Deliverable D – Conceptual Design

GNG 1103[B]

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Brief Summary

Our team developed a functional solution with a minimum of three subsystems. Those subsystems include clear boundaries between each of them that ensure interchangeability. Each member created a concept for one of the subsystems based on our team's problem statement, benchmarking and the list of prioritized design criteria. Also, we analyzed and evaluated each subsystem and chose the best global concept. Finally, we included the benefits and drawbacks of the different concepts that our team considered.

Problem Statement

Ambico, a door manufacturing company needs a jig to aid in the drilling of holes/tapping of their doors. It is our task to create a reusable, reliable jig(s) that is easy to operate that will fit the dimensions of the door hinge and backset, with the proper arrangement of holes for drilling/tapping.

Functional Requirements and Constraints

Table 1: Design Criteria

Jig Needs and Priorities	Grading scale (1-5, 5 being high priority)	Design Criteria
Reliability	5	Expected service life (years)
Ease of use	4	User-friendly
Durability	4	Maintenance (months)
Drilling/Taping support	4	Compatibility (with different tools)
Reproducibility and Precision	5	Accuracy (in)
Cost effective	2	Cost ($)
Clear labeling of sizes	2	Display measurements (inch)
Size	2	Mass (LBS)
Must be able to notify the laborer when they are done drilling through the frame	3	Visual Cues

Design Criteria

The size variations between hinge #1(4 ½" by 4 ½”) and hinge #2(4 ½" by 5”), while slight, demonstrate the importance of selecting the right size jig for the intended application. The backset measurements, particularly #1(¼") which is used of both hinge sizes, #2(9/16”) which is used for 4 ½” by 5” hinge, and #3(11/16”) which is used for 4 ½" by 4 ½” hinge, provide essential information for proper installation, ensuring that the jig will align correctly with the door and the routered intent. The screws are 12-24 thread and a depth of ¾". This highlights the importance of developing the right-sized holes so that the screws can fit in the jig. While keeping in mind the importance of durability and long-term use.

Concepts

Jig 1 – Nathan’s Design

This jig will be made from steel which will ensure durability. It has a handle to make it easy to use and stabilize as seen in *Figure 1 and Figure* 2. 4 extrusions come out of the jig at the points that need to be drilled and tapped. These extrusions eliminate the need to mark and measure the points. The jig is designed to fit into the routered box on the door, guaranteeing that the same points will be drilled on each door. This jig will be reliable because it has no moving parts, meaning there is nothing that can be broken except the frame of the jig itself. Also, this jig will be cost-effective because its design is simple, and it will only need to be made from a single material. Lastly, the jig’s extrusions are short enough so that when the laborer drills through the metal interior of the door the drill will slip through letting them know they have successfully drilled through the door.

