GNG 1103

Deliverable H: Prototype III and Customer Feedback

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1. Introduction

1.1. Background of the Report

Our team has reached the third iterative step in the process of prototyping and receiving feedback, which is the construction and testing of prototype III, a comprehensive physical prototype. This follows prototypes I and II, which were comprehensive and focused, respectively.

Each prototype was tested, and feedback was provided by the client and other relevant sources familiar with the design process. This feedback and our team's testing and brainstorming cumulated to the final design, which was tested against the original design criteria and constraints. Prototype III is constructed from materials suitable for the final product to provide accurate testing and analysis, and a final BOM for both our construction and the client's use is provided.

1.2. Scope of the report

This report provides a summary of the final prototype's design and construction, as well as feedback received. This will include:

- Design for the final prototype and its justification
- Test results for this prototype
- Feedback on Prototype III
- Our final updated design

This report is intended to summarize our final design which will be pitched to the client, as well as justification for this final design based on the design criteria.

2. Prototype III: A Comprehensive Prototype

Prototype III is a comprehensive prototype and can be seen in figure 1 and figure 2. It was made to add on to the base plate and clamping system which was created in prototype II. The design includes a detachable back set guide made of sheet metal.

The back set has five different holes which can slide on to the pegs of the base plate, spaced at 1/8" from each other to accommodate the door sizes the client needs. The door sizes will be from 1 ¾" to 2 ¾" in ¼" increments, so naturally the back set size will vary in 1/8" increments.

There is also a magnetized ruler that has a spot at the top of the jig, which measures 12" from the centre of the flush bolt cutout to the top/bottom of the door. Once the jig is clamped in place, this magnetic guide can be removed from the jig to avoid any bulkiness.

Figure 1: Prototype III – Isometric View

Figure 2: Prototype III - Side View

3. Justifications for Prototype III

To best understand how prototype III continues the work done in prototypes I and II a summary for the previous prototypes is provided below.

3.1. A Summary for Prototype I and Prototype II

For prototype I, both a digital and physical model were created. After testing the digital prototype, we found that we would need about 12” × 16” of sheet metal to make the baseplate and backset guides. The tests for the physical model showed that our jig design was self-centering. However, the main feedback we received was that our design was not very sleek, so we modified our clamp design to be more minimal.

For prototype II, we chose to focus on the clamp system. After testing we concluded that our new clamp system worked, but it was difficult to adjust, so we decided to use butterfly nuts to give additional leverage in the final prototype. During the feedback for this prototype, we were told that our overall jig design had too many pieces, so we changed our design so that we would only need one backset guide instead of five.

3.2. Developing Solution with Prototype III.

Prototype III is a fully functional version of our solution, which we can then test to ensure that our final product will indeed meet the client’s expectations. Many of the design criteria were verified by previous prototypes, and prototype III completed the criteria. Table 1 shows the progress each prototype made towards developing a solution where all the design criteria are met.

Table 1: A Summary for How Each Prototype Fulfilled the Design Criteria

Design Criterion	Prototype I	Prototype II	Prototype III
Adjustable	-adjustable and self-centering with raised screw clamp	-adjustable and self-centering with modified screw clamp	-adjustable and self-centering with modified screw clamp
Reduces time	-work time was greatly reduced	-N/A	Work time was greatly reduced
Non-clunky Design	-not overly large, but was also not sleek -consists of 7 pieces	-design is slightly simplified with modified screw clamps - consists of 7 pieces	-design further simplified with modified screw clamps and backset guide - consists of 3 pieces
Simple to use	-fairly easy to use, but has several pieces to keep track of	-fairly easy to use, but has several pieces to keep track of	-Very easy to use. -requires minimal instructions
Securely attaches to door	-not overly secure dur to prototype materials, but design itself showed promise	N/A	-with metal backset guide in place, it secures very well to door
Does not damage door	-due to soft materials for prototype, it does not damage door	-can cause damage to door because there is no lining	-with vinyl lining, it does not damage the door.
Durable in harsh environment	-due to prototype materials, it was not durable	-very durable as it is made from sheet metal	-very durable as it is made from sheet metal
Resilient	-not very resilient due to prototype materials	-very resilient as it was made from sheet metal and had bend in it for stability	-vinyl may need to be reapplied, but jig itself will last long time
Guides to 12” from top/bottom of door	-guide did not measure 12” from center of cutout	-N/A	-guide length was fixed to now measure 12” from center of cutout

Note. N/A indicates prototype was not suitable for testing the specified criterion.

4. Testing for Prototype III

Prototype III is the final protype and showcases the team’s best work in making a durable, and easy to use jig. To ensure our jig meets the client’s needs, vigorous testing has been done.

4.1. Test Plan for Prototype III

The tests for prototype III were done after the prototype was finished being built. The test plan was created in deliverable G and has been copied below to allow the reader to have an in depth understanding of each test done.

