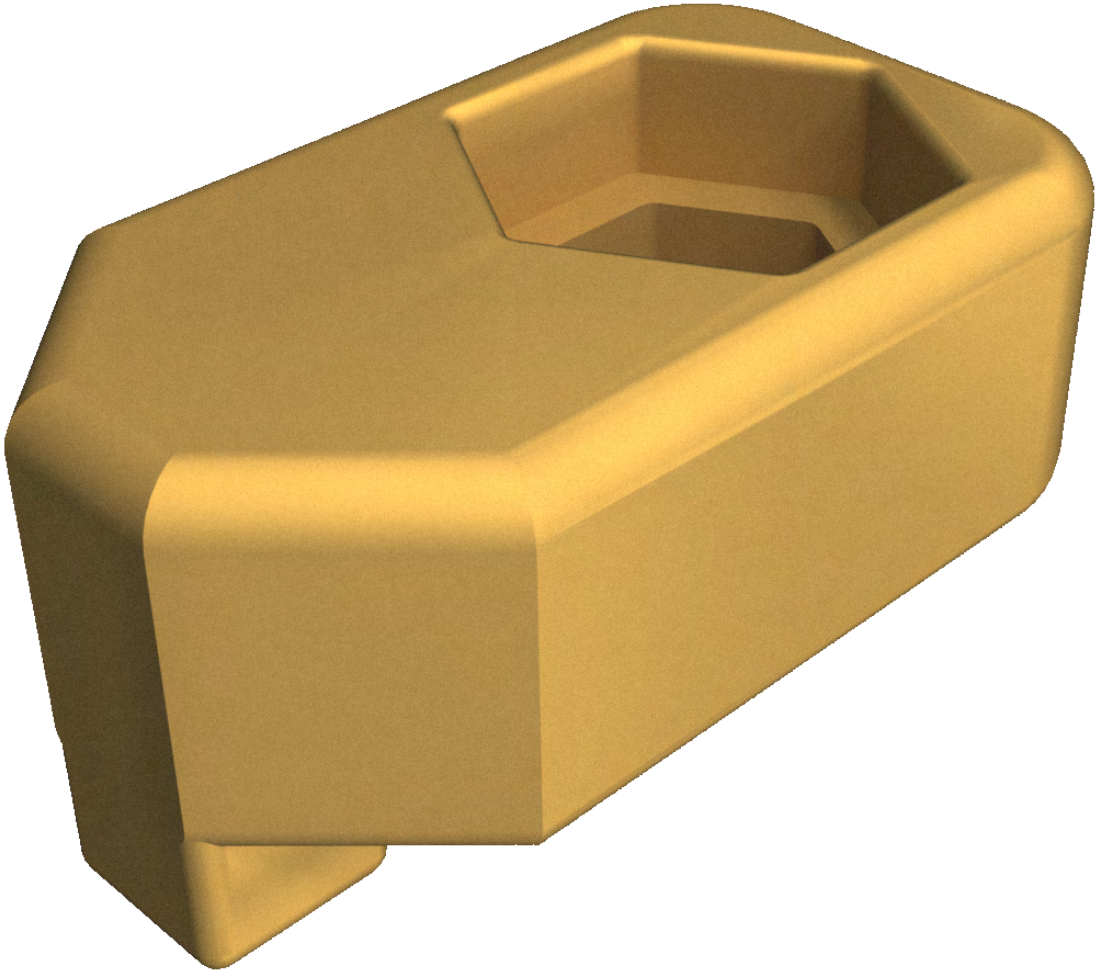
CAD ENGINEERING CHALLENGE



ONE POST HYBRID RETAINER

BLRS3

West Lafayette, IN

By Aaed, Andrew, Jack, Jacob, Jaden, Matthew, Nathan, and Nicholas

PREFACE

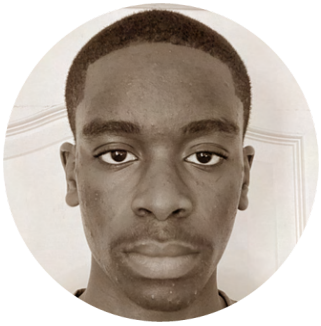
We are VEXU team **BLRS3** from West Lafayette, Indiana, and this is our take on the REC Foundation's CAD Engineering Challenge: the **One Post Hybrid Retainer**.