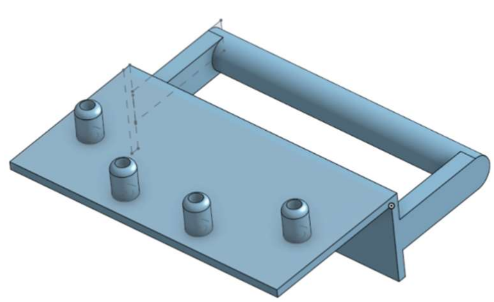

Figure 1: Jig 1 Isometric View

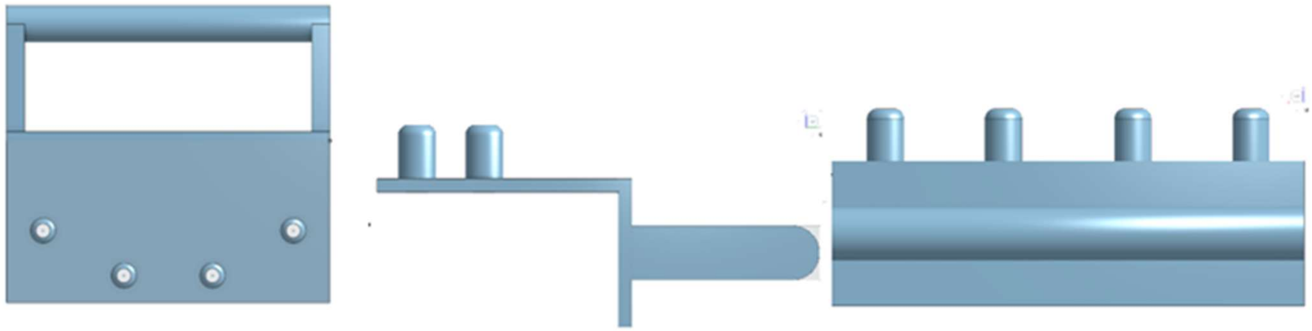

Figure 2: Jig Concept 1

Jig 2 – Jake's Design

The second concept was designed to be as simplistic and accurate as possible. During the first client, they mentioned that they have jig that the laborer's enjoy using for other types of doors. Therefore, it was a reasonable idea to take inspiration from that jig. In *Figure 3*, you can see an isometric view of the proposed jig. The jig is simple, there will be two different jigs for the two different hinge sizes. Both will use the dimensions of the size of hinge, with the correct hole locations. Around the hole locations, there is extrudes for drilling/tapping support. The thickness of the jig is the same depth of the inlay (3/16"). When using the jig, slide the jig into the inlay, then clamp the perpendicular part of the jig to the door to secure the jig when drilling/tapping. The jig can be modified with a handle or a built in C-Clamp. The top, front and right views can be seen in *Figure 4, Figure* 5 *and Figure* 6.

