The Standoff Cross Joint Coupler
Created by *THE RESISTANCE*

Introduction
The standoff cross joint coupler is a simple, compact, and lightweight method to create angled or revolving structures. Especially for structures commonly made of c-channels and shaft collars where odd angles are required, the low-profile standoff cross joint coupler provides a significantly lighter alternative for circular motion.

Part Usage
A standoff attaches to the ends of a standoff cross joint coupler with set screws. The middle hole also allows the coupler to attached to other structures. Attaching two of the couplers at the middle allows for thinner joints and crossbars. Multiple couplers can be used to provide more stability and attachment points. Applications of the standoff cross joint coupler include linkages (see images 5 and 10) and bracing (see image 11).

How Autodesk Products Were Used
Autodesk Fusion 360 was used to design and render the standoff cross joint coupler. The sketch, extrude, hole, and chamfer tools were used to create the new component. I used existing VEX part libraries to ensure the new part worked with the VEX system. Autodesk Inventor Professional 2017 was then used to create the example robot and verify the part matches VEX spacing.

Design Process
This component was inspired by the challenges presented in the VEX Robotics Competition. Rotational mechanisms are an important way to transfer energy and manipulate game objects. Additionally, having a stable, well-braced linkage ensures consistency and repeatability.

VEX currently offers many different structural parts including C-channels and bars. While C-channels are commonly used for lift systems, they are not always necessary. For example, in the 2017-2018 VEX Robotics Competition, In the Zone, the main lift system has to lift an object weighing only 0.26 lb. Thus, the weight of the C-channels can sometimes be a major drawback. After brainstorming other structural pieces for lifts, we arrived at the idea of using standoffs. Standoffs are

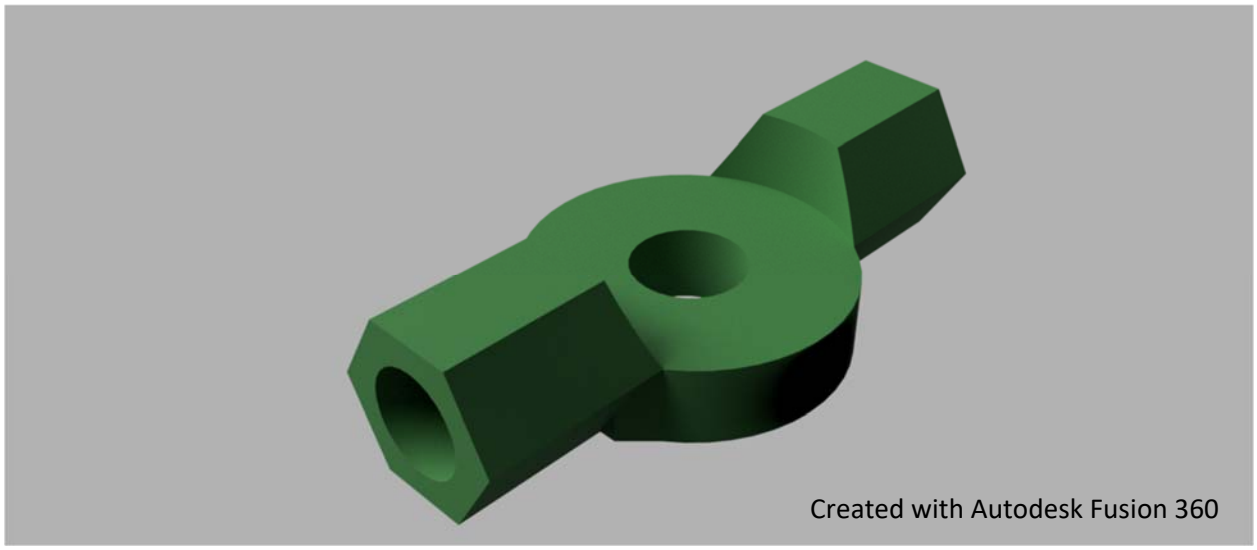
easy to connect to each other, have a slimmer profile, and are lighter than C-channels. While a 25-hole C-channel weighs 0.116 lb, a 12.5” standoff would only weigh 0.049 lb, or less than half the weight, and still have the strength to lift up the game object.