Our goal in designing the One Post Hybrid Retainer was to make prototyping **simple and quick** all while having a **versatile** solution. In the process, our part offers peace of mind by ensuring that any fasteners that are attached to the robot **stay attached** through rigorous match play.

When designing the part, we made use of **Autodesk Inventor 2022** to make all the necessary components. Our design was meticulously engineered into reality with many sketches, extrusions, patterns, and fillets. In this summary report, you will find all of the relevant design decisions and processes we took to carefully craft our design.

From all of BLRS3, thank you for taking the time to read our report.

MEET OUR TEAM



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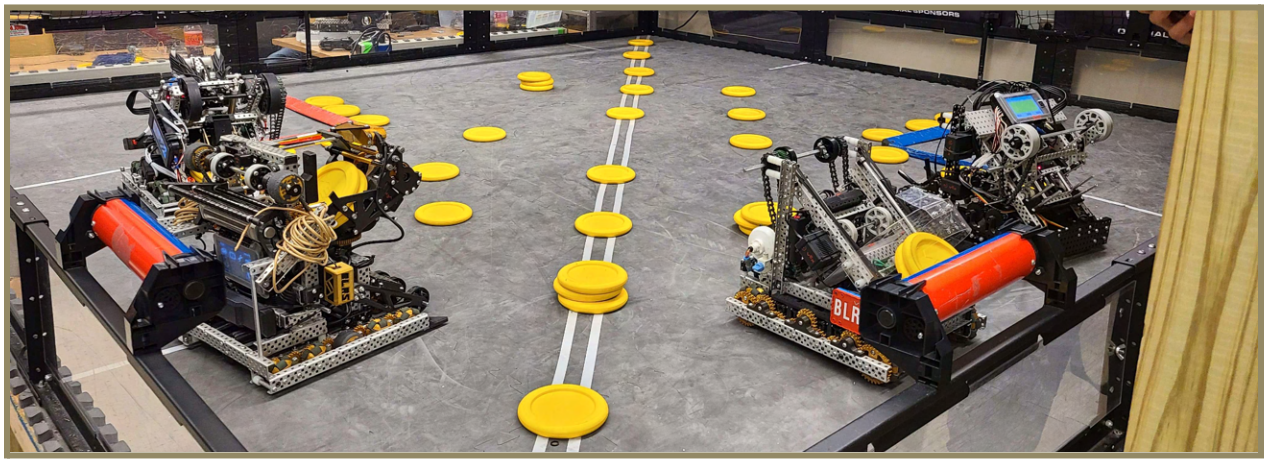
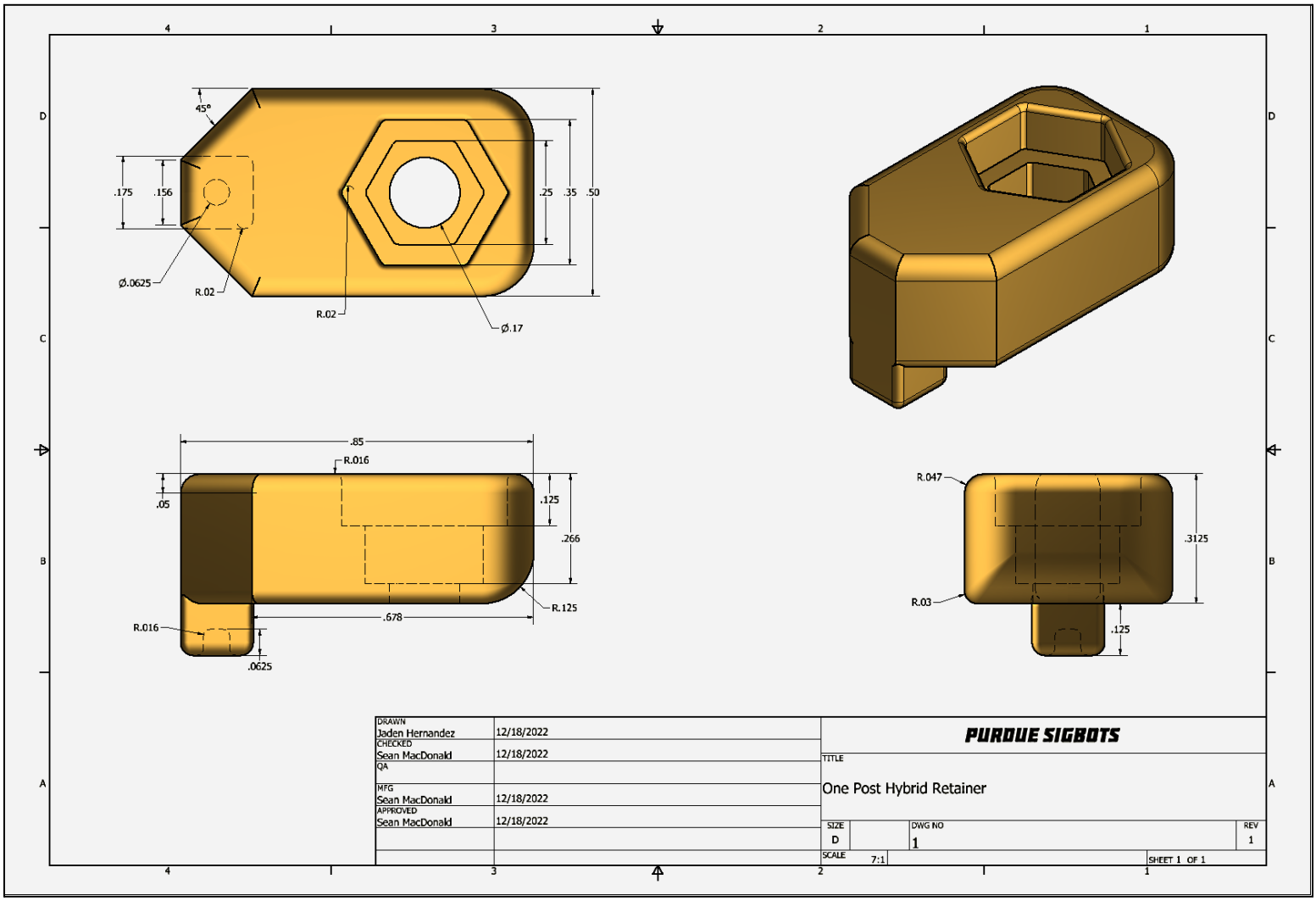
THE PROBLEM



