

USER & PRODUCT MANUAL

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Abstract

This document shows the overall process to reproduce our final prototype. It is intended to review and analyze all the materials and processes behind the production of a door hinge creation and allows the reader to reproduce our prototype.

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List of Acronyms and Glossary

Table 1 Acronyms

Acronym	Definition
UPM	User and Product Manual
US	Unhinged System
BOM	Bill of Materials
DIY	Do It Yourself

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Introduction

This User and Product Manual (UPM) provides the information necessary for users to effectively use the Unhinged system (US) and for prototype documentation.

Unhinged is a jig made specifically for making hinge holes in wood doors, the main idea is to save time and effort for the workers, and it must be able to allow the production of 1 to 2 more doors per station in a day. This product is made out of sustainable and reusable materials, along with advanced features that make the perfect system every door company wants to have.

This manual is intended to provide a customer with the knowledge necessary to operate the system; it also covers the ideology, background aspects, and theories behind the production process of a US. After reading this document, the user will be able to identify the risks and care recommendations of the system, they will also be able to empathize with the product and recreate the design.

Please read very thoroughly the whole document as it will allow proper usage of the product and will allow it to last longer.

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Overview

The background of this project lies in servicing a door-manufacturer company by designing a jig that can be used to fasten the process of hinges placing. A laborer spends a significant amount of time measuring and marking the placement of the holes required in doors to attach hinges. Once the holes are marked, they are drilled and tapped by hand in a very precise location and angle. There are 4 different variations of hinges:

- a. 5" Length x 4.5" Width with a 9/16" backset
- b. 4.5" Length x 4.5" Width with 1/4" Backset
- c. 5" Length x 4.5" Width with a 1/4" Backset
- d. 5" Length x 4.5" Width with a 11/16" Backset

The client's needs were discussed, and the requirements of the system were empathetically transcribed, and the system had to be reliable, easy to use and time-saving. These needs were translated into problem statements that were addressed during the design process. Those statements were:

1. The jig must be used to drill the pattern of holes for the hinges and speed up the time.
2. The jig can either be adjusted depending on the hinge type or multiple jigs can be made.
3. The jig should allow the laborer to know at what depth to stop drilling and ideally would aid in keeping the drill perpendicular to the door.

The design must be able to:

Make accurate holes as fast as possible(min): the main reason they are looking to change what they are doing right now is so they can save time and money. This means that if the device takes more time, they will not accept it.

Be attached to the door: It is also important for the device to have the capability to be attached and removed from the door. The worker needs his two hands to be free to hold the drill properly. Moreover, the device needs to be easily attached without taking much time.

Be used for multiple hinge sizes: the client uses two different hinges for their doors, which means that we should account for that by either making two separate devices or making an adjustable one.

Be operated in a dusty environment: the workshop is a dusty environment as all the manufacturing is done there. This means that the device cannot have a lot of complicated

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or small parts that can easily jam. So, it is preferable to have a device with as few moving parts as possible and to be easy to clean.

Our design team brainstormed a variety of prototypes and eventually landed on the basis that was transformed into our final design, the Unhinged System (US).

