Kepsoffs:

VEX Make It Real CAD Engineering Online Challenge

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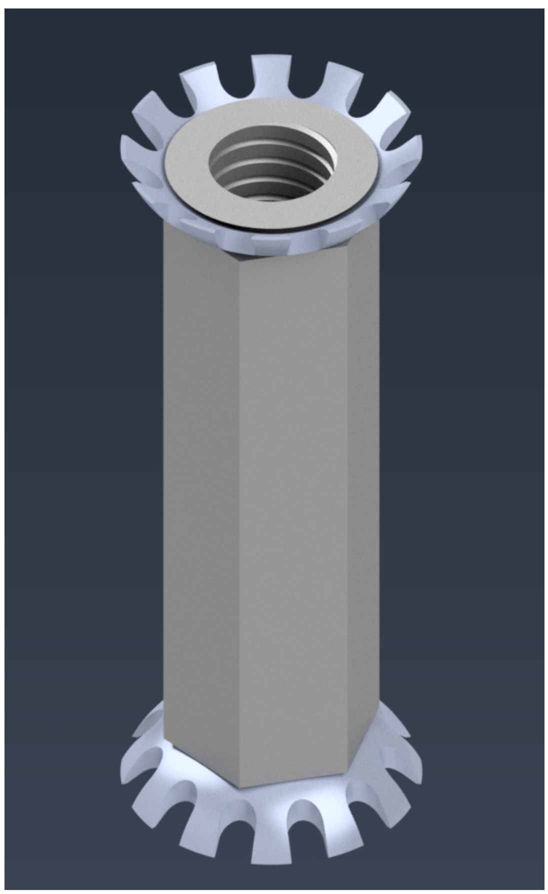
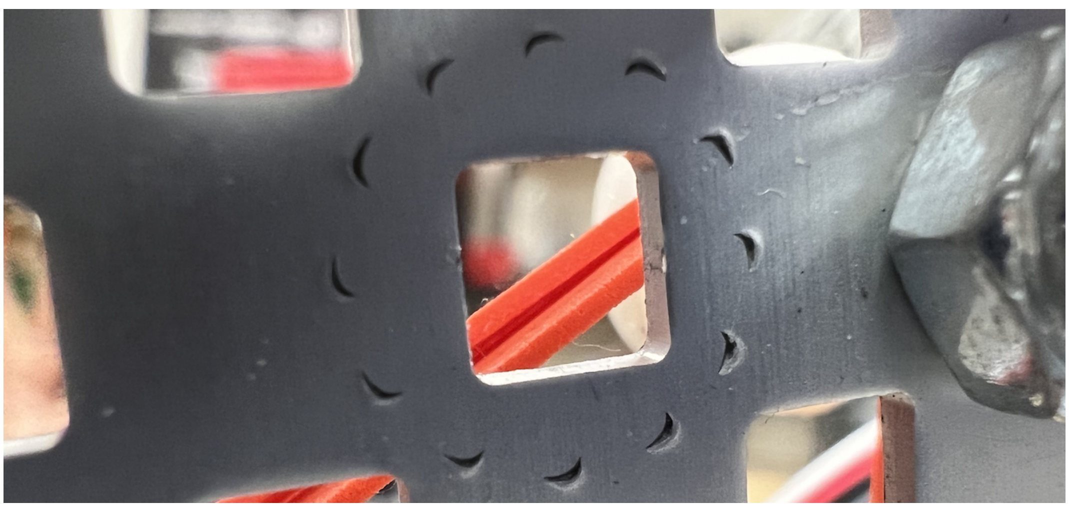


The Problem and Our Solution

VEX Robotics teams frequently use standoffs because they extend structures perpendicular to c-channels. However, our team noticed that standoffs come loose easily when dealing with intense movements and heavy loads (such as the Tipping Point mobile goals).

An existing solution is to use lock screws. Unfortunately, unscrewing lock screws is time-consuming, making it more difficult to iterate the robot.

However, Keps nuts don't have the same issue that standoffs do; the crown creates friction with the metal and keeps the nut from loosening. Also, it isn't time-consuming to unscrew Keps nuts.



