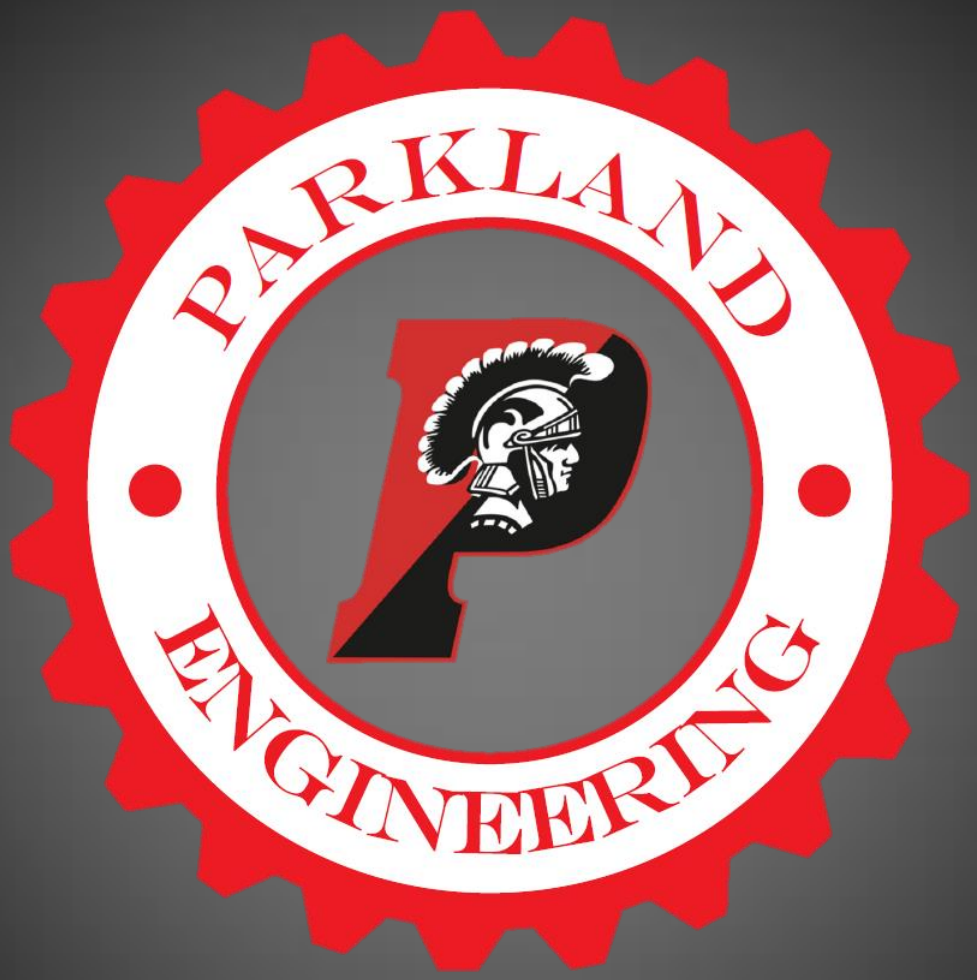

Make It Real CAD Challenge

Creation of a Locking VEX Pillow Block to Serve as a Hinge
AKA: Fitting a Square Peg into a Round Hole