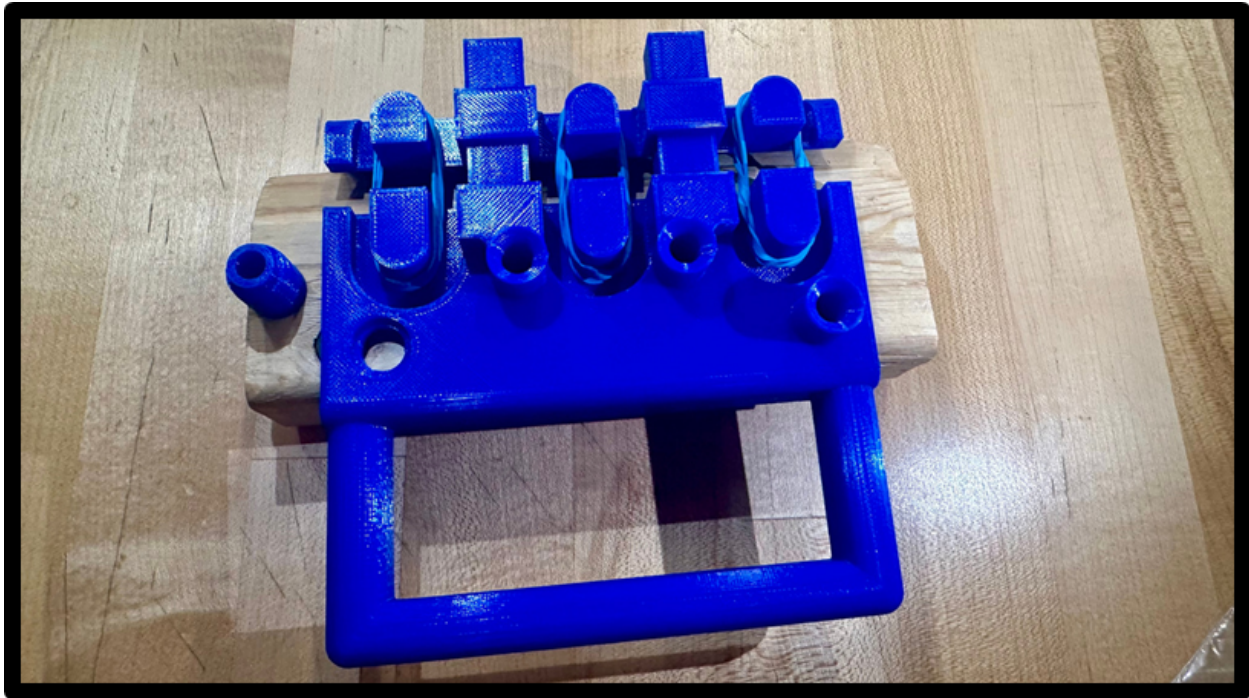


Figure 1 Final Prototype

We tried to find something similar online, however, there's nothing similar to the prototype, that's why our prototype is unique and so important for anyone who uses it. Our design is simple yet effective. It hooks onto the door which will eliminate the need for marking. As well as the nozzles will help guide the drill bit and the tapping bits into the exact location they need. The elastic will help clamp the jig securing it for when it is being used. Our prototype will speed up production whilst minimizing the damage to the doors.

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Cautions and Warnings

- Do not place your fingers directly in between the clamps, doing so can result in your fingers being pitched. Gloves can be worn while operating the jig although it is not necessary.
- Do not over-extend the prototype, this may cause it to break apart.
- Do not place it in temperatures over 40°C.
- Keep detachable nozzles in sight at all times. When placing them in the jig, be careful to position them correctly, otherwise the parts may burst and cause serious injury.
- Do not apply too much pressure into the jig as this may cause it to break apart.
- Keep away from flammable materials.
- After each use, properly clean the jig, this can improve the nozzles life.
- Always ensure the springs and rubber bands are in good condition, if not, please change them immediately. Not changing the springs or rubber bands when needed may cause the product to break apart and cause serious injury.
- Dispose of the nozzles, springs, and rubber bands properly.
- Store in a dry place and preferably off the ground.
- In case anything is not working as expected, please call us immediately to offer you support with the product.
- Unhinged is not responsible for any misuse by the client.

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Getting Started

Unhinged is made out of 3D printed parts with steel nozzles. This product is supposed to give more accuracy, precision and save time to the workers who have to mark, drill, and tap the holes for the placing of hinges in wooden doors. After multiple prototypes, we concluded that Unhinged was the best prototype of all and decided to implement it.

The product comes with four (4) nozzles made out of steel that will allow the drilling and tapping processes, giving the worker more stability and a better perception of where to stop drilling. Without the placement of the nozzles, the jig won't be as precise and effective.



Figure 2 Steel Nozzles.

We also have a slider; this part is considered one of the most important parts. It is supposed to hold the prototype in position where desired. It is a 3D printed part that will clamp the jig to the door.



Figure 3 3D printed slider.

To conclude, the product has a main body where everything is hold together. This main body is the part that holds the slider and the nozzles all together. It is a 3D printed part that has four (4) holes on the top face to hold the nozzles in place, and two (2) supports at the front part where the slider will slide through.