Another application that inspired the design of this part is bracing. Proper bracing is usually achieved with crossbars. One popular way to do this is with bars, 1x25 hole pieces of metal, placed diagonally across the two sides of the linkage to form an “X” shape. However, this requires two sets of these bars for a total of four bars to provide enough support. In contrast, only two lengths of standoffs would offer a lighter and more rigid solution. Four aluminum bars weigh 0.12 lb while the standoffs would weigh 0.098 lb.

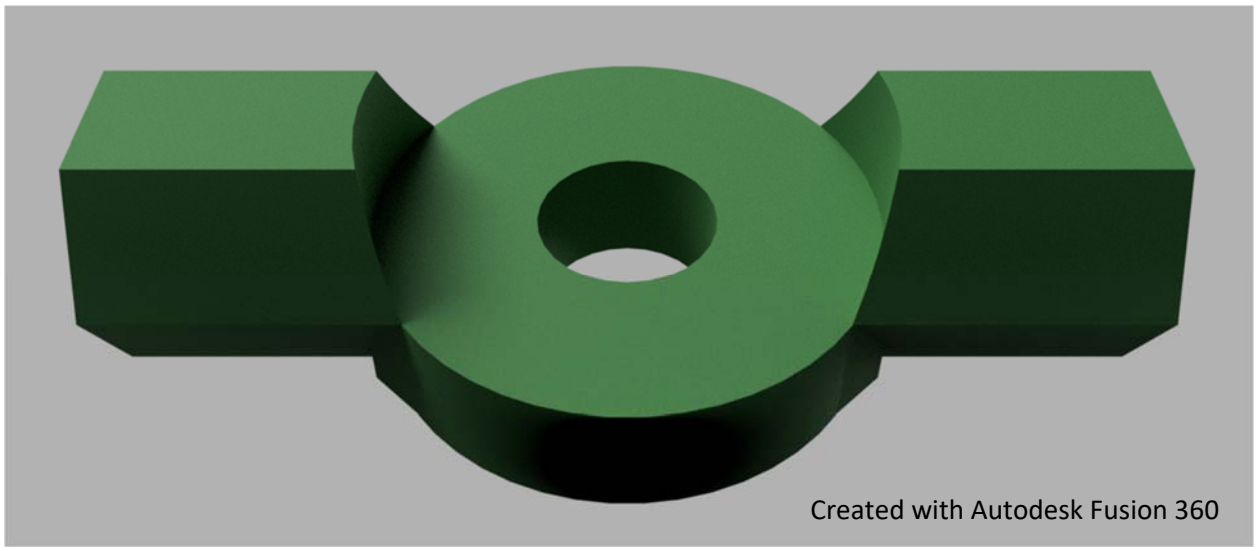
This part was designed to be compatible with the VEX Robotics Design System. The standoff cross joint coupler has dimensions 0.500” wide, 0.250” tall, and 1.000” long, with a single hole on the bottom. The hole fits size eight machine screws, facilitating attachment to VEX structure including C-channels, L-channels, rails, plates, etc. The low profile allows the standoff cross joint coupler to fit inside of a C-channel and in tight spaces. The component was modeled in Autodesk Fusion 360 and then 3D printed to illustrate its operation. I printed this model in two materials, ABS (see image 6) and PLA (see image 9), to ensure the robustness of the design.

