Deliverable H

GNG1103 B005

November 26th, 2023

Reema Adan, Lauren Coffin, Nora Jordan,

Sonya Pastorek, Nadia Rahman

Abstract

This document details the iterative development of the third prototype, aligning with predefined objectives set in the project plan and addressing the fundamental questions of "why," "what," and "when" in the goal of an enhanced solution. Emphasizing practical prototyping, the focus remains on specific tests and tangible outcomes. The prototyping test plan, analysis, and results are documented, accompanied by detailed images of the prototype. In seeking valuable insights, active engagement with feedback from potential users and leveraging suggestions from the third client meeting is a key aspect. Moreover, this document reflects the integration of updated Bill of Materials (BOM), specifications, and drawings, showcasing commitment to continuous improvement and project development. Drawing from client feedback and lessons learned in prior prototypes, the refinement of the third prototype's objectives marks a significant step in the solution's progression.

Table of Contents

1 Introduction

During the development of our second prototype, the objective is to seamlessly align with our project plan, navigating the iterative phases with an emphasis on practical prototyping. This report details our prototyping test plan, analyses, and results, offering a comprehensive insight into the evolution of our prototype. Actively seeking insights, we engage with potential users and incorporate feedback from the third client meeting. Notably, this prototype introduces key material changes for enhanced usability, such as foam cushioning to prevent damage on the door veneer and incorporating metal clamps welded onto the jig casing to provide a secure grip, ensuring the jig can support its own weight effectively. This report demonstrates our commitment to continuous improvement, showcasing the integration of an updated Bill of Materials (BOM), specifications, and drawings.

2 Prototype 3

The third prototype is a comprehensive physical prototype. This prototype is expected to be the result presented during design day. Additions to the previous iteration include foam padding on the paddles to ensure the device does not damage the veneer of the wood, the choice of clamp (screw clamp) was also finalized, and stoppers were added to prevent the plate from hinging forward past perpendicularity. The length of the stop collars was also significantly reduced to offer a more compact design. Some of the expected testing on this prototype includes ensuring that it can hold its own weight, measuring the time it takes to use, as well as, the general ease of use.

Prototype 3 aimed to advance beyond the scope of its predecessor, which primarily explored scale and basic functionality but faced significant drawbacks. The third iteration was designed to be fully operational, capable of securely clamping and unclamping from a door, bearing its own weight, guiding a drill accurately, and ensuring the drill remains perpendicular to the door. To achieve this, sturdy, accessible materials such as PLA from 3D printing and 24 gauge sheet steel for the casing were utilized. The emphasis was on ensuring that Prototype 3's durability and functionality met high standards, allowing clients to effectively simulate how a final product would enhance in-house workshop operations. Unlike the temporary clamping solution in Prototype 2, which used printed clamps joined with tape and lighter adhesives, Prototype 3 features clamps sourced from a readily available supplier, affixed to the casing through welding.

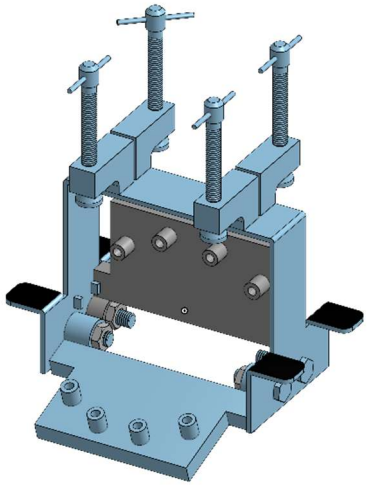


Figure 1. Assembly of final prototype (prototype 3)