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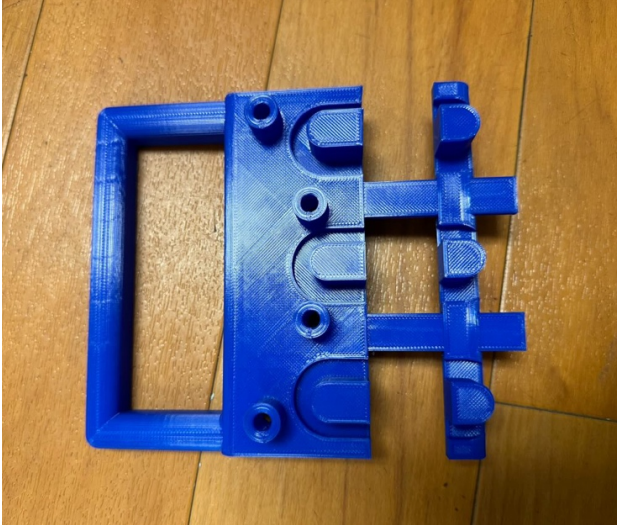


Figure 4 Whole working jig

Configuration Considerations

Please note, the jig comes in two different sizes: 4.5" by 4.5" and 5" by 4.5". The correct size must be selected depending on the required hinge backset. Please refer to your door specifications.

The door needing to be drilled should be placed or held (via stand/template) parallel to the floor so that will allow the user to drill comfortably. The jig can be used either upside up or upside down, the only condition is to be placed correctly depending on the backset.

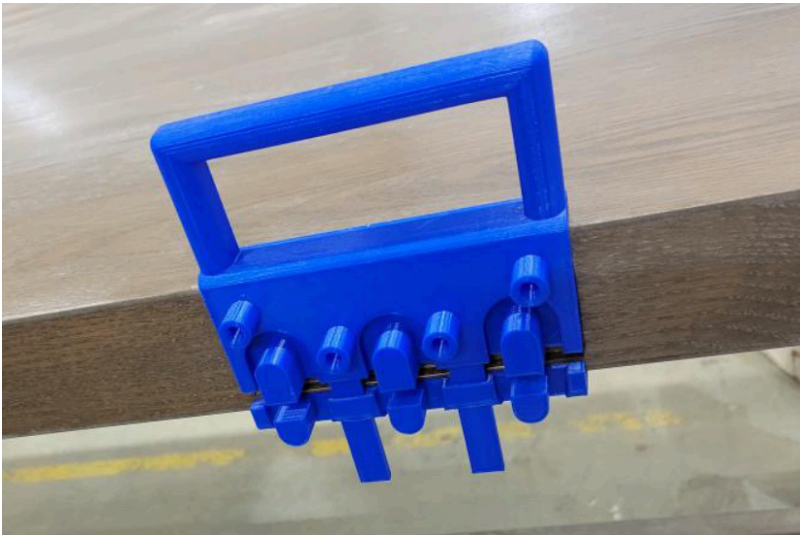


Figure 5 Proper usage of the hinge

If the worker places the door in a high position, this will allow a most comfortable drilling experience.

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User Access Considerations

The users meant to be using this prototype range from construction workers, door manufacturers, DIY individuals, and any individual who is fit to operate tools in a work environment. Please note, that this jig only requires one available hand to operate correctly. However, this prototype should not be used by persons who are not capable of operating tools in a work environment due to disability or medical conditions.

Setting up the System

The jig will come pre-assembled, should problems arise or need to be re-assembled for any reason, please refer to troubleshooting and support.

For ideal configuration, please ensure the elastic bands are attached tightly. The jig must be fully closed (tightened) when not in use so that a strong tension force is created when the jig is stretched, this will ensure the jig clamps onto the door securely.

Once ready to use, the jig should be carefully stretched over the surface and gently camped on as shown below.



*Video 1 Jig being clamped on a door.
You can find the video [here](#).*

Once clamped, the jig should sit securely on the door as pictured below.

