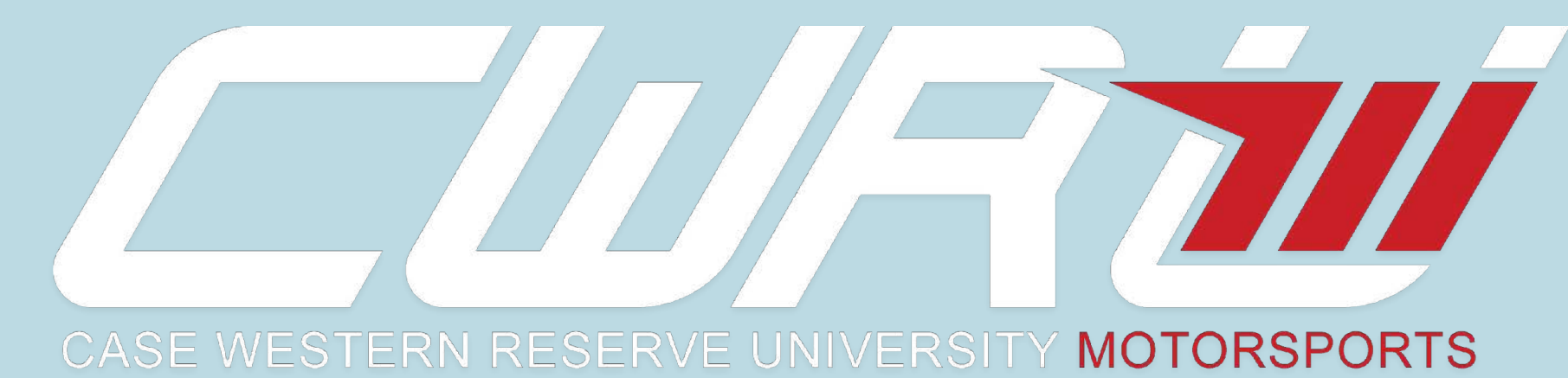


Hydraulic Brake Master Cylinder



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Introduction