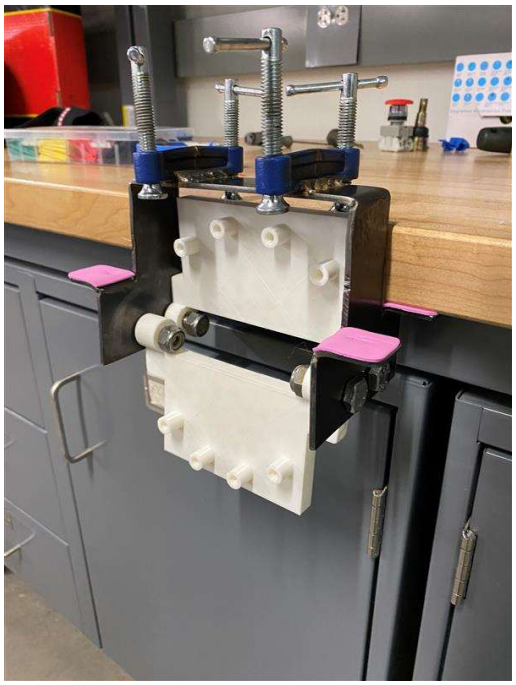


Figure 2. Front angled view of Prototype 3 while clamping

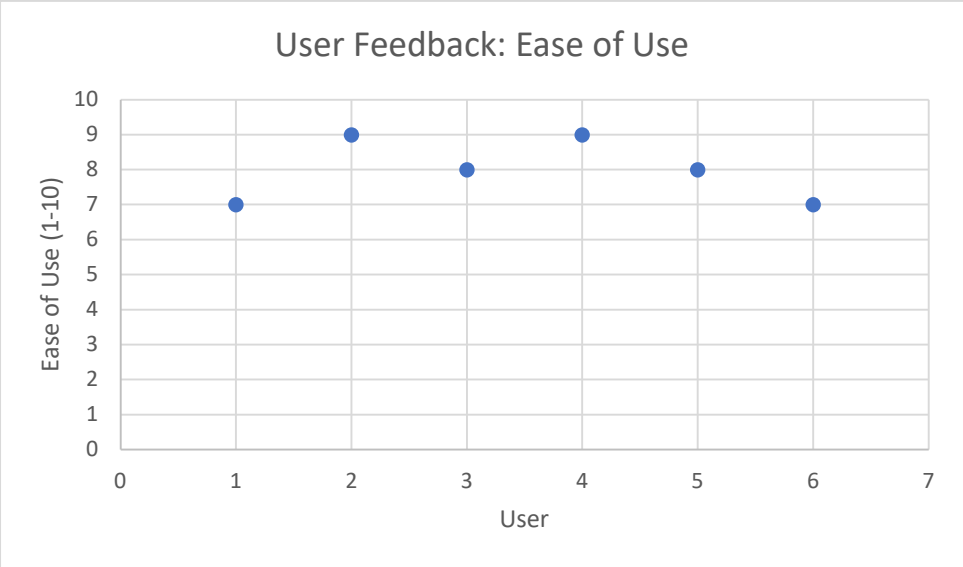
Figure 3. Side Angled view of prototype 3 while clamping