Conclusion

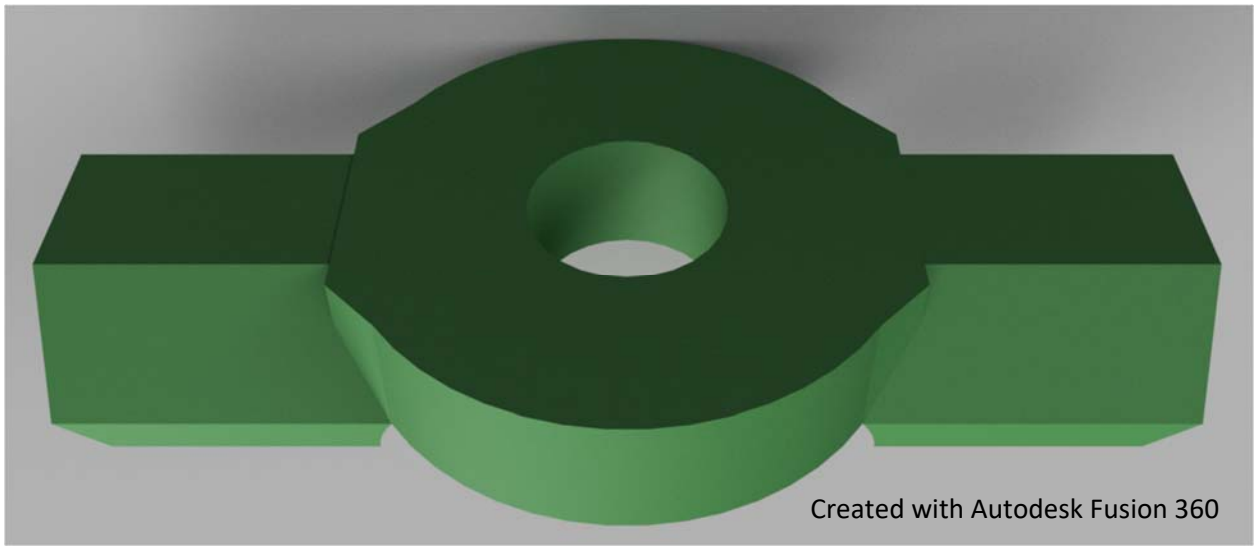
I will continue to use Autodesk Inventor to model robots and other projects. There are many advantages to modeling ideas in Inventor before building the real structure. By modeling the robot, we can test the feasibility of an idea. For instance, this year, we wanted a chain-bar lift mechanism on our robot. After building the lift, we found that the positioning of the lift made the robot longer than 18”, putting it out of size. If we had modeled our robot, this error could have been avoided. We can catch simple errors in the CAD model before beginning the building process. I know that many companies rely on modeling software such as Autodesk Fusion 360 to design their components, just as I have with the standoff cross joint coupler. Experience with modeling software will help me in my future career as an engineer.



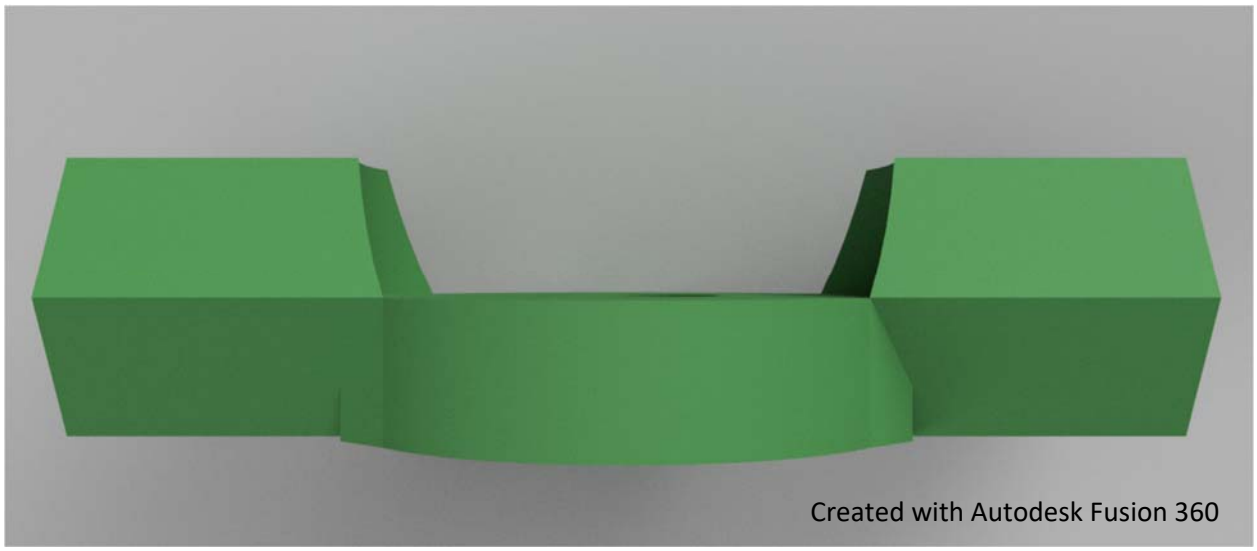
1. Isometric view of the standoff cross joint coupler



