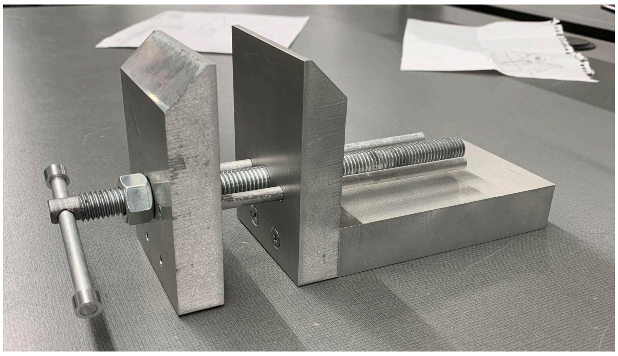
ENGR 377: MANUFACTURING PROCESSES

2021 Winter Term I

Lab Project Report

Lab Section: L1F



Group Number: 4

Student No.	Name	Percent Contribution	Signature
19943455	Ryan Prowten	25%	
30112361	Cole Reid	25%	
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49525165	Jaideep Sandhu	25%	

School of Engineering | Okanagan Campus

The University of British Columbia

1.0 Executive Summary:

Overview:

The item we are manufacturing is a table vice. This vice is manufactured from 6061 aluminium therefore will not be used for actual clamping purposes due to aluminiums soft properties. The vice designed has an easy to use threaded clamping system actuated by a handle to offer extra leverage when turning. There are also support rails on the same plane as the threaded rod to offer support, eliminate rotation and increase rigidity of the system.

Problem:

Vices commonly have imperfections in the machining process that lead to threads that are hard to turn or imprecise clamping surfaces. Vices need to allow users to quickly and easily clamp their desired surface with symmetric clamping faces in order to effectively use the device. Manufacturing processes depend on reliable vices in order to effectively machine products.

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2.0 Introduction:

This project was aimed at learning how to effectively use various metal machining tools in order to precisely manufacture either a vice or train car. Our group chose to design and manufacture a table vice. The material for our project was 6061 aluminium which is a relatively easy metal to machine therefore an easy metal for us to learn how to machine with.

We were required to be trained on and use all machines in the lab including the lathe, mill, drill press, vertical bandsaw, waterjet and belt sander. When designing our vice we designed it so it would allow us to use all of these tools at least the minimum amount of time required for the project requirements.

To ensure our design met the minimum number of manufacturing processes on each machine we first listed out the required operations and then as we designed the model in SolidWorks we matched machining operations to features of our model until no operations remained. The required operations included: water jet (by TA), milling, three turning operations and drill and tapp at least two holes.

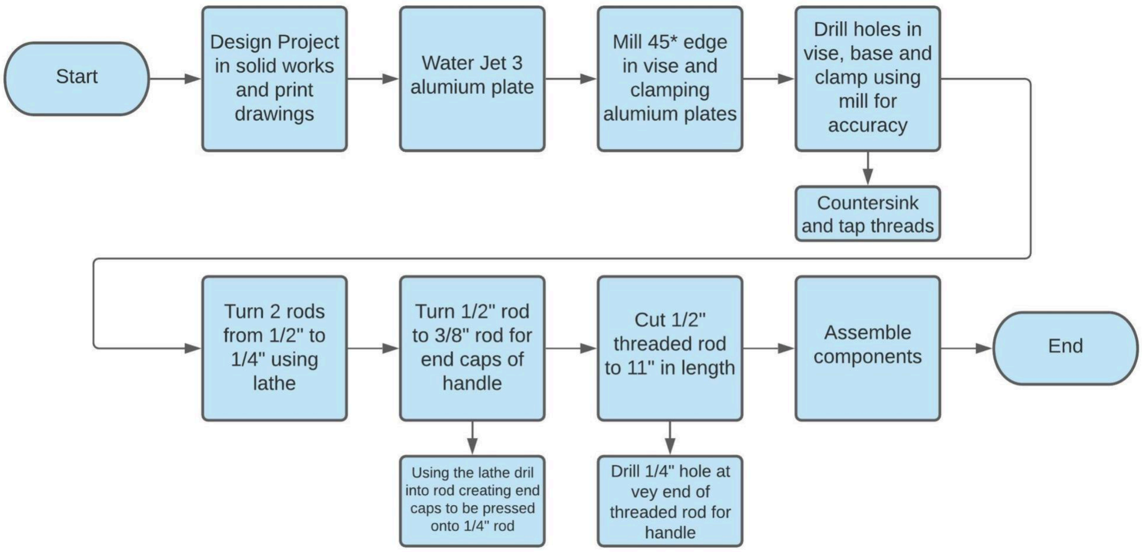
Problems we expected to encounter in the project were delays in machining due to either a limit of machines, an incorrect design measurement or simply not knowing how to use certain machines. To minimize delays we ensure our DXF files were submitted in advance of the lab and we had a plan ready for which machines to use and in which order before the lab.