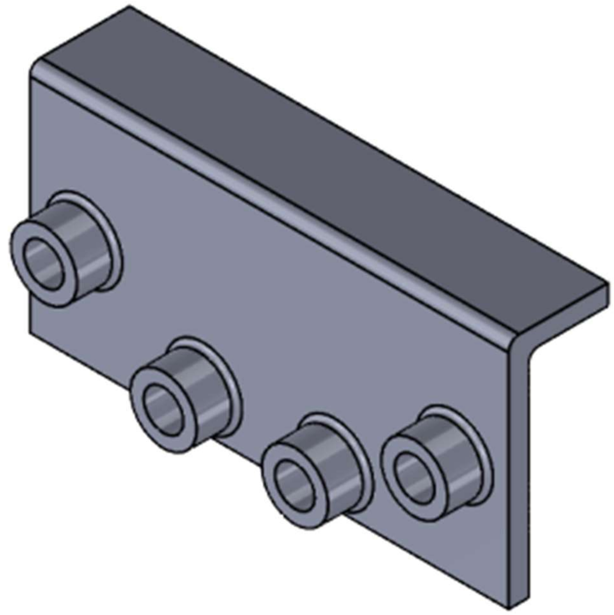

Figure 3: Isometric View of Jig Concept 2

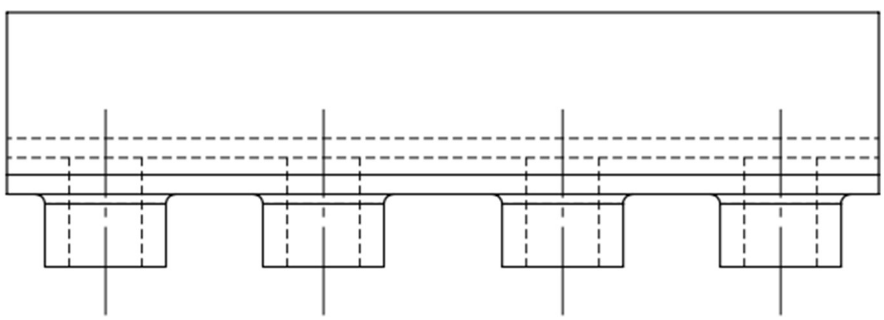

Figure 4: Top View of Jig Concept 2

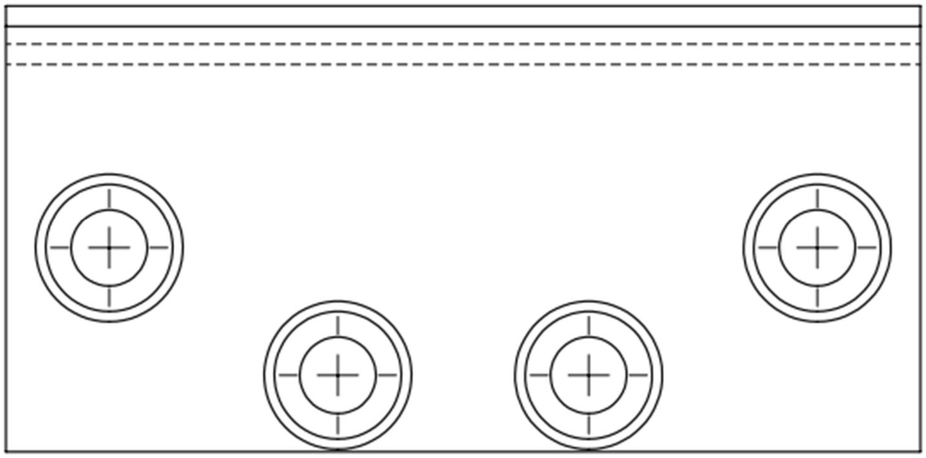

Figure 5: Front View of Jig Concept 2

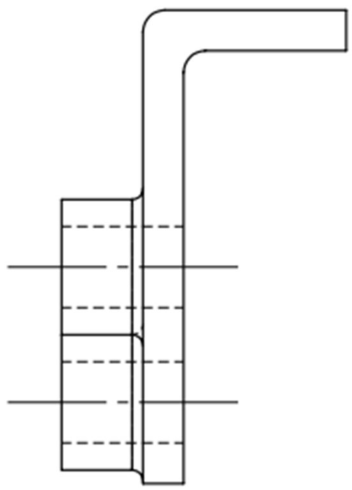

Figure 6: Right View of Jig Concept 2

Jig 3 – Jonathan's Design 1

This jig has two built in clamps that mimic a standard C clamp that allows the user to clamp and secure the jig in place, without the struggle of setting up and clamping down your own clamps. This results in a more user-friendly design and cuts down on time. This jig will be made from steel or cast iron to cut down on cost. The bottom piece of the jig will slide underneath the door to ensure a perfect lineup for drilling and tapping, the clamps will screw down onto the top of the door. The jig takes inspiration from the C-Clamp as found in *Figure 7*. The right, front, top and isometric views of jig can be seen in *Figure 8*.

Figure 7: Reference C-Clamp [1]