When it comes to designing robots, VEXU competitors really begin to adopt the **“time is money”** mindset, especially within the Purdue SIGBots organization. Most competitors have to find a healthy balance between academics and robotics, which becomes increasingly difficult when you consider that many competitors are pursuing degrees in **rigorous, time-consuming STEM programs**[1].

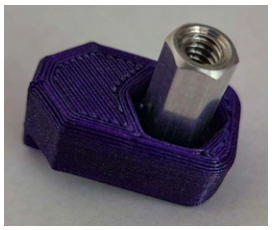
Our goal is to combat the time it takes to construct the BLRS3 robots with a simple solution that makes **rapid prototyping easier and building more convenient**. This way, we can develop designs faster and therefore be more prepared for our tournaments with the extra time we gain from having a streamlined design process.

OUR SOLUTION

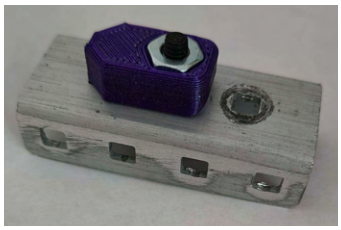


Our design that solves the problem of time consumption at the university level is the **One Post Hybrid Retainer**. This fastener retainer allows standoffs, low profile nuts, and any hex nuts to be retained within it while anchoring itself to a nearby hole with a square peg that minimizes any potential play in a given attachment point.

NOTABLE FEATURES



A standoff nested inside of the retainer.



A steel hex nut nested inside of the retainer while anchored to a C-channel coupler.

The One Post Hybrid Retainer boasts a two-stage, counterbore-esque hexagonal divot that has two different outer diameters: The top stage having an OD of 0.35” and the bottom stage having an OD of ¼”. These dimensions **match the outer diameters of any sort of standard hexagonal VEX fastener**[2][3]; most notably hex nuts, lock nuts, and standoffs. Generally speaking, this retainer should be **compatible with any #8-32 fastener**.

