GNG 1103

Design Project User and Product Manual

FLUSH BOLT JIG

Submitted by:

Jig Jackpot | Group 10

Samantha Cookson, 300284963

Rachel Ade, 300351087

Sam Delisle, 300299628

Abbygail Martin, 300308338

Amrou Eldeabis, 300268030

Ray Li, 300363073

April 10, 2024

University of Ottawa

Table of Contents

List of Figures

List of Tables

List of Acronyms and Glossary

Table 1. Acronyms

Acronym	Definition
AMBICO	The name of the company associated with the product/ project.
BOM	A list of all raw materials, components, and assemblies needed to manufacture the product.
JIG	helps guide tools and materials when making a flush bolt cut-out, ensuring precise and accurate results
UPM	User and Product manual: A document providing instructions and information for users on how to effectively use a product.

Table 2. Glossary

Term	Definition
AMBICO	The organization for which the Flush Bolt Jig was created, indicating the primary client and end-user of the tool.
Attachable Magnetic Guide	A detachable component of the jig used to fix it at specific distances from the center of the flush bolt cutout.
Backset	The distance from the edge of the cutout to the edge of the door, a crucial measurement for positioning the flush bolt installation accurately.
Backset Guide	An adjustable component of the jig used to change the distance between the edge of the cutout and the edge of the door, accommodating different door sizes.
Baseplate	The foundational component of the Flush Bolt Jig, containing the precise cutout needed for flush bolt prep and integrated clamp system.
Bill of Materials (BOM)	A list detailing all the materials and components required to construct the Flush Bolt Jig prototype, including quantities and unit prices.
Clamping Subsystem	The mechanism integrated into the baseplate for securely fixing it to the door during the routing process.
Design Files	Technical documents containing schematics, CAD drawings, and specifications necessary for producing the Flush bolt jig prototype.

Design Thinking Process	Methodology used for Problem-solving and innovation, involving stages such as empathizing, defining, ideating, prototyping, and testing.
Equipment list	Inventory of tools and machinery needed for Manufacturing the prototype, including alternatives for certain processes.
Flush bolt JIG	A specialized tool designed to streamline the process of routing a cutout for flush bolt installation on wooden doors, reducing time and maintaining accuracy.
MakerRepo	Repository containing design files, technical documentation, and other resources related to the development and manufacturing of the Jig.
Product Documentation	Information detailing the specifications, design, and construction of the Prototype.
Routing Process	Procedure of cutting, trimming, or shaping doors using a router.
Spot Welder	Machine used to join metal parts together by applying heat and pressure to create a weld.
Trouble shooting and support	Section providing guidance on identifying and resolving errors, as well as offering maintenance instructions and contact information for additional support.
Vinyl fabric lining	Material applied to the underside of the jig to protect the door from damage during the routing process.
12” / 24” Guide	Used to determine the distance of the flush bolt cutout from the top of the door.

1 Introduction

1.1 Background of the Report

This User and Product Manual (UPM) provides the information necessary for AMBICO technicians to effectively use the Flush Bolt Jig and for prototype documentation.

This product was created for AMBICO to reduce time in the process of routing a cutout for a flush bolt on a wood door. AMBICO expressed the need for a new solution that saves time, while maintaining accuracy and preventing any damage to the door. They emphasized that the jig should be durable in their factory environment, and extremely user friendly and self-explanatory.

Key assumptions that were made based on AMBICO's presentation, as well as client meeting, include:

- The only door sizes that need to be accommodated are from 1 ¾" to 2 ¾", varying in ¼ inch increments (5 total door thicknesses)
- The technicians will know which door size they are working on when making the flush bolt cut-out.

1.2 Scope of the Report

This document serves to orient users of the system and prepare them for the use of the flush bolt jig. This includes:

- An overview of the problem, and key features of our unique solution
- Conventions used in the product
- A walkthrough of the use of the system
- Detailed description of each feature
- Troubleshooting and support in the event of errors
- Documentation of the construction of the final prototype
- Documentation of tests performed on the final prototype
- Conclusions and recommendations

2 Overview

At AMBICO, the routing of the cutout for flush bolt installation is a time-consuming process due to the current method in which the technician must manually measure and place a template, before tracing with a pencil mark and routing carefully by hand along this mark. This increases time spent on the cut-out and poses a risk to precision.

The main needs of a new solution are for it to be easy to use, self-explanatory, non-damaging to the door, precise (to the 1/32"), and to decrease time in the flush bolt cut-out process.

