Deliverable F – Prototype I and Customer Feedback

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Prototype Design

Unfortunately, as a team, we were unable to develop and make a prototype for this deliverable. The reasoning was due to time-constraints, and not being able to make it to the Makerspace to 3D-print our jig. However, to make up for the lost prototype, the plan is now to 3D print two versions this week. Also, the first stage of testing will commence intimately following completion of the 3D print. Furthermore, to make testing easier, we will be creating a testing jig to accommodate both sizes of jigs.

There also has been no update to the design of our jig. The current configuration of the jig can be found in the following Figures.

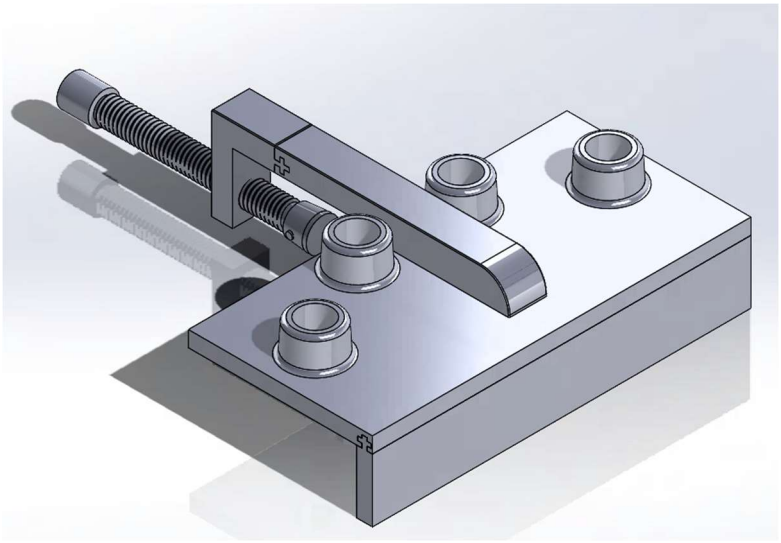

Figure 1: Isometric Hinge Jig

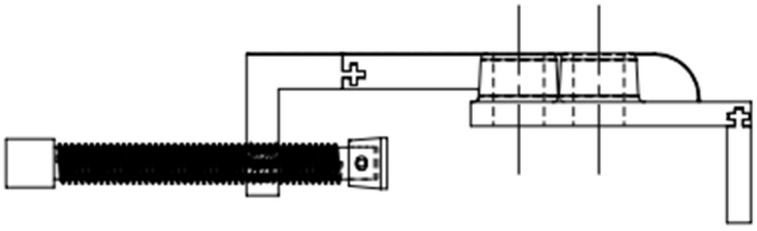

Figure 2:Front View of Jig

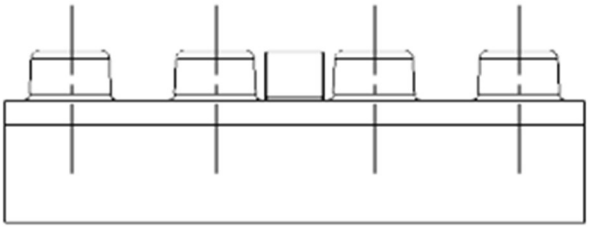

Figure 3: Side View of Jig

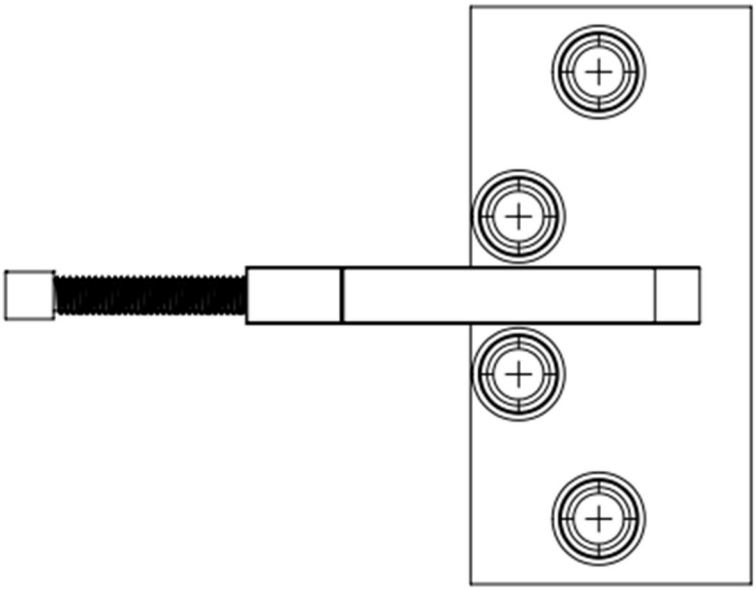

Figure 4: Top View of Jig

BOM

There has been no update to the bill of materials. Still awaiting approval for purchasing of materials.

Table 1: Bill of Materials for 4.5" Jig

Component	Workhours	Labour	Materials	Total
Base	2.25 hours	N/A	2.35in3 (38.51 grams) x $0.13/gram [1]	5.01
Base Plate	1.5 hours	N/A	0.69in3 (11.31 grams) x $0.13/gram [1]	1.47

C-Clamp Base	1 hour	N/A	0.18in3 (2.95 grams) x $0.13/gram [1]	0.38
C-Clamp Screw	0.5 hours	N/A	0.18in3 (2.95 grams) x $0.13/gram [1]	0.38
Finisher	0.5 hours	N/A	0.02in3 (.33 grams) x $0.13/gram [1]	0.04
Pin	.1875 hours	N/A	0.01in3 (0.16 grams) x $0.13/gram [1]	0.02
Sealing Cap	N/A	N/A	1 x $2.88 [2]	2.88
			Total	$10.20

Table 2: Bill of Materials for 5" Jig

Component	Workhours	Labour	Materials	Total
Base	2.5 hours	N/A	2.54in3 (41.62 grams) x $0.13/gram [1]	5.41
Base Plate	1.75 hours	N/A	0.77in3 (12.62 grams) x $0.13/gram [1]	1.64
C-Clamp Base	1 hour	N/A	0.18in3 (2.95 grams) x $0.13/gram [1]	0.38
C-Clamp Screw	0.5 hours	N/A	0.18in3 (2.95 grams) x $0.13/gram [1]	0.38