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Contents

INTRODUCTION

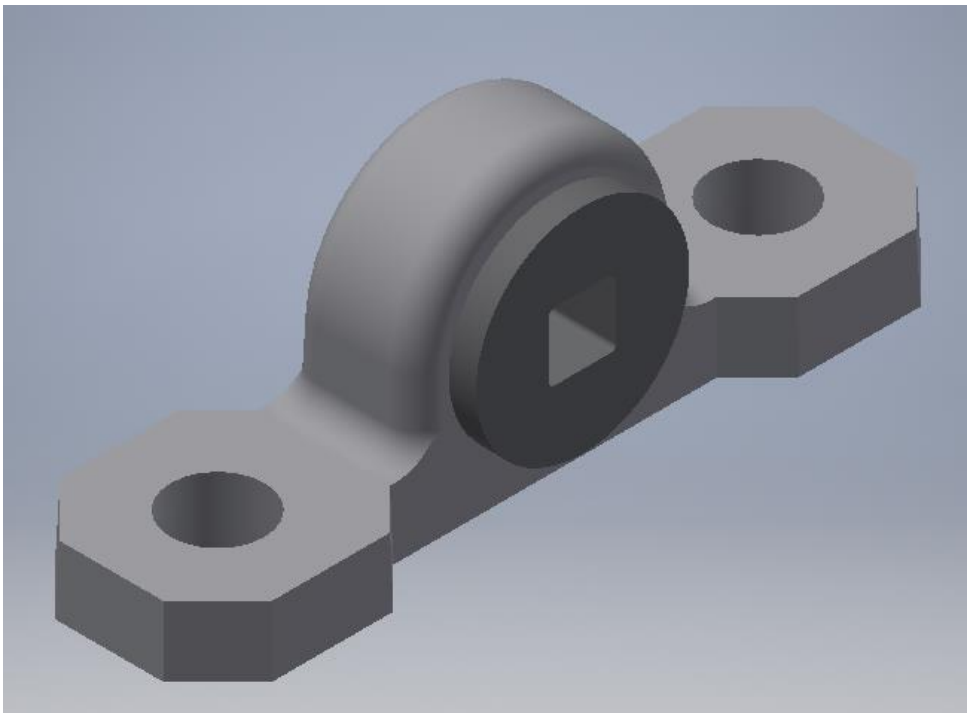
Team 4001E modified the existing VEX pillow block with a 1/8th in. square shaft insert. This allows the pillow block to lock onto a shaft whereas the existing pillow block allows a shaft to spin freely. The modified pillow block can then be used to make a customizable hinge by connecting a normal pillow block on one plate to our modified pillow block on an adjacent plate with a 1/8th in. shaft.