Figure 1. Jig Jackpot's Solution for AMBICO - Prototype III

As shown in figure 1, some of the key features of our solution include:

- A base plate which contains the precise 6 ¾” by 1” cut-out needed for flush bolt prep.
- An integrated clamp system which uses threaded rivets and padded screw clamps
- An adjustable “back set guide” which changes the distance between the edge of the cut-out and the edge of the door, in order to center the cut-out on various door sizes.
    - Our current design includes doors from 1 ¾” to 2 ¾” in ¼” increments
- Magnetically detachable arms which allow the technician to place the clamp at the appropriate distance from the end of the door.

The jig is made of steel sheet metal, and includes threaded rivets, carriage bolts, rubber clamp pads, wing nuts, and vinyl fabric lining. The back set guide adjusts by containing various rectangular holes that are slid onto pegs on the base plate to create the fixed side of the integrated clamp system.

2.1 Conventions

Certain industry and project specific terms are used in this document, including:

Backset	→	Distance from the edge of the cut out to the edge of the door
12 inch guide/ 24 inch guide	→	Guiding arms which measure 12 or 24 inches from the end of the door to the *center of the cut-out* (the guides themselves are not 12 and 24 inches long)

3 Getting Started

This section provides a general walkthrough of the system from setup through exit. It also explains the general setup of the system and how all the components work together.

3.1 Configuration Considerations

The design has four subsystems: the baseplate, clamp, backset guide, and 12"/24" guide. As depicted in Figure 2 the baseplate and backset guide fix together by the rectangular pegs on the base plate and rectangular slights on the backset guide. The 12"/24" guide measures from the center of the cutout to the top/bottom of the door and it is attached via a magnet. This is also depicted in figure 2.

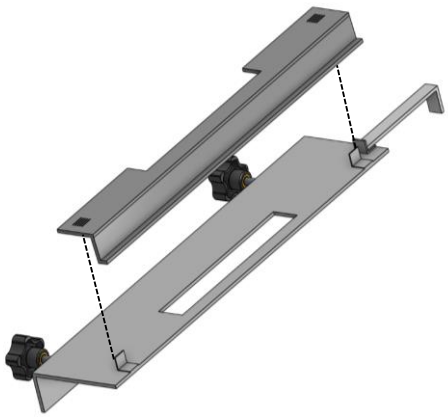

Figure 2. Baseplate and Backset

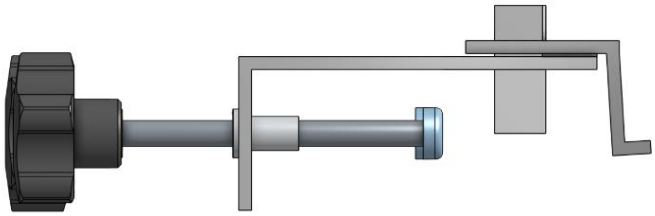

Figure 3. Clamping Sub-System

As shown in figure 3, the clamping system is a screw clamp and is integrated into the baseplate.

3.2 User Access Considerations

The Jig Jackpot door jig was custom made for AMBICO. At AMBICO they make custom doors with 86.5˚ bevels. Additionally, their doors are of five widths from 1 ¾" to 2 ¾" in ¼" increments. The Jig Jackpot jig was custom designed with the above in consideration and so our product is limited to individuals who make doors with the same specifications. However, the jig design could be modified (i.e., the bend in the backset can be set to any angle not just 86.5˚ and the backset guide can be made for any limited number of door widths) for other users.

3.3 Setting up the System

The procedure needed to set up the system is as follows:

1. Lift the backset guide off the rectangular pegs. Chose a hole on the backset guide that corresponds to the desired backset length. Slide the backset guide onto the rectangular pegs again so that the pegs go through the holes for the desired backset. If the backset guide is already set to the desired backset you can skip this step.
2. Place the 12" or 24" guide on the designated guide slot, sliding it all the way towards the back of the guide slot to ensure accurate measurement.
3. Place the jig with both guides on the door. And line up the jig so that the 12" or 24" guide hooks onto the edge of the door.
4. Tighten the clamp by turning the knobs clockwise. Be careful not to over tighten the clamp as this can cause damage to the finished door.
5. Remove the 12" or 24" guide and begin the routing process.
6. Once the routing is complete, following the steps in section 3.5 “Exiting the System” to properly remove and put away the jig.

3.4 System Organization and Navigation

The three main components of the jig include the baseplate, backset guide and attachable 12” or 24” guide. The baseplate includes integrated C clamps, rectangular pegs which are spot welded to the baseplate and a rectangular cut-out which allows for the routing process. The backset guide is at an 86.5˚ bevel and has rectangular slits which allow for it to be placed onto the rectangular pegs at the desired location. The attachable guide allows the centre of the cut-out to be placed 12” or 24” from the end of the door as required. The baseplate and backset guide fix together by the rectangular pegs and slits and adjusts by 1/8” increments depending on the door thickness and cut out requirements. The attachable arm guide fixes to the baseplate and can be removed during the routing process to reduce bulkiness.