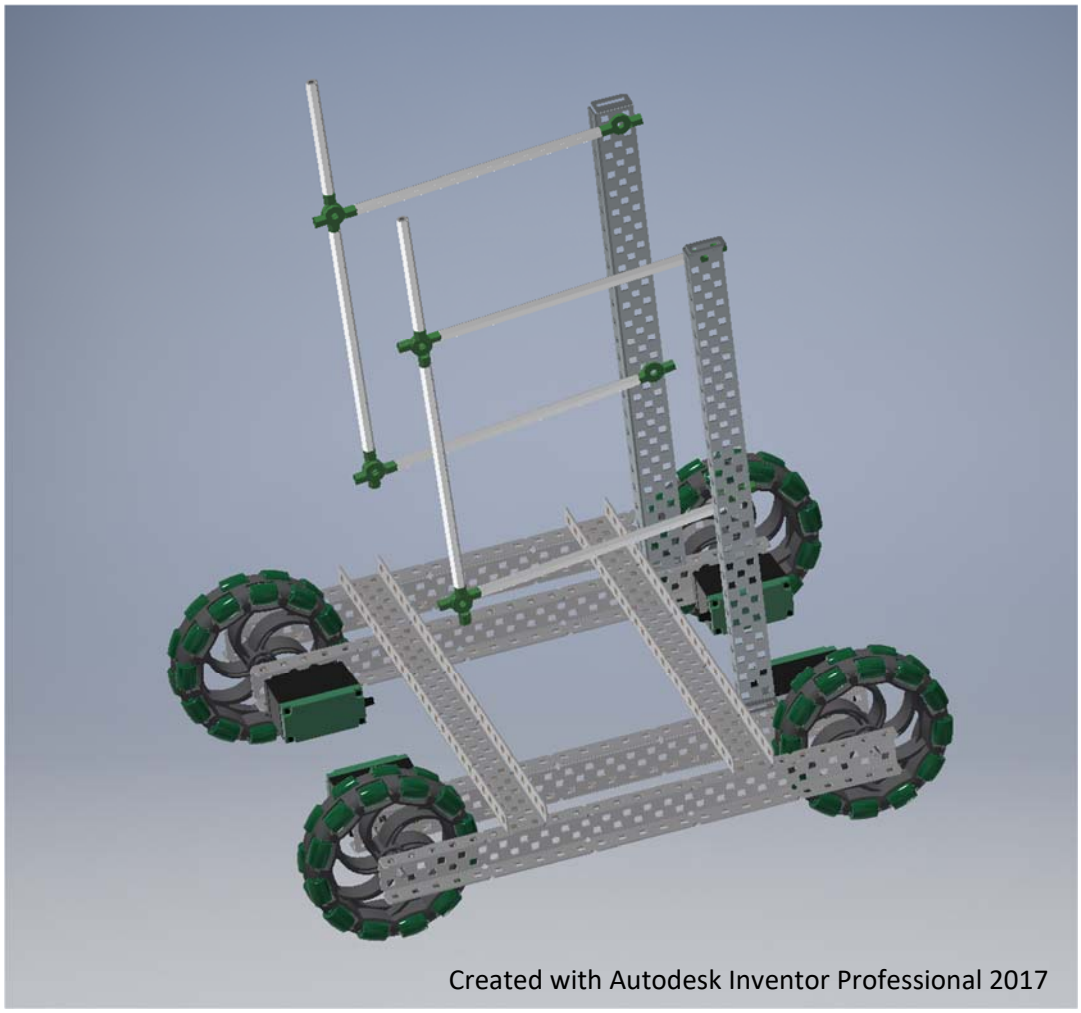
2. Front-top view of the standoff cross joint coupler



