GNG 1103-B

Design Project User and Product Manual

Getting' Jiggy Wit It Concept and Care Guide

Submitted by:

Getting' Jiggy Wit It – Group 5

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Table 1. Acronyms

Acronym	Definition
UPM	User and Product Manual
PPE	Personal Protective Equipment
EID	(Equivalent Identification Number) Items under the same number are intended for the same use
Qty	Quantity
BOM	Bill of Materials

Table 2. Glossary

Term	Acronym	Definition
Bushings		Referring to the stop collars on the plates
Preset(s)		Referring to the hinge plates on either side of the jig.

1 Introduction

This User and Product Manual (UPM) provides the information necessary to guide users, particularly workshop technicians, DIY enthusiasts, and carpenters, with the knowledge needed to efficiently and safely operate the 2-in-1 door hinge jig. The 2-in-1 Door Hinge Jig is crafted for one-handed use, providing a cost-effective solution with versatile preset options for both 4 by 4 and 5 by 5 door sizes. This document assumes a basic familiarity with workshop tools and practices and outlines essential safety considerations for a seamless user experience. It is a resource for individuals seeking a streamlined approach to door hinge installations, offering step-by-step guidance and insightful tips for optimal results.

Explore the functionalities of the 2-in-1 Door Hinge Jig, from basic operations to advanced techniques, unlocking a new dimension in precision drilling. This document highlights getting started: a brief introduction to the jig's features, an in-depth exploration of subfunctions for use, troubleshooting and support as guidance for overcoming challenges, and testing and validation to ensure effective operation.

Safety is paramount. Thoroughly inspect the jig before operation, avoiding any visible defects. Adhere to weight limits, prioritize one-handed use, and refrain from modifications for your safety. Commercial replication requires permission. Our commitment is to your safety and success in using the 2-in-1 jig.

2 Overview

The 2-in-1 Door Hinge Jig addresses the critical need for precision in drilling holes onto doors, ensuring straight perpendicular holes, and streamlining operations in a workshop environment. By consolidating all subfunctions into a single jig, the design eliminates the risk of missing parts common in scenarios where components are removable. This innovation not only enhances efficiency but also provides a reliable and comprehensive solution for workshop tasks. The fundamental needs of users are met through the jig's support for two presets—one for a 4x4 guide and another for a 5x5 guide. This product is unique for its one-handed usability, quick installation and use within five minutes, and the efficient 2-in-1 mechanism.