3.5 Exiting the System

To put away the jig, first loosen the clamping system by turning the knobs counterclockwise. Next, simply lift the jig from the edge of the door and place it either on a hook or a shelf at the technician's workstation. Make sure the magnetic guides are placed with the jig, so as not to lose any of the pieces. The guides are magnetic so they can be placed on any part of the jig with metal exposed.

4 Using the System

4.1 Baseplate

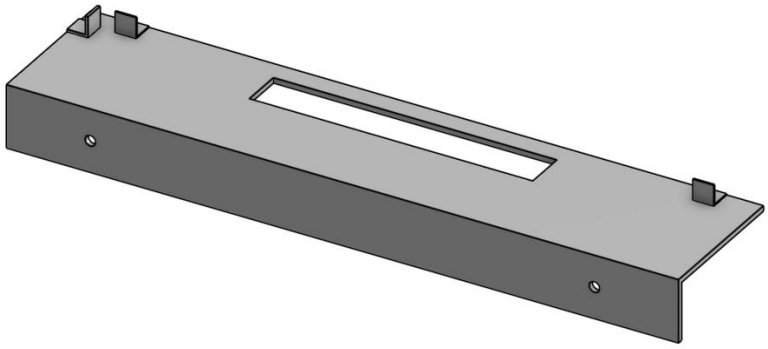

Figure 4. Baseplate Subsystem

The steel base plate (Figure 4) is adjustable and self-centering with modified screw clamps, rectangular pegs, and a 6-3/4" by 1" rectangular cut-out for the flush bolt cutout. The jig can be set to any of their five door widths by clamping the baseplate to the edge of the door with the backset guide attached. They can route by placing the machine over the rectangular cut-out which is on the baseplate.

4.1.1 Rectangular pins

Rectangular pins which are spot welded onto the baseplate allow for the backset guide to be placed at the respective position depending on the doors thickness.

4.1.2 Integrated Screw Clamp

The integrated screw clamp is a clamping system which is part of the base plate and allows for the baseplate to be fixed to the door during the routing process. The knobs can be twisted to fasten the clamps to the door such that the jig will not move during routing.

4.2 Backset guide

An adjustable backset guide (Figure 5) was required since the thickness of the doors vary. The distance from the edge of the cut-out and the edge of the door- called the “backset”- will change depending on the door size. The backset guide is at an 86.5˚ bevel as required. The backset guide has five rectangular holes so that the pegs which are fixed on the base plate can slide in and out of the holes. The holes are spaced at ⅛” increments from each other to accommodate the door sizes

which the client required. The door sizes vary in ¼” increments from 1 ¾” to 2 ¾”, so the backset size should vary by ⅛”.

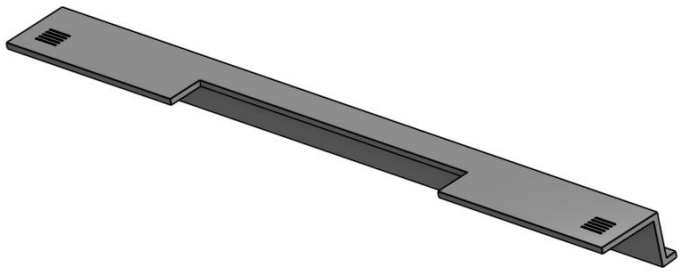

Figure 5. Backset Guide Subsystem

4.2.1 Rectangular holes

Rectangular holes at ⅛’’ intervals, which slide onto the “pins” made of sheet metal allow for the backset guide to be secured onto the baseplate at the desired location depending on the thickness of the door. Simply slide the baseplate pegs into the rectangular holes at the desired position.

4.3 Attachable Magnetic Guide

As depicted in Figure 6 our Jig comes with an attachable guide which allows the user to fix the clamp 12’’ or 24” from the center of the flush bolt cut-out to the top or bottom of the door. After the jig is clamped in place this guide can later be removed to reduce the bulkiness of the system.

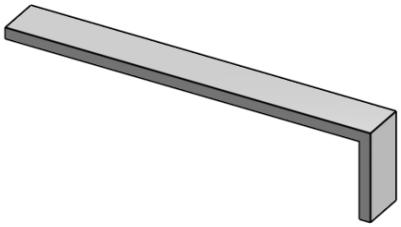

Figure 6. Detachable Magnetic Guide Subsystem

5 Troubleshooting and Support

This section describes the errors that may occur and the corrective actions that can be taken. The section also describes regular maintenance actions and options for additional support.