3 Prototyping Test Plan

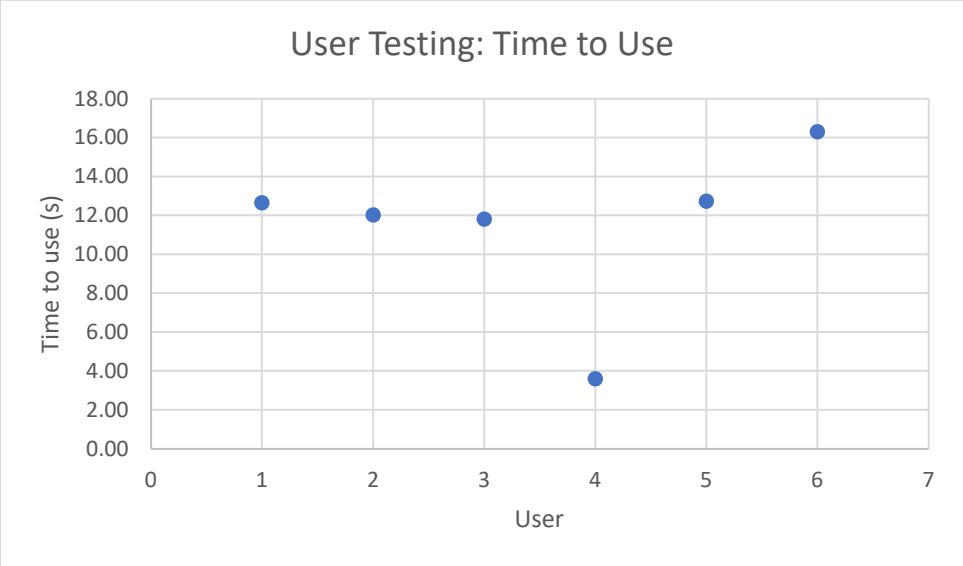
3.1 Prototyping Test Plan

ID	Design Specification	Test Method	Measurement	Number of tests	Timeline
1	Drill can fit into the cavity	A standard drill will be inserted into the drill holes on the guide plates	Boolean: Yes or No (If no what is the margin of error in inches _	1	Thursday , Nov. 24
2	Timed use of jig	Surveyed graduate students will be timed clamping and unclamping the jig	Time (seconds)	2	Thursday , Nov. 24
2	Timed use of jig	Surveyed undergraduate students will be timed clamping and unclamping the jig	Time (seconds)	4	Thursday , Nov. 24
3	Ease of use	individuals will be surveyed on how easy they think the jig is to use	Rating of 0-10	6	Thursday , Nov. 24

3.2 Feedback



Graph 1: User Feedback: Ease of Use



Graph 2: User Testing: Timed Use of Jig

3.3 Analysis

Upon evaluation of user feedback and time measurements, a noticeable improvement in the prototype's efficiency becomes evident. The recorded times, ranging from an impressive three seconds to 16.30 seconds, provide concrete data on the prototype's usability. Notably, the average time has seen a significant reduction from the previous testing phase – nearly halving

the recorded durations from Prototype 2. Users, including undergraduates and master's students, expressed positive sentiments about usability, praising features like the reversible design and user-friendly clamps. Suggestions for future improvements, such as in the long-term, incorporating an automated clamp feature with the use of artificial intelligence or technology and, applying lubrication for smoother operation of twistable clamps, offer valuable insights for ongoing enhancements. The combination of quantitative and qualitative data underscores the positive trajectory of the prototype's development.

3.4 Results

The outcomes of user testing, supported by quantitative data, highlight a notable improvement in the prototype's usability. Recorded times, with the fastest at approximately three seconds, demonstrate a tangible and significant reduction compared to previous testing. The average ease-of-use rating of 8, derived from user evaluations, aligns with the quantitative data, indicating a positive and consistent user experience. User-specific feedback, including suggestions for lubrication, adds depth to the interpretation of the data and will be implemented on Design Day. As we progress, these results, backed by both quantitative and qualitative insights, serve as a robust foundation for refining the design and ensuring continued alignment with user expectations and project objectives.

4 Updated Specs

4.1 Updated BOM

Product	**Cost (CAD)**	**Qty**	**Reason for selection**	**Link**
Foam sheets	4	1	Thin material allows for cushioning to protect veneer from any sharp edges or harsh pressure without compromising seal and attachment to door.	*Link not available, sheets purchased at Dollarama for price listed
2-1/2 in. 3-Way C-Clamp	9.99	2	Holds wood, metal and other materials in place.	https://www.princessauto.com/en/2-1-2-in-3-way-c-clamp/product/PA0008968505
24 Gauge Galvanized Cold-Rolled	29.99	1	Ideal for general-purpose fabricating and machining, Cold rolling increases strength and produces a	https://www.princessauto.com/en/24-x-48-in-24-gauge-galvanized-cold-rolled-steel-sheet/product/PA0009055062

Steel Sheet			smooth surface. Galvanized finish for corrosion resistance. All-steel construction for long-lasting durability.	
Filament	15.15	447g	Material was selected due to simplicity of accurate representation, cost effectiveness and availability.	*None
ABP A4-70 bolt	1.1	4	Facilitate rotation and replacement of hinges, as necessary.	*None
Total	**73.52**			
Total (real)	**39.13**			

It is important to highlight that costs that have been identified in red are hypothetical. These materials were available without specific purchase, this is reflected in the real total cost.

4.2 Updated specifications

In the development of our final prototype, based on learnings from the second iteration, we focused on aligning with our core design goals: ease of use and durability. We identified key areas for improvement; notably, the previous prototypes couldn't support their own weight, leading to a deformable jig casing and overall functional issues. Addressing these, we replaced the sheet metal with 24 gauge cold rolled sheet steel for the jig casing, chosen for its strength and ready availability. For the preset system, we continued with 3D printed plates, appreciating their accessibility and non-interference with the prototype's functionality. Additionally, we've incorporated foam padding around the jig casing. This ensures that clamping doesn't damage delicate wood veneers, enhancing the product's usability and longevity.