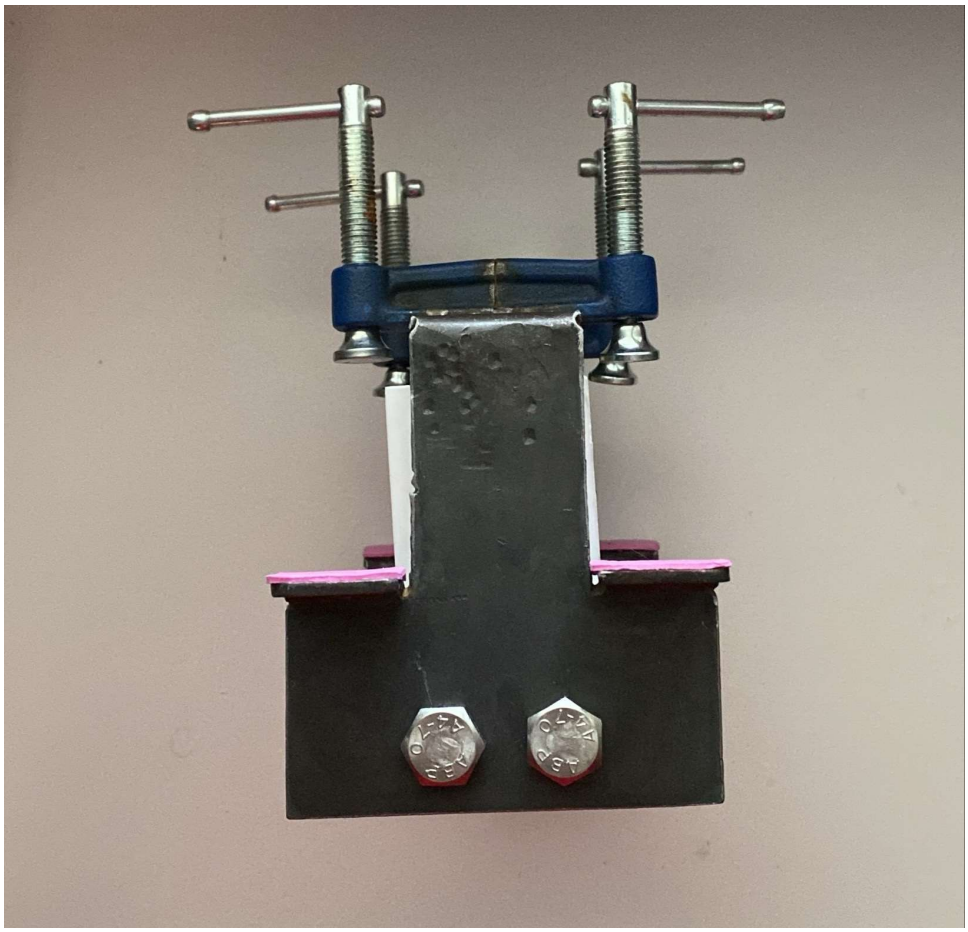

Figure 1. Side view of Hinge Jig

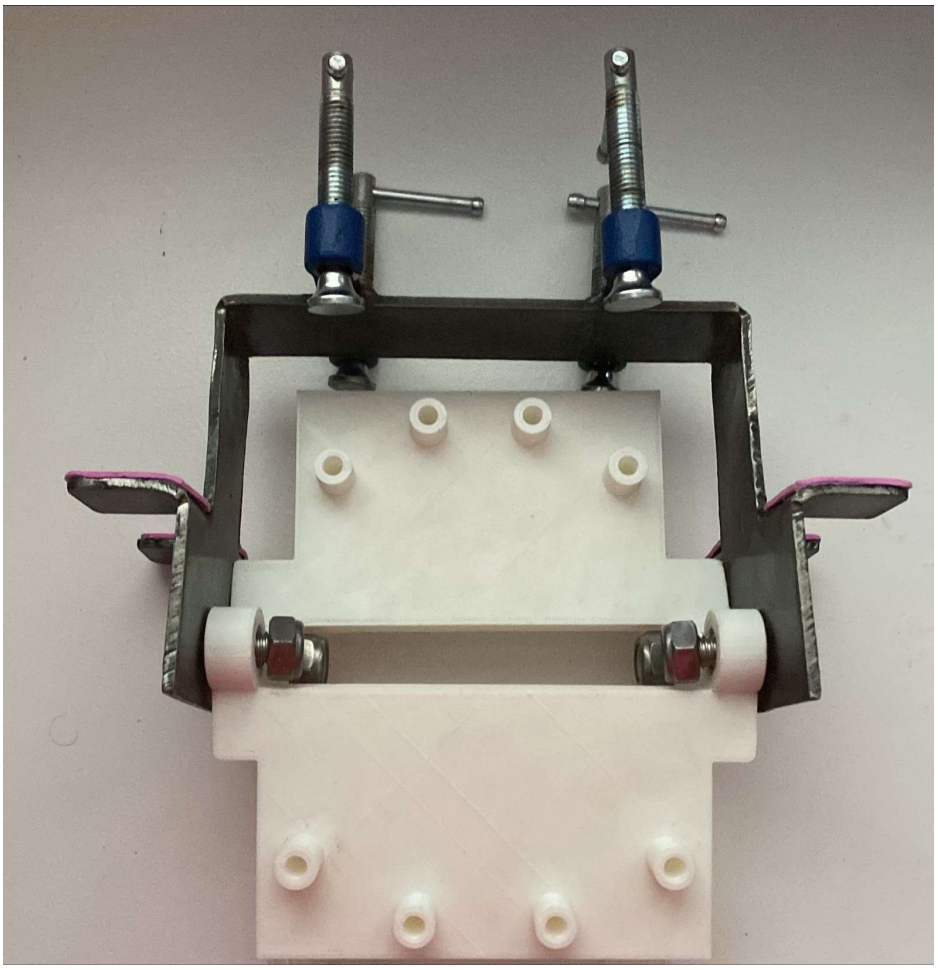

Figure 2. Front view open of Hinge Jig

The jig is a robust solution, transitioning from a 3D Computer-Aided Design (CAD) to a final product with metal screw clamps, a durable jig casing, and bolts. It started as a concept in 3D CAD and evolved through various prototyping stages, including cardboard and 3D printing, culminating in a predominantly metal jig. The construction emphasizes sturdiness and longevity, incorporating features like metal components and rubber padding to prevent door veneer damage.

The jig's user access mode prioritizes simplicity over complexity, avoiding intricate controls or digital interfaces. Instead, it offers a hands-on, practical approach to door hinge installations. This straightforward design aligns with user-centric principles, making the jig accessible to a broad audience. The manual operation ensures ease of use without the need for specialized training or technical expertise.

2.1 Conventions

To ensure clarity, the term "*Download*" within this manual signifies that users should open the referenced document from the designated table. This convention is employed to guide users through the document, facilitating easy access to the relevant information

2.2 Cautions & Warnings

Prioritize safety with these essential guidelines to ensure a secure and efficient experience while operating the 2-in-1 Door Hinge Jig. From proper tool compatibility to workspace stability, these precautions aim to safeguard both the user and the integrity of the jig.

- **Safety First:** Use appropriate safety gear, such as safety glasses and gloves, during the drilling process to prevent any potential injuries.
- **Stable Workspace:** Ensure you are working on a stable and flat surface. Avoid using the jig on uneven or slippery surfaces to maintain stability and prevent accidents.
- **Compatible Tools:** Only use drills and accessories that are compatible with the jig. Using improper tools may result in inaccurate drilling or damage to the jig.
- **Readiness Check:** Before each use, inspect the jig for any visible damage, dents, or sharp edges on the casing. If any issues are found, refrain from using the jig until necessary repairs are made.
- **Permissions and Waivers:** In a professional or shared workshop setting, ensure that you have the necessary permissions and waivers to use the jig. This helps maintain a safe and compliant working environment.
- **Regular Maintenance:** Keep the jig well-maintained by regularly lubricating moving parts. Replace any worn-out components promptly to ensure optimal performance.

3 Getting started

Before starting, make sure all necessary tools are available and in place for use and that the jig is configured properly, as in all clamps are fully opened, and the bolts are loosened to make the plates easy to manipulate open and closed, but not overly loose as the let the plates fall out of any position they are set into. When using the jig to drill or tap holes, be sure to wear personal protective equipment (PPE), such as goggles, gloves, and steel toed boots.

3.1 Configuration Considerations

Before beginning, make sure to assemble all separated pieces of the jig featured on the equipment list below.

Equipment:

- Jig casing with attached clamps
- Bolts
- 4.5 Inch Preset Plate
- 5 Inch Preset Plate

Tools:

- Wrench
- Lubricant

Align the holes in the knuckles of the preset plate, with the holes in the side walls of the jig casing. Next, insert the bolts, one side at a time, and tighten with a wrench so that you have the desired manoeuverability of your preset plates. Test your clamps to assure ease of use. If they are difficult to turn, add a small amount of lubricant until they have the desired amount of slip.

3.2 User Access Considerations

This product specifically targets the labourers who work in Ambico's workshop preparing custom doors for their clientele, to streamline the preparation process.

3.3 Accessing/setting up the System

When beginning use of the device, make sure that the flat side of the desired plate is facing the door. Then be sure to grasp it underhanded, with four fingers in between the hinge knuckles, and the thumb on top of the casing, between the clamps. Next, place the jig against the door, so that the flat side of the plate fits snugly inside the routed hole, and that the jig casing is flush to the door. Next, turn the clamps clockwise to secure the jig to the door tightly.

3.4 System Organization & Navigation

The product is comprised of the jig casing and the two preset plates. The jig casing will have 4 clamps welded to the top wall, and holes in the side wall for articulation with the plates, which are attached by bolts.

The product, once assembled is one single piece, that is double sided so as to facilitate ease of use and ease of transition between requirements.