An example from our robot of how the crown of the Keps nut digs into the metal

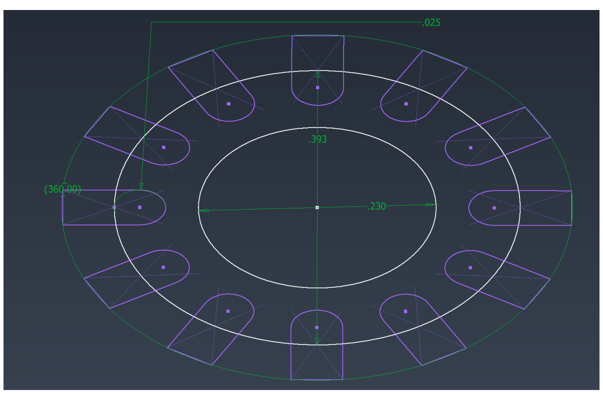
Thus, we designed a "Kepsoff," a standoff with crowns on both ends. The Kepsoff has the functionality of a standoff with the strength of a Keps nut. It is perfect for subsystems that need to withstand heavy loads (like a lift) or maintain rigid integrity against motion and shock (like a chassis).

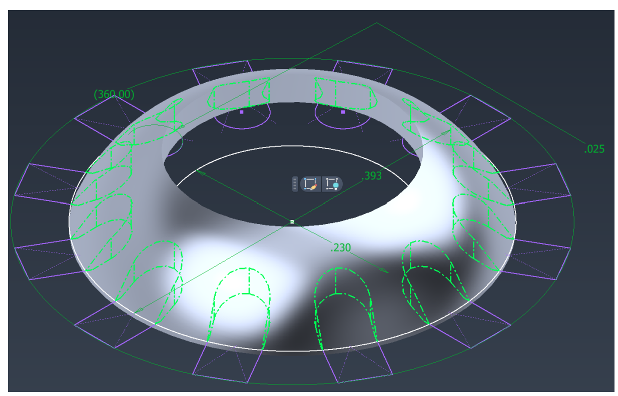
Our Autodesk Inventor and 3D Printing Process

We used Autodesk Inventor 2022 64 bit edition (build 153) to model and render the Kepsoffs. We considered using the pre-existing CAD file of Keps nuts for the crown and standoffs, but the crown was flattened in the model and wouldn't fit correctly into the standoffs, so we decided to model original parts from scratch.

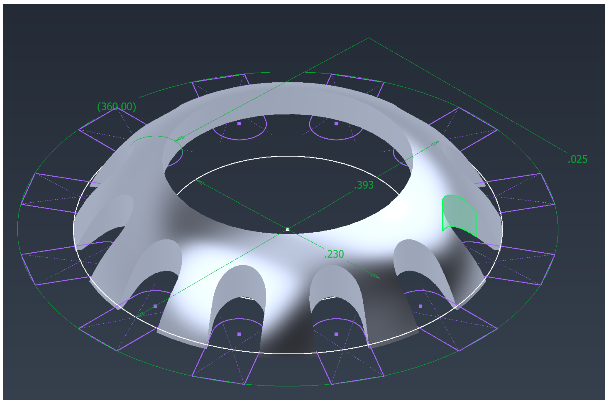
1. “Crown”

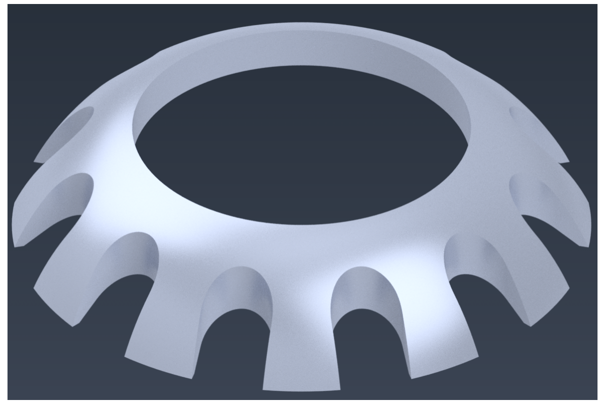
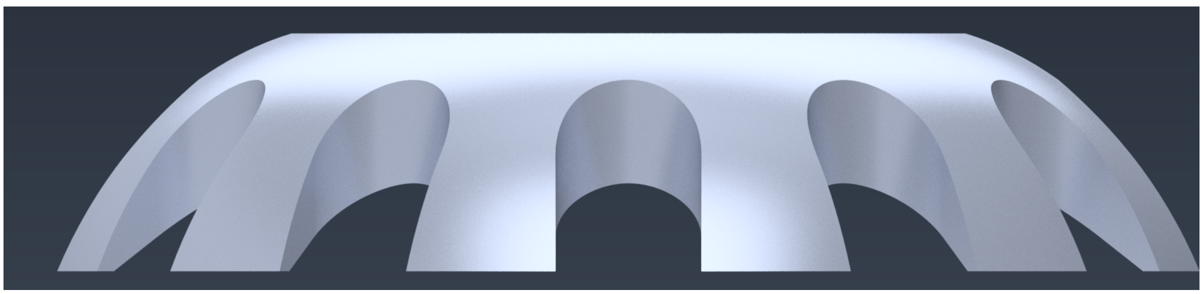
We made a cylinder with a hole through it by making two concentric circles and extruding the section in between. We then used the bevel and chamfer function to form a curved down, circular sheet. We used the rotate function on a beveled rectangle and extruded the pattern upwards to cut through the crown body.





