GNG1103 B00

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Abstract

This report is dedicated to the development of conceptual designs for a door hinge jig. It employs a multifaceted approach, integrating insights from user benchmarking, technical benchmarking, and a meticulously prioritized set of design criteria. The central inquiry revolves around crafting a highly functional and adaptable solution comprised of a minimum of three well-defined subsystems to ensure seamless interchangeability and enhanced efficiency. Influenced by user benchmarking, the designs prioritize user needs, ensuring not only technical excellence but also user-friendliness. Technical benchmarking ensures alignment with industry standards and ease of use, positioning the solution at the forefront of innovation. The prioritized design criteria place emphasis on key attributes, including durability, user-friendliness, cost-effectiveness, and sustainability. This project contributes to the advancement of the prototype by coordinating user-centric design with technical prowess, resulting in a solution that excels on all fronts.

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1. Introduction:

This report presents the culmination of a comprehensive analysis of diverse design options, resulting in the identification of our initial solution. This solution integrates an imbedded and interchangeable preset sub-system, a robust support sub-system, and an integrated levelling and depth signaling system. Each team member actively contributed by designing their own concepts. Subsequently, the advantages and disadvantages of these concepts were carefully evaluated to guide the selection of features for *substitutability* for three *conclusive* subsystems. The primary objective of this report is to provide an all-encompassing overview of the entire concept generation, examination, and evaluation process, with a central aim of identifying the most promising concepts for further development.

2. Functional Solutions:

1.1 Solution 1:

Solution 1 is a design that makes use of a swappable preset sub-system system, a support sub-system, and a combined levelling and depth signaling system.

Subsystem 1 – Clamping device.

Firstly, to allow the system to switch between presets the decided solution is reversible. One side has all the requirements for the 4.5 by 5-inch hinge while the other side has the requirements of the 4.5 by 4.5-inch hinge. To ensure that the presets do not interfere with one another, a hinged edge permits the preset not in use to be moved out of the way. The main disadvantage of this system is the loose preset which can get in the way when drilling. In addition, the hinge will require some maintenance such as oiling.

Subsystem 2 – Depth + angle of entry control.

The combined depth-levelling system will include thickened plates that fit snuggly into the pre-routed holes. These plates will have stop collars around the holes which will stop the drill once it has reached the desired depth. Additionally, the collar's depth and the guide ensure that the drill remains straight and perpendicular. Only a straight drill would be able to properly insert into the holes and drill into the door. Unfortunately, this could add weight to the jig and the stop collars add to the irregular shape. The stop collars could also be damaged if the drilling is harsh.

Subsystem 3 – Ability to fit both hinge sizes.

Lastly, the support system relies on double-sided one-hand clamps. These can be manually and quickly adjusted to the desired strength using a button, and they support the hinge well no matter which side is being used. The lower support paddles provide the opposing force. Furthermore, to prevent the plate in use from falling over and to facilitate storage, small magnetic knobs hold the plates in the upright position. Padding is also present on the clamps so that the veneer on the door is not damaged. The one-hand clamps also allow faster attachment. The added attachments, while sturdy, make the jig flimsier and potentially more difficult to store.

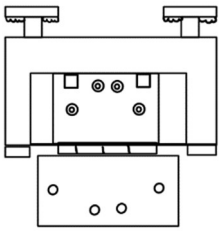


Figure 2.1.1: Front view

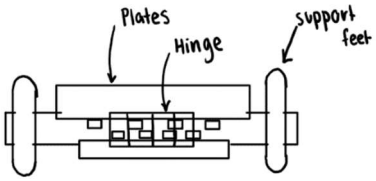


Figure 2.1.2: bottom view

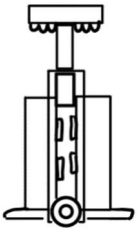


Figure: 2.1.3 Side view

Criteria	**Score 1-5**
Jig allows hole marking	5
Jig signals when to stop drilling	5
Jig is compact and easily held	4
Jig is reliable	4
Jig is durable	3
Jig is appropriately priced	3
Jig is easy to use	4
Jig stays in place while drilling (support system)	5
Jig weight	3
Hinge offset compatibility	5
Speed of use	4
Includes Preset Adjustability	5

2.2 Solution 2:

Subsystem 1 – Clamping device.