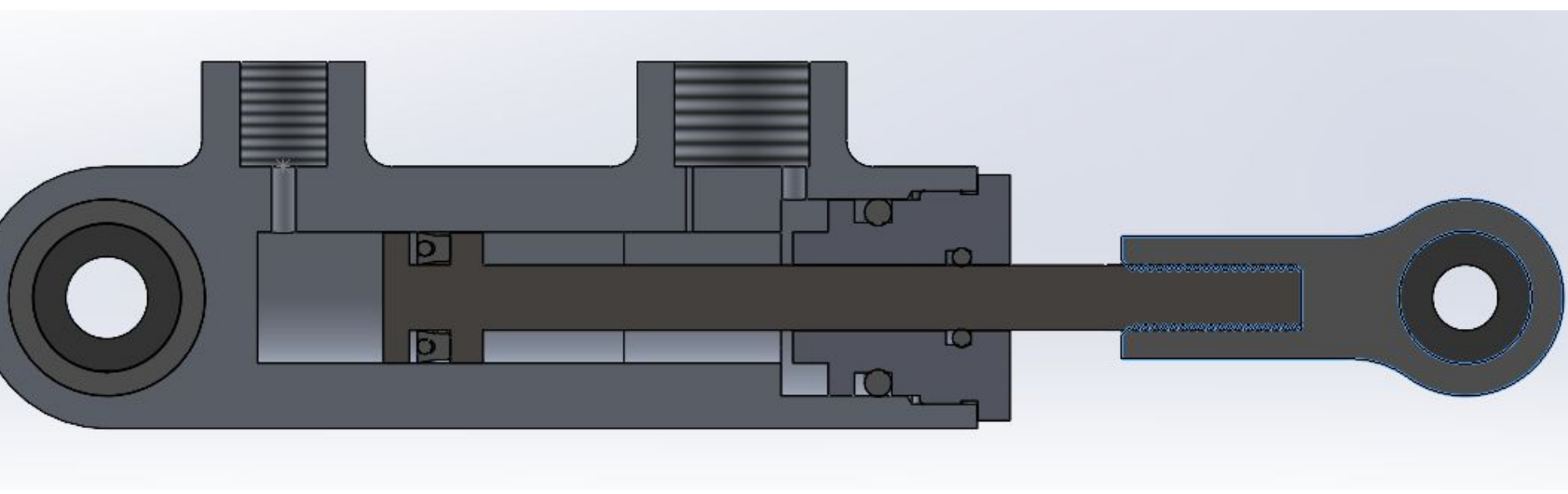
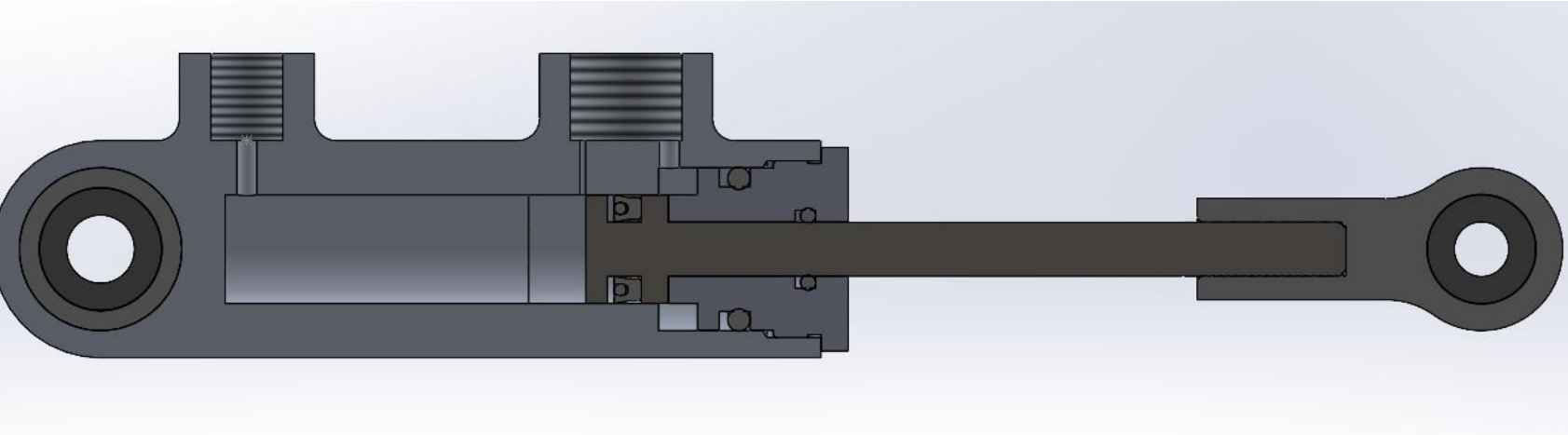
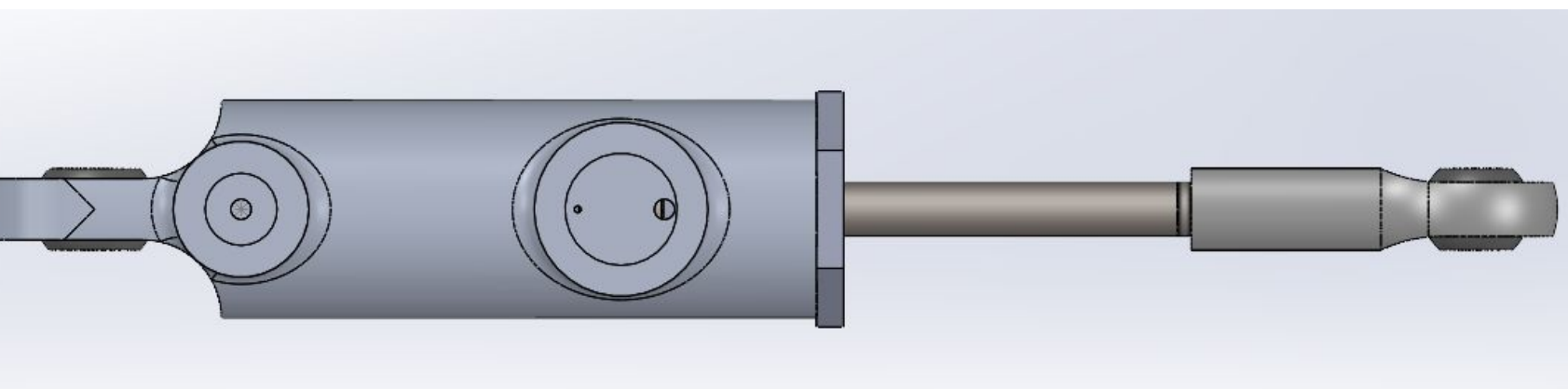