5.1 Error Behaviours

Our jig was designed to minimize system failures and errors; however, it is still possible that errors may occur. If the jig is not functioning correctly, please find the error in table 3, then look to the right for the possible corrective actions to resolve the error.

Table 3. Possible Error Behaviors and the Recommended Solutions

Error	Solution
Clamp not fastening	1. Check the threading on the screws. If the threading is damaged, replace (item #_ on BOM). 2. If threading on screw is not damaged, check the threading on the rivet nut. If the threading is damaged or the shape is distorted, replace (item #_ on BOM).
Backset distance is not accurate	1. Check the backset angle. If it's bent out of the 86.5° angle use a break or some other strong force to bend it back to 86.5°. 2. If the backet angle is at 86.5° and the issue persists, manually measure the backset distance for each hole in the backset guide. If the measurements are not accurate there was likely an error in the laser cutting process. To fix this, first check that the dimensions in the laser cutting file are correct, then laser cut the backset guide again. Lastly, bend the piece to 86.5°.
Door is getting damaged	1. Check if the clamp is over tightened. If it is, loosen the clamp. 2. If the clamp was not too tight, but the door was damaged check the vinyl/hard rubber on the jig. If any spots show significant wear and tear, replace (item #_ and/or #_ on BOM).

5.2 Maintenance

To avoid failure, the jig needs to be properly maintained. Below is the list of actions that should be performed regularly to ensure the jig stays operational.

- Check the adherence of the vinyl/hard rubber lining on the metal baseplate and backset guide. If the adhesive is failing apply superglue to vinyl/hard rubber and apply force for about 20 seconds or until glue is dry. If vinyl/hard rubber is not adhering to the metal, remove the old adhesive with sandpaper and apply new vinyl with superglue.
- Check the backset guide angle (it should be 86.5°). If the backset guide is bent out of this angle use a break or some other strong force to bend it back to 86.5°.

5.3 Support

If the above trouble shooting does not resolve the issue or if you have any questions regarding the jig feel free to contact Rachel at rachelba78@outlook.com. Please be sure to explain the errors observed or any questions with as much detail as possible for a fast resolution. For emergency assistance, call or text 613-362-1507.

6 Product Documentation

Jig jackpot created a jig that is not only easy to use, but also to manufacture. There are 4 main subsystems that fit together cohesively to create the final prototype. The final prototype created is made from 1/32" steel sheet metal, however a thicker sheet metal would improve the design as it would be more durable, we would suggest 1/8" if the manufacturer has access to tools that can cut through thick materials. The thicker the sheet metal the better the path the router has to follow around the cut-out.

The first and second subsystems are the baseplate and the clamping mechanism, which are the basis of the design. During the ideate phase, our team decided to opt for a design that was dependent on the backset lengths instead of a design that self centered regardless of the backset. To do this, a solid base is needed that has no moving parts. To have minimal parts, it was decided the clamping system would be integrated into the baseplate, so the baseplate was bent, and two holes were added. Using threaded rivets and screws, the clamping system was created. Ideally, the screws would have rubber stoppers on the end to ensure no damage to the door during the clamping process. Furthermore, wing nuts would be used as handles on the screws to facilitate the clamping process. The final aspect of the baseplate is its non-damaging property: the underside that is in contact with the door is lined with vinyl. This ensures the wood finish is not damaged, however this material doesn't need to be vinyl, it could be any material that is to the manufacturer's disposal, as long as they are certain it would protect the door.

The third subsystem is the backset guide, which is the moving part of the design. It is custom fit for AMBICO's doors, so it has an 86.5-degree angle to accommodate their doors, however this can be changed for whatever the user needs. The backset has 5 different holes for the 5 different door sizes that AMBICO requires, however if different sizes are needed it is very easy for the manufacturer to add or move these measurements during the manufacturing process.

The fourth and last subsystem is the 12" and 24" magnetic guide to the top of the door. This component was added to ensure the user wouldn't have to measure at all during the cutout process. Furthermore, it is detachable so that once the jig is clamped the guide can be removed to ensure the jig isn't bulky and the magnet doesn't interfere with the routing process. These are two extensions that magnetically attach to the provided space on the baseplate. They are measured to be 12" and 24" from the center of the cutout. If the user has different measurements for the placement of the cutout they can easily change the dimensions of the guide during the manufacturing process.

6.1 Subsystems of the Prototype

There are four subsystems for the prototype, the baseplate, clamp, backset guide, and 12"/24" guide as shown in figure 7 below.