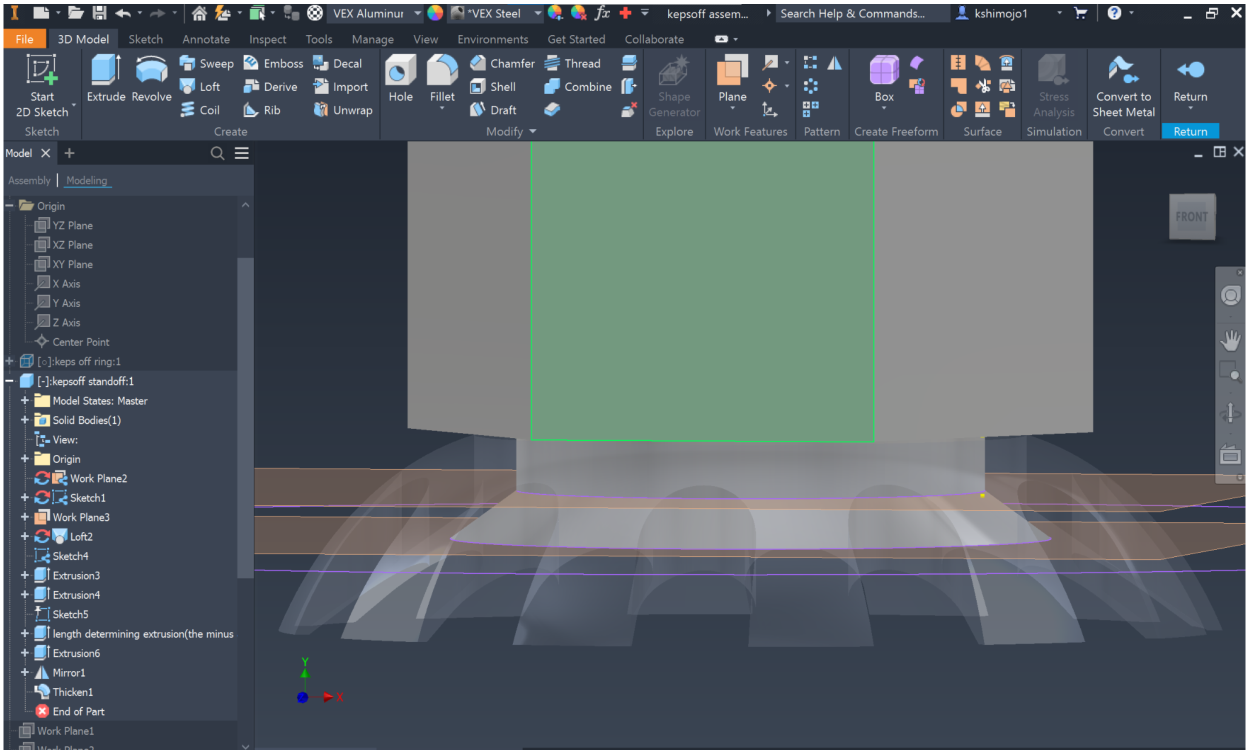
This is the final edition of the crown; it was later scaled along the y axis to make the crown “prongs” longer and sharper for better grip.