To ensure ease of use in a busy shop environment, we decided to consider a spring steel clip design to secure the Jig to the door. This design can be accurately used one handed. The drilling guide portion of the jig sits directly in the pre routed hole on the door. This allows the arms to securely grasp the outside faces of the door. Contact between the jig and the door is made with thick rubber feet, this protects the wood veneer from damage and helps best secure the jig while drilling.

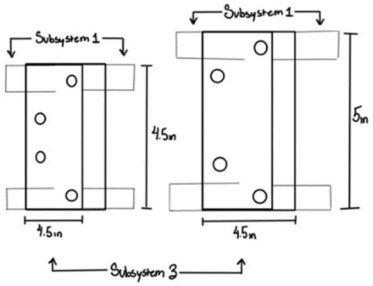
Subsystem 2 – Depth + angle of entry control.

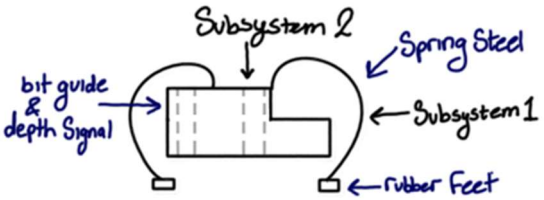
When drilling and tapping holes that will secure a hinge in the future, it is important to ensure that they are drilled at both the correct depth and angle. Utilizing a built-in stop collar design, we can account for both factors at once. This stops collar protrudes enough from the jig that the user will require very little

effort to maintain a perfect 90-degree angle. As one of the most important constraints of this design we felt it important to ensure the user error was mitigated as much as possible.

Subsystem 3 – Ability to fit both hinge sizes.

After a lengthy discussion it was clear that the simplest, most accurate solution was not in fact an adjustable jig, but two jigs. One measuring 4.5/4.5inches and the other measuring 4.5/5inches. When analyzing the jig dimensions, we found that the holes on the smaller jig were too similar to make a straightforward jig for use in a busy environment. To alleviate the guesswork and human error in the process of drilling and tapping these important holes, we felt the best solution would be to have two straightforward jigs.





Criteria	Score 1-5
Jig allows hole marking	5
Jig signals when to stop drilling	5
Jig is compact and easily held	4
Jig is reliable	4
Jig is durable	4
Jig is appropriately priced	3
Jig is easy to use	4
Jig stays in place while drilling (support system)	5
Jig weight	3
Hinge offset compatibility	5
Speed of use	5
Includes Preset Adjustability	1

2.3 Solution 3:

Subsystem 2 – Depth + angle of entry control.

The third design solution also utilizes a combined levelling and depth signaling system, again in the form of depth stop collars integrated into the jig (figure 2.3.1). The combined subsystem optimizes the accuracy of the jig while improving the concision of the solution, allowing for a more reliable product.

Subsystem 1 – Clamping device.

A screw can be manually adjusted to clamp to working area on the door (figure 2.3.2). This makes for easily adjustable tightness done by quick manual adjustment. However, this subsystem adds bulk to the jig, and if the depth of the working door is not significant, adequate clamping may be challenging.

Subsystem 3 – Preset adjustability .

Similarly, to solution 2, this solution requires the use of two jigs to bypass the bulk created by the additional subsystems, each one with its own permanent preset hinge specification.

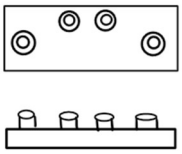


Figure 2.3.1: Depth Stop Collars

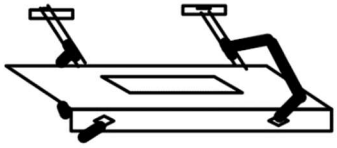


Figure 2.3.2: Screw clamping subsystem

Criteria	**Score 1-5**
Jig allows hole marking	5
Jig signals when to stop drilling	5
Jig is compact and easily held	2
Jig is reliable	4
Jig is durable	4
Jig is appropriately priced	3
Jig is easy to use	4
Jig stays in place while drilling (support system)	5
Jig weight	3
Hinge offset compatibility	5
Speed of use	4
Includes Preset Adjustability	1

2.4 Chosen Solution

After much conversation and analysis, the design team decided to go forward with Solution 1 – a combined depth signaling and levelling system, a swappable preset system attached by its own hinge, and a support subsystem.