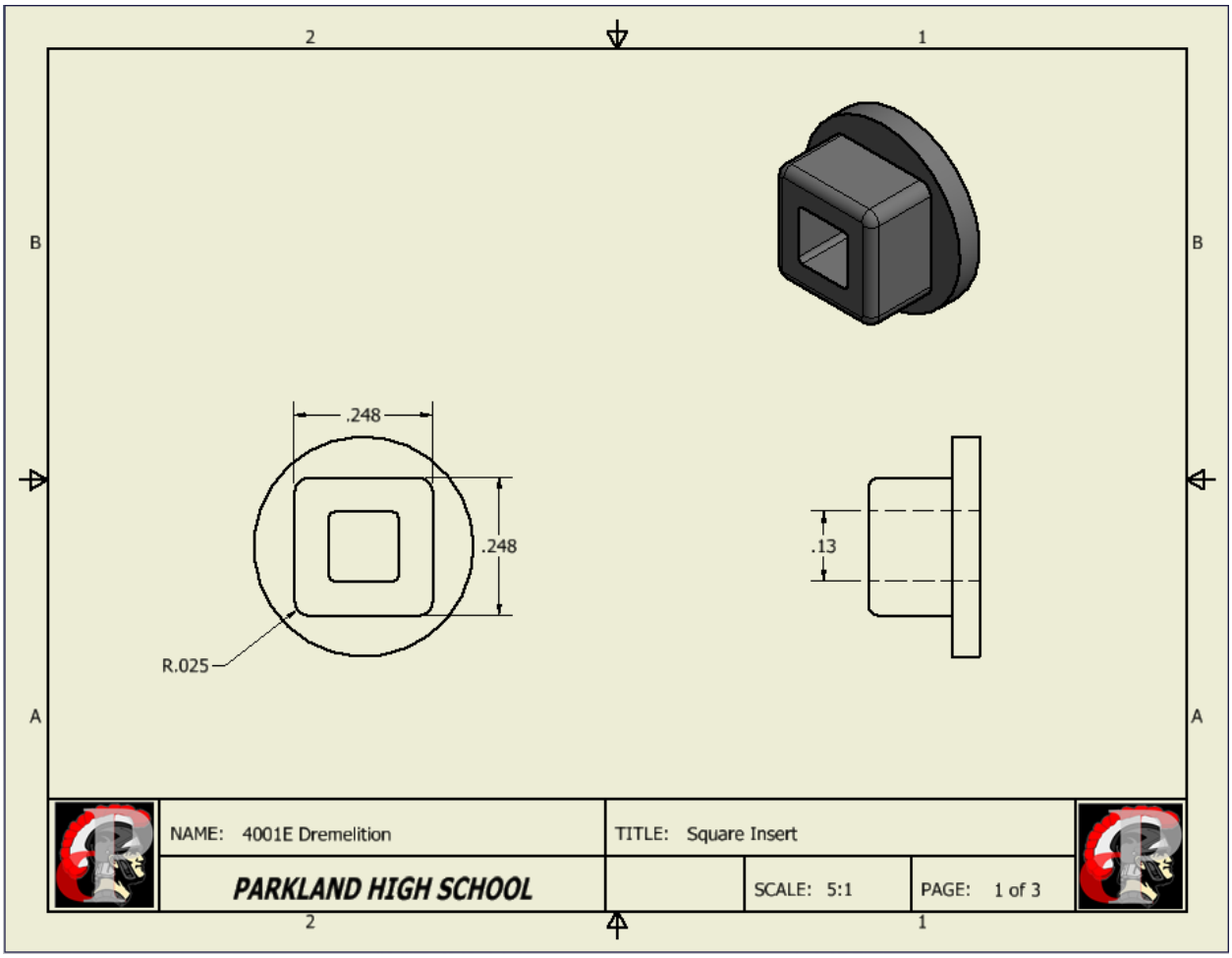
INSPIRATION AND APPLICATION

Our robot design for the VEX Starstruck competition utilizes a fork intake that unfolds from the initial 18”x18”x18” starting position. To do this, we used a VEX hinge. However, we needed a way to lock the fork intake in place once it unfolded. To save on motors, we mandated that our solution must be passive. After brainstorming, our team agreed that a ratchet and pawl system would be the best approach. To incorporate a ratchet gear, the center of the gear must align with the hinge axle. There is currently no VEX part that works with the hinge to convert the hinge axle to a 1/8 in. shaft, so we set out to create our own hinge. By attaching pillow blocks on the adjacent plates and connecting them with a shaft, we were able run a shaft that aligned with the VEX hinge in order to mount the ratchet gear. However, the gear needs to rotate with the plate of the fork intake, so we were inspired to construct a pillow block that could lock onto a shaft.