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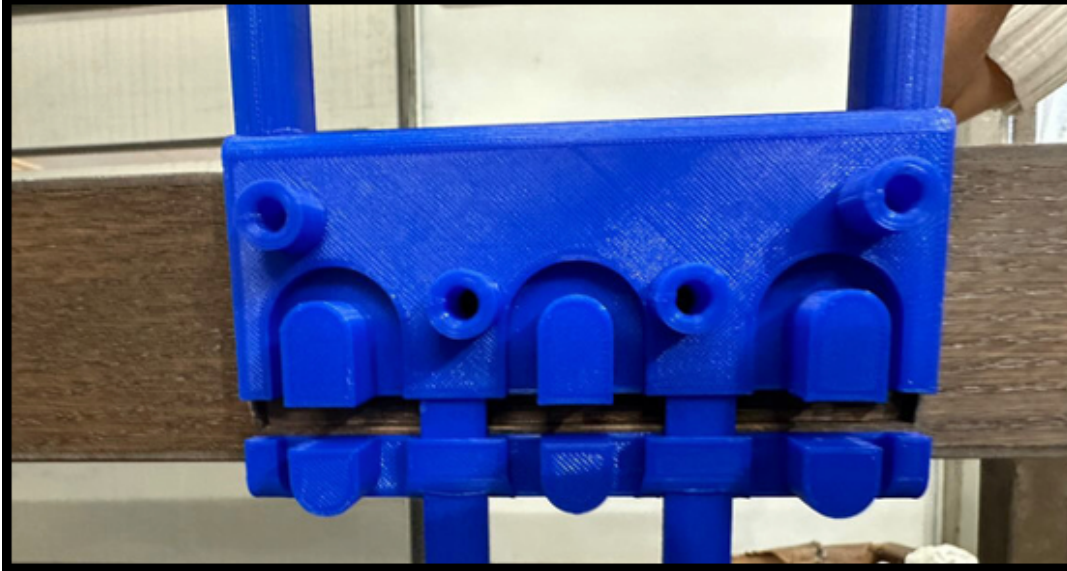


Figure 6 Jig ready to start drilling process.

System Organization and Navigation

During the usage of the US, you will be able to find five (5) parts that compose it. These five parts are:

- Main body
- Slider
- Nozzles
- Rubber bands
- Springs

The main body will be responsible to holding all of the other four parts together. The Nozzles will be placed in the holes on the top face of the main body; this will be placed by just applying pressure into the main body. The slider will be placed in the front of the main body (placed at the supports), this can be placed by just sliding it through the supports. The rubber bands and springs are meant to hold the slider in place and make it strong enough to hold the clamp in position; to place them just slide them through the upper spaces designated for them.

Exiting the System

Once you are finished using the prototype, you can hang it on a hook on the workbench or leave it on top of the workbench. Since it is durable and does not get

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damaged by being left somewhere and there is no dust to worry about, it can be left outside.

Using the System

To use the system, there are a few features you will need to take into consideration, these features allow the best functionality of the jig.

Slider

The slider is the main operational part of the jig and the main aspect which makes the jig usable. In order to use the slider, the user latches the slider part of the jig on to the opposite side of the door where the backset is while holding the handle of the jig. The user next pulls the handle back in order to stretch the rubber bands and pull the entire jig around the door.

When the slider is opened bigger than the size of the door the handle side is lowered into the desired position and placed down onto the door frame and slowly the user stops pulling back, and the rubber bands will pull the jig into position and firmly attach itself to the door frame.

Nozzles

The nozzles are removable, this feature allows the jig to have a long lifespan since the most common wear point of the jig is the nozzles. To remove the nozzles, simply hold the jig and pull on the desired nozzle, this will free the nozzle.

The nozzle can now be serviced, or it could also be replaced depending on the required operation. The new or repaired nozzle can be simply placed back into the jig.

Please dispose properly of any nozzle you remove from the jig. They are made out of steel, which makes able to melt and make new nozzles out of the same material.

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Troubleshooting and Support

Please follow accordingly this section. In this section you will find information about sources of error and the effective procedure you as the customer will have to do to fix this error.