3.0 Manufacturing procedure:

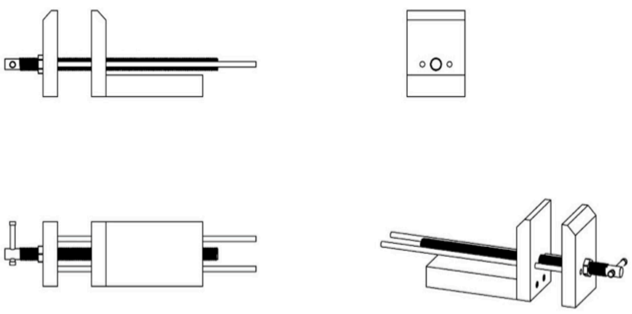
3.1 Parts list

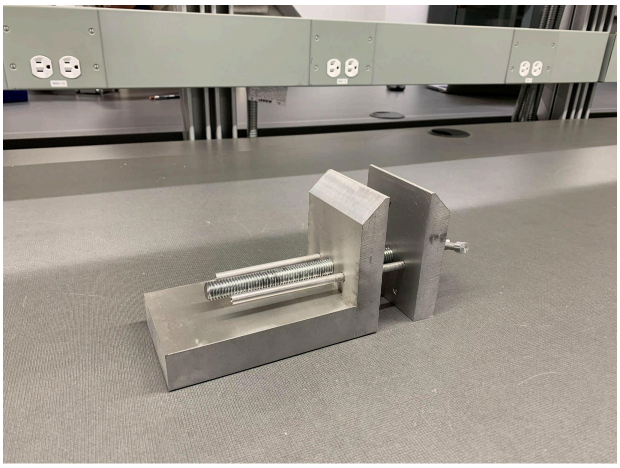
- Aluminum plate 1” thickness
- ½” Aluminum rod
- ¼” Threaded rod
- ½” Threaded rod
- ½” -13 Threaded Nut
- 10-24NC Screw

3.2 Manufacturing process flow chart



3.3 Isometric Drawings





3.4 Reference to Appendix

6.0 Appendix

- 6.1 Initial Drawings
    - Omitted Angle Part
    - Initial Clamp
- 6.2 Final Drawings
    - Base
    - Rod ¼' and ½" threaded
    - Handle
    - Clamp
    - Final Assembly

3.5 Manufacturing Process

The manufacturing process was divided into three major parts. The first part consisted of the machining process of the attaching clamp, detaching clamp and base pieces followed by the machining processes for the rods, handle and finally the assembly.

The first machining process consisted of the milling of the attaching and detaching clamp. These pieces were secured in the mill at an angle of 45 degrees and face milled in order to produce a smooth surface 45 degrees with 0.44 inches of width and thickness. Next both clamps had ¼" holes for ¼" rods drilled 1.50 inches from the bottom and 0.80 inches from the sides. A larger ½" inch hole for a ½"-13NC size rod was drilled into both parts 1.50 inches from the side and bottom. The ½" hole for the attaching clamp was also tapped in order to secure the middle rod as well as two additional 0.19-inch holes were drilled and counter-sinked into the bottom of the piece 1 inch from the side and ½" inch from the bottom.

The base piece had two 0.19- inch holes to support two 10-24NC screws drilled, counter-sinked and tapped 1 inch from the side and ½" inch from the side on the face connecting to the attaching clamp.

The vice assembly consisted of two ¼” rods and one middle ½” rod. Two ½” inch aluminum rods were turned in the lathe to the required size of ¼”. A ½” threaded rod was cut to 11 inches with a ¼” hole drilled into one side for the handle. The vice handle was turned from a ½” aluminum rod to a size of ¼” capped at both ends.

Finally the parts were assembled and formed the vice as shown in the pictures in section 6.8 Final Pictures in the Appendix.

3.6 Division of Labour:

In order to distribute the work evenly our group took turns on each component of the project, ensuring that each member got a chance to use all of the tools and equipment. If one member was more confident in a certain aspect they would provide support or suggestions where needed. Tyson took lead in the drawings and basic design of the project, taking suggestions where needed to create a functioning project. The TA’s were also a huge assets in regards to operating the machines and proper techniques that are only achieved by experience.

4.0 Manufacturing Challenges:

a)

At the beginning one issue that we ran into with respect to design was coming up with a design that was functional. We took into account previous years projects and noted which designs worked and those that did not. We found that a common issue with these designs was binding along guide rails. With this in mind we designed all through holes to have a reasonable tolerance such that binding was less likely while also providing a structurally competent fitment. This resulted in our part operating smoothly and functionally. Another challenge we encountered during the initial design process was determining whether our design would be machinable. With little to no shop experience within our group we had to intuit whether an idea for the design would be feasible or not. This led us to breaking down the parts into small achievable cuts. For example, the base and attached clamp parts may have been able to be machined from one piece of metal but it seemed easier to machine two smaller blocks and screw them together after. Also the force created in the vice is concentrated in the clamps and therefore the strength of this joint was not crucial.

b)

1. One of the obstacles we ran into was when using the lathe on the smaller 0.25” rod. It was initially 0.5” and needed to be machined down. It is relatively long and skinny and therefore when we put it in the lathe it vibrated slightly during rotation. This led to the two 0.25” rods having a rough and slightly uneven finish.
2. Another hurdle was tapping the small 0.19” blind and through holes in the base and clamp respectively. We found that tapping holes of that size became a lot of work especially around the end of the tap. This however did not cause any issues with the part.
3. Lastly, we struggled with time. We finished the piece at the end of the fourth (last) lab. While we finished it on time, we did have to skip a piece that was not crucial to the functionality of the vice.

c)

1. We had accounted for possible variations in radius during the design process but this still caused some rubbing in the through holes of the clamps. Luckily it only took some sanding to even out the surface and the rods slide much better now.
2. To assure that we finished on time we skipped an angle piece (shown in the initial shop drawings). This piece was aesthetic and not vital to the structural integrity of the vice. We decided to omit it during the first lab after seeing how long machining took and changed designs right after to accommodate the loss of this piece.

d)

Given the opportunity to do this lab again with the knowledge of machining we've gained during this experience, we would design a piece with more complex machining operations. Armed with the information we have now we would feel more comfortable designing a more complex structure that we could assure would still be viable.

e)

In terms of enabling activities in the shop, having more TA's in the shop could help. We found that with four people in one group there was only so much each person could do at one time. With a whole group on one machine, three of the group members end up watching until they take their turn on the machine. With more supervision there would be more chances for delegation and increased production speed in the shop.