The main goal we had in mind was to keep our solution as streamlined and simple for actual everyday use, as possible, to cut down on loose parts, and keep the jig as sturdy, durable, yet compact as possible. It was noted early on that some solutions would lead to bulkiness or would not allow for the jig to lay flat against the door, like the initial idea to have the interchangeable plates attached by a pin mechanism in the corner. It worked at first glance but the team realized to would lead to the jig not being able to lay flush to the door and level, depending on which preset the worker is using. Not to mention this idea doesn't allow for a stop collar to be implemented, elsewise the plates would not lay flat. In its stead we decided on two different templates for the different standard hinge sizes, but they would be attached to each other, reminiscent of a door hinge, so they don't interfere with the other preset during the marking and drilling and ensuring consistent depth measurements. The depth system is a combined depth levelling system, where stop collars are used to keep the drill at the right depth when drilling but also the jig will fit into pre-routed holes ensuring that in tandem with the stop collars, only a drill that is parallel to the ground will be able to drill effectively. This particular system increases ease of use for the user and makes it so they can complete their task quickly and effectively, given that the jig will be one streamlined piece.

Our clamp system is going to be double sided hand clamps so that the tightness and position of the jig can be easily adjusted and secured by hand, regardless of which side of the jig is being used. It will also have cushioning so that the wood veneer is not damaged, but the jig can remain tightly secured. These features were chosen because other ideas posed were functional, but they lacked a certain ease of use.

Overall, the design team felt as though this solution, and all the features of it, solved all the problems posed and will provide the client with a solution to address their concerns and meet their needs.

Conclusion:

The design team has navigated the concept generation process, resulting in a compelling solution. This solution incorporates the innovative concept of a preset integrated stop collar for each hole, which serves a dual function, seamlessly handling leveling while streamlining the preset functionalities. Additionally, the implementation of hinged presets within the clamp and a padded button spring clamp has significantly improved the overall performance and user-friendliness of our chosen idea. We also considered the feasibility of separate jig solutions, each with its permanent preset hinge specifications, uniform leveling criteria, and clamping mechanisms. The ability to interchangeably evaluate and compare these concepts ultimately led to the selection of our integrated solution as the most promising path forward. Through this rigorous process, we have paved the way for further development, ensuring that our project continues to progress effectively and efficiently.

4. Appendix

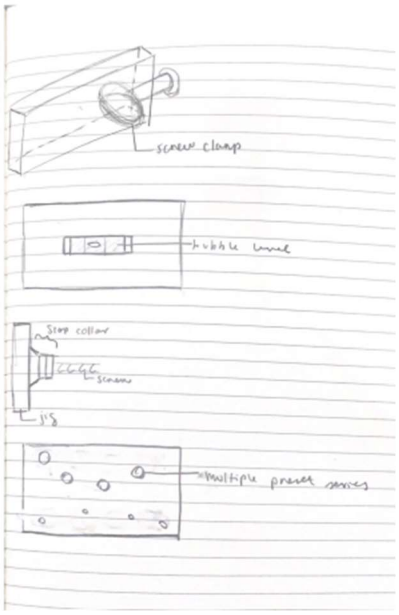
Lauren's Ideas:

Screw Clamp: Screw can be manually adjusted to clamp to working area on door, cushioning can be added to prevent damage to veneer. Advantages: easily adjustable tightness (easy to remove), quick manual adjustment. Disadvantage: adds bulk to jig, depth of working door not significant, adequate clamping may be challenging

Bubble level: When jig is clamped, bubble indicator in glass vial for relative level. Advantages: simple system, inexpensive. Disadvantages: Awkward bulk added to jig, precision can vary

Depth stop collar: Integrated in jig, catch drill bit when desired depth is reached. Advantages: appropriate for consistent drill bit size, accuracy. Disadvantages: Material used can damage drill bits, will require thorough analysis to ensure drilling angle preserved and drill bit is properly secured

Preset series: Series of presets integrated into the side of the jig. Advantages: Does not compromise jig durability/ sturdiness, inexpensive. Disadvantages: closely sized presets limited, without proper identification of matching holes, series could be misleading



Sonya's Ideas:

Clamping/support system: Firstly, there are magnetic strips that attach the hinge to the jig ensuring it stays in place. There are two, one-hand clamps built onto the jig, they are tightened using a squeeze trigger, and released by a button. There are stationary padded clamps on the back which provide the opposite force when the one-hand clamps are tightened. The clamp heads are long to decrease the pressure applied on the veneer and are covered in foam or rubber to prevent

damage to the door. Some disadvantages include clunkiness caused by the excessive clamping measures and their irregular shape. Also, the magnet might be too strong or not strong enough and interfere with the drilling or not cover enough of the hinge acausing it to move around.