Fig. 1: Tilton Master Cylinder (\$250)

Design



Fig. 2: Cross section of U-Cup seal used between the piston and the master cylinder body.



Results

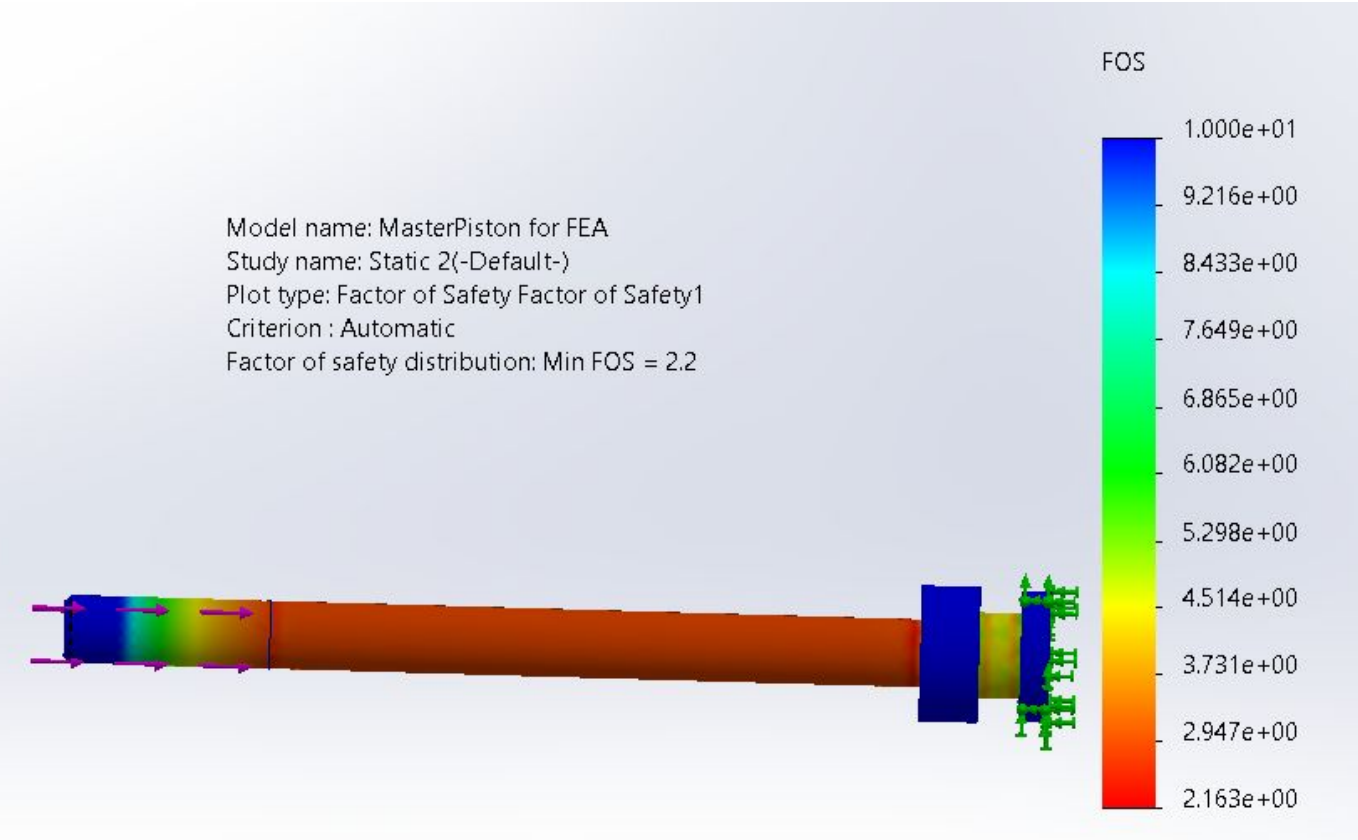


Figure 6: Static Sim of Master Cylinder Piston with FOS of 2.0 