3. Bottom view of the standoff cross joint coupler

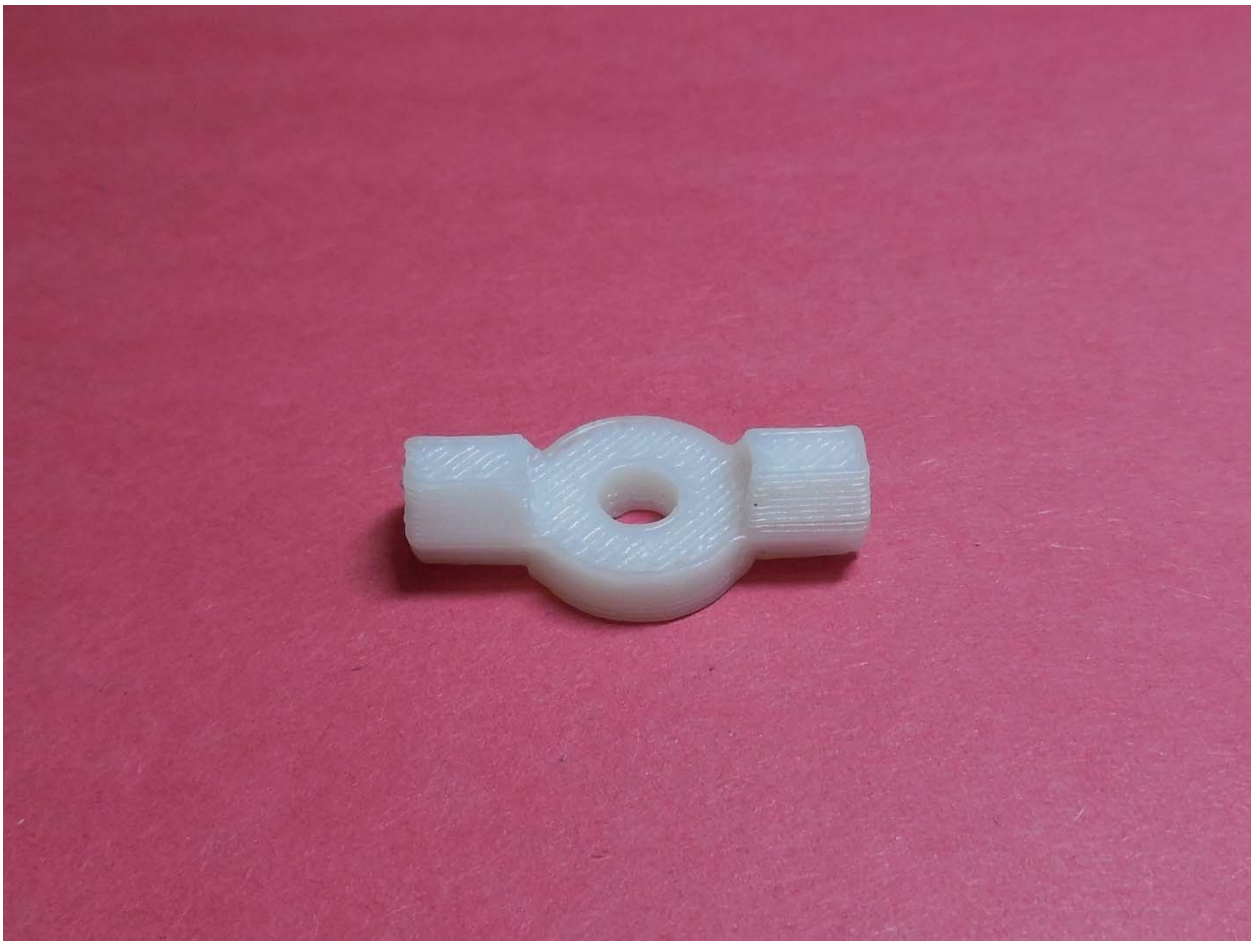


4. Side view of the standoff cross joint coupler

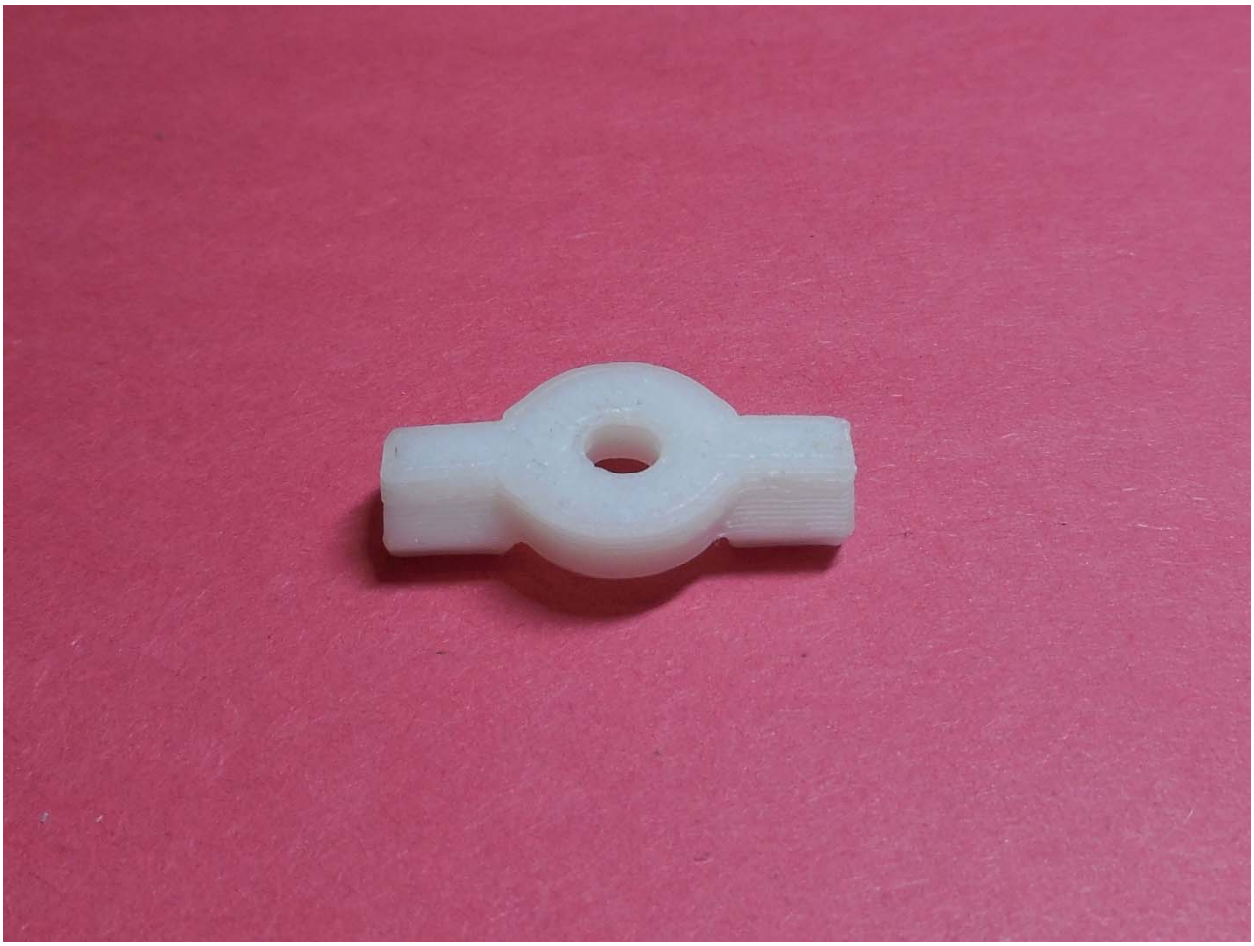