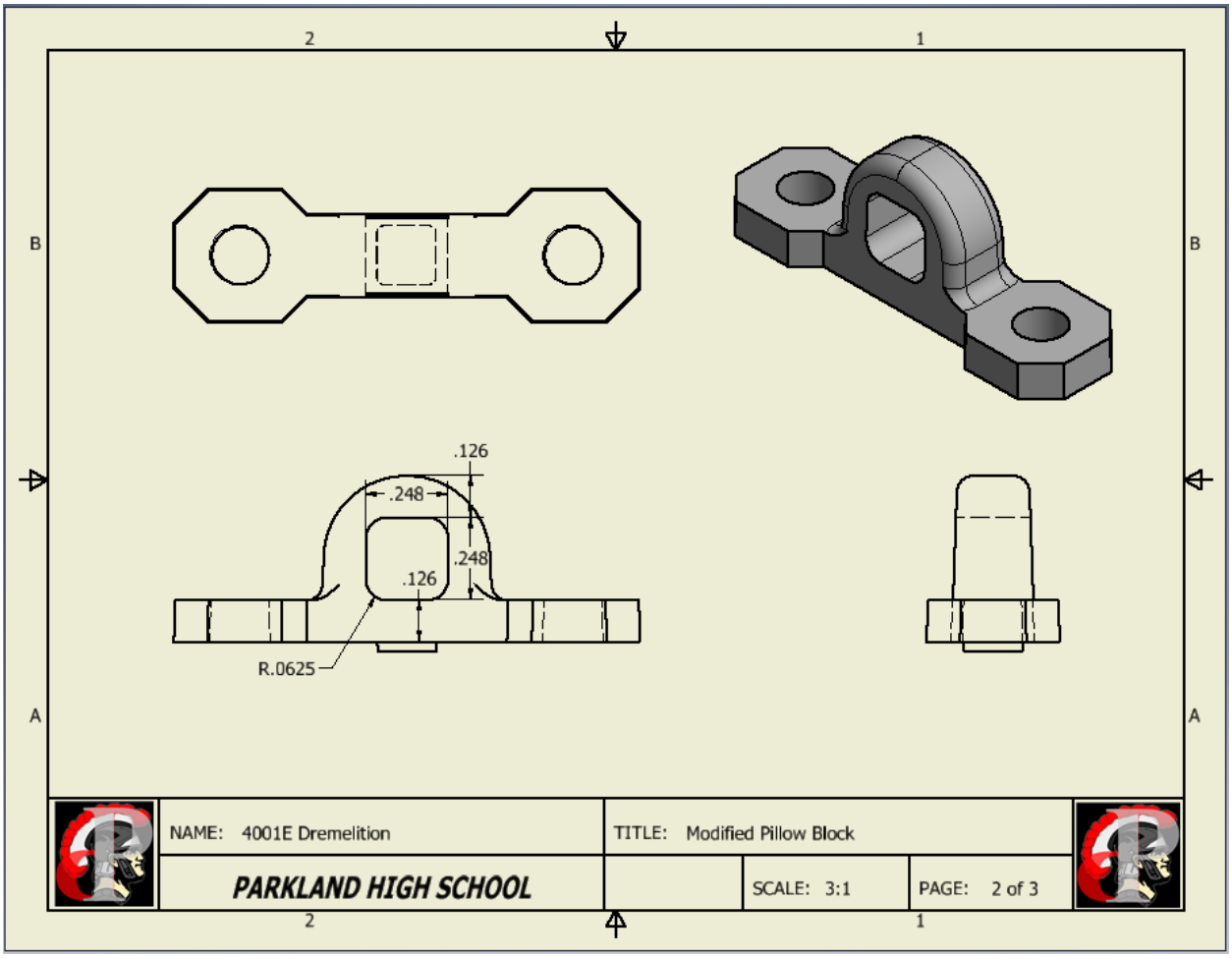
DESIGN

Team 4001E CAD modeled our part in Autodesk Inventor 2017. An assembly model was created to combine a pillow block and a square high-strength gear insert. Below are photos of the design and specifications.