Load is applied as a force at the threads. Fixed on the pressure side.

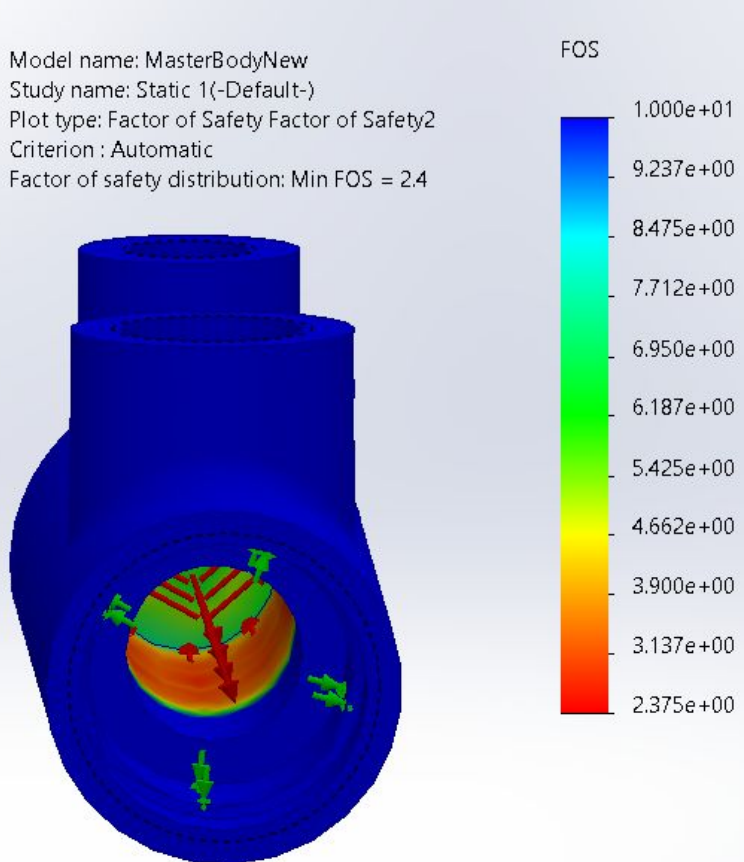


Fig. 7: Static Sim of Master Cylinder Body with min FOS of 2.4 Load is applied as a pressure on the inside of the bore. Fixed at the bolt hole.