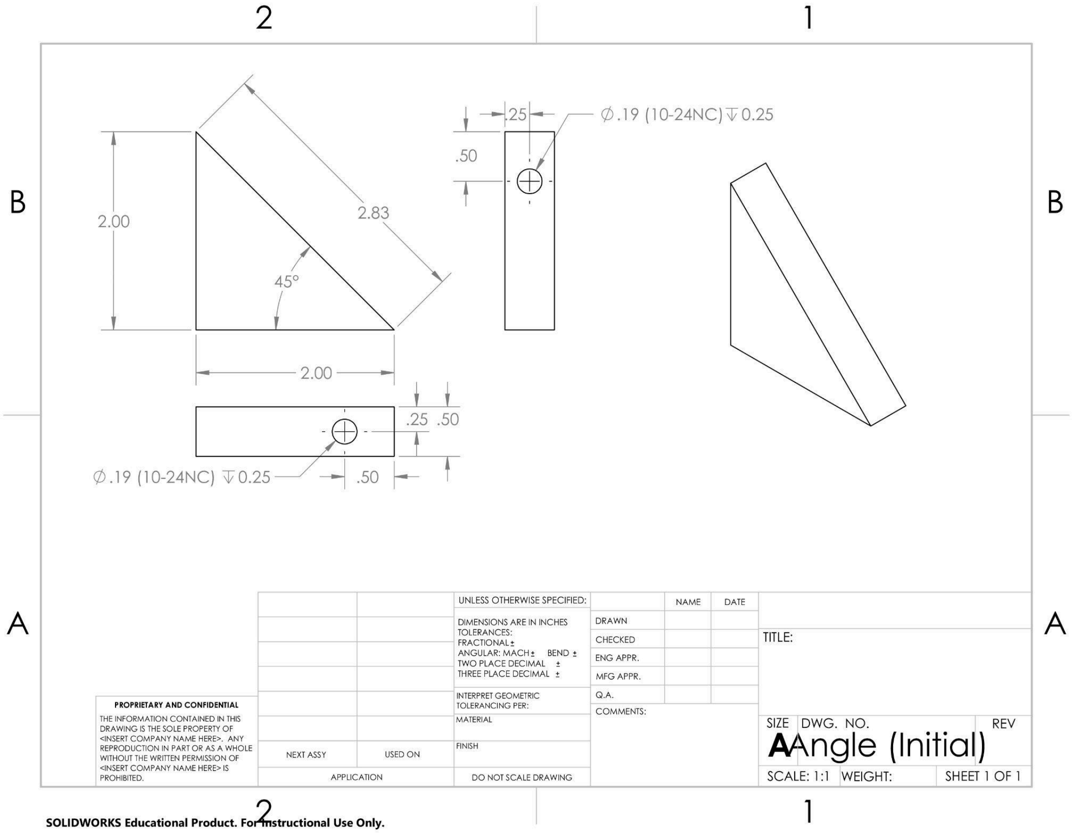
5.0 Summary & Conclusions:

During this lab, our group had the responsibility of designing, machining and assembling a vice out of 6061 aluminum. This was accomplished using a variety of metal working tools including but not limited to a drill, mill, lathe, water cutter, bandsaw, sander etc. Throughout the lab we had to use critical thinking and problem solving to overcome unforeseen obstacles that arose during machining and assembly, as well as choosing the correct tools for each operation. This would not have been possible to achieve within the given amount of time without the cooperation of the entire group. In addition, the TA's were massively helpful, with a wealth of knowledge and expertise they expedited the whole process while teaching us how to operate complicated machinery effectively and safely.

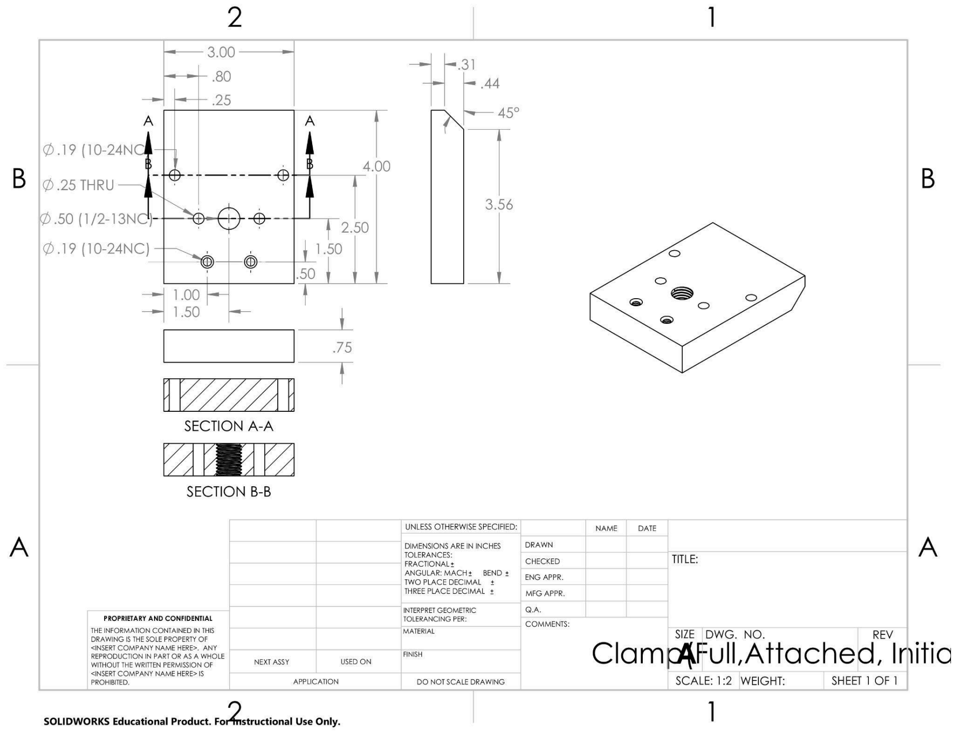
6.0 Appendix:

Initial Drawings (only two differences from final drawings):

1. Omitted Angle Part

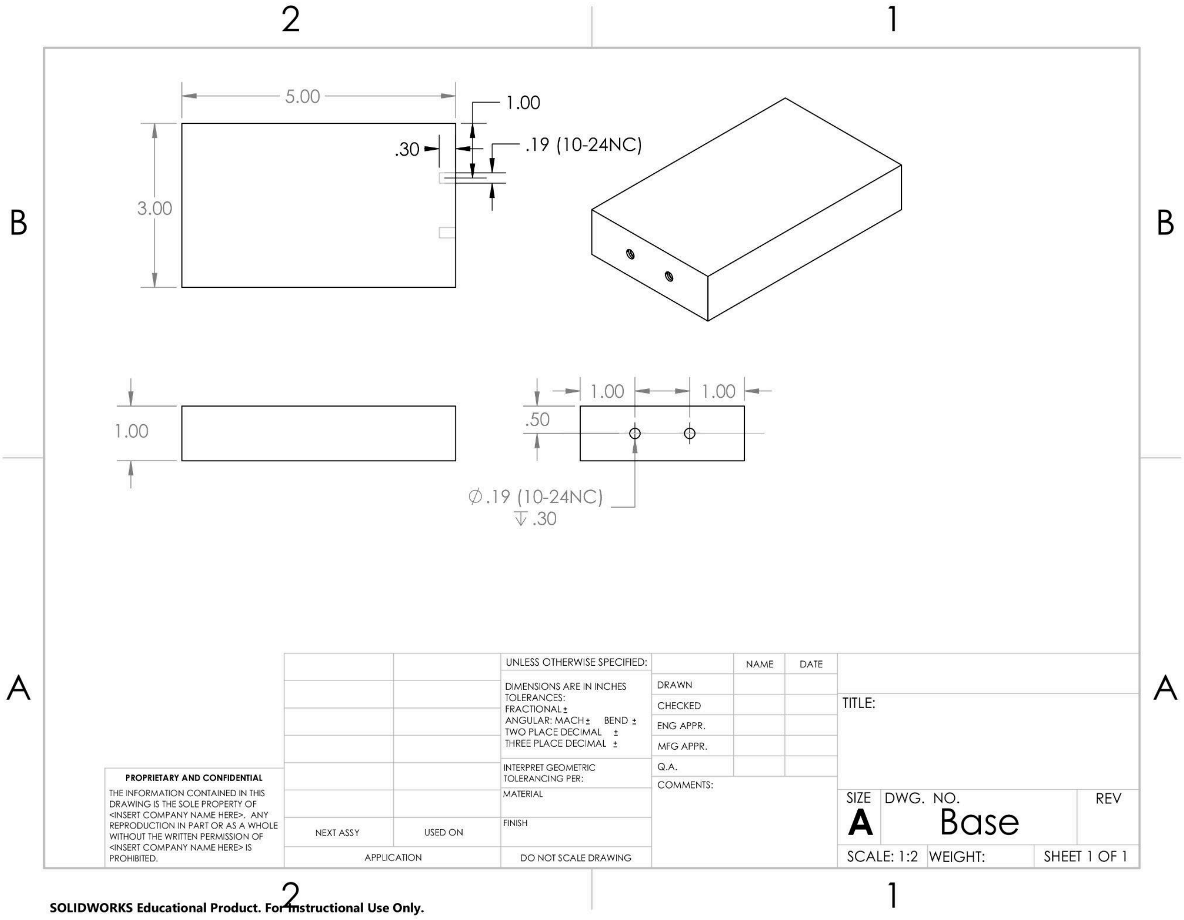


2. Initial Clamp with Holes for Screws

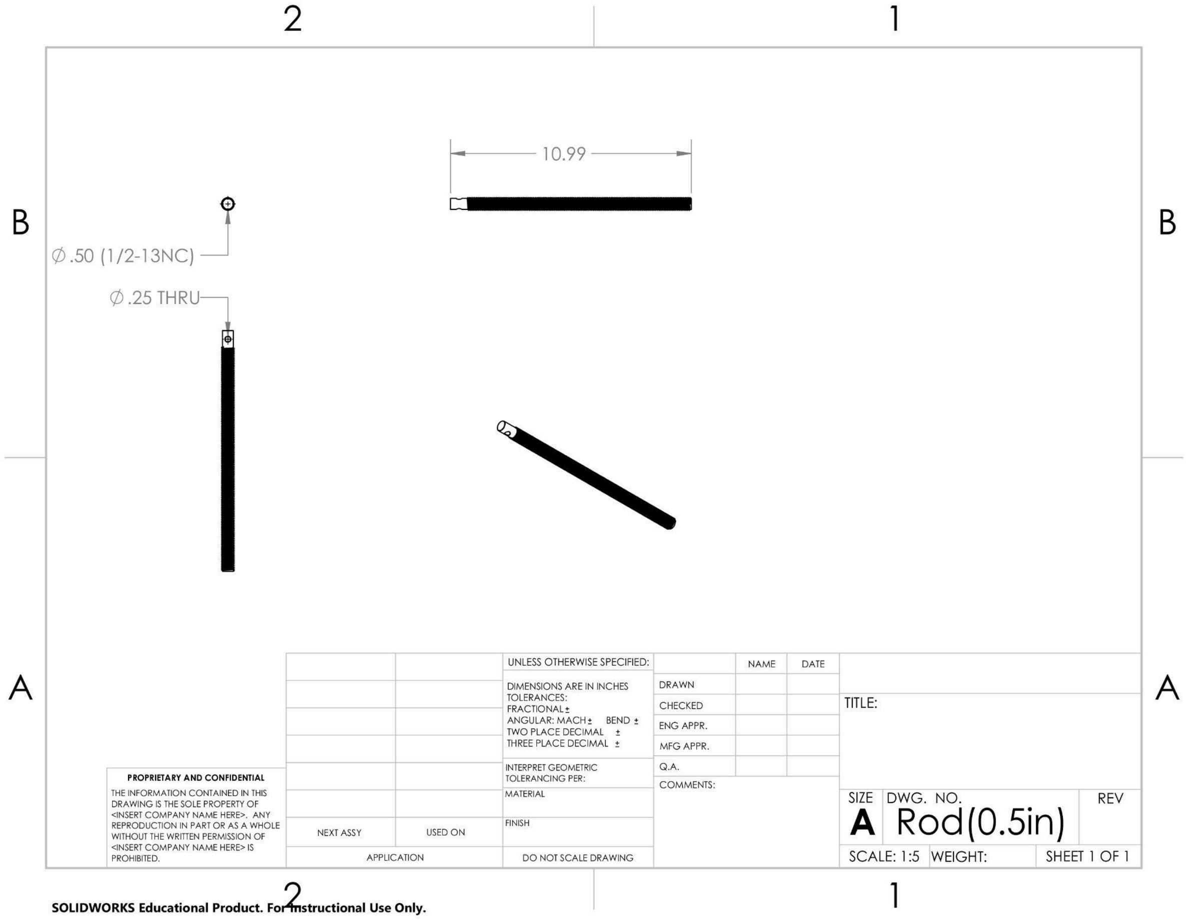


Final Drawings:

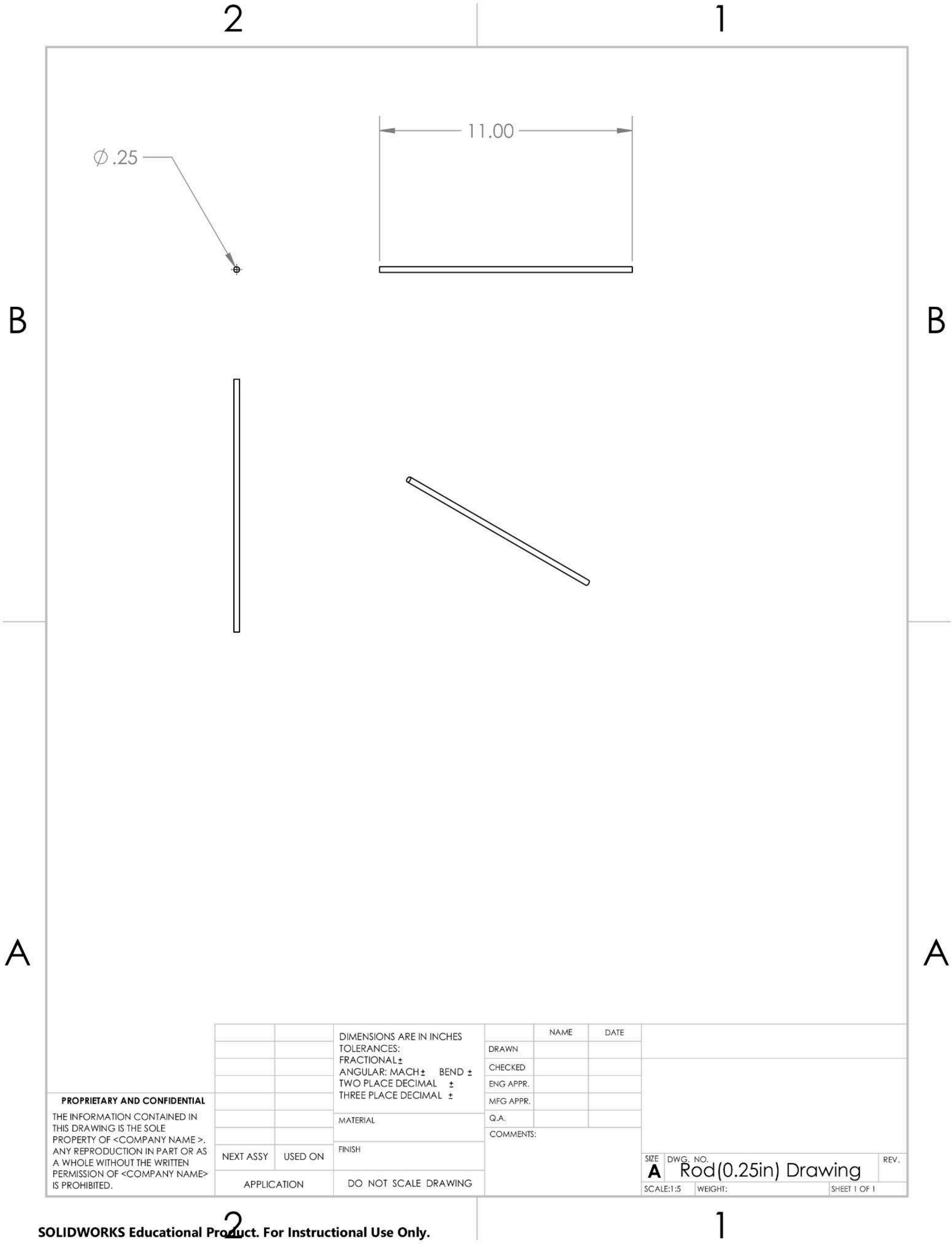
1. Base



2. Rod (0.5", Threaded)



3. Rod (0.25”)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