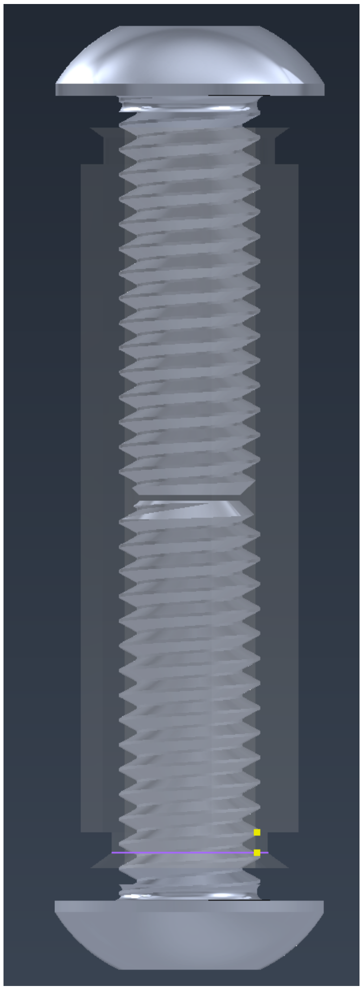
2. Standoff

Referencing a transparent crown piece, we made a sketch on a plane (orange) inside the crown piece, as seen in the image below. We drew two concentric circles—one just slightly smaller than the inside of the curved crown piece, another 0.164in in diameter—to have Vex's screw thread (UNC #8) extrude-cut later.

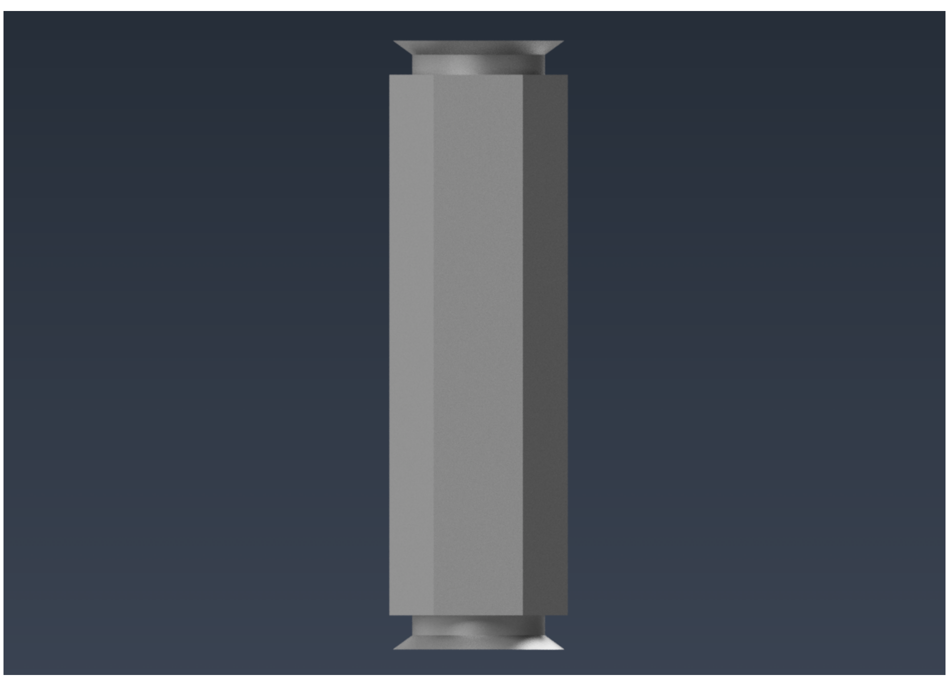


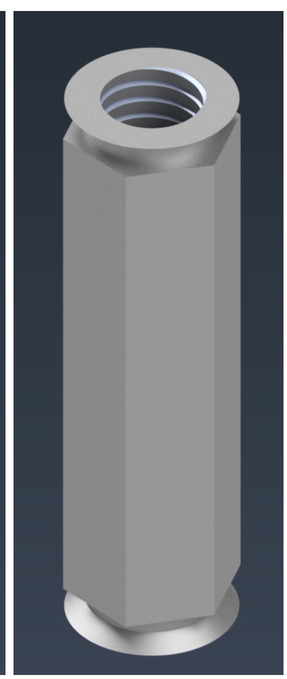
We made a second sketch from a second plane offset from the first, at the height where the crown's cylindrical hole starts. On this sketch is a circle with its diameter 0.015 in smaller than the crown's cylindrical hole for slack, so the crown can freely spin on the standoff part and be tightened with a wrench.

The loft function was then used between the circles on the 2 aforementioned sketches to make the slanted indent that keeps the crown on. Extruded upward, the cylinder is extruded upward, a new sketch with a hexagon is made, then extruded again for the standoff part.