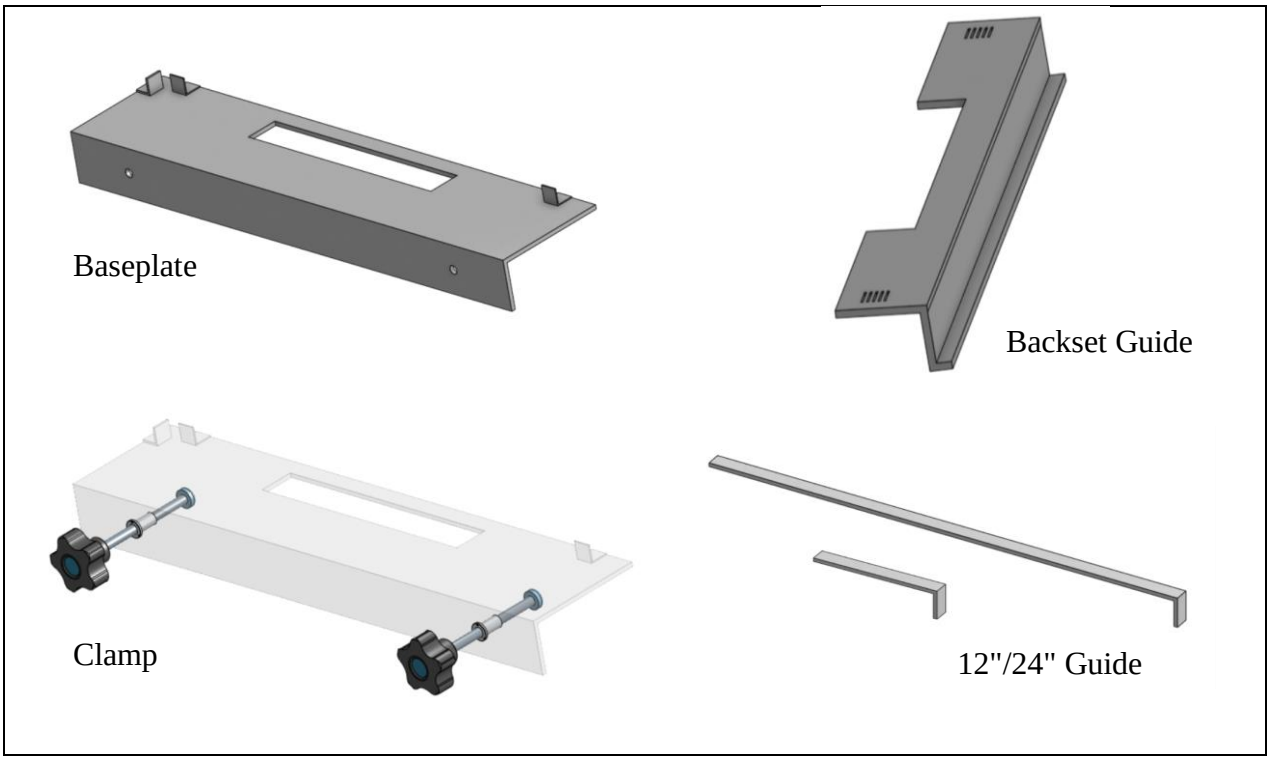

Figure 7. The Subsystems

6.1.1 BOM (Bill of Materials)

The bill of materials to make a refined version of the prototype is shown below in table 4.

Table 4. Bill of Materials

Item #	Item Description	Product Link*	Quantity	Unit Price	Amount
1	12 x 16-inch 16 Gauge Steel Sheet	Paulin 12 x 24-inch 16 Gauge Steel Sheet | The Home Depot Canada	1	$25.38	$25.38
2	5/16" Rubber Padded Screw Clamp	Screw Clamp | Ali Express	2	$0.89	$1.78
3	5/16" Rivet Nut	Rivet Nut | Amazon	2	$0.77	$1.54
4	10mm x 3mm Refrigerator Magnet	Refrigerator Magnet | Amazon	1	$0.41	$0.41

5	20" x 30" x 5mm, White Foam Board**	White Foam Board | Dollarama	1	$1.50	$1.50
6	Super Glue 3g	Super glue | Dollarama	1	$1.25	$1.25
				Sub Total	$31.86
				HST	$4.14
				Total	$36.00

Note. all prices are in Canadian Dollars.
*Product link name shortened. Please click on link directly to view product details.
**Item can be replaced with any other sort of protective material such as vinyl, rubber, etc.

6.1.2 Equipment list

To make the prototype the following equipment is needed:

- Scriber*
- Ruler*
- Foot shear*
- Dremel*
- Punch*
- Drill Press*
- Brake
- Rivet Nut Tool
- Spot Welder

*Indicated equipment can be substituted for a metal laser cutter

6.1.3 Manufacturing Instructions

The manufacturing instructions have been divided into three subsections: Baseplate and Clamp, Backset Guide, and 12" (or 24") Guide.