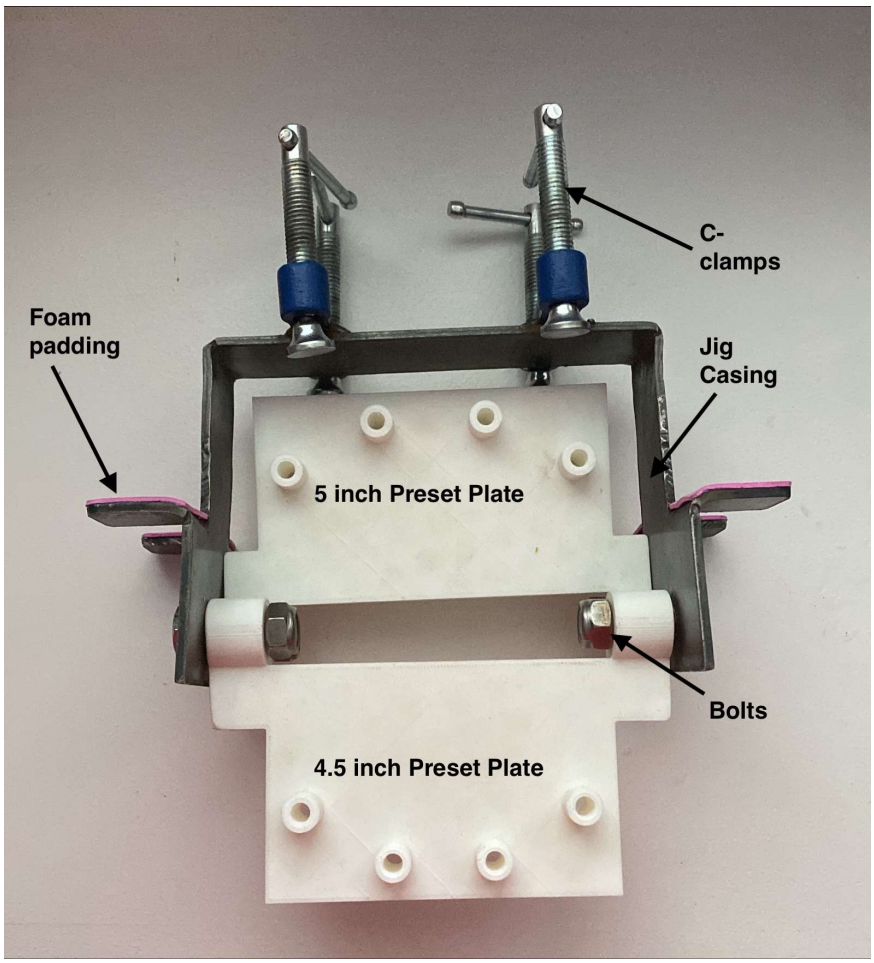

Figure 3 Parts of Prototype

3.5 Exiting the System

To disengage use of the product, close the jig by lifting the lowered preset plate so the stop collars are inside the jig casing walls, parallel to the plate that was just in use. Then, turn the clamps counter-clockwise while supporting the jig, to release pressure on the door.

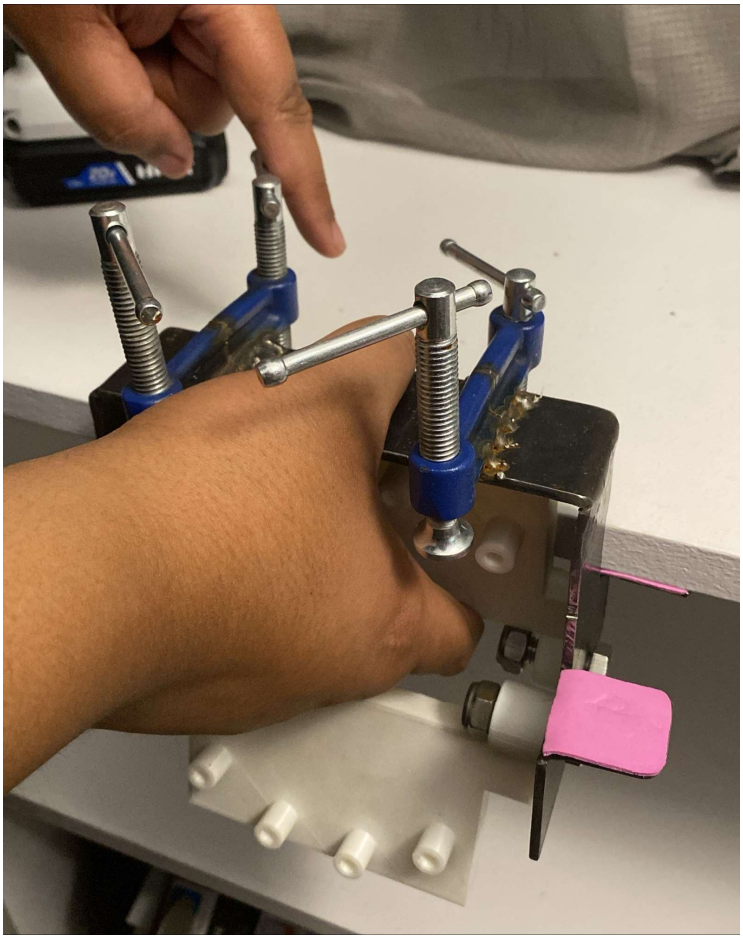

Figure 4 Rotating the c-clamps counter-clockwise to release pressure and remove jig

Figure 5 Removing loosened jig from the wood by sliding it off perpendicularly

4 Using the System

The following sub-sections provide detailed, step-by-step instructions on how to use the various functions or features of the Gettin' Jiggy Wit It double sided adjustable door hinge drilling guide.

4.1 Hinge Presets

The product's frame holds two hinge presets, one side has the requirements for the 4.5 by 5-inch hinge while the other side has the requirements of the 4.5 by 4.5-inch hinge.

