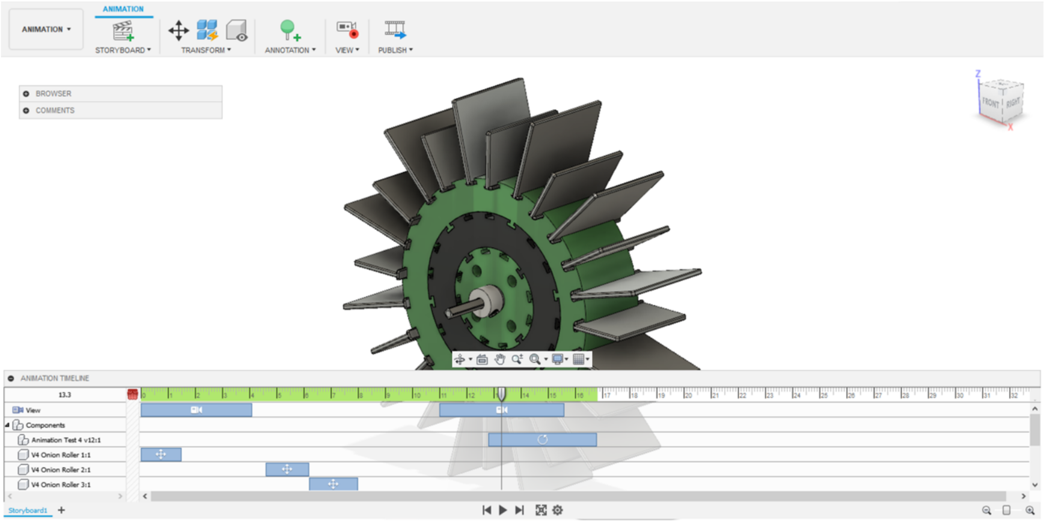

Figure 10. Animating the Onion Roller in Fusion 360.

We used Fusion 360 version 2.0.11894 to animate how the Onion Roller would be assembled and function. We imported the .stl files from Tinkercad as meshes, then converted them to solid bodies, and then components. We adjusted the camera angles using the fit and pan functions.

The 3D Printing

We 3D printed the .stl files from Tinkercad using a Prusa i3 MK3S printer and PETG filament. When we first printed the Onion Roller, we noticed that the holes for conveyor-belt inserts, screws, and high strength shaft inserts were too small. This print was thick, causing it to be clunky and use more material. Therefore, for the final design, we increased the size of all holes and cut its thickness by ¼.

Figure 11. Two 3D printed finalized Onion Rollers, which includes a separated Onion Roller (left) and a maximum sized Onion Roller (right).

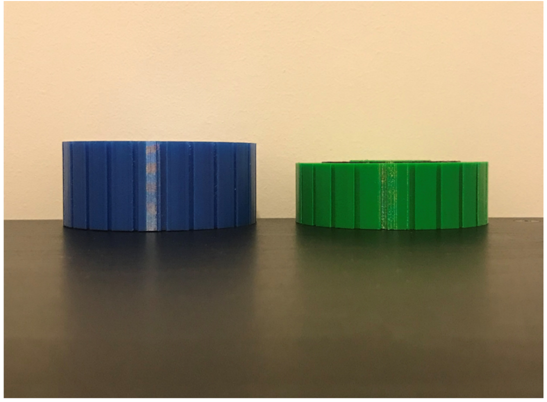

Figure 12. The final design of the Onion Roller (right) and the initial design of the Onion Roller (left).

Testing

After 3D printing two finalized Onion Rollers, we tested both on our robot. This robot previously used an intake system made of sprockets, conveyor-belt inserts and base links, and tank treads to collect game pieces. However, this intake system was fragile, unnecessarily complex, and nonfunctional.

Once we replaced it with the Onion Rollers, our robot picked up objects easily. We simply connected the Onion Rollers to 393 motors using shafts, and added collars, conveyor-belt inserts, and spacers. We used the maximum size to pick up smaller objects, and the medium size to pick up larger objects. Our robot can now intake various objects by adjusting the Onion Roller's layers!

