Hingineers

Group 17

Evan Trainor - 300136249

Chayton Munro – 300304143

Andrew Stepanenko – 300362332

George Omoregie – 300325739

Mehdi Boudjemline – 300371792

November 5, 2023

Abstract

This deliverable will demonstrate how our group intends to carry out testing the first prototype of our jig, as well as potential improvements that can be made as a result. The reader will observe how this test is to be carried out keeping the feedback received from our clients in mind, while also discussing how the specific roles of the jig's subsystems are applied the testing process. At the end of this deliverable, the reader will view the updated bill of materials table from the result of this test and the plans for the second prototype test, with a sufficient understanding of how the jig is to be applied within the context of this testing field.

Table of Contents

Introduction

This deliverable specifically discusses how the proposed jig will remain stable and secure to the door while in use, given the received client and external feedback to make necessary adjustments that will optimize the jig's overall performance. Given the results of the first test, an updated bill of materials is provided as well as the test plan for the second prototype adjusted in favour of the performance of this first prototype.

Feedback Outline

During our second client meeting the clients pointed out many things good and bad within our 3 functional solutions.

> During the first functional solution the clients liked how we were attaching the jig to the door by using more of a mechanical aspect with rubber to hold it in place, they also liked the way we attached the jig in functional solution 3 as it was an easy slide on and off but they said we need to be careful when sliding it on and off as the door has a varnish on it at this stage. The advice they gave us is that we should find a way to combine the two with the mechanical part being on the side where the backset changes sizes between the doors. We took that and made that into our main final design.
>
> The clients also said when we were showing how the holes are lined up and drilled to make sure to use a plate as it interchangeable but make sure to secure it properly and sturdy as using the drill can cause it to move. They did like our plate design based on the how easy it is to line up. Going with the plate design we had designs that had moveable holes and that also guided the drill and there would be one plate so we wouldn't have to switch it out but they said it would just be a lot easier to switch the plate for different sized hinges instead of trying to move the holes to a different spot as they could move out of that spot with the vibrations from the drill and the saw dust could clog up those holes after a long time if not cleaned.
>
> The next piece of advice the clients gave us is that they wanted to make sure that we were sticking with the drilling/tapping they have now as its easy for the labourer to drill and tap. So, when we proposed the auto drilling and the multiple drill bits spinning at once they very quickly shut that down.
>
> So, after all this the client said they wanted a jig that could be secured onto the door without leaving marks on the varnish and be secure to withstand the drills vibrations. The client wanted us to leave how to drill and how to tap just the way it is and to instead have a plate that can be easily slid into the jig for different sized hinges and is also thick enough to guide the drill so it can be a straight hole for the screws later.

Prototype Demonstration & Summary

The first prototype designed in this deliverable prioritizes the security and stability of this jig when latched onto the door. To ensure that the jig remains attached to the door, both suction cups must be airtight and secured on the door to prevent any unwanted moving which may cause unintentional harm to the jig or the door itself. To test this, we will simulate how the suction cups will attach to doors of different widths spanning from 2 ¼ '' to 3'' and observe how stable the jig is.

For this specific prototype test, we do not need to include the subsystem that contains the mold as it is not pertinent to the process of ensuring that the jig itself is secured to the door.

Our first step is to bring out the suction cup arms so that we may put the jig in place and ensure it is in the right spot before it is secured. We then move the suction cup arms onto the door and secure it on, ensuring that the suction cups are tight and will not move during the drilling/tapping process. Once the suction cups are in place, the drilling may begin. We must take note of how the jig reacts to movement and vibrations caused by the drilling and ensure that this does not affect its security to the door. After this process is complete, the suction cup can then be released, and the test will be considered a success. This test is repeated for multiple widths of the door as previously mentioned to make sure that the jig is adapted to these sizes.

We could not find any information an Ambico's website about the average size of the doors. However, another company named Sun Mountain Custom Doors stated that the thickness of their doors typically range between 2.25" and 3" (Sun Mountain Door, 2014).