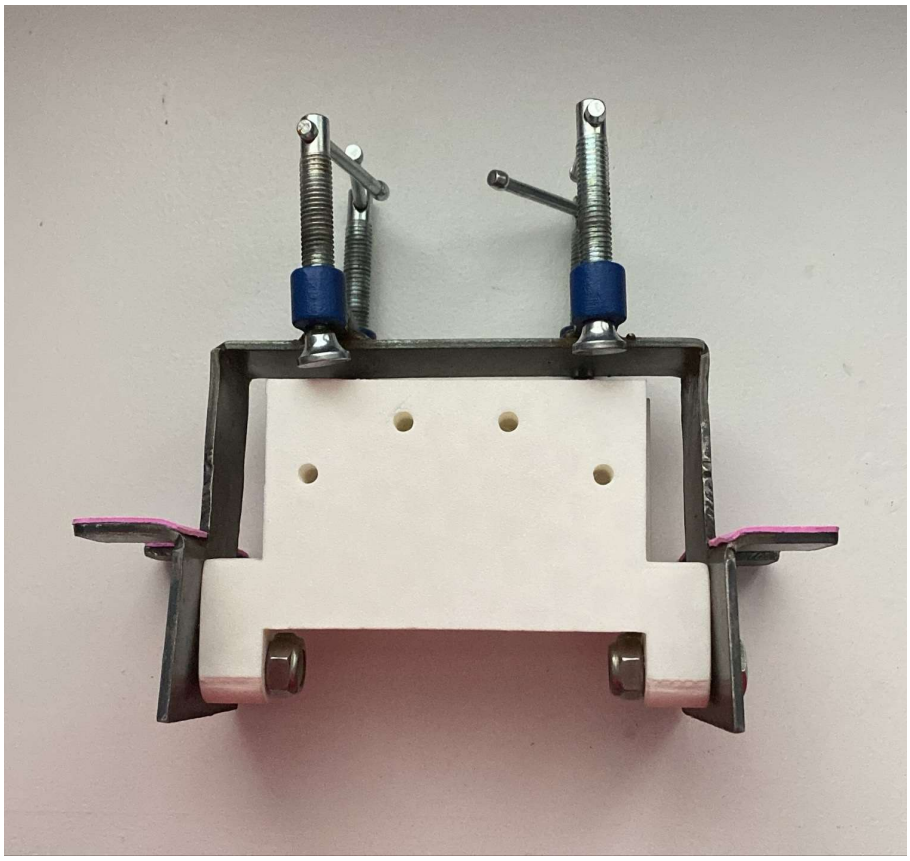

Figure 6 Closed Jig, 4.5 inch preset plate front view.

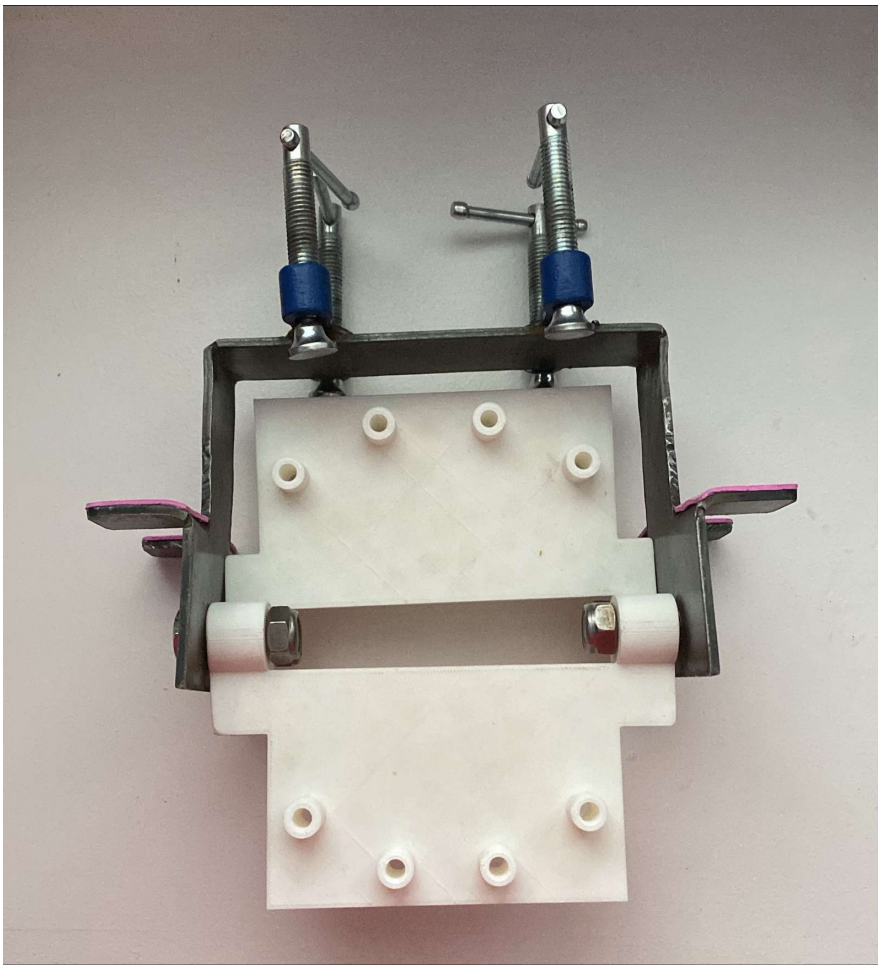

Figure 7 Open Jig, lowered 4.5 inch preset view. 5 inch preset in use.

To use, raise the preset with the desired requirements completely upward. Bring the opposite present is all the way down (see figure_ above). Slide the preset into the door's backset, the lower support paddles provide the opposing force on the bottom door face.

4.2 Screw Clamping System

The product is equipped with two clamps holding two screws each (see figure below).