4.3 Updated Design Drawing

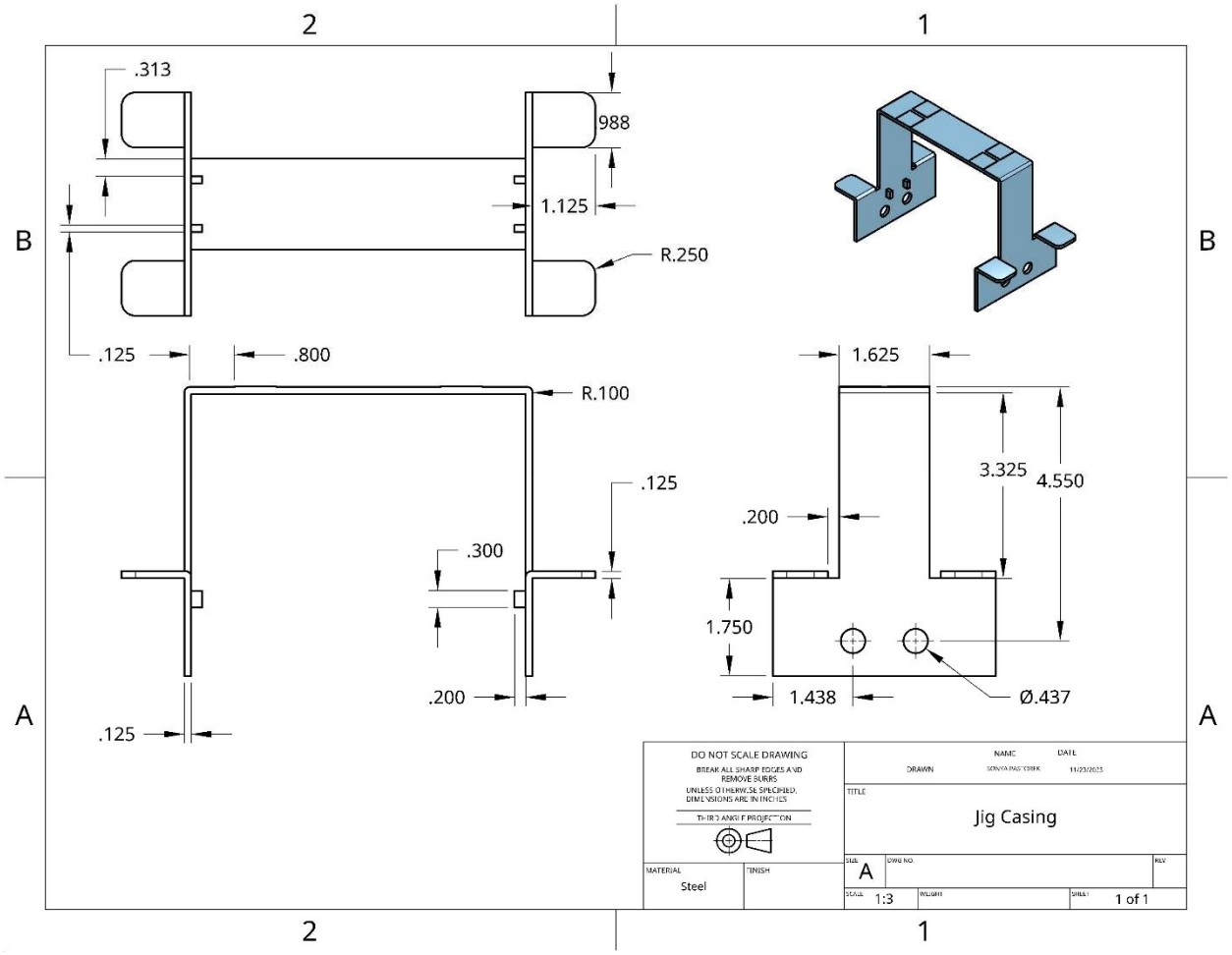


Figure 3 Jig Casing

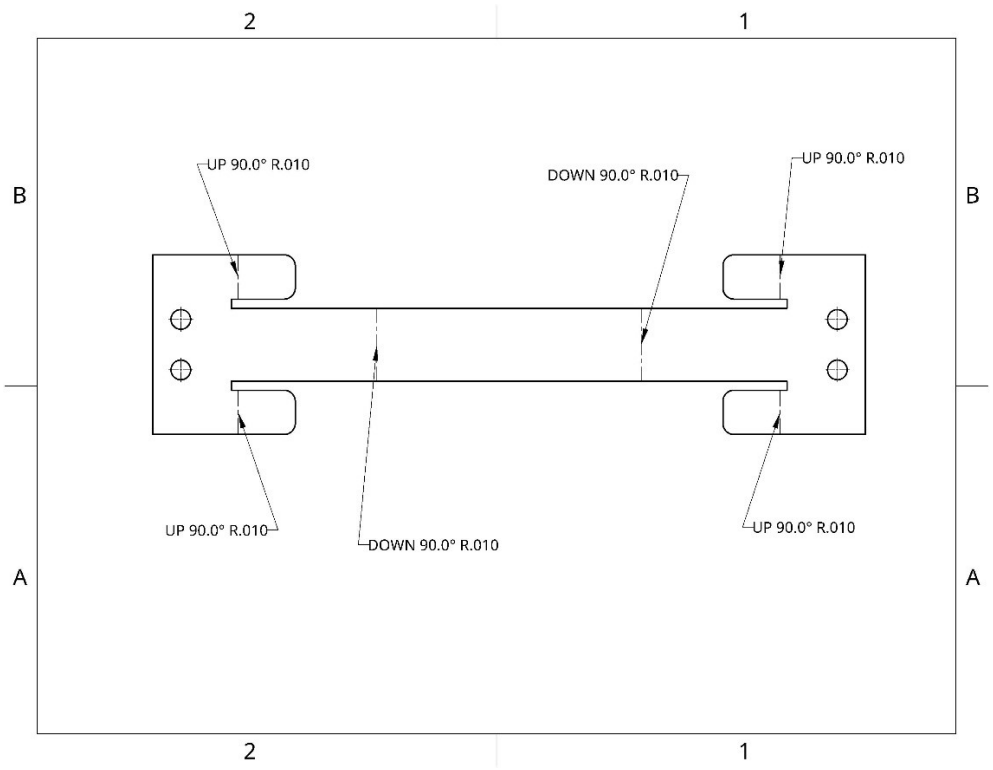

2
1
B
A
UP 90.0° R.010