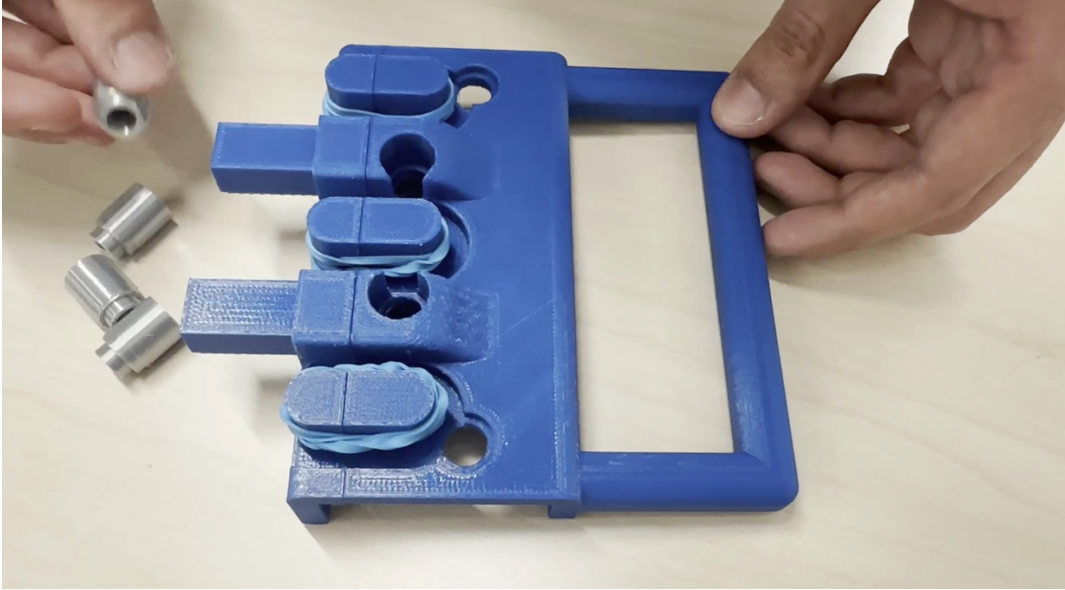
Error Behaviors

If the product presents any of the following errors, please contact us immediately or replace the jig immediately. Failure to do so may result in injury.

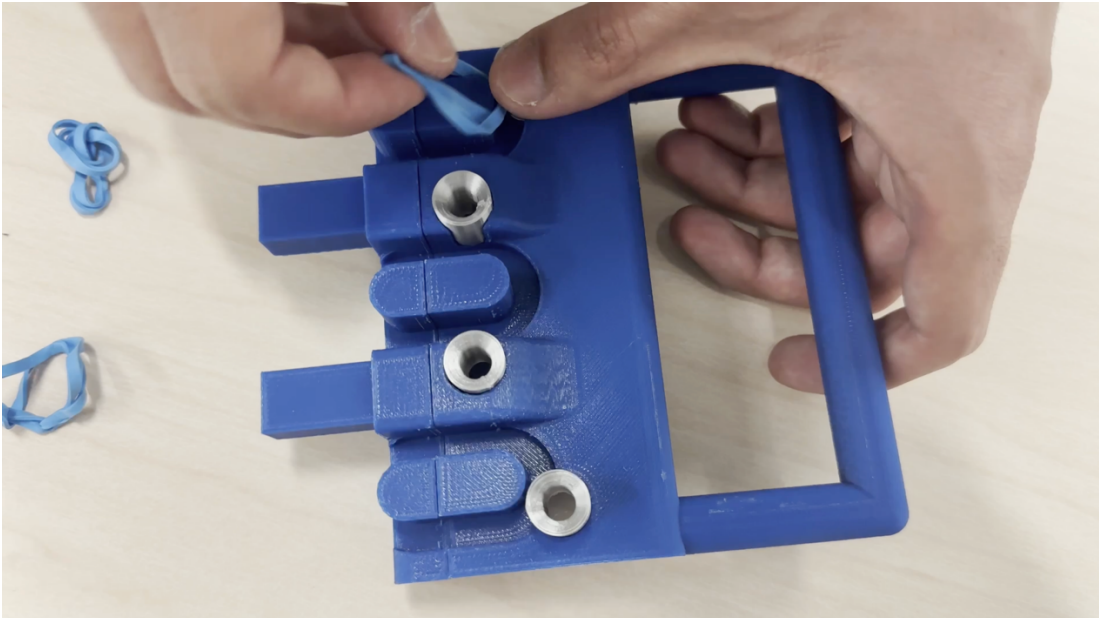
1. **Nozzles:** Nozzles may be affected after multiple uses. The jig is designed to account for this. Once the nozzles are worn out enough (this will be evident through cracks or the drill won't be as straight), this would be the time to replace them with new nozzles. Simply pull them hard and they may come out. To insert new ones, simply press them towards the jig.
2. **Broken rubber bands:** Rubber bands are one of the main parts of the jig as they give more stability to it. If one or more rubber bands break, please replace them immediately. To replace the nozzles, you will have to slide them up and off the jig. Replace them with new one by placing them in the same position.
3. **Breakage:** Although the jig is designed to withstand drops and breakage, this can happen at any time. If this happens, please replace the jig. Make sure to place the nozzles, slider, springs, and rubber bands again in place.
4. **Drilling problems:** If you ever feel that the drill does not fit properly, please replace the nozzles immediately.
5. **Stuck or cracked slider:** Without the slider, the jig won't be able to work. Please remove it by removing the rubber bands, the springs and pulling it out of the jig. Once it is out, replace it with a new one by sliding it into the new jig, make sure to place the rubber bands and springs in place again.