Figure 3.1: Magnetic Attachment System

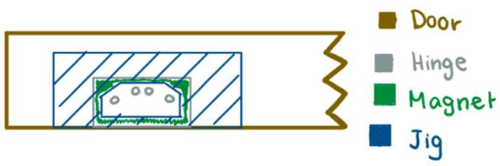
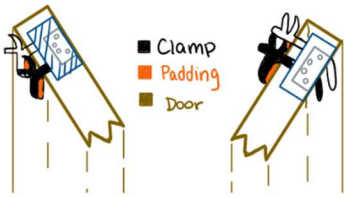


Figure 3.2: Clamping System



Levelling system: The Jig is pre-built with the clamps perpendicular to the door and a mini builder's level to ensure the device is level. The drill guide will allow the drill to be rested against it and maintain the bit's orthogonality. The strange shape may make it prone to breaking and make it strange to store. It also does not always guarantee perpendicularity.

Depth Signaling system: Magnetic stop collar fits and sticks around the hinge holes. It stops the drill from going too far. I could get lost easily or be difficult to move or unable to center around the hole. It could also damage the drill bit.

Figure 3.3: Depth Signaling System

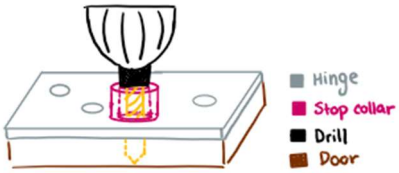
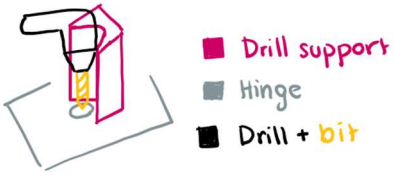
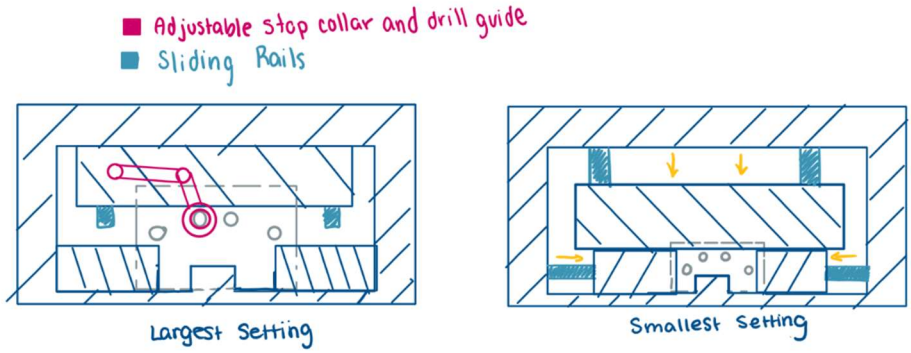


Figure 3.4: Leveling System



Swappable preset system: The left and right sides as well as the back of the jig can be pushed in and out. This can be done by spinning a nob or a pushing a button that would release the setting locks and allows the sides to move. An adjustable stop collar attaches to the hinge by a magnet, or it is attached to rails so that if can be moved into any configuration (this is connected to depth signaling and levelling). Some issues could be the rails getting stuck or slightly inaccurate to the measurements when adjusting. Due to the many moving parts the system could become fragile due to lack of support.

Figure 3.5: Adjustability



***Other ideas: If we want to get fancy, we could program an Arduino with a laser sensor which would beep or flash if it is not level. Arduino sense how far the drill has gone down

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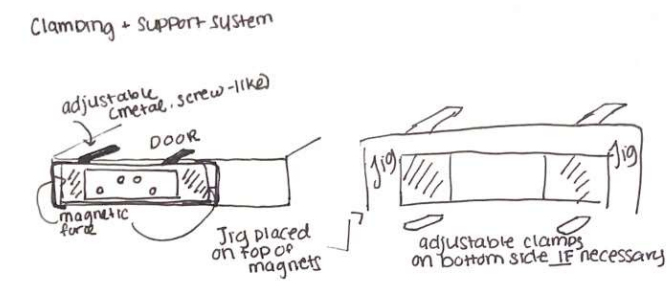
Nadia's Ideas

1. Clamping/Support System: The clamping/support system utilizes an magnetic clamping mechanism. Powerful magnets are strategically placed on the jig to securely hold the door in position. The jig also features adjustable, non-slip rubber feet that provide stability during hinge installation. These feet can be easily positioned and locked into place.