DOWN 90.0° R.010
UP 90.0° R.010
UP 90.0° R.010
DOWN 90.0° R.010
UP 90.0° R.010

Figure 1 Sheet Metal drawing of casing

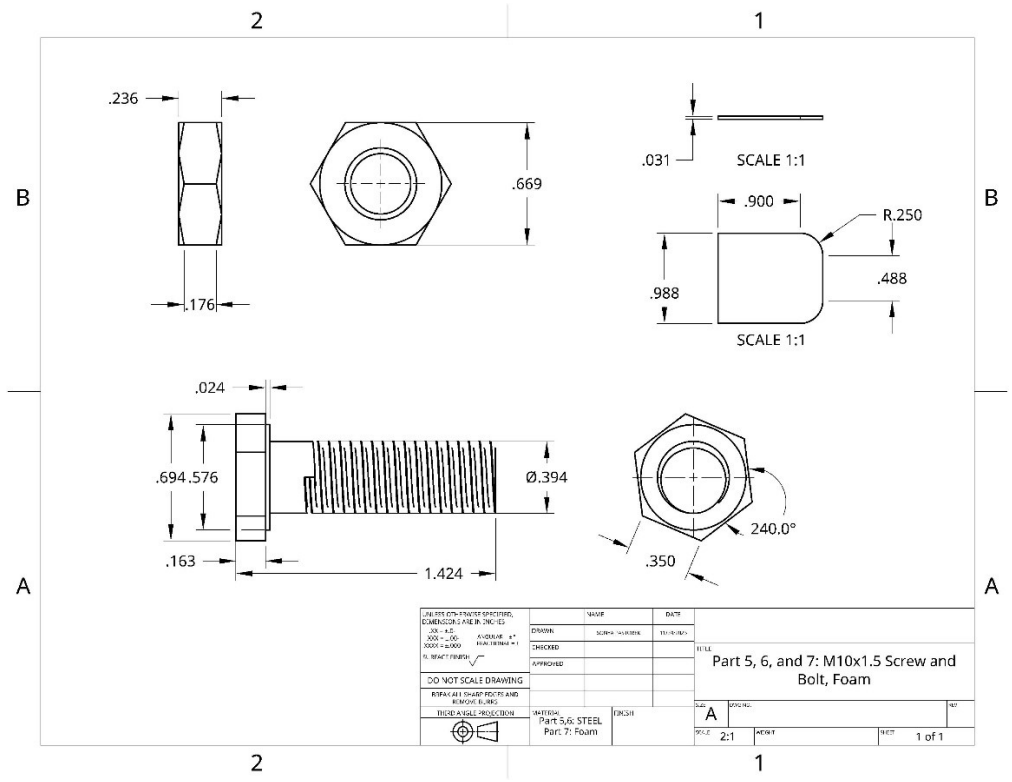