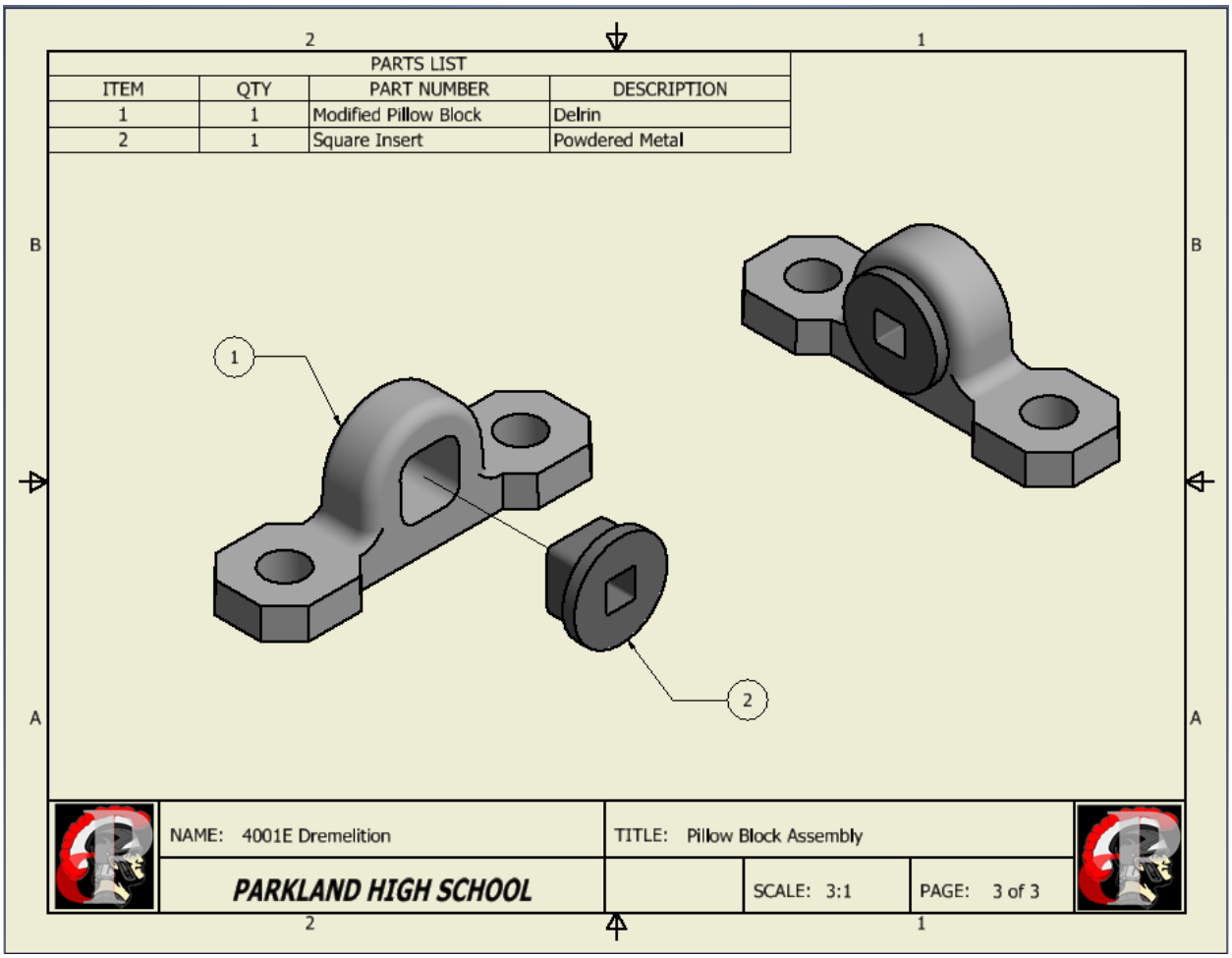




CAD Drawing 1: Square Insert



CAD Drawing 2: Modified Pillow Block



CAD Drawing 3: Pillow Block Assembly

PROTOTYPE

First, we widened the center hole of the pillow block with a drill and interference fit a square gear insert into the pillow block. This prototype proved successful, but we needed a way to produce several modified pillow blocks with identically oriented square inserts.

MANUFACTURING

Team 4001E programmed a CNC machine at our school (Parkland High School) to cut a square into the existing pillow block. We then used an arbor press to fit the square insert into the pillow block. The manufacturing process is pictured below.

Left: Here is the pillow block mounted to a specially carved block so that we can produce multiple parts without the need to re-zero the CNC machine

Right: The result of machining the pillow block

Top: The pillow block is held in place on the arbor press so we can interference fit the square insert.

Bottom: Using the arbor press to fit the parts together to produce a final product