- *Disadvantage:* Regular checks to ensure magnet security may be necessary. Will the clamps damage the wood?



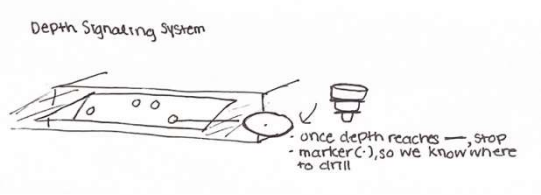
2. Levelling System: A self-leveling design - The jig is equipped with an internal pendulum that automatically adjusts and levels the device when placed on the door. This feature ensures precise hinge installation even on uneven surfaces. (This may be out of the box and hard to design but an idea!)

- *Advantage:* The self-leveling system automatically adjusts for precise leveling, making it user-friendly.
- *Disadvantage:* Occasional calibration checks may be needed to ensure ongoing accuracy.

3. Depth Signaling System: Hinge installation with a set of color-coded depth markers - These markers are crafted from lightweight plastic, ensuring they are long-lasting and easy to handle. Somewhat like mini traffic lights – each

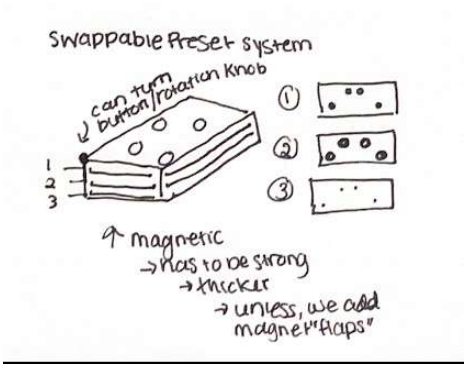
color corresponds to a specific hinge depth. When it's time to drill, you select the right "traffic light" marker and attach it to the drill bit. As you drill, watch for the marker to signal you - once it touches the door's surface, you know you've reached the correct depth, and it's time to stop. It's like having a built-in depth guide, taking the guesswork out of the process and ensuring precise hinge installation.

- *Disadvantage:* Can be misplaced but replacements should be readily available and affordable. Also, it is not attached to the jig itself. Precision might not be great.

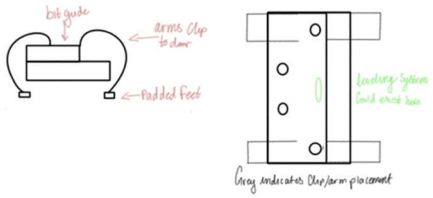


4. Swappable Preset System: A jig with sliding slots - marked for various hinge configurations. Users can easily adjust these slots using a simple rotating knob or a push-button lock release. Once set, they securely lock in place. The system also features an adjustable stop collar that magnetically attaches to the hinge, aiding in drilling precision.

- *Disadvantage:* Proper support is crucial to avoid fragility issues due to multiple moving parts. Can make it weigh more and thicker in size.



Nora's Ideas



1.Padded Clip Device The jig itself has an arm similar to a clip seen on a pegboard (see "a" on sketch) This clip extends past the jig only far enough to fit the smallest back set but has enough flex to accommodate the largest back set. Advantage: quicker to install over other clamping or screwing devices, is also easy to remove.

Disadvantages: clip may weaken over time and possibly snap. Clip may cause damage to veneer if not properly used

2.Jig fit to pre routed hole

Jig will be made to the exact dimensions that are routed for the hinge. This mitigates user error. Disadvantage: We would need two jigs, one for each size of hinge.

3.Depth stop collar

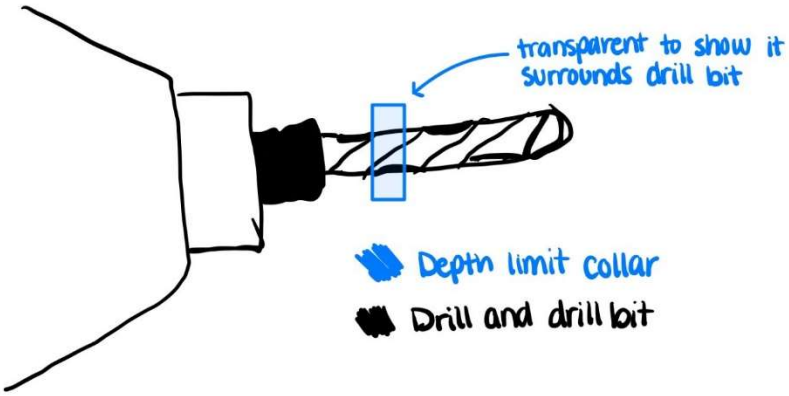
Protruding bit guide and stop collar ensures drill bit enters at a 90-degree angle and indicates the user when it is time to stop drilling. Disadvantage: Will only work for one drill bit size. Relatively minimal user error unless the bit guide is damaged,