Finisher	0.5 hours	N/A	0.02in3 (.33 grams) x $0.13/gram [1]	0.04
Pin	.1875 hours	N/A	0.01in3 (0.16 grams) x $0.13/gram [1]	0.02
Sealing Cap	N/A	N/A	1 x $2.88 [2]	2.88
			Total	$10.80

Objectives

Typical objectives include communicating and getting feedback for ideas, verifying feasibility, analyzing critical subsystems or system integration, or reducing risk and uncertainty.

The objective of our prototype with the rubber stopper and the C-clamp is to make sure it meets the specified criteria of our test plan. Those criteria evaluate the accuracy, durability, and user-friendliness of the prototype. We will also make sure that the prototype can be manufactured in a respective time frame set by our client. For the prototype uncertainties, we will identify and manage them during the testing phase.

Client Feedback:

The feedback received from your client on the group concept or detailed design. Specify how the feedback will be used to inform future design choices and improve the solution.

- Liked the C-clamp idea and would like us to proceed with it. However, we must choose a durable material that will not scratch or damage the wood of the door when the C-clamp is used.
- Not fond of the handle idea, it is best to go in a different direction.
- They liked the extrusions for drilling and tapping support, but they want us to make sure the extrusions do not hamper productivity by being too long.
- They would like us to select a durable material to make the jig out of.
- They stressed the importance of simplicity when designing and manufacturing the jig.
- They want all parts of the jig to be easily replaceable in case they break.

Analysis:

- We are including rubber stoppers on the end of the C-clamps to not damage the wood during operation. We picked rubber because it will retain its performance longer than foam and won't retain dust and dirt like velvet.
- The C-clamp has been streamlined to one screw so that the grip is evenly distributes the clamping force and will keep the jig perpendicular to the door's surface ensuring accurate drilling operations.