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proLIGHT 1000 Machining Center
Single Tool
Post Processor: proLIGHT 1000 Single Tool
Material Type: Machinable Wax
Material Size: X0.5000 Y0.5000 Z0.2500
Material Origin: X0.0000 Y0.0000 Z0.0000
Units: Inch
Tool #1: 0.1250  .125" End Mill
05
Pocket, Pocket 1
S5000
M03
G0Z0.05
X0.002Y0.002
G1Z-0.0625F3; Plunge
G1Y-0.002F8
X-0.002
Y0.002
X0.002
G0Z0.05; Retract
G0X0.0645Y0.0645
G1Z-0.0625F3; Plunge
G1Y-0.0645F8
X-0.0645
Y0.0645
X0.0645
G0Z0.05; Retract
G0X0.002Y0.002
G1Z-0.125F3; Plunge
G1Y-0.002F8
X-0.002
Y0.002
X0.002
G0Z0.35; Retract
G0X0.0645Y0.0645
G1Z-0.125F3; Plunge
G1Y-0.0645F8
X-0.0645
Y0.0645
X0.0645
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N44X-0.002
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N46X0.002
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N50G1Y-0.0645F8
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N69M02; End of File
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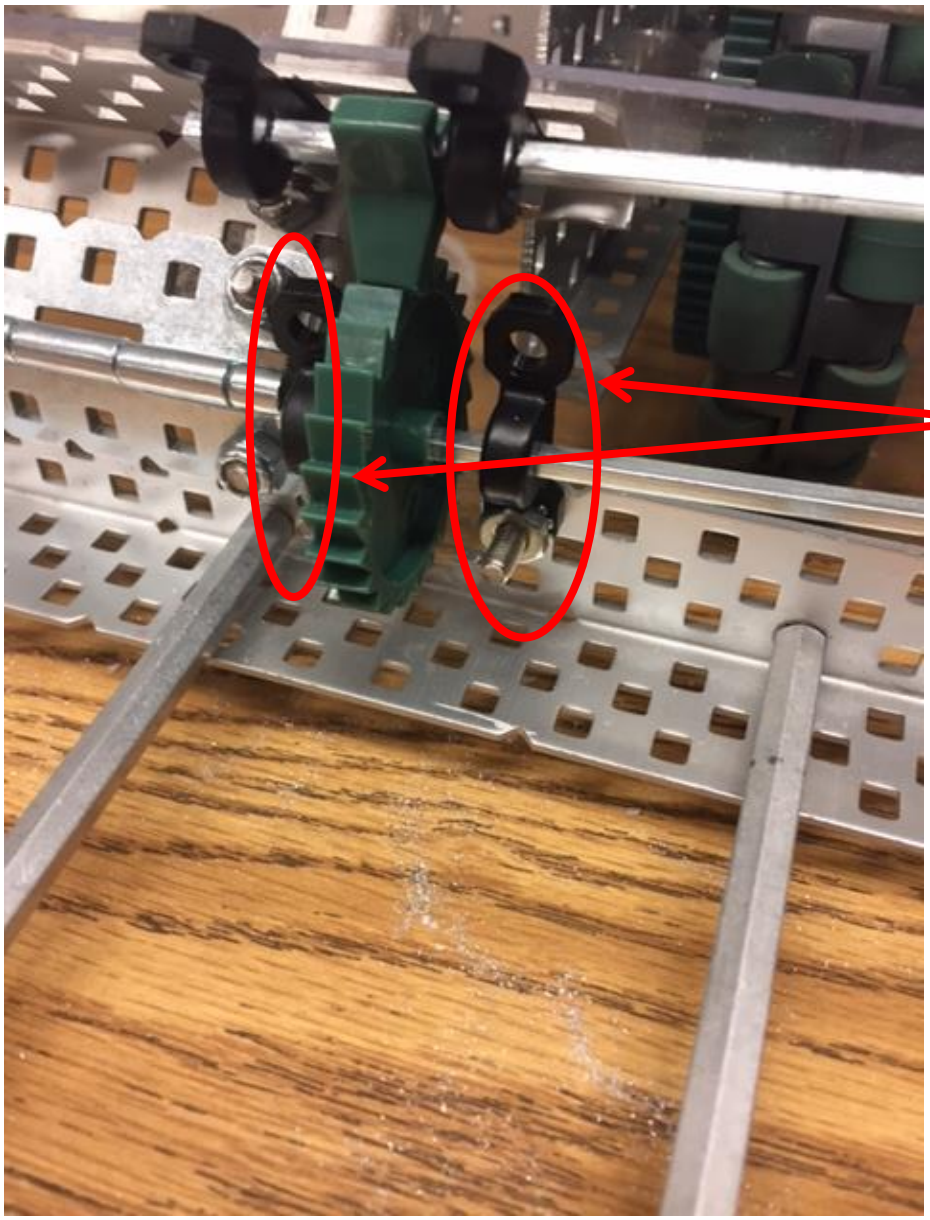
CNC Programming

-Code telling the CNC machine to cut a square into the pillow block

FINAL PRODUCT

Here you can see the final implementation of our modified pillow block system as a locking mechanism for our fork intake.



These are the two modified pillow blocks. They lock onto the shaft so that when the fork rotates into the downward position, the ratchet gear turns with it.

CONCLUSION

As a modification to existing VEX parts, the locking pillow block that we created is already legal for use in the VEX competition and has proved an integral part of our VEX Starstruck robot. The uniqueness of our custom locking mechanism helped us win the design award at the Sarah Heinz House Pittsburgh competition in December. This part could be 3D printed as one solid part instead of an assembly, thus increasing the strength and durability of the piece. Traditional ABS plastic printing (which our school uses) would likely be too brittle, but other hard plastics may prove a viable option.

Through the completion of this project, we learned that each robot dictates a unique approach, and pre-fab parts are not always sufficient. By using the design process and thinking “outside of the box”, our team was able to overcome a challenge faced when designing and building our robot. AutoCAD Inventor was critical in visualizing our part before we began manufacturing, as well as programming the CNC machine. Our team 4001E frequently uses CAD to model a system before building, as we have found that construction occurs much more smoothly when we have a precise design.

Most members of our team plan to pursue a degree in engineering, and 3D modeling is an important step of the design process. Not only does it help visualize the exact dimensions of a part or assembly, but many other tools are available to test the 3D model (such as interference and stress) before expensive materials are spent on a poor design.