6.1.3.1 Baseplate and Clamp

1. To start take a piece of 1/8" sheet metal and cut it to a rectangle of dimensions 16" by 5" using a shear or laser cutter.
2. On the long side of the plate, using a laser cutter or Dremel, cut a 6-1/2" by 1” rectangle in the plate, 1/2" from the end of the plate. This cut-out should run lengthwise along the edge of the plate, as shown below in figure 8.

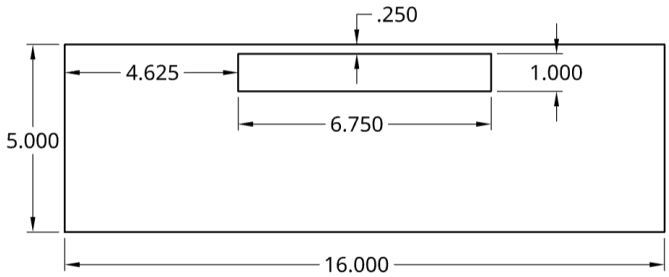

Figure 8. Manufacturing Steps 1-2

3. On the side opposite the cut-out, drill two holes in the baseplate, each 2" in from the ends of the plate and 3/4" from the bottom of the plate (see figure 9). This is where the threaded rivets will be installed, so the diameter of these holes is dependent on the size of them. This hole can also be laser cut.
4. Opposite the cutout, on the same side as the holes for the clamping system, bend the sheet metal to a 90-degree angle 1-1/2" from the end using the shear.

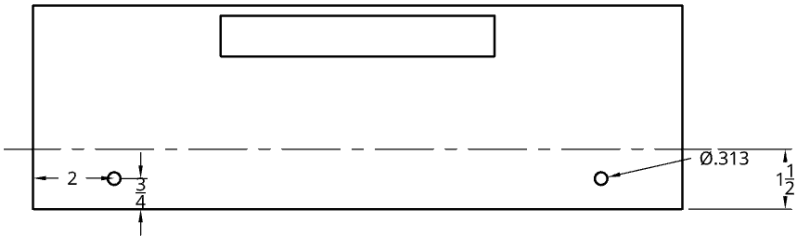

Figure 9. Manufacturing Steps 3-4

5. Now using 1/32" sheet metal, make two 1/2" by 3/4" rectangles and from 1/8" sheet metal one 1/2" by 1" rectangle using the shear or the laser cutter (see figure 10). The two 1/2" by 3/4" rectangles will be welded to the baseplate as the pegs for the backset guide and other rectangle will be for the 12"/24" guide.
6. Bend all three pieces at a 90-degree angle 1/2" away from the short edge using the brake. One side of each piece will be welded to the baseplate while the other will be sticking up for the backset guide or 12"/24" guide.

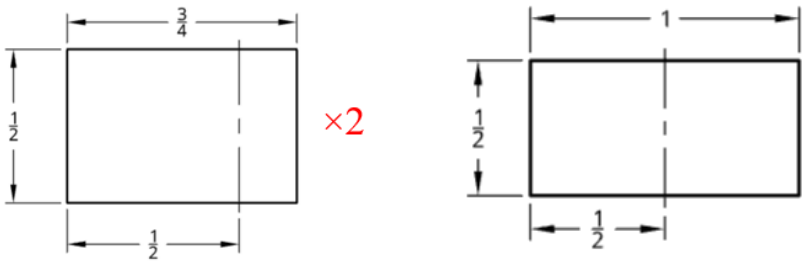

Figure 10. Manufacturing Step 5-6

7. Spot weld the two pegs 7/8" from the sides of the baseplate as shown in figure 11, and the side being welded to the baseplate will be flush against the end as shown below. These should be on the same side of the baseplate as the cut-out.
8. Spot weld the third piece 1/2" from the end of the plate perpendicular to the other pegs, while the end of the piece welded down is flush with the end of the baseplate (see figure 11).

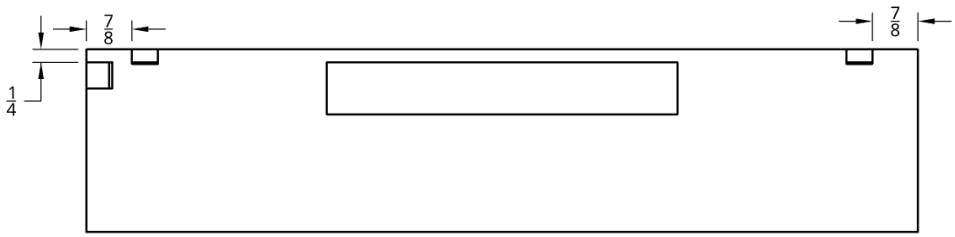

Figure 11. Manufacturing Steps 6-8

9. Finally, install the threaded rivets using a rivet nut tool in the two holes drilled in step 3 and fasten the Rubber Padded Screw Clamps through the rivet nuts as shown in figure 12.