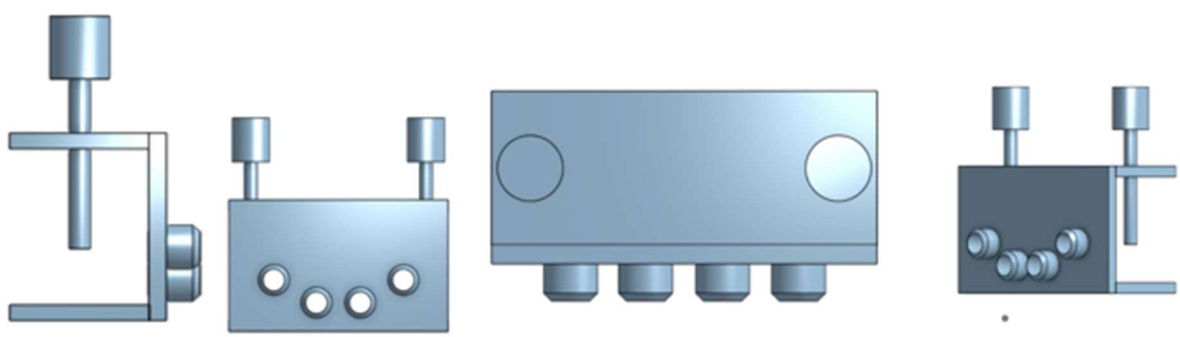

Figure 8: Jig 3 with All Views

Jig 4 – Jonathan's Design 2

This jig will also be made from some steel or metal. It is like the other designs; however, it has some added features. For example, as seen in *Figure 9* the grey piece shown is a piece of foam tightly secured to the top of the jig. This helps reduce the amount of pressure on the wood table from the clamps which will reduce the chance of damaging the product and having to restart. The extended pieces of the top of the jig as seen in *Figure 10*, allow the user to clamp both sides firmly to secure the jig in place, as well as being out of the way of the drill and tapping.

Figure 9: Jig 4 Top and Isometric Views

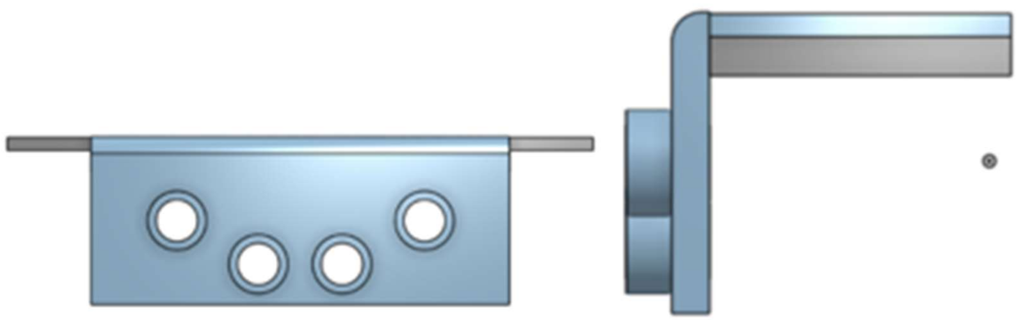

Figure 10: Jig 4 Front and Right Views

Jig 5 – Andrick's Design

This jig will be made from steel or metal. This concept is really similar to the previous jigs and super simplistic. Still, the only new feature is a semi-circle part (scale protractor) that allows the user to verify if all angles or in the norms.