Table 2: Tests and Objectives for Prototype III

Test ID	Test Objective (Why)	Prototype used and Basic Test Method (What)	Description of Results to be Recorded and how these results will be used (How)	Estimated Test duration and planned start date (When)
1	Ease of use – backset guide	Using the physical comprehensive prototype, set the backset to various sizes to ensure easy sliding on/off	Record ease of sliding on/off, ask a peer with no background knowledge of the product to perform the test as well to confirm.	5-10 minutes, March 15
2	Ease of use – clarity of door sizing	Using the physical comprehensive prototype, 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.	Record if the individual was able to identify door sizes and appropriate backset positions easily (Y/N)	10-15 minutes, March 15
3	Clamp effectiveness	With the comprehensive prototype, clamp the jig to a piece of wood within 1 ¾" to 2 ¾" and assess stability.	Record any movement under applied forces, use these results to determine if the clamp design needs to be modified.	20 minutes, March 15
4	Accuracy – Cut-out size, backset length, 12" guide length	Using the complete comprehensive prototype, carefully measure all critical dimensions to ensure accuracy.	With tape measures or rulers, confirm that all dimensions are accurate to the design.	20 minutes, March 15

4.2. Test Results and Analysis for Prototype III

After making the prototype several tests were performed to analyze the quality of the jig. These tests and results are shown in table 3.

Table 3: Test Results for Prototype III

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

5. Client Feedback for Prototype III

During the development of prototype III, we actively sought feedback from both Alexander Vandette and the previous semester's winning team (Nora and Reema). Their feedback included:

- Enhancing the clamping system.
- Making the material thicker around the flush bolt cutout to better guide the router.
- Adding an additional raised guide for the router (e.g., wooden or metal "bumpers" around the cutout)
- Adding a bent piece of material to the backset guide to increase structural integrity, as bent sheet metal is much less flexible than flat sheet metal.

Adding the router guide and increasing stability will improve the ease of use of the jig, as well as precision. Our team has decided to incorporate Alexander Vandette's and last semester's winning team recommendations for our prototype as we feel it will best satisfy the client and user's needs.

6. Updated Design

After completing prototype III, we found several flaws in our design which led us to update our design. The changes are as follows:

- Use 1/8" sheet metal as opposed to 1/32" for stability and rigidity.
- Move 12" guide about 1-1/2 inches closer to the cutout.
- Add wooden or metal "bumpers" for the router around the cutout.

A final version of our product with these above changes made can be seen below in figure 3. For a more interactive view click here. Additionally, as shown in table 4, the new design would now total CAD$40.30. This is the cost for someone to make the jig without the resources at uOttawa.

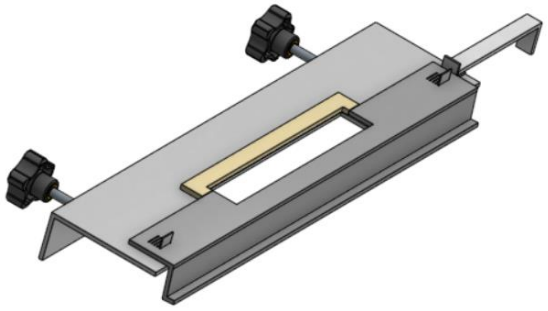

Figure 3: Our Final Updated Design (for client)

Table 4: Updated BOM for Client

Client BOM					
Item #	**Item Description**	**Product Link***	**Quantity**	**Unit Price**	**Amount**
1	12 x 16-inch 16 Gauge Steel Sheet	12 x 24-inch 16 Gauge Steel Sheet | The Home Depot Canada	1	$25.38	$25.38
2	3/8 x 6-inch Carriage Bolt (16 UNC)	3/8 x 6-inch Carriage Bolt | The Home Depot Canada	2	$1.95	$3.90
3	3/8-inch Wing Nut (16 UNC)	3/8-inch-16 Wing Nut| The Home Depot Canada	2	$0.76	$1.52
4	3/8” Rivet Nut (16 UNC)	Rivet Nut | Amazon	2	$0.85	$1.70
5	10mm x 3mm Refrigerator Magnet	Refrigerator Magnet | Amazon	1	$0.41	$0.41
6	20" x 30" x 5mm, White Foam Board	White Foam Board | Dollarama	1	$1.50	$1.50
7	Super Glue 3g	Super glue | Dollarama	1	$1.25	$1.25
				Sub Total	$35.66
				HST	$4.64
				Total	**$40.30**

Note. all prices are in Canadian Dollars.

*Product link name shortened. Please click on link directly to view product details.

7. Conclusion

The design and construction of prototype III led to productive design changes, which improved structural integrity and functionality based on feedback and team discussion. Major changes have followed the construction of each prototype, affecting the subsystems as follows:

Table 5: Summary of changes across the three prototypes

Subsystem	Prototype I	Prototype II	Prototype III
Baseplate	Width of the smallest door size	Wider baseplate to accommodate integrated clamp system	Wider baseplate to accommodate integrated clamp system
Clamp system	External "C – clamps" fixed to the baseplate	Integrated C-clamp style clamping system, part of the base plate	Integrated C-clamp style clamping system, part of the base plate
Backset guide	Five separate guides, one for each door size	N/A (focused prototype)	One guide only
	Circular holes to attach to pins on the baseplate	N/A (focused prototype)	Rectangular holes at 1/8" intervals, which slide onto "pins" made of sheet metal

These changes led to a functional physical comprehensive prototype that will allow the client to thoroughly understand our design and its benefits. In this report, the final design was justified in terms of the design criteria and client needs, to demonstrate the effectiveness of this final design.