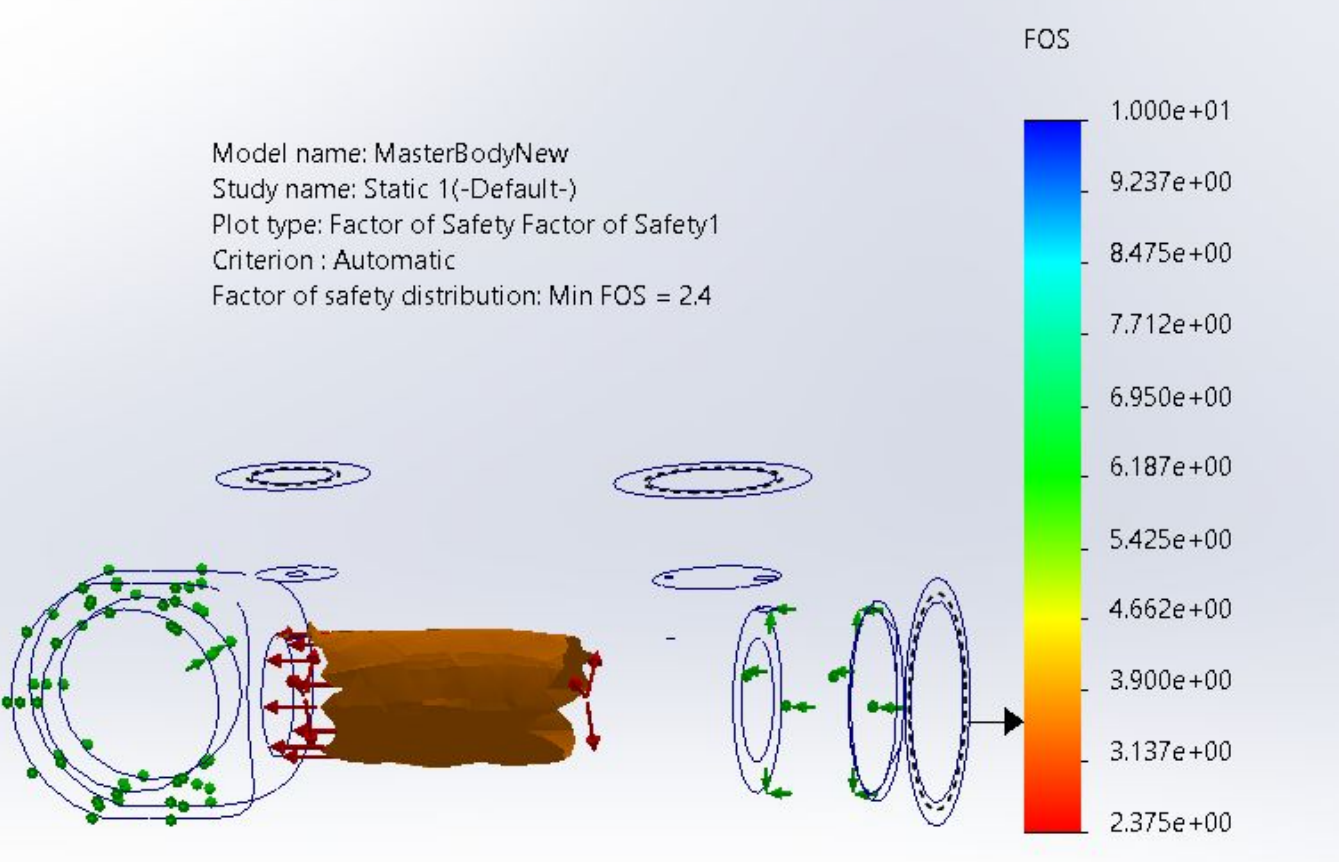


Fig. 8: Static Sim of Master Cylinder Body - Isoclippped at FOS of 2 Load is applied as a pressure on the inside of the bore. Fixed at the bolt hole.