Please refer to the following videos where you can see how to replace the parts:

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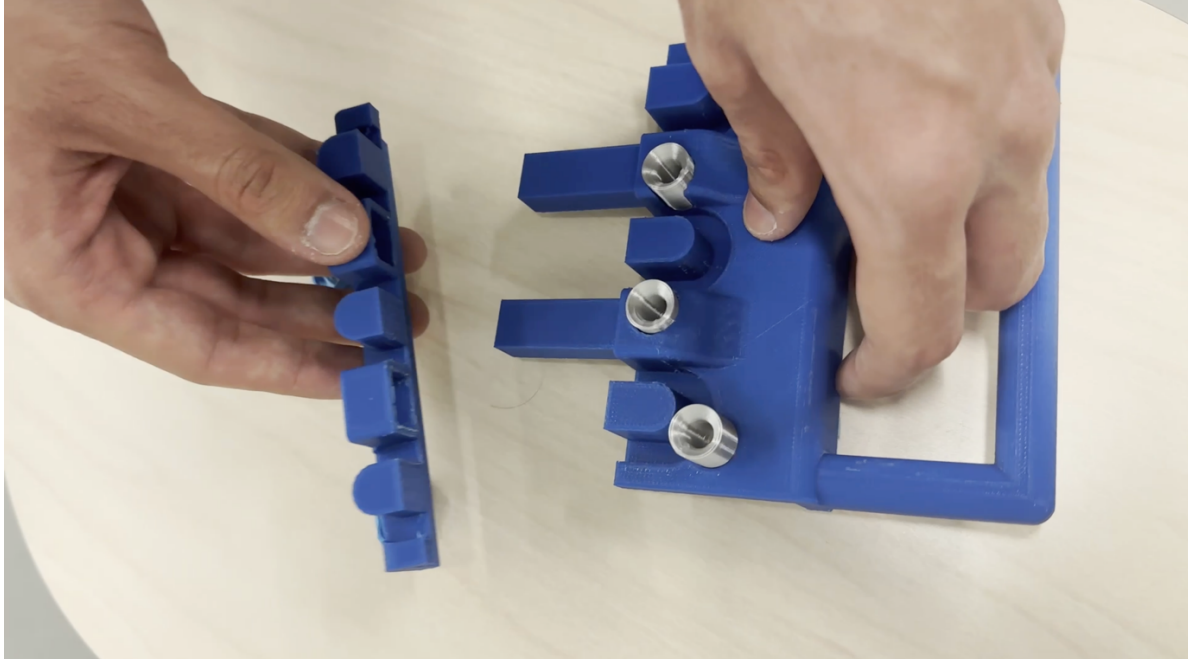


*Video 2 UNHINGED - Replacing the Nozzles
You can find the video [here](#).*



*Video 3 UNHINGED - Replacing the Rubber bands.
You can find the video [here](#).*

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*Video 4 UNHINGED - Replacing the Slider.
You can find the video [here](#).*

Special Considerations

This product manual is for a working prototype for an easy and portable jig that adheres to customer specification requests; AMBICO. Please note that the following instructions only provide instructions for a prototype and are not intended for repeated use under working conditions.

Maintenance

To ensure the proper working of the product, please check every day the nozzles and ensure they are in perfect condition, if something doesn't look good, replace them. Replace the nozzles after they are worn down or damaged. Please check the whole jig for cracks or damage, if so, please replace the whole system immediately. Please also check the rubber bands, if they are frayed or have snapped, they will need to be replaced also. Store in a dry place and preferably off the ground.