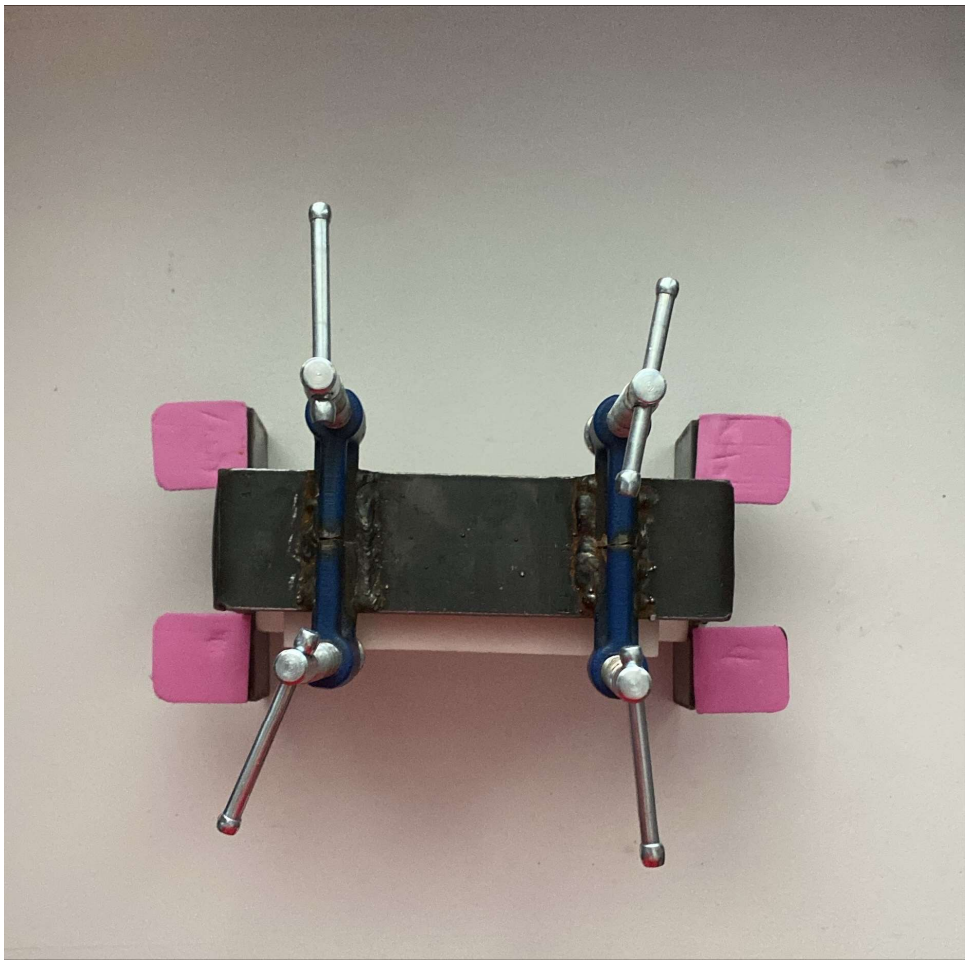

Figure 8 Top View of Jig

To fasten the product, manually adjust the screws directly above the preset with desired requirements once it is in the door backset. Tighten the screws until the feet touch the door with the desired strength (see figure below), the drilling guide should be able to support its own weight when this step is complete. and quickly adjusted to the desired strength using a button, and they support the hinge well no matter which side is being used.

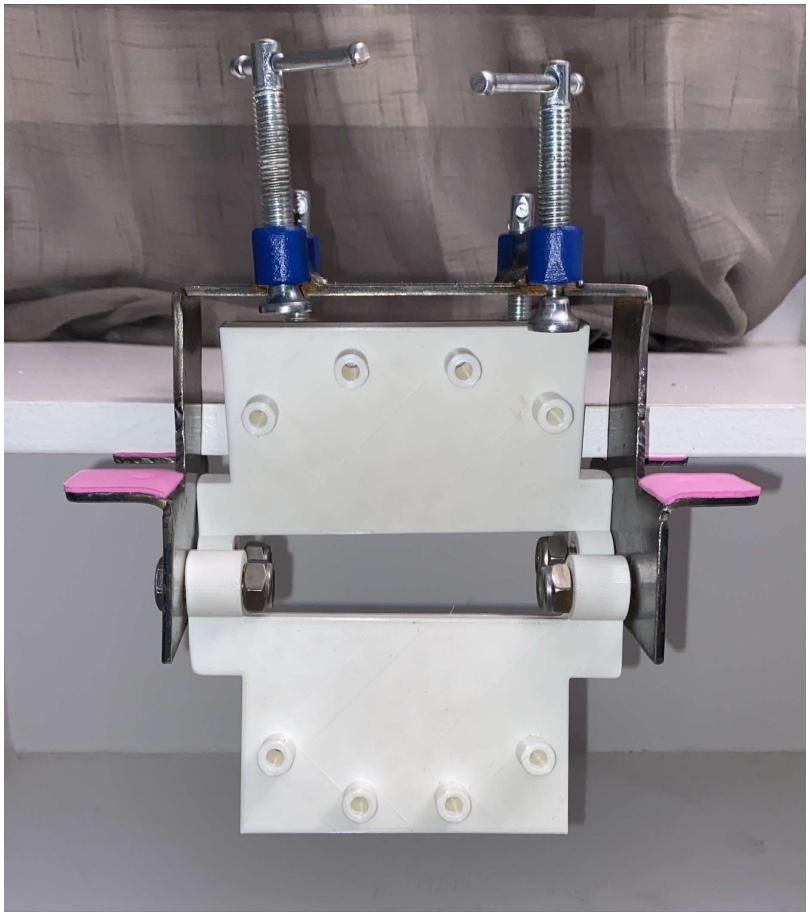

Figure 9 Front View clamped jig, 4.5 inch plate lowered, 5 inch preset in use.

4.3 Angle of Entry Control

The levelling system includes hardened steel bushing around the holes of the hinge presets that ensure the drill remains straight and perpendicular (figure). Only a straight drill can properly insert into the holes and drill into the door. When the drilling guide has been fastened to the door as desired, drill as per usual directly into the holes with a 7/32” drill bit.

5 Troubleshooting & Support

5.1 Error Messages or Behaviors

Table 3 Behaviour and Corrections

Behavior	Steps to Correct
Drilling guides not opening/closing	- Check for obstructions both in the pre routed hole, and within the jig assembly itself. Remove if any, if not, continue to troubleshoot. - Ensure hardware (nut and bolt assembly) is well lubricated. If not, an oil-based, bearing lubricant is recommended. - Ensure the guide housing has no visual deformities that might lead to an obstruction. This could occur if the assembly is dropped from a height or if it.
Clamps not opening/closing	- Check for obstructions both on the surface of the door and on the clamping mechanism. Remove if any, if not, continue to troubleshoot. - Ensure the clamping mechanism is well lubricated. If not, an oil-based, bearing lubricant is recommended.

5.2 Special Considerations

If a drilling guide becomes damaged it can easily be replaced. Using two 7/16’ wrenches locate the nylock nut and bolt on either side of the drilling guide you’d like to replace. Holding the bolt with one wrench, loosen the nylock nut until it comes loose. Repeat on the other side and replace the drilling guide.

The process can be repeated in reverse to re-install the drilling guide. First ensure the drilling guide is oriented properly. The bushings should be facing into the center of the device. Then, re insert the bolt through the assembly and into the drilling guide. Using both wrenches again secure one to the bolt and tighten the nut with the other.

5.3 Maintenance

After every use it is important to clear the bushings and jig body of any wood shavings dislodged in the drilling process. In most cases these can simply be swept away with your finger, for smaller debris a brush might be preferred

To keep the jig in proper working condition. The nut and bolt assemblies will need to remain lubricated. With regular use, we recommend oiling this assembly once every two weeks. An oil-based bearing lubricant has proven to be best in maintaining proper movement of the components. However, it might tend to attract dirt. Best practices here would include ensuring any extra lubricant is wiped away after application.

5.4 Support

Throughout the expected life of this jig, we are here for your support. Please feel free to contact us at *Let's Get Jiggy Inc.* With any questions or concerns regarding either the manufacturing of your jig, or its regular use and maintenance. We would love your thoughts on improving our process for you and our other customers. Should anything come up, send us an email and we will get back to you within 3-5 business days to either suggest a solution or setup a call for more information.

Technical questions or concerns: spast056@uottawa.ca
Repair and manufacturing questions or concerns: njord026@uottawa.ca

However, should you need **emergency assistance** please do not hesitate to contact 911 or your local emergency service providers.