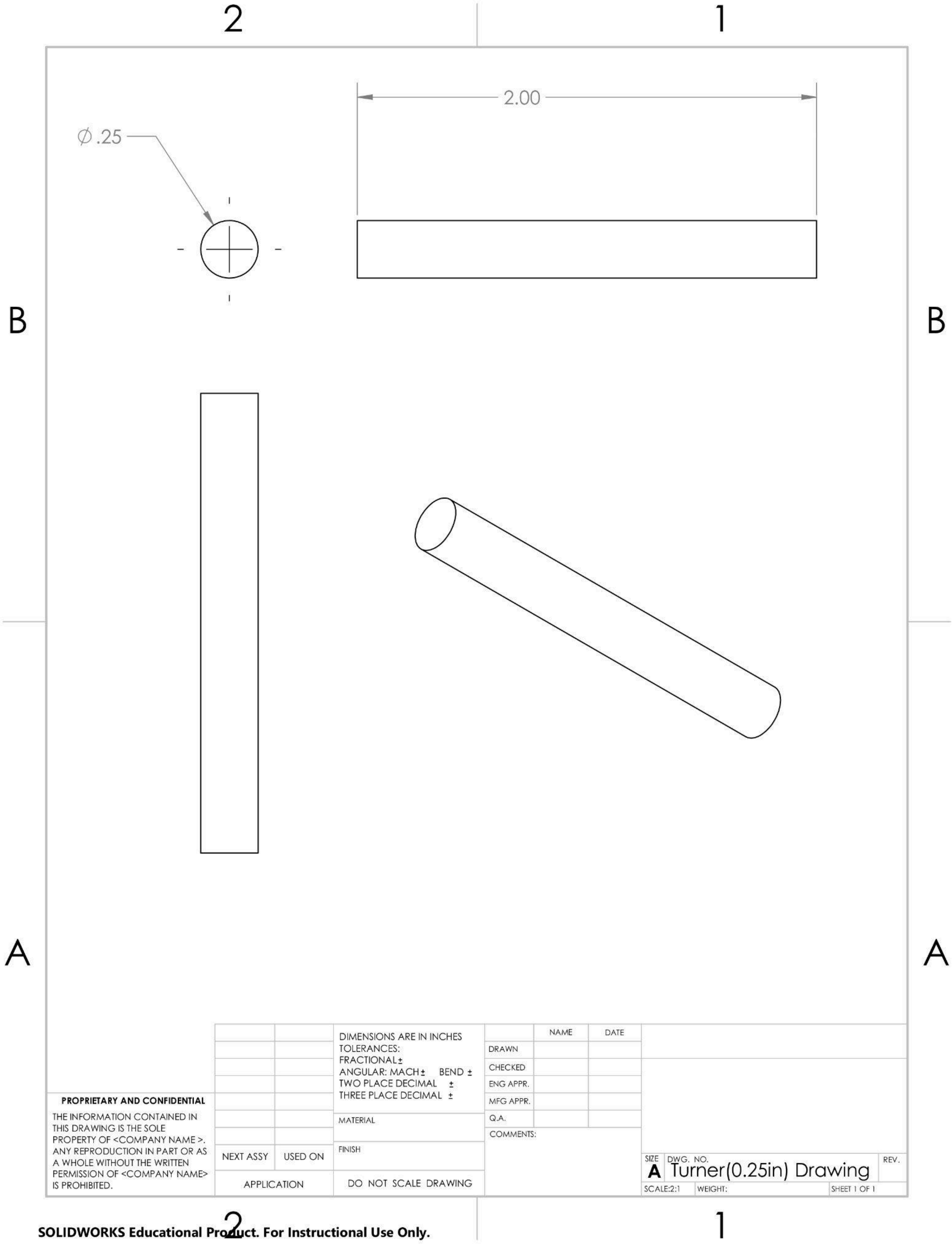
4. Handle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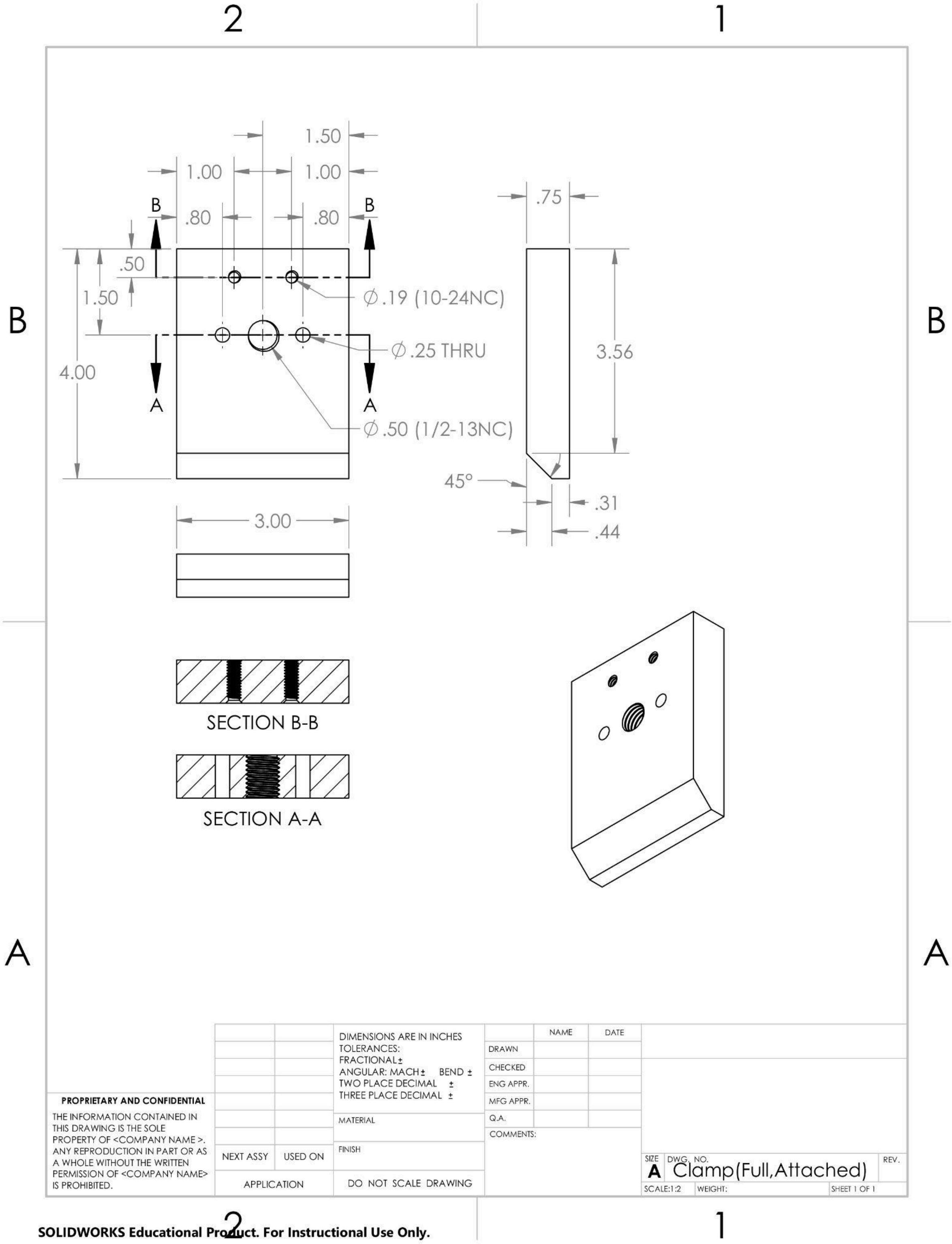
5. Clamp (Attached)