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Support

If you encounter any problems not mentioned here, please contact us for advice or guidance through the process.

Nicolas Alvarez

Email: nalva086@uottawa.ca

Product Documentation Bill of Materials (BOM)

Table 2 Bill of Materials (BOM)

ITEM DESCRIPTION	SOLD	MEASUREMENT	QUANTITY	UNIT PRICE	COST
3D FILAMENT	HERE	KG	1	\$ 33,99	\$ 33,99
ELASTICS	HERE	BAGS	1	\$ 1,69	\$ 1,69
SPRINGS	HERE	UNIT	3	\$ 2,79	\$ 8,37
		SUBTOTAL			\$ 44,05
		TAXES			\$ 5,73
		TOTAL			\$ 49,78

Equipment List

The following is a list of equipment needed for the construction of the US:

- 3D printer.
- Filament (you can choose the color).
- Steel nozzles.
- Springs
- Rubber bands
- Foam

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If you want to make the body of another material, you can use carbon fiber or metal, it depends on what you would like. Our jig can be custom-built to what our clients and customers would like.

Instructions

In this section, we will describe the whole process of making the Unhinged system.

Nozzles

The nozzles are one important part of the jig, without them, the jig would be only a piece of metal with holes, which is not the idea. They must be durable, that's because the drill must go through them, so, we decided to make them out of steel.

To make the nozzles, we start by making a model for them, this model must be done online and must perfectly fit the jig. Take into account that the nozzles need to be able to remove by just pulling them off. Also, take into account that the drill must go through it. After having the model, just simply melt the steel and place it inside the model, after freezing, it may have the form of the nozzle. Now, you have just finished the nozzles and are ready to start with the next part.

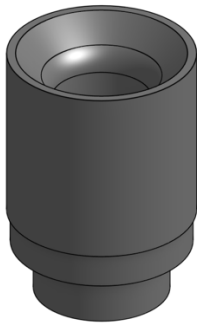


Figure 7 Nozzles design

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Main body

The main body is a 3D printed part. This is able to maintain in place the nozzles and the slider. It must be thick enough to support the vibration of the drill. It must have a U-shape hanger where the worker will be able to hold the jig. It must also have two support bars where the slider will be placed and four (4) holes to place the nozzles.

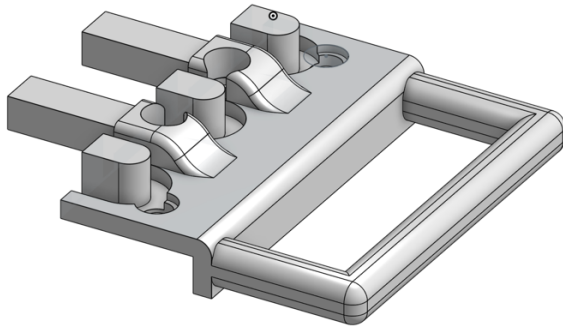


Figure 8 Main body design

Slider

The slider will be able to clamp the jig in position on the door. This part is one of the most important as it is the part responsible to clamp the jig and give stability to it. You must take into consideration that the slider must be able to slide along the support from the main body.

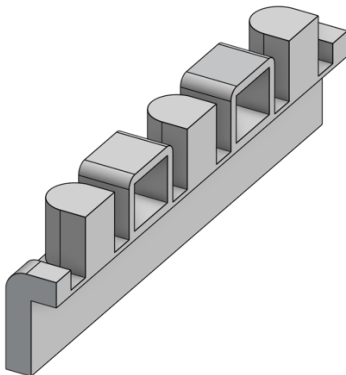


Figure 9 Slider design

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Testing and Validation

Table 3 Prototyping Test Plan

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	Test durability of the overall jig. Can handle a rough environment	The material we choose to make it out of will have to be durable. Maybe use a hard plastic or 3D printed material. Could use steel but might be too heavy.	A good jig will withstand drops from the table or getting the jig of the door if it is dropped. Should be strong also against being hit against a door when working.	November 14, 2023
2	Test that the jig will be able to clamp on the door and stay there.	This can be tested using a drill at the maker pro at school or using a household drill. We will clamp the jig down and see what happens when we start drilling.	The jig will need a strong enough clamp to latch onto the door and withstand the vibrations from the drill and when put the drill into the nozzles must not move.	November 20, 2023
3	Test that the nozzles are big enough for the drill bit and taper.	We will find the right drill bit size and taper size and test that the nozzles will be wide enough to fit the drill bit without getting worn down by the friction of the drill. This can be done when testing the jig clamp.	This will show us if we need to resize the nozzles or not. They should fit perfectly with a little bit of room.	November 20, 2023