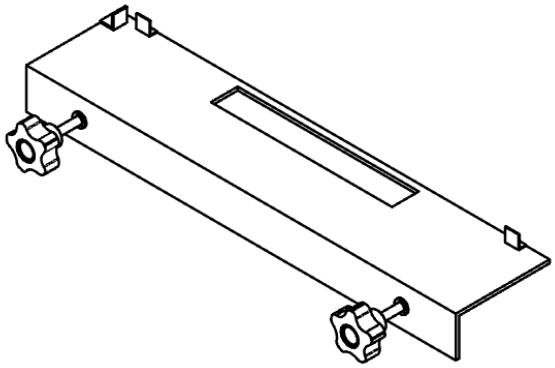

Figure 12. Manufacturing Step 9

6.1.3.2 Backset guide

10. Cut a piece of 1/8" sheet metal with dimensions 15" by 2-3/4" using a shear or laser cutter.
11. On one of the long sides, using a laser cutter or Dremel, cut a rectangle 1" deep into the piece and 6-3/4" wide. This cutout should start 4-1/8" down from the top of the sheet (see figure 13.

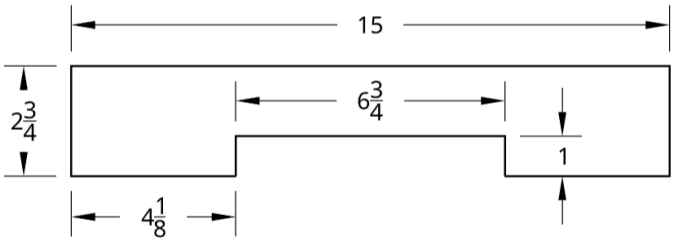

Figure 13. Manufacturing Steps 10-11

12. Using a laser cutter or Dremel, make 5 rectangular cutouts of dimension 1/32" by 1/2" that are each 3/32" apart. The first cutout should be 0.5" from the end of the plate, and the fifth should be 1” from the end. The cutouts should be 3/8" in from the outer ends of the plate. See figure 14 for details.

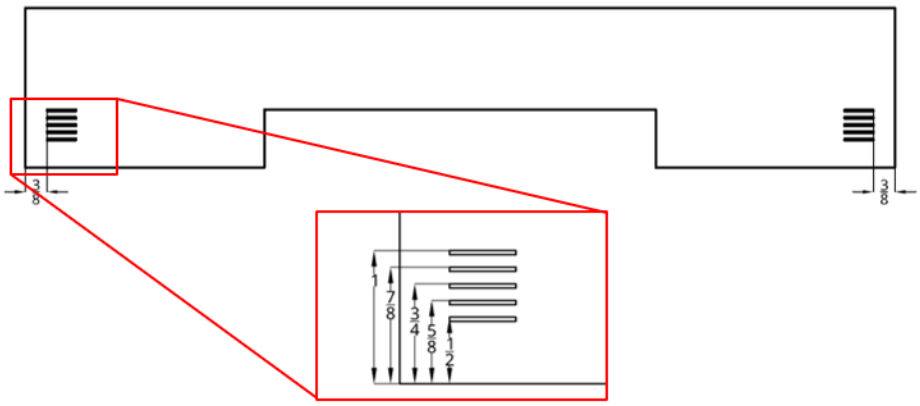

Figure 14. Manufacturing Step 12

13. To finish the backset, bend the sheet at an 86.5° angle 1-1/2" from the end of the sheet, opposite the previous cutout. Optional: Add a 90° bend 3/8" from the edge for additional stability as shown in figure 15.

Bend 1 Bend 2

Figure 15. Manufacturing Step 13

6.1.3.3 12" (or 24") guide

14. Use a scriber and ruler to mark a 1/2" x 5-1/8" rectangle for the 12” guide (or 1/2" x 17-1/8" for the 24" guide) on a piece of 1/8" sheet metal.
15. Use a shear to cut the metal into the given rectangle as depicted in figure 16. Alternatively, you could also laser cut this piece and skip step 1.
16. Line up your ruler with the 1/2" side of the rectangle. Move it 1" away from the edge and mark the line.