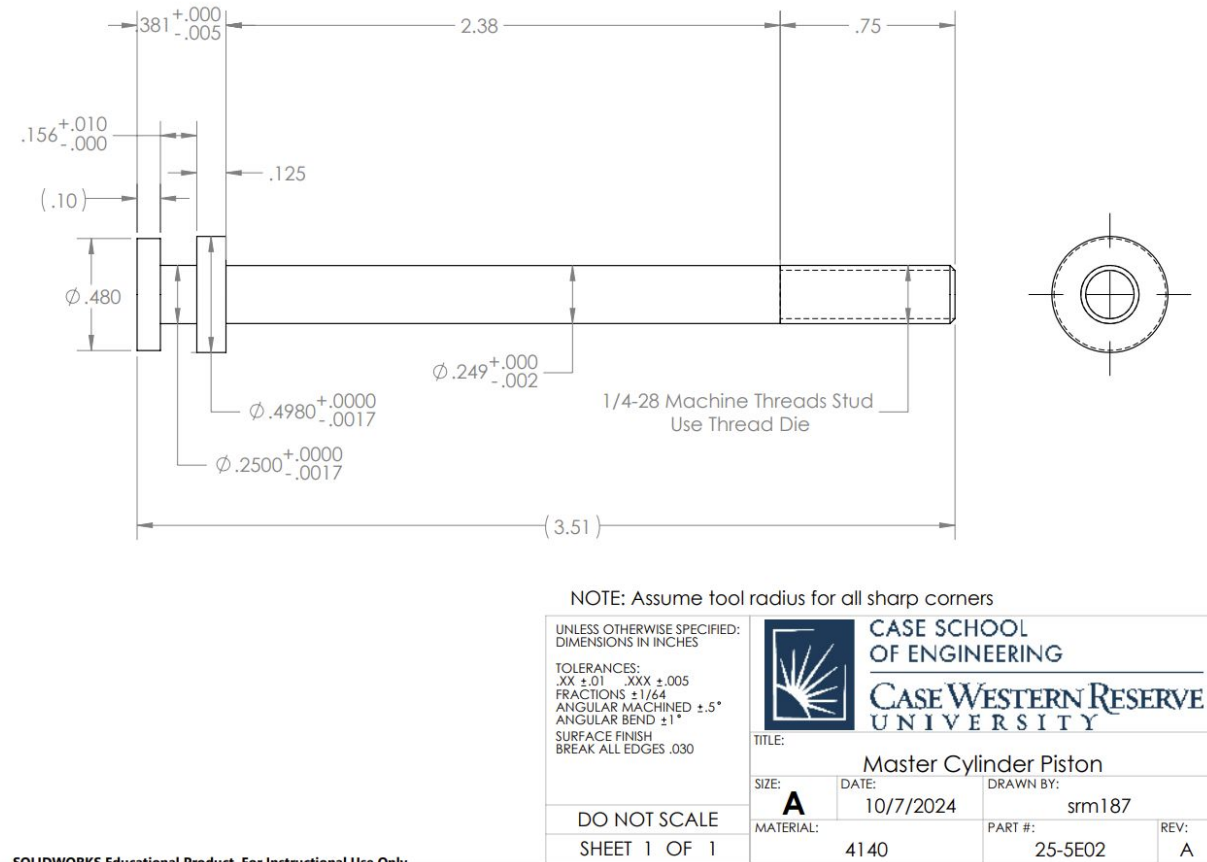