4.None

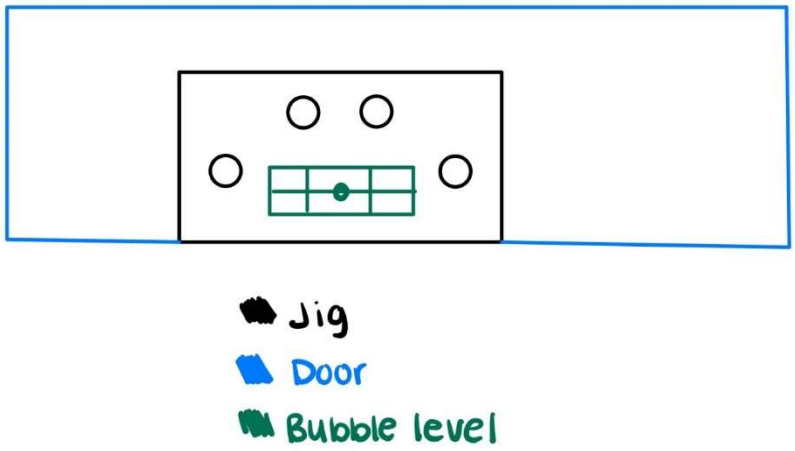
I personally believe that in order to ensure this jig is as effective as possible in a busy work environment we should have two jigs. One for the 4.5/4.5 hinge, and one for the 4.5/5 hinge. The holes are much too close together to create an accurate jig that will increase productivity.

Reema's Ideas

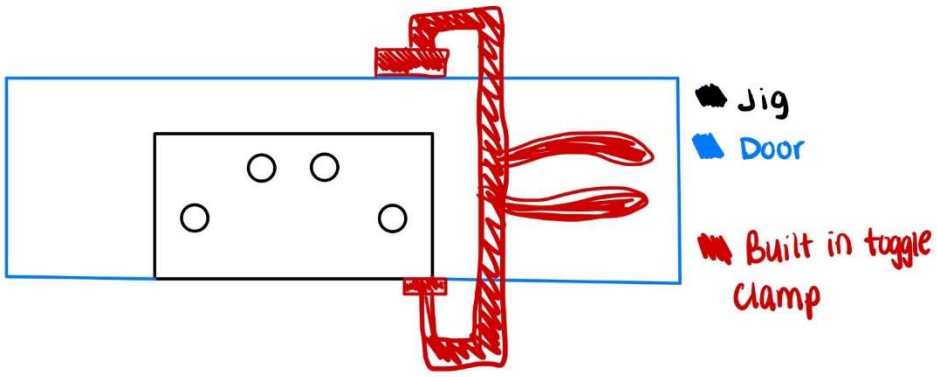
Depth Signaling System: To keep the drill from being able to drill far too deep, stop collars can be attached to the drill bit so that while using the jig it is easy to use and reproducible.



Levelling System: In order to keep the jig perpendicular to the floor and level, a bubble level could be attached to the jig on the front facing side, since they are easy to source and accurate, however this poses the problem that it may be able to indicate error but it cannot prevent it.



Clamping system: The clamp for the jig could be a very simple, built in toggle clamp, that can be adjusted by hand. The clamp could also be slightly modified so that all sections that touch the wood panelling would be cushioned so as to not damage the wood veneer. This also leaves room for the material to be a better gripping one like a pleather, or a suede, so that it provides extra grip to the clamp, to compensate for the fact that it won't be clamping as hard as it could on a solid steel door without a veneer.



Preset system: Attachable plates with a locking mechanism could be used, and they could be attachable to the jig with a screw/pin that would articulate with the corner of the jig. The desired plate could be affixed with a pin screw in the corner and the jug would be a general template and the plates could be

used to manually adjust the hole positions