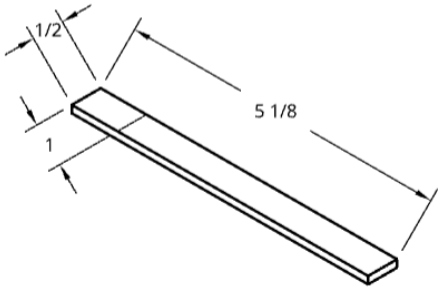

Figure 16. Manufacturing Steps 14-16

17. Bend the sheet metal 90° at the marked line using the break (see figure 17).
18. Optional: add vinyl or rubber lining to the underside of the guide but be sure to leave at least 1" on the non-bent end free of material for the magnet. The lining on this piece is optional since this piece is unlikely to damage door either way since it’s removed during the routing process.

19. Use superglue or any other strong adhesive to glue a 10mm x 2mm magnet to the end of the guide without the bend.

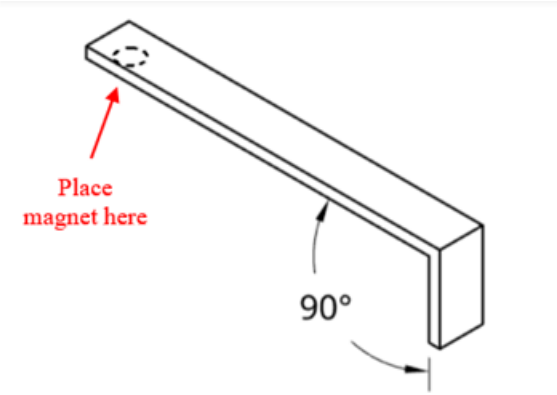

Figure 17. Manufacturing Steps 17 & 19

6.2 Testing & Validation

Several tests were conducted to ensure the final product was functional. Please see table 5 below for testing details.

Table 5. Description of Tests and Results Achieved

Test ID	Description of test method and materials used.	Results
1	Set the backset to various sizes to ensure easy sliding on/off. Ask others to rate how easy it is to change backset lengths. (Note. 1=very difficult and 10=very easy)	Average score: 9
2	Ask a peer from another group to change the backset for a 1 ¾" door, 2" door, etc. to see if the labels on the guide are clear. Responses are given as Y or N.	All said Y (yes)
3	Clamp the jig to a piece of wood within 1 ¾" to 2 ¾" and assess stability.	The jig was stable and did not move. Also, with the vinyl the door was not damaged by the clamp.
4	Carefully measure all critical dimensions to ensure accuracy.	All dimensions were within 0.1mm to what they were supposed to be

7 Conclusions and Recommendations for Future Work

To conclude, our prototype has 3 pieces; the baseplate, backset guide, and 12" guide. All subsystems are made from 1/32" sheet metal, which is easy to work with and affordable. While making our final prototype we learned the value of good planning, as well as being prepared. We especially learned the importance of dividing tasks and making clear blueprints *before* arriving at the workshop to begin manufacturing, to save both time and effort.

For other's who might wish to improve upon our work, we'd recommend looking at ways to make the jig adjustable for all door widths and not just the five requested by AMBICO. This would make the product useful for more people and benefit the client because they may have new custom doors they want to create in the future. Others interested in this project might also consider making an additional guide which traces the secondary hole required to install the flush bolt mechanism. This template was of less importance to AMBICO but implementing it would be as simple as cutting out an additional subsystem very similar to the backset guide, able to slide onto the pegs but with a different sized cutout hole.

Given additional time, we would make a fourth prototype made from 1/8" sheet metal (instead of 1/32") since this is what we decided we be best for routing and stability. With the prototype we could not only test the effectiveness of the design, but also the feasibility (i.e., is it even possible to make our design from metal this thick? What are the manufacturing challenges that occur?). With more time, we would also add labels for the different backset widths, which was not done due to time constraints. Both of these changes are most easily done with the tools available at AMBICO, so we are confident that the client will have no issue creating the optimized version of our design.

APPENDIX: Design Files

The document titled "User and Product Manual (UPM) for AMBICO Flush Bolt Jig" serves as a guide for AMBICO to effectively utilize the Flush Bolt Jig prototype. However, it is informed by and references several other relevant documents and sources throughout its contents. Table 6 serves as a summary of its relationship to other documents:

Table 6. Referenced Documents

Document Name	URL	Issuance Date
Deliverable B	Deliverable B	January 28, 2024
Deliverable C	Deliverable C	February 4, 2024
Deliverable D	Deliverable D	February 11, 2024
Deliverable E	Deliverable E	February 25, 2024
Deliverable F	Deliverable F	March 3, 2024
Deliverable G	Deliverable G	March 10, 2024
Deliverable H	Deliverable H	March 24, 2024
CAD and BOMs	CAD and BOMS	March 2024
Prototype	CAD prototype design	February 2024
Final Design	CAD Final Design	March 2024

Note. All documents can also be found in our MakerRepo: https://makerepo.com/samdelisle/2008.gng1103g03flush-bolt-jig-jig-jackpot