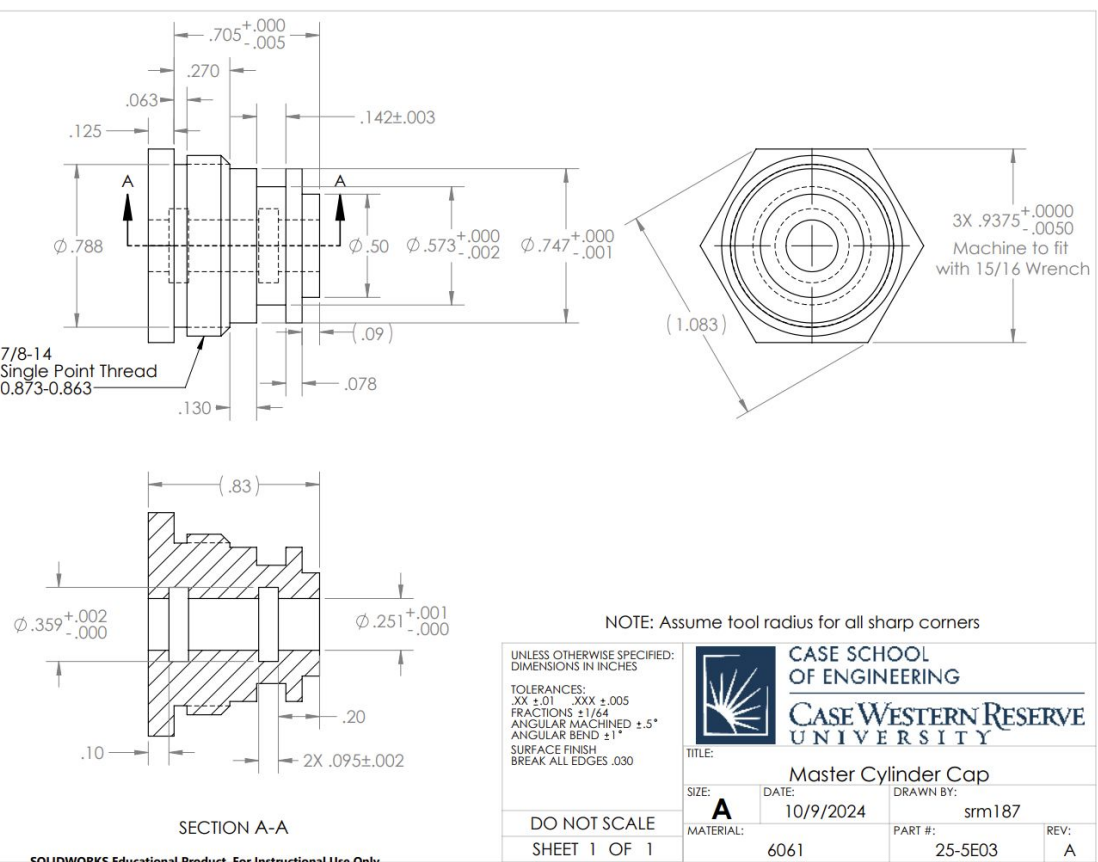