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4	Test the nozzles can withstand the drills friction and won't break during the drilling	This will be able to test the different materials we need for the nozzles. The nozzles might have to be steel while the body can be plastic or something else. This will be done when testing the hole size.	It should be able to withstand the drilling friction on the side walls of the nozzles. It will help decide the best material to use.	November 20, 2023
5	Test that the holes are drilled straight using the nozzles.	This is to ensure the drilled holes are straight and not on an angle. If the holes are crooked the door will need to be restarted. This is an important thing to get right. We will do the same time as the ID 2, 3 and 4. When testing the nozzle size, we can test the straightness of the drilling as well as test the straightness of the drilling.	This should be straight as an arrow and in the middle of the holes so the hinges will fit perfectly.	November 20, 2023
6	Test that it will be easy to use for the workers.	This can be done by getting someone who's not in our group to try out the jig as if they were the workers, just to see how someone new handles it.	This should be an easy prototype to use. It should be simple, quick, and efficient. We are trying to maximize the efficiency of the jig.	November 21, 2023

The results of the prototype were very positive. We tested the durability of the prototype by dropping it from a desk to how much will the jig resist; at the end of our tests, it held up, we were not able to break it. We also tested the functionality and ease of use of the jig by untrained people, the result was overwhelmingly positive: the jig was easy to use, and people liked how well it worked. The test to determine the right metal to make the nozzles turned out to be a hardened steel. The steel resisted friction the best, the only problem being that it is a more expensive metal to begin with. If you compare the cost with the longevity, you can see that it is worth it in the long run.

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We are happy with the prototype III and believe it will greatly increase the speed of preparing the door for a hinge and therefore increase revenue for AMBICO.

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Conclusions and Recommendations for Future Work

In conclusion this journey of designing and creating the prototype for the jig has taught us a lot of things. We learned to better work in a group, to listen to each other's ideas, and to manage our time. These three factors were crucial skills to learn for the whole process of the product. Through prompt and effective communication, we were able to gather multiple ideas that ended up with the production of our jig, after multiple failures, we were able to improve on it. We also learned the fundamentals of designing a product and bringing it to life. At the end of this journey, we were able to better understand all the members of the team and mutually cooperate. We are all proud of our product and hope that you as the final customer are too.

For future groups that pretend to recreate our product, we highly recommend making sure you all participate and manage your time. If the work amount gets too much it'll be a lot harder to catch up. You will need to get proper filament and calibrate the 3D printer to get the temperatures right. Start printing as soon as possible as this will give you more time to work on any issue that may arise. Always communicate with each team member, this will ensure a safe and comfortable workspace for everyone, and you will be more effective.

During the US production, we found out that the metal nozzles need to be made of hard steel. Ensure nozzles can be easily replaced and perfectly fit in the holes designed for them. Also, ensure the body is hard enough to withstand wear and tear. Ensure the 3D printer is perfectly calibrated for the material you are using; this may have a great impact on the final product. Our main issue was with the project budget, we only had \$50 to make a jig for two different size door hinges. If given a larger budget, we could have finished our design the way it was meant to be.

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APPENDICES

APPENDIX I: Design Files

Table 4 Referenced Documents

DOCUMENT NAME	DOCUMENT LINK	ISSUANCE DATE
Hinge Jig 4.5"	<u>Link</u>	December 1, 2023
Hinge Jig 5.0"	<u>Link</u>	December 1, 2023
Hinge Jig Slider 4.5"	<u>Link</u>	December 1, 2023
Hinge Jig Slider 5.0"	<u>Link</u>	December 1, 2023
Removable Nozzles	<u>Link</u>	December 1, 2023
Group 16 - UNHINGED Final Presentation	<u>Link</u>	December 1, 2023
Maker Repo page	<u>Link</u>	December 1, 2023