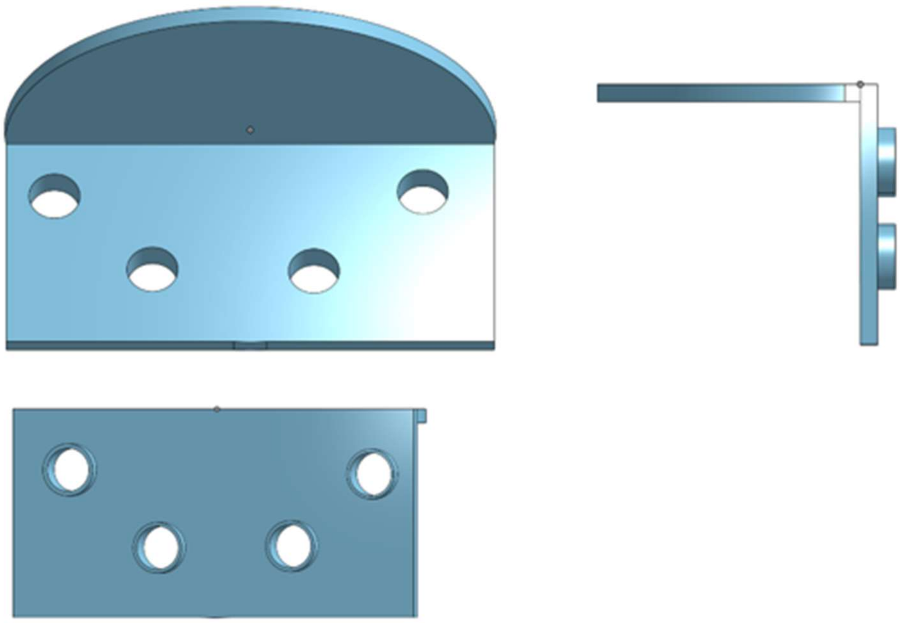

Figure 11: Jig 5 Isometric, Right and Front Views

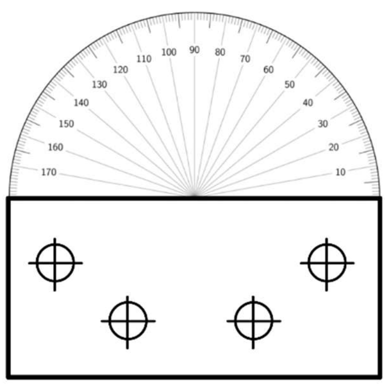

Figure 12 : Jig 5 Top View (Drawing)

Benchmarking

The benchmarking uses a scale of 1-5, with 5 being the best and 1 being the worst.

Table 2: Benchmarking Concepts

Needs	**Rating**	**Percentage**	**Jig 1**	**Weight**	**Jig 2**	**Weight**	**Jig 3**	**Weight**	**Jig 4**	**Weight**	**Jig 5**	**Weight**
Reliability (years)	5.0	16.0%	4.0	64.0	4.0	64.0	4.0	64.0	5.0	64.0	4.0	64.0
Ease of Use	4.0	12.9%	4.0	52.0	5.0	64.5	4.0	51.6	5.0	64.5	5.0	64.5
Durability (months)	4.0	12.9%	5.0	64.5	4.0	51.9	4.0	51.6	3.0	38.7	4.0	51.6
Drilling/Tapping Support	4.0	12.9%	5.0	64.5	5.0	64.5	5.0	64.5	5.0	64.5	3.0	38.7
Reproducibility and Precision (in)	5.0	16.0%	5.0	80.0	5.0	80.0	5.0	80.0	5.0	80.0	5.0	80.0
Labeling of Sizes	2.0	6.5%	4.0	25.8	4.0	25.8	4.0	25.8	4.0	25.8	4.0	25.8
Cost-Effective	2.0	6.5%	4.0	25.8	3.0	19.4	3.0	19.4	4.0	25.8	4.0	25.8
Size (LBS)	2.0	6.5%	3.0	19.4	4.0	25.8	3.0	19.4	4.0	25.8	3.0	19.4
Visual Clues of completion of drilling/tapping	3.0	9.7%	4.0	38.7	4.0	38.7	4.0	38.7	4.0	38.7	3.0	29.0
Total		100%		434.7		434.7		414.9		402.0		398.8

Concept Decision

The concept's final decision was made based on the subsystems that our team benchmarked. First, we developed a rating system in which we gave each subsystem a specific weight (as a percentage) and graded each single subsystem (1 being low and 5 being high). After that, we calculated the final rating for each jig design by multiplying the weight (in percentage) by the rating (1 to 5). In the end, we contrasted each rating and selected the highest. Nathan

Malench and Jake Brown both received the same final score. Therefore, we chose to combine the two designs. The handle element in Nathan's design was the sole thing that set it apart. However, Jonathan Swyer, one of our team members, had a fantastic feature that none of us had thought to incorporate into our design. A C-clamp is a part of Jonathan Swyer's design. His characteristic gave the jig additional stability. Thus, this element was incorporated into the final decision design. To sum up, the design of our team jig will incorporate the handle feature of Nathan Malench, the clamp feature of Jonathan Swyer, and the base feature of Jake Brown.

Project Plan Update

https://www.wrike.com/workspace.htm?acc=4975842&wr=20#/folder/1215239062/list?viewId=202489438

References

[1] [Online]. Available: https://www.artnews.com/wp-content/uploads/2020/11/61cmGYrNrL._AC_SL1200_.jpg.