5. Four-bar linkage mechanism incorporating the standoff cross joint coupler

6. Isometric view of the ABS 3D printed standoff cross joint coupler

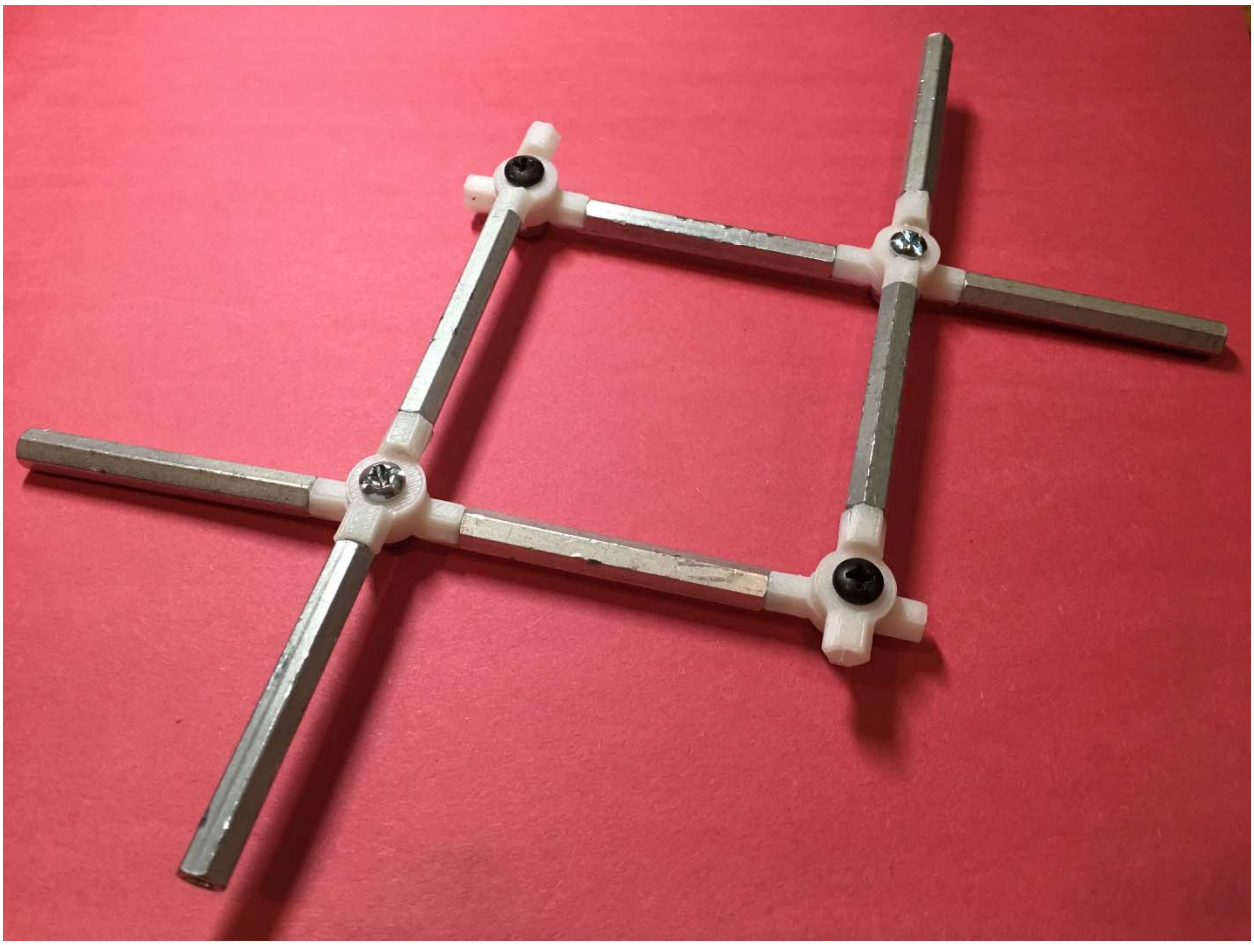