The first test will use a door with a width of 2 ¼ ''. The jig's bottom plate is placed underneath the door with the suction cup arms up and when the jig is set in its preferred position, the suction cup arms are brought down on the door and verified to be airtight so that the drilling may begin. These suction cups should be able to withstand all the vibrating and movement that come with the drilling process. How the suction cups are attached to the door is shown below:

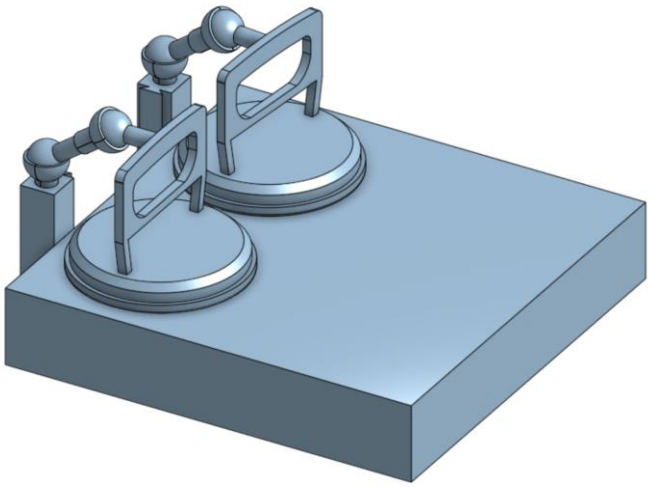

Figure 1: Test with 2.25" door

The same test with the same target is carried out with a door featuring a width of 3 ‘’. The same procedure is used, and the same result is expected as shown below:

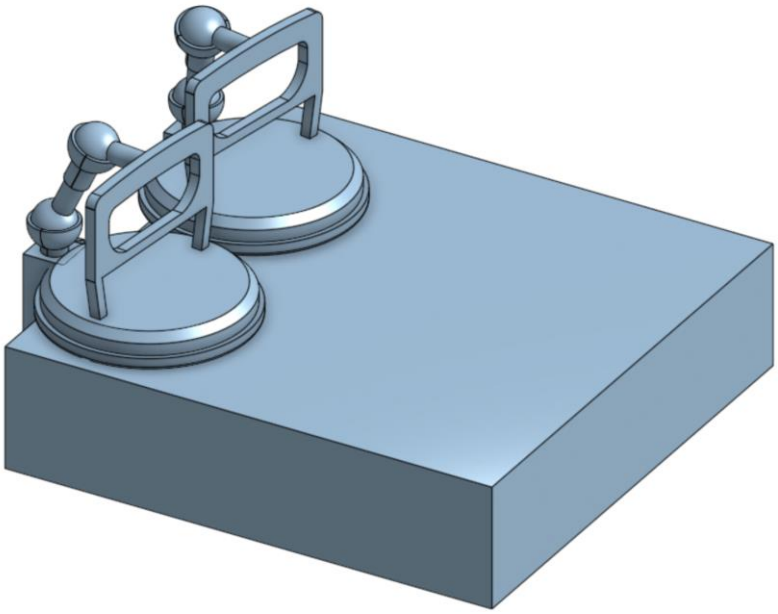

Figure 2: Test with 3.0" door

After reviewing how the 3D design of the jig fares with both sizes of doors, it is possible that the length of the ball and socket joints need to be extended so that the suction cup has some space from the edge of the door to ensure that it maintains a safe and secure hold. This is especially the case for the jig shown with the 3 ‘’ door, as it looks to be impossible for the suction cups to keep a stable hold on the door with short arms. Aside from this, the jig appears to function as intended and is safely attached to the door.

Subsystem Analysis

Our design consists of 3 main parts: suction cups (for holding the door down), metal inserts (for various hinge sizes), and adjustable joints (for various back set sizes).

Suction cups are made of a rubber material with a concave shape. This allows the cup to be pressed on to a surface and release the air that is trapped within it. As the air is released, a vacuum is created inside the cup that pulls both the cup and the surface together thus allowing us to secure our jig to the door when they are attached. Suction cups are crucial to our design as they can stick to a flat surface easily without leaving any residue and requiring a lot of force to secure it.

Also, the metal inserts we are going to use are made of a steel composite to ensure that the inserts can last long as they will be used in a harsh environment for many years. Steel can withstand high temperatures, friction/scratches from other materials like wood, and have a low elasticity coefficient meaning they are hard to deform. The inserts will be held in using the normal force of the jig and the friction between both the insert and the jig where the insert will be inserted into.