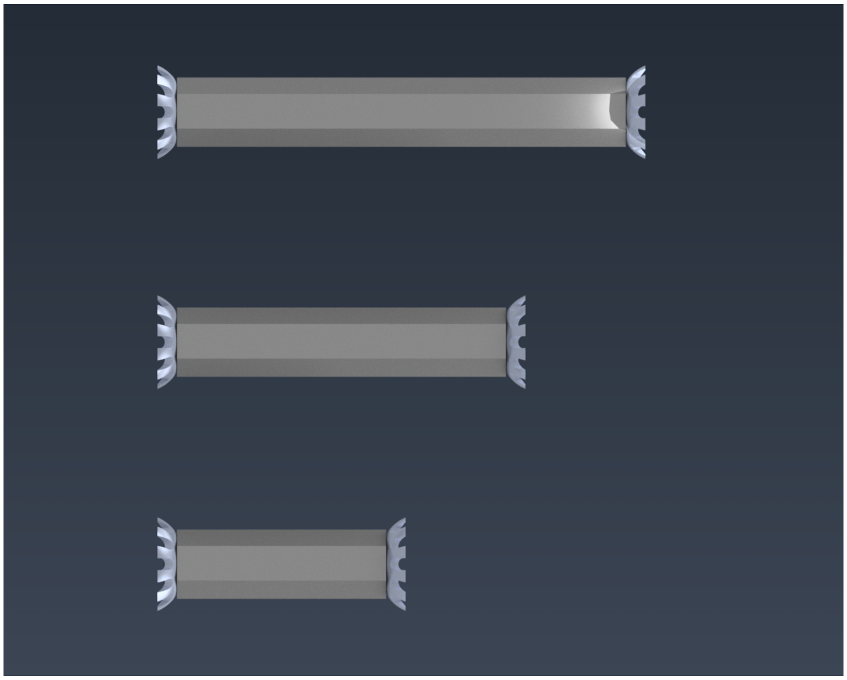


We initially thought that the thread function would model the screw threads so we can use screws on the 3D printed demonstration, but testing and research showed that it only added a 2D image of a thread: which is why we imported a 0.5in vex star screw CAD from the official website, scaled it up by 1.2 on the x and z axis (to account for 3D printing warping and expansion), inserted onto the standoff part with insert constraints in an assembly file, and finally used a combine/boolean function to make a cutout of the screw thread that can be included in the 3D print and tested (this coudn't be done in an assembly file, so we derived a part file from that assembly file and did it there).