- The final product will be made of ABS plastic with metal components for extra durability where it is needed. The prime example of this is the metal bushings around the drilling holes to not accidentally destroy the jig.
- The C-clamp is operated by a knob that is twisted to tighten and loosen the screws. To make turning the knob easier the surface will be given a rough texture to give it additional grip for the technician to work with.

Testing Plan

Our test plan will be testing the accuracy, ease of use and durability of the jig. For accuracy we will be making a test jig either out of wood or PLA to simulate the door and the backset of the door. We will then use the measurements provided by the client to mark down where the holes should be drilled. Once the holes are marked and checked we will use the jig and compare where the holes we marked are to where the jig drilled.

To test ease of use, we will drill the holes then validate the jig's performance by checking the quality/accuracy of the holes made.

The durability test will be the last one as we'll be testing the jig to its breaking point. Drop tests, stress tests, etc. We will be destroying the prototype to learn from it.

Table 3: Testing Plan to Create Second Prototype

Test ID	***Test Objective (Why)***	***Description of Prototype used and of 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	Cost	Calculate the amount of material required to create the prototype.	The different material costs will be weighed against each other, determining the cheapest material to build the prototype out of.	Start: Duration: 1 hour
2	stress	Using samples of each material	For this test, we subject same size samples of the different materials to different levels of	start: Duration: 1 hour

			stress and see which one is the most durable.	
3	Ease of use	Construct multiple prototypes, one of each material	Use each prototype in its intended way and make note of which one was the easiest to use, the lightest, the most rigid, etc...	start: Duration:1 hour

Additional Feedback

One of our group members had a discussion with some additional people that work in the wood carpentry industry and his dad who happens to be a licensed engineer. Their insight will be helpful in developing a better prototype.

They liked the idea of being able to clamp down on to the table to have a hands-free jig instead of the old ones they had to hold with one hand and drill with the other. They also like the extrusions on the jig that allow the user to have precise drilling and tapping without having to guess as well as making sure it stays perfectly horizontal. As well as the rubber stopper on the bottom of the clamp which would prevent the force of the clamp from damaging or warping the finish.

There comments/feedback was that we should keep in mind about the screw mechanism for the C clamp that it shouldn't get caught jammed so make sure that it is perfectly aligned. Also based on what the clients in the client meeting said make sure the backsets and required measurements are perfectly executed to enable the upmost accuracy. They also said, make sure the clamp is durable and won't break if a mistake is made while drilling, clamping, or dropping It on the concrete. Make sure it's durable so add more metal parts and not just the 3D printed material.

When brining up other groups Ideas and other potential ways to make the jig like making it have adjusting parts for different sizes or making it automated, they suggested to keep it simpler because the clients that will be using them won't want to mess around with an automated jig that they don't know how to use. As well as the customers who buy them if they went to retail the everyday person might not be as educated on the electronics or other mechanisms which would deter them from the jig. So, keeping it simple and user friendly is key.

Acceptable Fidelity

For the accuracy test of the jig, as stated in our test plan we will be doing trials on a wood rig to mimic the door and backset to test the accuracy of our drilling and taping. We will be doing continuous trials of drilling and taping using our jig. We won't stop until we do multiple successful trials in a row to ensure that the accuracy doesn't change and that it stays consistent. For the durability test we will be measuring how much stress and force it can take, by using various testing methods to test the strength of our jig and the quality of the jig. We will be making changes and modifying it until it reaches the same level of quality or better than the jigs they would use in the workshop. For ease of use will be giving random people the jig to carry out the drilling and tapping and record the performance. We will be doing these field tests until we get a consistent number of successful trials where the user drills and taps the holes to the clients desired measurements without knowing our end goal. This will ensure that the tool is easy to use/ user friendly and won't be confusing in professional hands.

Wrike Link

https://www.wrike.com/workspace.htm?acc=4975842&wr=20#/folder/1215239062/timeline3?viewId=202489442

References

[1] "3D printing cost ABS," MakerSpace, [Online]. Available: https://makerstore.ca/shop/ols/products/abs-per-gram.

[2] McMaster-Carr, [Online]. Available: https://www.mcmaster.com/3837N13/.