Figure 2 Part 5,6,7

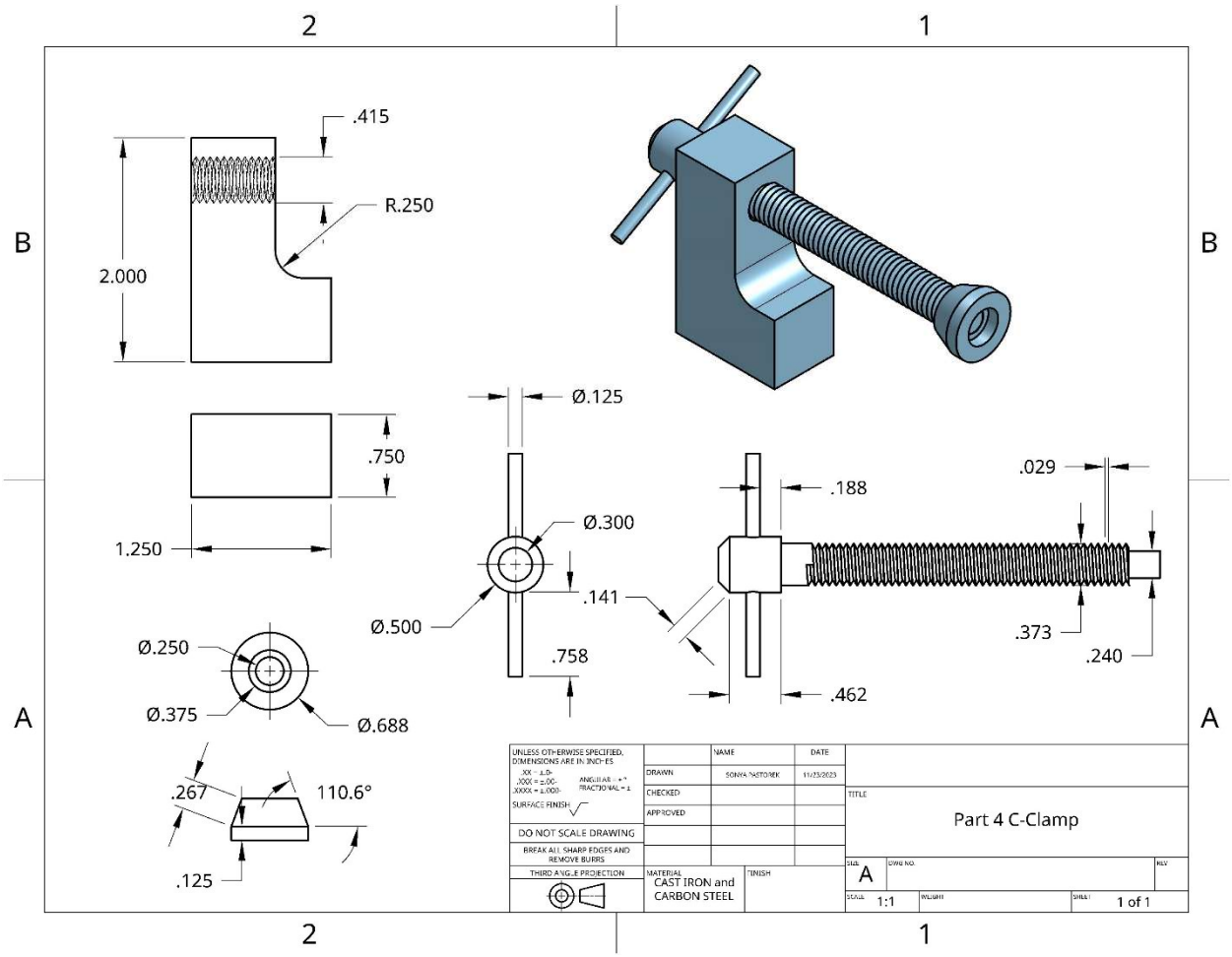


Figure 3. Visualization of C-clamp, it is not an exact recreation of purchased clamp