6 Product Documentation

The final prototype was designed to follow Ambico's requirements and constraints as described in the Maker repo posting. The following section will describe the manufacturing process of the final prototype and include recommended adjustments to processes or materials where applicable. Most dimensions are adjustable; however, the measurements for the hole patterns and back sets were provided by Ambico and remained constant.

The final prototype was built upon an iterative process of updates. For this reason, there were many adjustments made to the design including the shape of the body, clamps, and presets. Most notably, the first prototype had a rod to attach the preset plates to the jig body; however, it was replaced by bolts to minimize bulk and allow easy replacement and maintenance of the preset plates. Additionally, due to time and material constraints, the group had to settle on the use of C-clamps as the main clamping mechanism. To improve ease of use a spring clamp or one-handed clamp is more favourable. Exploring clamping options would be a valuable addition to the design. A model of Prototype 3 was built using Onshape; however, the clamps are of different shape as the clamps of prototype 3 were purchased and not fabricated from the CAD file itself.

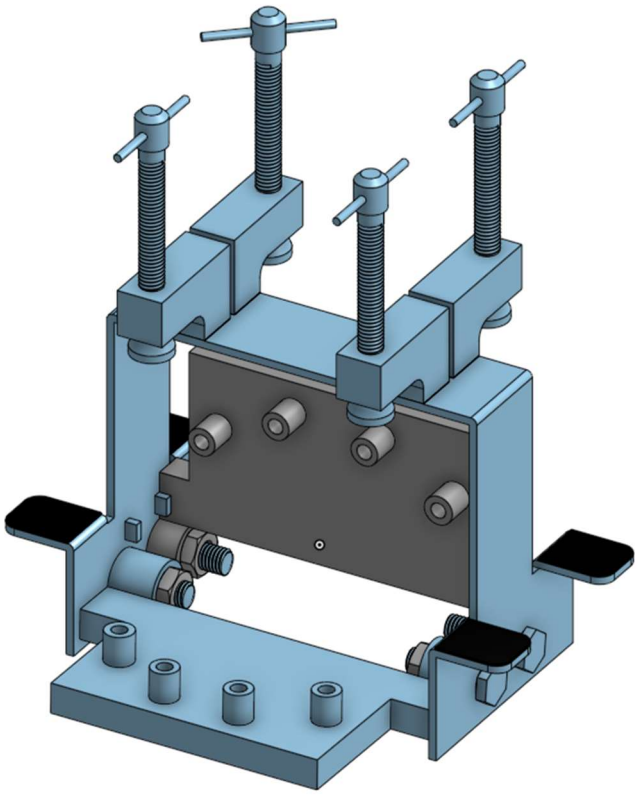

Figure 10 Assembly of final prototype (prototype 3)

Table 4 List of Parts

Part #	Part	Sourcing
1	Jig Body	Plasma-cut
2	4.5 in. Preset Plate	3D Print
3	5 in. Preset Plate	3D Print
4	C-Clamp	Purchase
5	ABP A4-70 bolt	Purchase
6	ABP A4-70 nut	Purchase
7	Foam Padding	Purchase

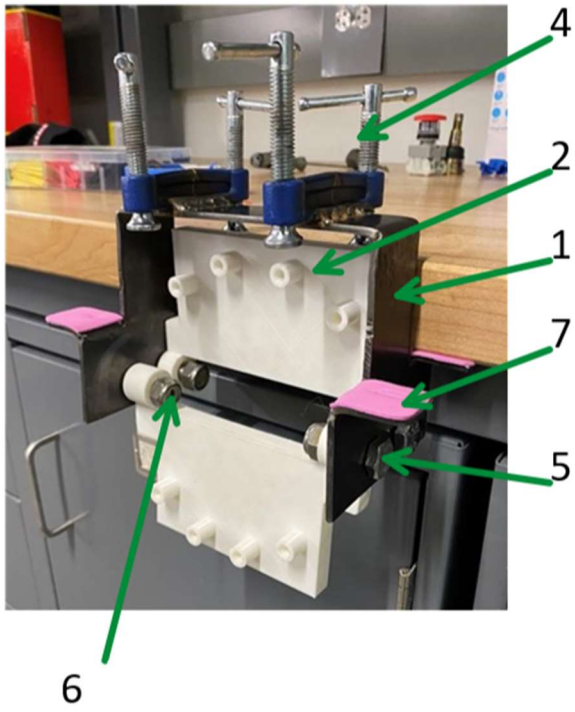

Figure 11 Annotated Jig sourcing diagram

6.1.1 BOM

Table 5 Comprehensive BOM of Final Prototype

EIN	Material	Unit Cost	Qty	Extended cost	Source/Link
1	24 Gauge Galvanized Cold-Rolled Steel Sheet	$29	1	$29	https://www.princessauto.com/en/2 4-x-48-in-24-gauge-galvanized-coldrolled-steelsheet/product/PA0009055062
2	Foam sheets	$4	1	$4	Dollarama
3	PLA Filament	$15	447g	$15	N/A
4	2-1/2 in. 3-Way C-Clamp	$9	2	$18	https://www.princessauto.com/en/2 -1-2-in-3-way-cclamp/product/PA0008968505
5	ABP A4-70 bolt	$1	4	$4	N/A
Total Cost				$74	

Table 6 Adjusted BOM For Final Product

EID	Material	Qty	Extended cost	Source/Link
1	Steel sheet	1	$29	https://www.canadiantire.ca/en/pdp/steelworks-weldable-steel-sheet-16-gauge-assorted-sizes 0616149p.0616250.html?rrecName=Similar%20Items%20&rrecReferrer= product&rrecProductId=0616149P&rrec ProductSlot=1&rrecSchemeId=product1_rr&rrec=true
2	EPDM Commercial Grade 60A Rubber Sheet	1	$4	https://www.homedepot.com/p/Rubber-Cal-EPDM-1-16-in-x-36-in-x-288-in-Commercial-Grade-60A-Rubber-Sheet-Black-20-109-0062-36-288/303366665
4	2-1/2 in. 3-Way C-Clamp	2	$18	https://www.princessauto.com/en/2 -1-2-in-3-way-cclamp/product/PA0008968505
5	ABP A4-70 bolt	4	$4	N/A
6	Press-Fit Drill Bushings	8	$42	https://www.mcmaster.com/96511A796/
Total Cost			$88	

6.1.2 Comprehensive List of Equipment:

- Plasma Cutter
- 3d printer (Ultimaker 2+)
- Sheet metal Bender
- Metal Saw
- MIG welder
- Needle Nose Plyers
- Sandpaper
- Grinder
- Scissors
- Adhesive