Lastly, the adjustable joints on the arms are going to be important to have as they clients have different measurements for their holes and their inserts depending on what door they are creating at the time. This means that our hinge must be able to move freely and lock into place on the y-axis of the jig to ensure that it can move up and down to the desired height and can be locked into place when the height of the jig is set. The joints will be created out of a hard material (such as steel or a hard plastic) to ensure that they can last long when being moved many times over the course of the jigs use.

External Feedback

After discussing with other potential clients/users, we have received the following feedback that may benefit the stability and usability of the jig:

- It is important to consider if the suction cups may damage the material of the door while latched on.
  - The force exerted on the door surface due to the distance in air pressure inside and outside the suction cup may leave a mark on the door surface when the jig is removed.
  - It may be worth considering exchanging the suction cups with something less likely to damage the material.

- The suction cups should not be able to rotate easily, the base of the cup should be parallel to the surface of the door.
- There may be too much flexibility present in the jig because of the ball-socket joints. The intent is to keep the jig as rigid as possible.
- The suction cup arms should be conjoined at the base to allow for simultaneous movement, making it easier to adjust the height of the jig.

Updated Targets/Goals

After having conducted the tests, we have found that the ball and socket joins require longer arms to accommodate for wider doors.

Goals for the second prototype:

Alignment Test: Ensure precise alignment of the mold with the door edge and maintain consistency.

Measurement Accuracy Test: Verify that drilled/tapped holes match mold measurements with high accuracy.

Security Test: Ensure the mold remains securely in place to prevent damage or incorrect drilling/tapping.

Updated Bill of Materials

Table 1: Bill of materials

Item Name	Description	Quantity	Cost (CAD)	Extended Cost (Tax)
Aluminum Vacuum Heavy Duty Suction Cup	Is a suction that is used for glass but in the reviews, we found one being used on a finish used on the doors at AMBICO. (2 Pack).	1	$32.99	$37.94
Ball and Socket Joint	Is the joint that will be used at the end of the metal rod to connect the suction cup to the rod. (2 Pack).	1-2	$1.91	$2.20-$4.39
Steel	One of our group members has left over steel that we are able to use so that will be for the rods going to the suction cups as well as for the hinge jig that has the holes for different size hinges. Also be used for the locking mechanism of the steel hinge plate.	Depends on the size of pieces.	Free	Free
Tee Connector Fitting	Will be used to let the rods that have the suction cups on them move accordingly to the different sized backsets on the door.	2	$2.30	$2.64

			Total after tax:	$42.78-$44.97
			Budget:	$50

Second Prototype Test Plan

Test Methods (*How*):

Alignment Test:

Secure the jig in a fixed position: -

Place the mold into the jig.

Ensure the mold does not move and is perfectly parallel to the edge of the door.

Verify that the jig's frame holds the mold in place securely.

Use measurement instruments to check the alignment of the mold relative to the door.

Perform multiple alignment tests to ensure consistency.

Measurement Accuracy Test:

Secure the jig with the mold in place: -

Use the drilling/tapping tools to make test holes based on the mold's measurements.

Measure the accuracy of the holes drilled/tapped with respect to the mold's measurements.

Perform multiple measurements at different points along the door.

Security Test:

Secure the mold in the jig.: -

Apply force to the mold to simulate external factors that could potentially displace it.

Verify that the mold remains securely in place and does not get displaced during the test.

Ensure that the drilling/tapping tools do not inadvertently drill in the wrong place or damage the door due to mold displacement.

Data to Be Recorded (*How*): -

Results of alignment tests, including measurements of mold alignment relative to the door.

Measurements of the accuracy of holes drilled/tapped in comparison to mold measurements.

Observations regarding the security of the mold in the jig during the security test.

Any anomalies or issues encountered during the tests.

Estimated Test Duration (*When*):

The test plan can be completed in one or more working sessions, depending on the complexity and number of tests to be conducted. Each test may take a relatively short time, and the overall duration will depend on the number of repetitions and any necessary adjustments to the jig.

Conclusion

To conclude, we found a few flaws in our design during our first prototype. The most notable flaw is that the suction cups cannot be seated onto the door properly, as seen in figure 2. We will discuss and implement the new changes in following prototype. As we redesign the arms that connect the suction cups to the main door, we will also take the external and outlined feedback received into consideration.

References

Wright, E. (2014, July 15). *Custom Size Doors (Thickness, Width, and Height)*. Sun Mountain Door. Retrieved November 5, 2023, from https://www.sunmountaindoor.com/blog/custom-size-doors-thickness-width-and-height/