Fig. 9-10: Drawings of the 2 different manufactured components. On the left is the Master Cylinder Cap (25-5E03), and on right is the Master Cylinder Piston (25-5E02). Both components had tight tolerances to ensure the parts fit together as intended and the hydraulic fluid is sealed properly from leaks.



Fig. 11: Images of manual manufactured components. The manual components were manufactured in Sears Think[box] using a manual lathe and manual milling machine. Both components had tight tolerance and surface finish considerations that made machining additionally difficult. The entire assembly will include the 2 manual lathe components, 1 cnc lathe component, as well as seals, springs, and bearings.

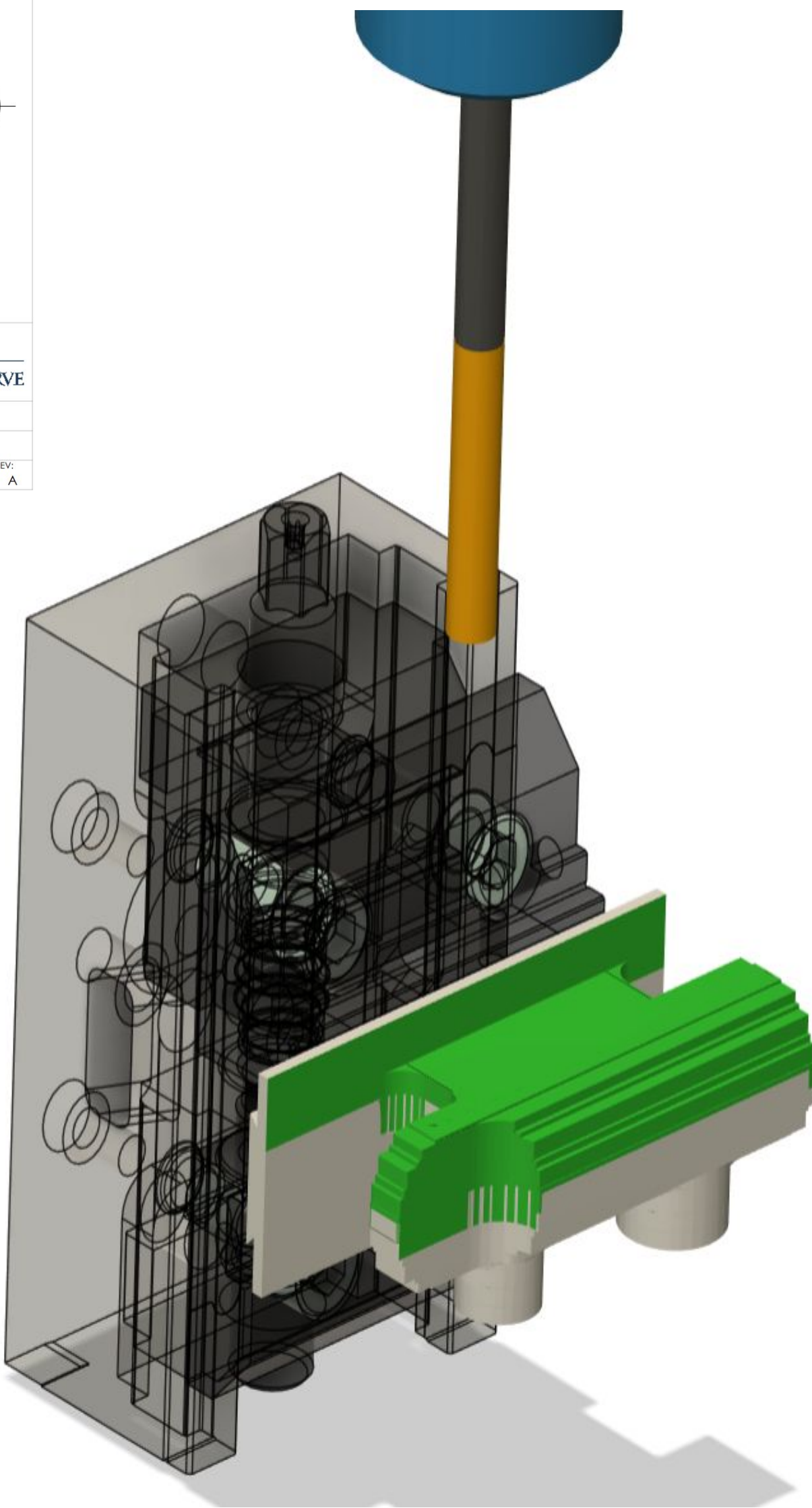


Fig. 12: Master Cylinder Body CAM CAM programmed in HSMWorks. To be machined on our 1997 Haas VF-3. 2 operations with the first and main operation being a 4 axis setup with a dovetail fixture.

Conclusions

- The hydraulic brake master cylinder project successfully met its design objectives of compactness, reliability, and cost-efficiency based upon the design. Key deliverables that were hit included a full assembly CAD model and FEA results confirming structural integrity at high pressure.
- The design addressed challenges such as achieving high-pressure sealing and maintaining precise manufacturing tolerances.
- While the project achieved its primary goals, opportunities for future improvements remain. More comprehensive testing needs to be done on the component to validate its use in the vehicle's braking system.
- In conclusion, this project provides a practical, cost-effective solution for hydraulic braking in competitive off-road applications and sets the groundwork for further advancements in small vehicle brake systems.

Limitations

- One key limitation of the project was the amount of testing done on the component. Because of the amount of time it took to design, run analysis, and manufacture the different components, there was little time in the semester to test the master cylinder.
- Another limitation is related to the analysis. For the FEA some assumptions and simplifications were made. For example the loads were assumed to be directly centered and no side loads were accounted for.

Acknowledgments

Thank you to Dr. Richard Bachmann for his mentorship on this project and to the CWRU Baja team and its members.