6.1.3 List of Software Used:

- Onshape

- Ultimaker Cura 5.5.0

6.2 Jig Body

The body of the jig is the main support system and base of the design. Multiple measurements need to be considered when designing the body. Firstly, the width of the body is larger than the hinge specifications to ensure a drill would be able to fit inside of the cavity and reach the preset plate on the other side to drill into the door. Due to the width, the knuckle of the plate presets was placed on the left and rightmost edge and widened so that it touches the internal walls of the jig and prevents sliding. The height of the body is also elongated to ensure adequate clearance for the preset plate as it rotates. The difference in height from the paddle to the top considers back set sizes and the overhang of the clamps. The holes on the jig are used to screw the knuckle of the preset plates on to the jig. They are calculated to ensure the preset plates sit inside of the pre-routed hole at 3/16-in deep and that the edge of the jig just touches the door. Ideally, two metal pieces acting as stoppers would be welded on the inside walls of the jig. These would prevent the preset plate from rotating inward and keep the plate perpendicular as a worker drill. Due to time constraints, they were not included in the final prototype. The Jig design includes stationary bottom pads which provide the opposite clamping force to the c-clamp.

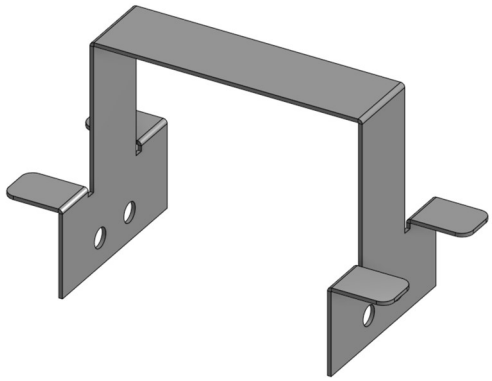

Figure 12 Jig Body

6.2.1 Materials

- 24 Gauge Galvanized Cold-Rolled Steel Sheet
- Foam sheets
- Onshape

Galvanized steel is ideal for the body of the jig due to its use for general-purpose fabricating and machining. Cold rolling increases its strength and produces a smooth surface, the galvanized

finish is ideal for corrosion resistance, and an all-steel construction provides long-lasting durability. It is also considered appropriate for the factory working conditions. Nonetheless, galvanized steel is heavy so exploration of other lighter materials that are also durable should be explored. For example, the second prototype used an aluminum-based sheet metal. This was effective but was prone to bending and could lead to inaccuracies.

The foam is added to the supporting pads on the jig body to protect the veneer on the door from scratching or damage. Foam provides an extra cushion and a barrier between the wood and metal of the jig. Foam was chosen due to time constraints so a better alternative would EPDM Commercial Grade 60A Rubber Sheet or Natural rubber. Natural Rubber is compressible, elastic, flexible and durable and is feasible for an industrial environment. Commercial-grade rubber EPDM materials work great as an outdoor liner or pad, are made of high-quality EPDM rubber for long-lasting use, and are oil- and weather-resistant so easy to maintain.

6.2.2 Equipment List

- Plasma cutter
- Grinder
- Scissors
- Adhesive

6.2.3 Instructions

1) OPEN and DOWNLOAD the document: Flat Sheet Metal Body Drawing.dxf
2) Use a plasma cutter to cut out the shape of the jig body into the steel sheet metal (using the drawing as a template)
3) Use a sheet metal bender to bend the sheet metal to the specifications described in the document
4) Grind any rough edges of the body until smooth
5) Mark and cut the sheet of foam to the dimensions of Part 7 in the image below. Do this 4 times

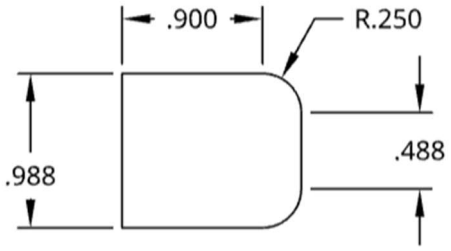

Figure 13 Part 7: Foam cushion dimensions

6) Use the adhesive to attach the pieces of foam to the top surface of the paddle of the steel body. As shown on Figure 10.

6.3 Preset Plates

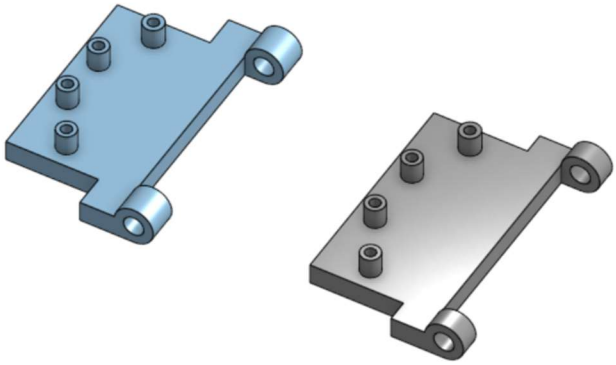

Figure 14 Preset Plates

6.3.1 Materials

- PLA Filament
- ABP A4-70 bolt
- Ultimaker Cura (5.5.0)

PLA was selected for the preset plates due to its simplicity, accurate representation, cost-effectiveness, and availability. Any 3-D printed parts were printed using 0.8mm PLA with 20% infill. Despite that, PLA is not very durable or appropriate for factory working conditions. A possible replacement would be steel for durability purposes, but steel may be heavy so other high durability materials should be explored. The presets using steel would be manufactured by machining and the bushings attached separately.

6.3.2 Equipment list

- 3d printer (Ultimaker 2+)
- Needle Nose Plyers
- Sandpaper

6.3.3 Instructions

1) Print the components in the following document using the Ultimater 2+ 3D printer
    a. DOWNLOAD Part 2&3 Preset Plates.stl
2) Use the plyers to remove any debris or clogged holes in the printed plates and sand to remove any rough edges.