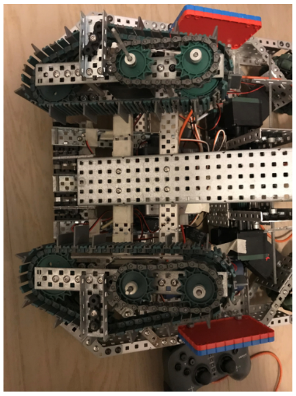

Figure 13. Our robot before using the Onion Roller.

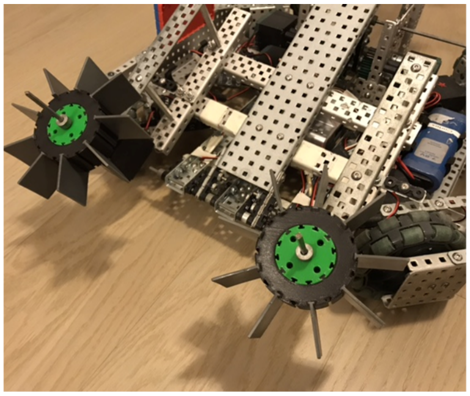

Figure 14. Our robot using only the innermost and middle layers of the Onion Roller.

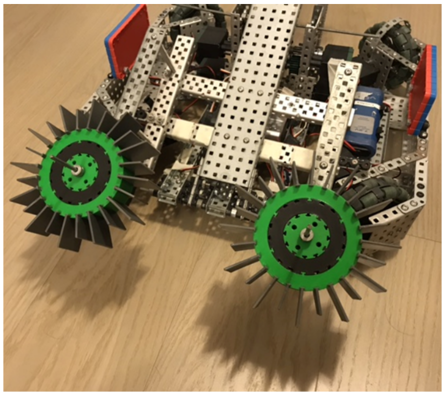

Figure 15. Our robot using maximum sized Onion Rollers.

Although this robot uses the Cortex system, the Onion Roller is adaptable to the V5 system by connecting it to a V5 motor with a shaft. Rubber band intake rollers can also be made using the Onion Roller.

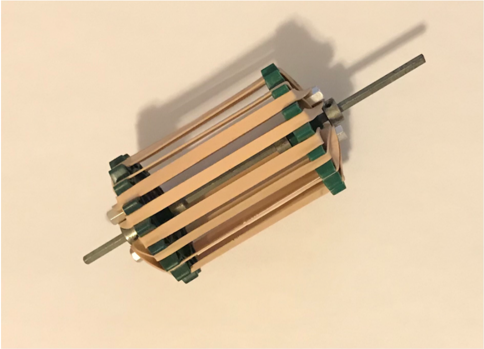

Figure 16. A rubber band intake roller made with VEX parts. This is another common type of intake.

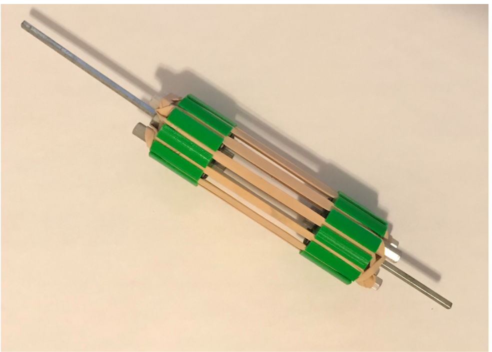

Figure 17. A rubber band intake roller made with the Onion Roller's innermost layer.

Conclusion

Through this project, we learned how to model in Tinkercad and animate in Fusion 360. We enjoyed using Autodesk 3D design software and will use them again for future projects. This project also built our problem-solving and teamwork skills, which will help us succeed throughout our academic careers. Overall, the Onion Roller is a versatile and reliable replacement to current VEX rollers. Given the importance of intake systems in all VRC games, the Onion Roller can give any team an advantage in any competition. *It's so reliable and customizable, it'll make you cry tears of joy!*

Acknowledgements

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