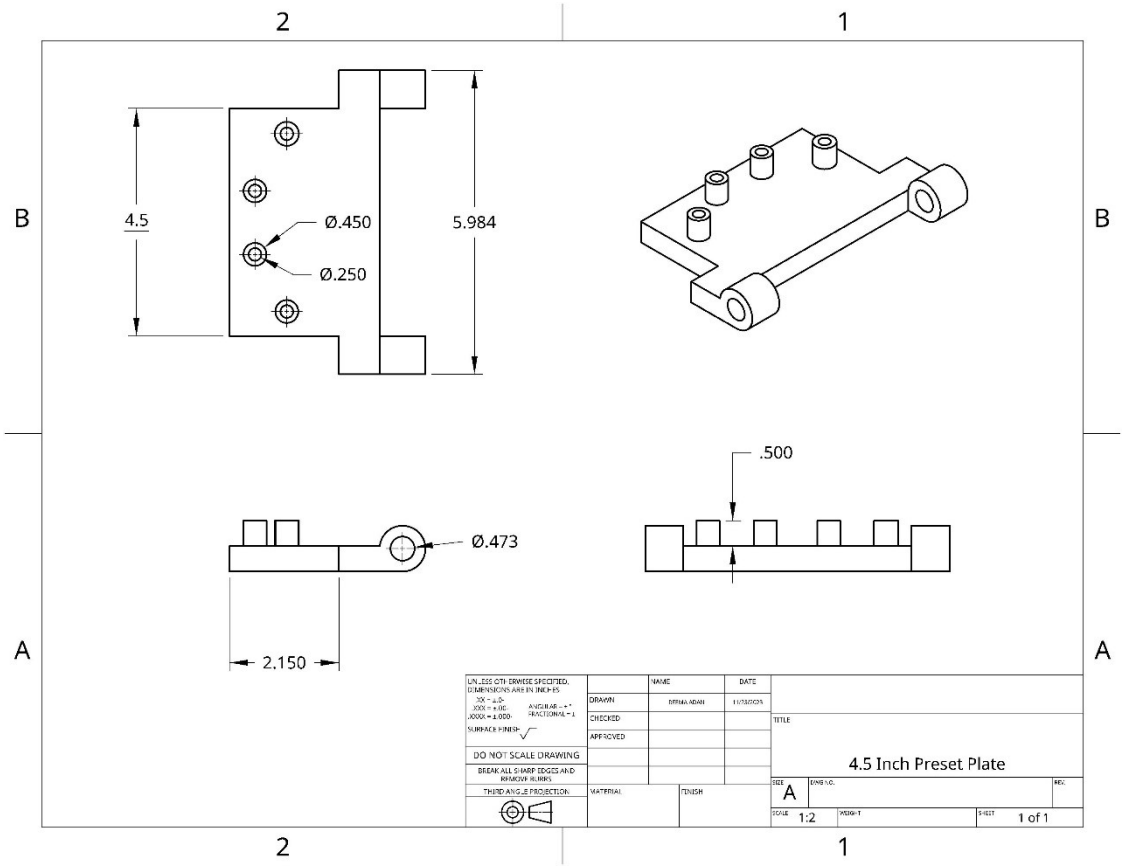


Figure 7.. 4.5 Inch Preset Plate Detailed Drawing

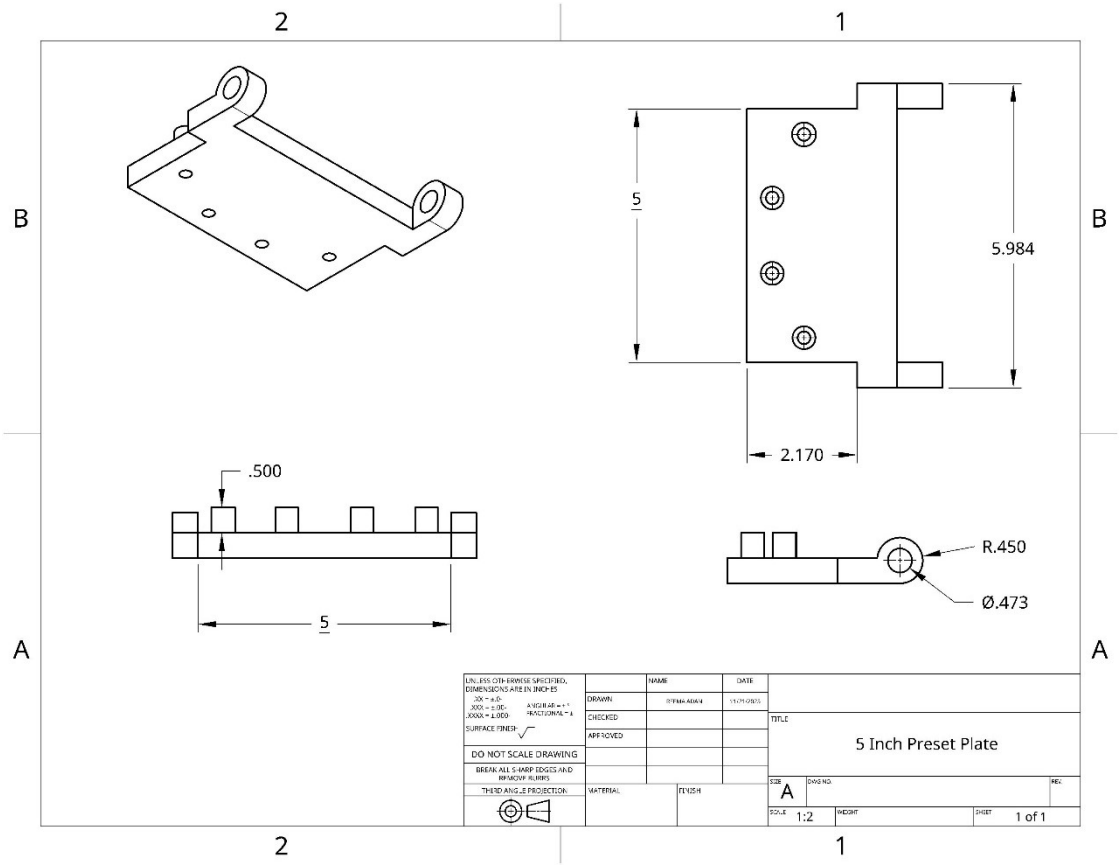


Figure 8. 5 inch plate preset detailed drawing

5 Conclusion

Our design team concludes this phase of prototyping with a sense of accomplishment and a clear plan for further refinements. The substantial reduction in average testing times, nearly halving from the previous iteration, underscores the effectiveness of our design improvements. Positive user feedback, particularly praising the reversible design and user-friendly clamps, aligns with our commitment to creating a solution that resonates with our users. As we integrate valuable insights, such as the application of lubrication on the clamps for easy twistability, we are well-prepared to enhance our prototype's usability even further. These outcomes encourage us to present ourselves with confidence. We are excited to demonstrate our final jig on Design Day, ready to showcase the culmination of our hard work and dedication to creating a user-centric solution.

Wrike Snapshot:
https://www.wrike.com/frontend/ganttchart/index.html?snapshotId=HRgNtON1a6J4bnQPqiOUqJEZRhO2TURc%7CIE2DSNZVHA2DELSTGIYA