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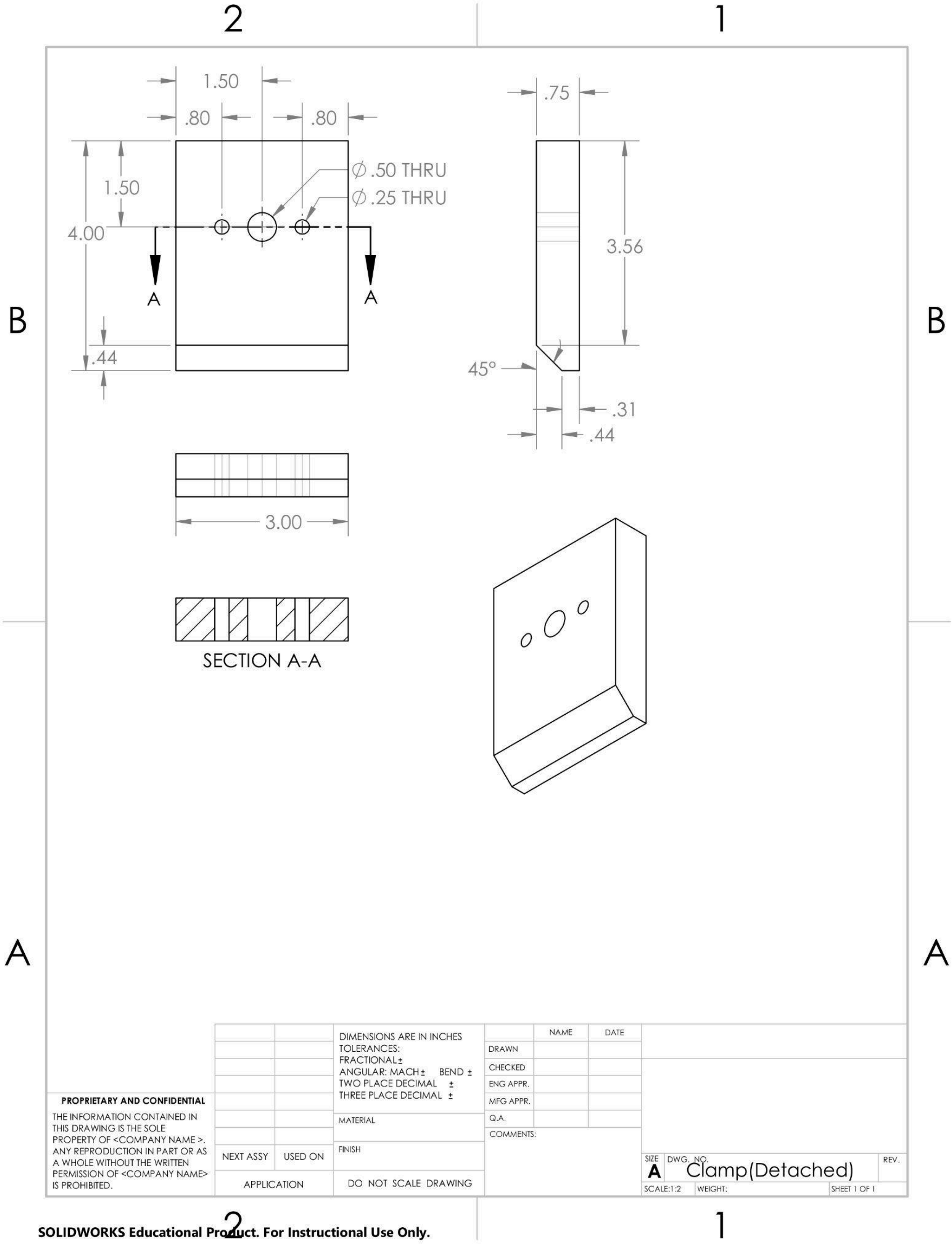