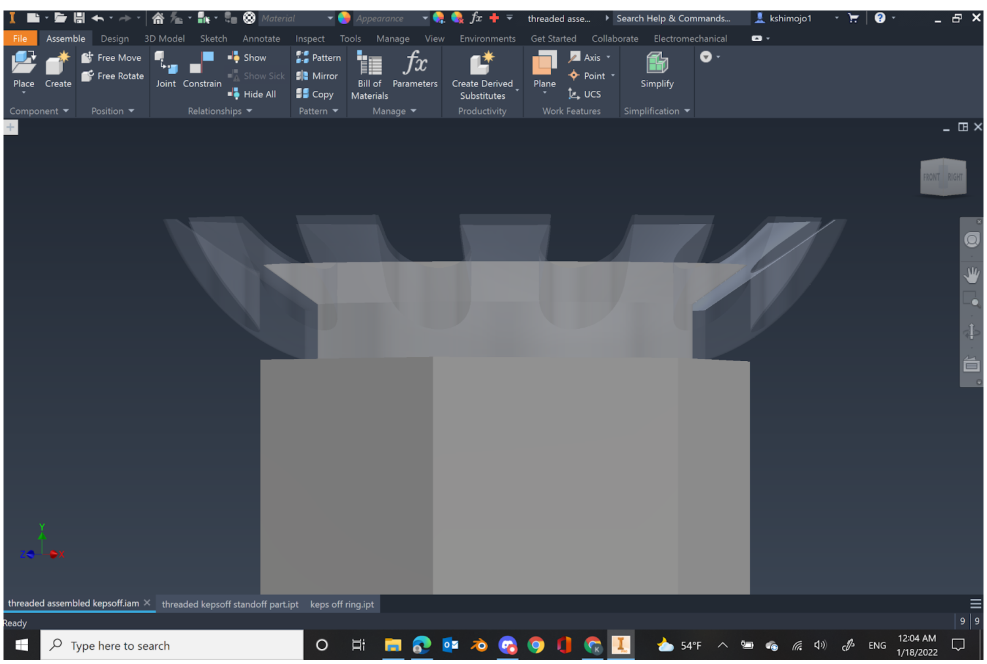




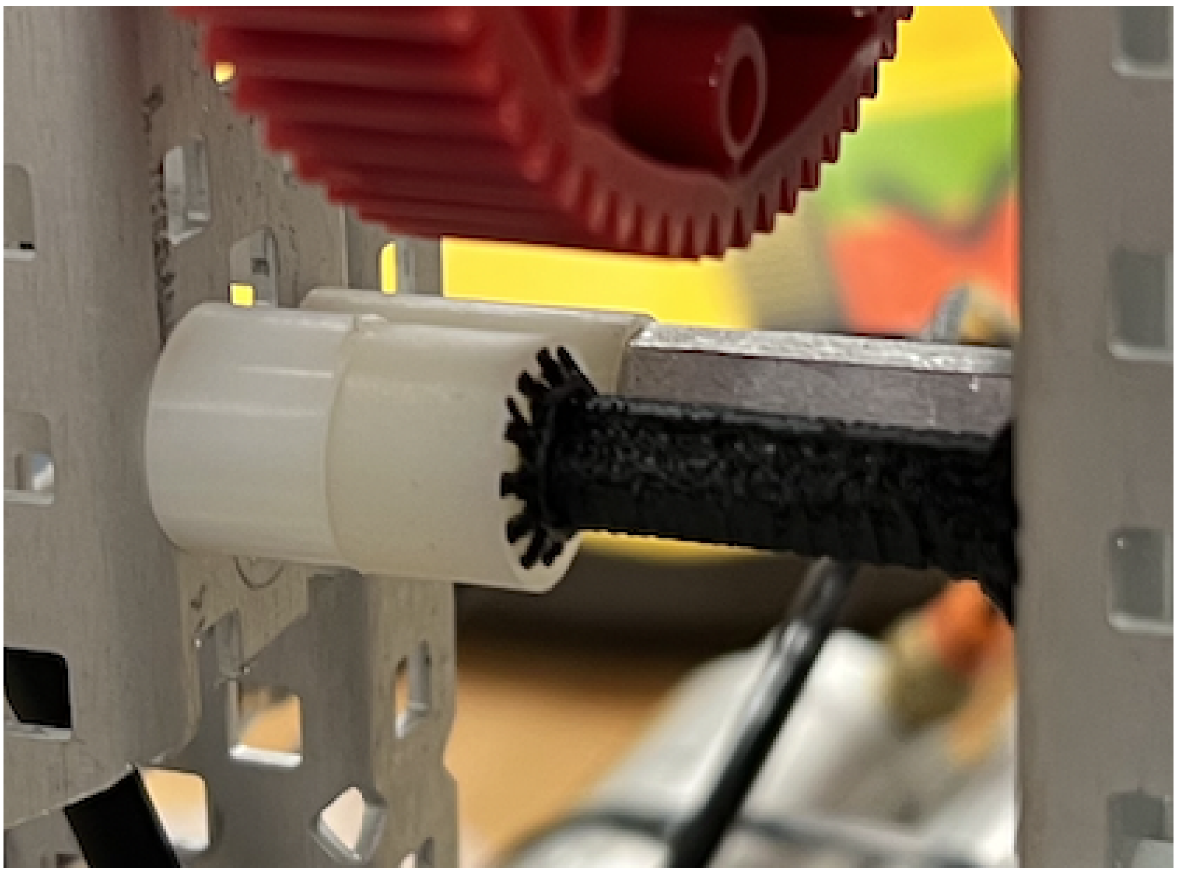
Finally, we put 2 crowns and a standoff part in an assembly file and used insert constraints to place them together. We also made different length versions by modifying the extrude function (1in, 0.75in, 0.5in).



Transparent side view to check for overlaps and appropriate slack between crown piece and standoff part:







Key Lessons and Takeaways

Although we faced numerous challenges while modeling the Kepsoff, we learned more about Autodesk Inventor in the process. One challenge was that we needed the crown to be free-spinning in the model because we wanted to 3D-print a functional Kepsoff. Modeling the curved crown was also challenging, but we did it thanks to Autodesk Inventor's beveling tool. Finally, we had to find a way to model screw threads. We did that by importing a CAD file of the star screw from the VEX Robotics website, scaled the model up, and used Autodesk Inventor's combine and boolean function to impose the star screw into the hole of the Kepsoff.

Learning more about the function of Autodesk Inventor has prepared us for our future years in VEX Robotics. Currently, our team creates CAD models of our robot designs. A greater understanding of Autodesk Inventor will help us design more accurate models. In VEX U, CAD modeling will become even more important for us because teams can use their own functional 3D-printed parts on their robot. Beyond VEX Robotics, being able to use Autodesk Inventor will also help us bring ideas to life during our future careers as real-world engineers.