6.4 Assembly

6.4.1 Materials

- 2-1/2 in. 3-Way C-Clamp
- ABP A4-70 bolt
- ABP A4-70 nut
- Jig Body
- 4.5 and 5-inch preset plates

6.4.2 Equipment list

- MIG welder
- Metal saw
- Sandpaper

6.4.3 Instructions

1) Use the metal saw to cut the C-clamps horizontally in half. Cut near the top and bottom of the clamp so that the crew mechanism and horizontal rod are preserved, discarding the middle portion.
2) Attach the clamps onto the jig case using a MIG welder. Attach them in the formation shown by the image below:

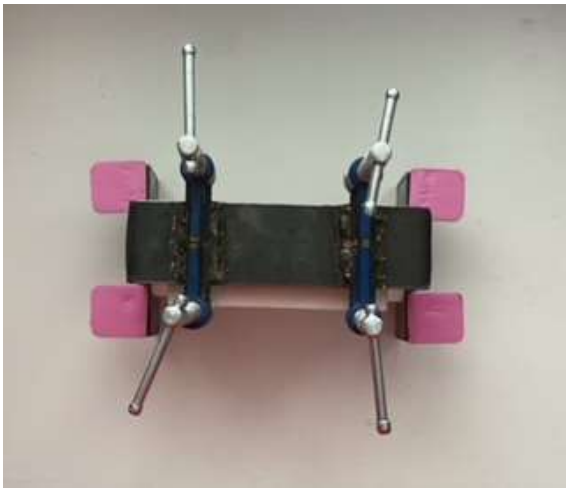

Figure 15 Top view of Prototype 3

3) Attach the plates to the jig body. The bushings should face the center of the body as shown in figure 14 and the holes of the body should align with the hole in the knuckle of the preset.

4) Screw the ABP A4-70 bolt into the hole and tighten it enough so that the preset plate is still able to rotate freely.
5) Do the previous 2 steps for the other preset plate

6.5 Testing & Validation

The testing of prototype 3 focused on functionality and ease of use. The first test included ensuring the ability to drill properly with the prototype. This included inserting a drill into the hole of the presets and ensuring that the drill fit comfortably. This was tested using a pass/fail method. The prototype passed as the drill could easily be inserted into the jig. The second major testing area was ease of use. Ease of use was measured qualitatively and quantitatively. Undergraduate and graduate students were timed clamping and unclamping the jig to analyse the speed at which a worker of varying skill levels would be able to use the clamping system. The results are displayed in the graph below:

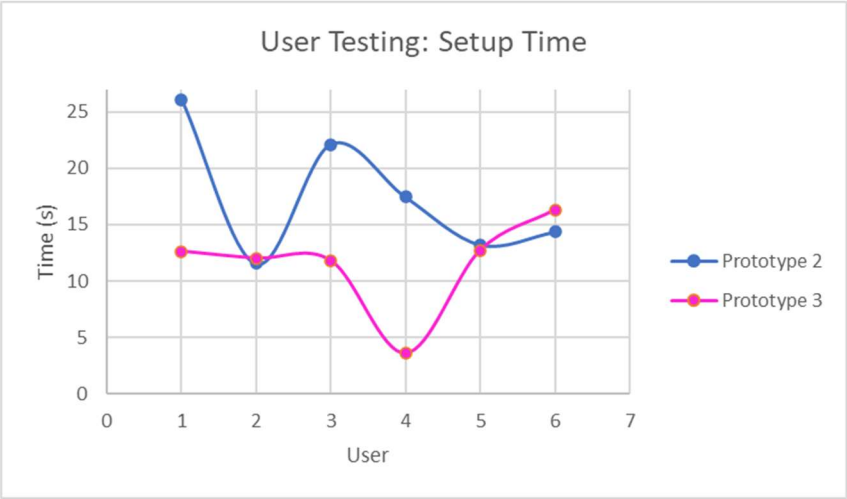

Figure 16 Time to clamp Jig

There is a considerable decrease in the time it takes to clamp the jig between prototype 2 and 3. This is due to sturdier clamps being used and a smother screwing mechanism. The time to install the jig was on average 8 seconds.

The same users were then asked to rate the ease of use of the jig on a scale of 1-10. Their scores are shown in the graph below:

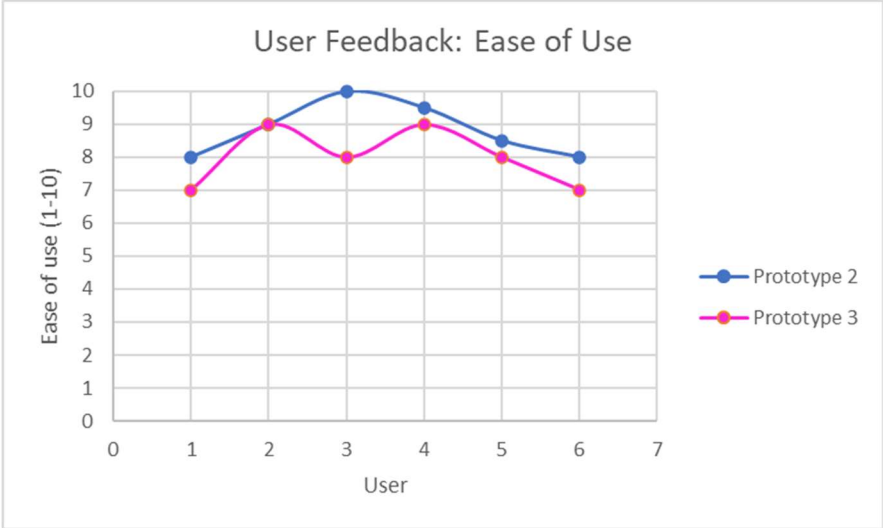

Figure 17 User feedback on Ease of Use

Overall, users 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.

7 Conclusions and Recommendations for Future Work

A feature that was important to us throughout the design process was ensuring the jig was compact and could be used “on the fly” meaning the technician could use our jig without any complex setup or assistance. In doing this we had to keep the case for the drilling guide assembly small. An important consideration that will need to be made when augmenting jig dimensions for even more drilling guide sizes, will be the backset calculations. Our jig as it is now (set for both 4.5’/4.5’ and 4.5’/5’hinges) accommodates all backsets. If in the future the case dimensions are increased to accommodate more hinge sizes, this might need to be re-evaluated.

As well, moving forward we would choose to make the drilling guides themselves out of a stronger material. As it stands the drilling guides are a 3D printed PLA filament with hardened steel bushings pressed in. To increase the structural integrity of our device and prolong the life of our drilling guides, in the future they should be made from a stronger material. Something durable, yet still light. Our recommendation would be 6061 aluminium. This grade of aluminium is light and easy to machine, yet very sturdy. This change would be relatively cost effective as a sheet of aluminum capable of creating 4 drilling guides would only cost $45.

8 Bibliography

Aluminum https://store.buymetal.com/aluminum accessed on December 9, 2023.

APPENDICES

9 APPENDIX I: Design Files

Table 7 Referenced Documents

Document Name	Document Location and/or URL	Issuance Date
Part 2&3 Preset Plates.stl	Maker Repo https://makerepo.com/lcoff038/1869.gettin-jiggy-wit-it	Dec 11 2023
Flat Sheet Metal Body Drawing.dxf	Maker Repo https://makerepo.com/lcoff038/1869.gettin-jiggy-wit-it	Dec 11 2023