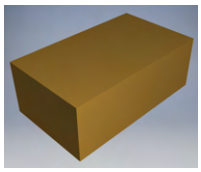
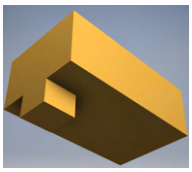
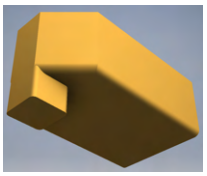
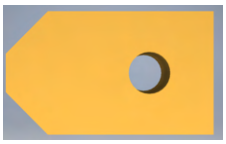
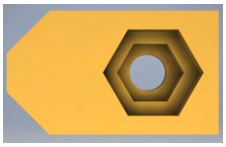
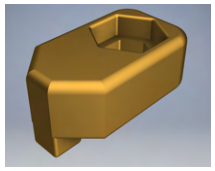
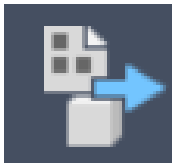
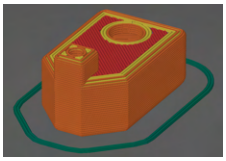
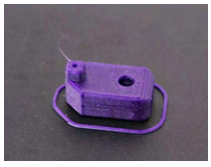
The retainer also has a square peg with a width of 0.175”; a width that is only marginally smaller than VEX C-channel holes. The peg is ⅛” long, which allows it to protrude through two C-channels consecutively, **making it perfect for eliminating play between two C-channels** since its width allows it to fit snugly in the hole.

DEVELOPMENT PROCESS


[4]

Our design shares a strong resemblance to VEX's 1-Post Hex Nut Retainer. It's no coincidence; the design of the One Post Hybrid Retainer was inspired strongly by the 1-Post Hex Nut Retainer and was actually meant to **innovate upon VEX's original design to make it more versatile**.

When broken down in Autodesk Inventor 2022, the retainer itself had a simple design process. It began as a rectangular prism that was carved with chamfers, fillets, and hexagonal extrusions.

 Base rectangular extrusion; 0.85" x 0.50"	 0.175" x 0.175" x 0.125" square peg is added below.	 Fillets and chamfers define the part further.	 0.175" OD hole is made for the screw to fit through.	 Counterbored hexagonal divots are added.
 1/32" fillets make the design smoother and lessens filament use.	 Retainer can be exported as an STL file.	 A slicer program converts the model into a GCODE file.	 GCODE file is transferred to a 3D printer.	 The One Post Hybrid Retainer is manufactured!

ECONOMIC BENEFITS

Beyond the versatility of the One Post Hybrid Retainer's features, the part itself offers many benefits when it comes to the actual manufacturing process.

The simplicity of the One Post Hybrid Retainer and its accompanying CAD files allows it to be additively manufactured via any commercially available 3D printer with PLA filament. We found that, with optimal settings, the part would only take around **13 minutes to manufacture**. This means you could hypothetically manufacture **50 of them in a span of a little over 11 hours.**

Layer Height	Infill Concentration	Filament Usage	Manufacturing Time
0.28 mm	15%	1.62 g	~13 minutes

via PrusaSlicer

Not only is the manufacturing time short, but it only uses 1.62 g of filament. If we consider that most filament spools contain around 1 kg of filament[5], then each retainer would only **take up 0.1% of the filament** on the spool, making it a very economic design for robot construction.

CONCLUSION

In summary, we have been able to design a versatile, economic part that will make our design process more streamlined. Whereas a pack of 1-Post Hex Nut Retainers or 1-Post Standoff Retainers may take multiple days to deliver from VEX's warehouse[6], our One Post Hybrid Retainer offers a quick, simple, yet versatile alternative for VEXU teams that can be **manufactured in mere minutes** in their classroom, laboratory, or living space. However, knowing all of this, **what knowledge has our team taken away from designing this?**

This season, our team has spent time manufacturing parts that are large scale with little concern for print time or filament usage. However, this is the first time our team has learned to create a model that **optimizes the manufacturing time and filament usage to be as little as possible** by making use of large chamfers and fillets so it can be mass produced. In the future, we can use this same approach to **rapidly prototype using manufactured parts** while saving on time and money.

REFERENCES

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