7. Front-top view of the ABS 3D printed standoff cross joint coupler

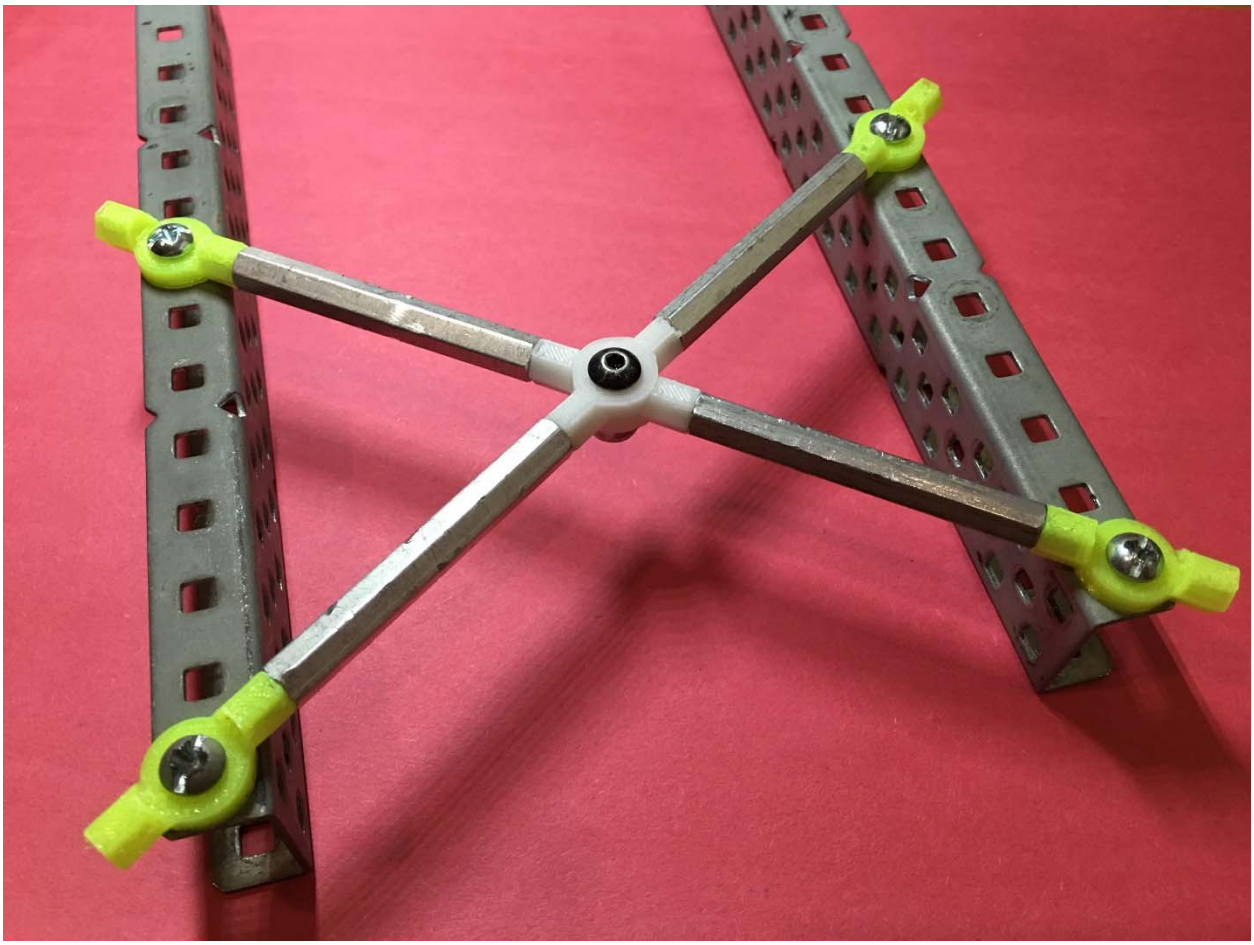


8. Bottom view of the ABS 3D printed standoff cross joint coupler

9. Isometric view of the PLA 3D printed standoff cross joint coupler



10. A scissor linkage mechanism using the standoff cross joint coupler



11.Crossbar bracing using the standoff cross joint coupler