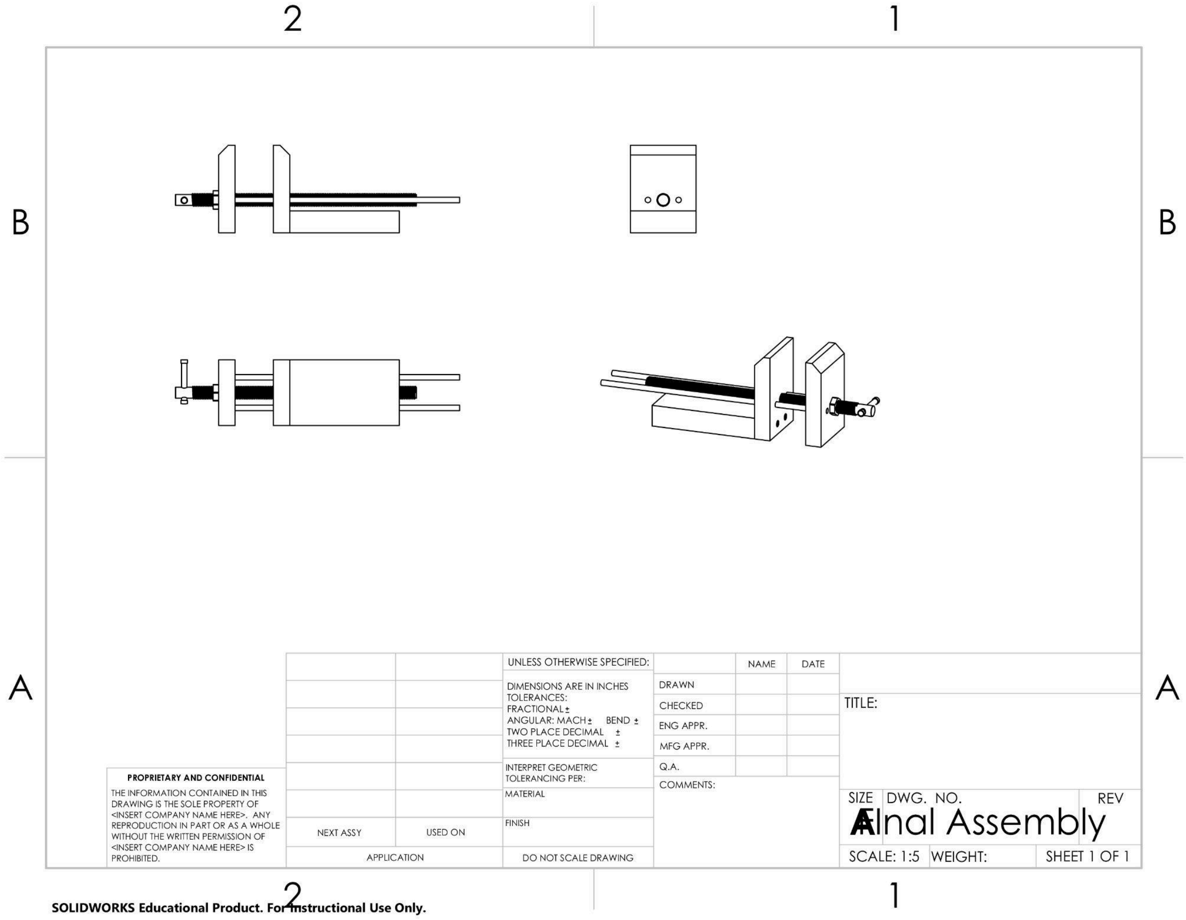
6. Clamp (Detached)



7. Final Assembly



Finished Product Pictures: