# UNHINGED

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**November 5, 2023**

# UNHINGED

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## Abstract

We prepare this deliverable to provide a prototype and analyze it for bugs or possible improvements. It is prepared based on the customer's feedback from the meeting we had with him. This deliverable will also break down this device and its critical components.

## Updated Prototyping Plan

The customer feedback was very positive. There were very few things they wanted us to change. The most important comment was that the clamps be sturdy enough so that the jig would not move with the vibrations of the drill. They also commented that the nozzles needed to be 1/16 inch wider. We took these comments very seriously and really wanted to incorporate their comments. To make sure the nozzles were larger, we increased the size in Onshape for when we had to 3D print them. We also changed the design of the clamp to increase its strength. It will now be more robust and will not move when drilling and tapping.

This final design will meet the customer's specifications and make it easier to prepare the door hinges. Also, since the customer has had very few negative things to say about our design, we have no need to test other prototypes. We will focus primarily on our pre-existing prototype and continue to improve it to meet our customer's needs.

### Plan 1

In this first prototype, plastic materials were used for the entire structure and its most obvious advantage is the cost of production. The plastic used was PLA and the model was 3D printed, which means that the first prototype can be changed quickly and easily, and multiple prototypes can be made as fast as the 3D printer is able to produce them, which is relatively fast. The downside of this prototype is that it is not durable and most likely will not last very long, which is one of the design criteria for this project. This was demonstrated by the fact that the prototype broke down quickly. Overall, the prototype is perfect for what needed to be demonstrated, which is the main purpose of a prototype.

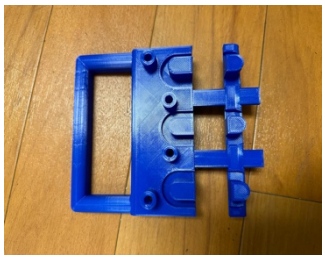

*Figure 1 Prototype 1 upper view*

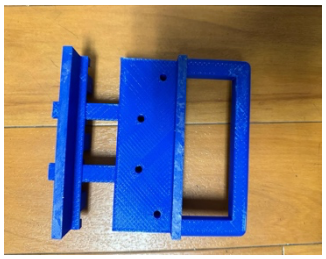

*Figure 2 Prototype 1 bottom view*

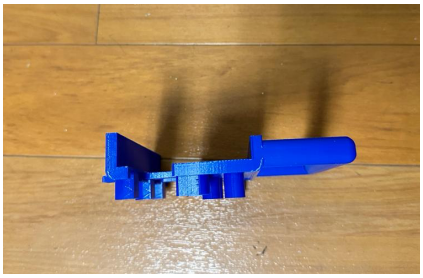

*Figure 3 Prototype 1 side view*

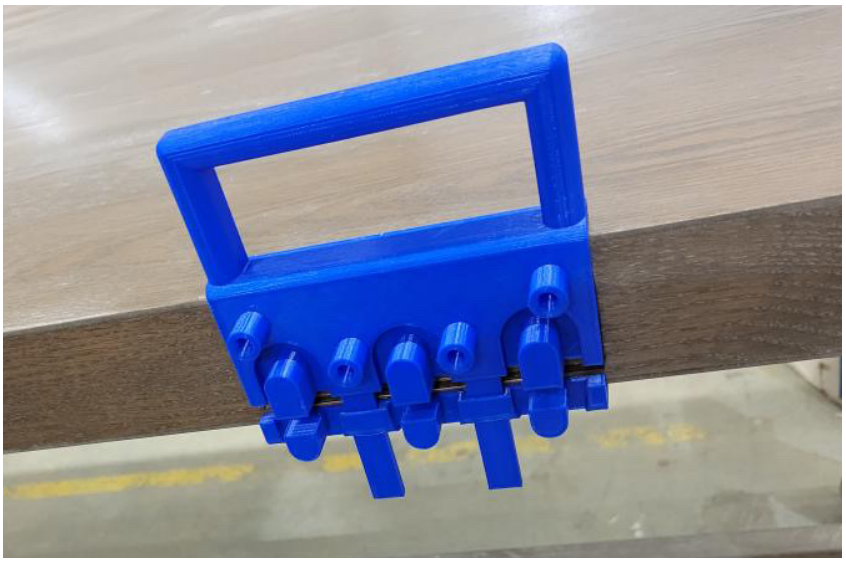

*Figure 4 Test of prototype 1 on a door*

## Revised Budget

The major part of the cost of production is the materials from which the product is made. The material must be anti-wear and solid, at the same time, the object with which it comes into contact must not be damaged by the product itself. Here are some possible solutions provided:

### 1) Use of plastic materials for the whole structure

#### Advantages

The advantages are obvious, due to the characteristics of the material itself. The weight of the product is light and soft. It is easy to customize with manufacturers, who are able to provide final production decisions in a short time. 3D printing can be produced on a small scale and have faster interactive versions.

- Low cost (relatively).
- Light weight.
- Easy to customize small-scale products.
- Convenient for later modifications and upgrades, with small trial and error costs.

#### Disadvantages

The drilling missions will cost a lot of wear and tear, causing the product to have poor sustainability. The heat produced by friction may damage the product, especially the nozzle part. In addition, products made of this material tend to have large errors. The use of better materials and processes of the same type will reduce this situation but will increase the cost.

- Low anti-wear property.
- Low high thermal resistance.
- Poor sustainability.
- Material limitations can lead to slight errors.

Estimate Cost

In general, most likely due to the manufacturing process of our product are compression molding, perfusion molding, and 3D printing. They need to contact the model manufacturer to determine the model and test generation, this leads to the final mass production of a reliable type of products. The final costs are related to:

- Mold customization cost +
- Raw material cost +
- Technology/Process +
- Other costs (taxes, labor, model modification, customization, etc.)

*Table 1 Approximate Costs Model 1*

| Cost Index | resinous/plastic-like materials |
|---|---|
| Raw material cost | $20-$40 per kg |
| Mold customization | $50 per set |
| Manufacturing technique | $20 for plastic-like / $40 for resinous materials |
| **Total** | **$110 estimate** |

2) The use of metal materials for the total structure and the addition of a rubber gasket to prevent the door from being damaged and the slide due to low friction on the door and product surface.

Advantages

Metallic materials have a great advantage in terms of sustainability, and their production error is low.

- Wear resistant.
- Accuracy, extremely low errors.
- High sustainability.

Disadvantages

Normally, metallic materials have a high weight. Although corrosion and oxidation can be solved with a coating, its cost is high. Even the material (metal) is more expensive than plastic products.

- Heavy.
- Difficult to handle.
- Corrosion and oxidation.
- High cost (relatively).

Estimate Cost

The product can be manufactured by metal pouring and metal cutting. These shapes have a long fabrication life but extremely low errors once measurements are unsafe. Coatings may incur additional cost. Better alloys will also increase costs. The final costs are related to:

- Mold customization cost +
- Raw material cost +
- Technology/Process +
- Coating cost +
- Other costs (taxes, labor, calibration, customization, etc.)

*Table 2 Approximate Costs Model 2*

| Cost Index | Metallic materials |
|---|---|
| Raw material cost | $15 per kg |
| Mold customization | $70 per set |
| Manufacturing technique | $50 for metallic materials |
| Coating cost | $20 per sq.m. |
| **Total** | **$155 estimate** |

3) Use of plastic materials in the body of the product, use of metallic materials on the surface that are easy to wear, such as the surface that comes into contact with the drill rod (nozzle).

This type of product combines the relative advantages of the two previous solutions. The overall weight of the product is light while maintaining the quality. The most important feature is the possibility to replace key parts. Parts (nozzle) that are heavily worn due to the drilling process can be replaced and are made of metal/alloy. This is a challenge of manufacturing technique. The combination of different materials requires low production tolerances and material joining characteristics, as well as having the highest cost. But everything is guaranteed. The final costs are related to:

- Mold customization cost +
- Raw material cost +
- Technology/Process +
- Coating cost +
- Cost of model modification +
- Calibration cost +
- Other expenses (taxes, labor, custom costs, etc.)

*Table 3 Approximate Costs Model 3*

| Cost Index | Composite materials |
|---|---|
| Raw material cost | $20-$40 per kg / $15 per kg |
| Mold customization | $100 per set |
| Manufacturing technique | $40 for plastic-like / $60 for resinous materials/ $50 for metallic materials |
| Coating cost | $20 sq.m. |
| Calibration fee | $10 per time |
| **Total** | **$300 estimate** |

Estimated Actual Price from the specialized dealer.

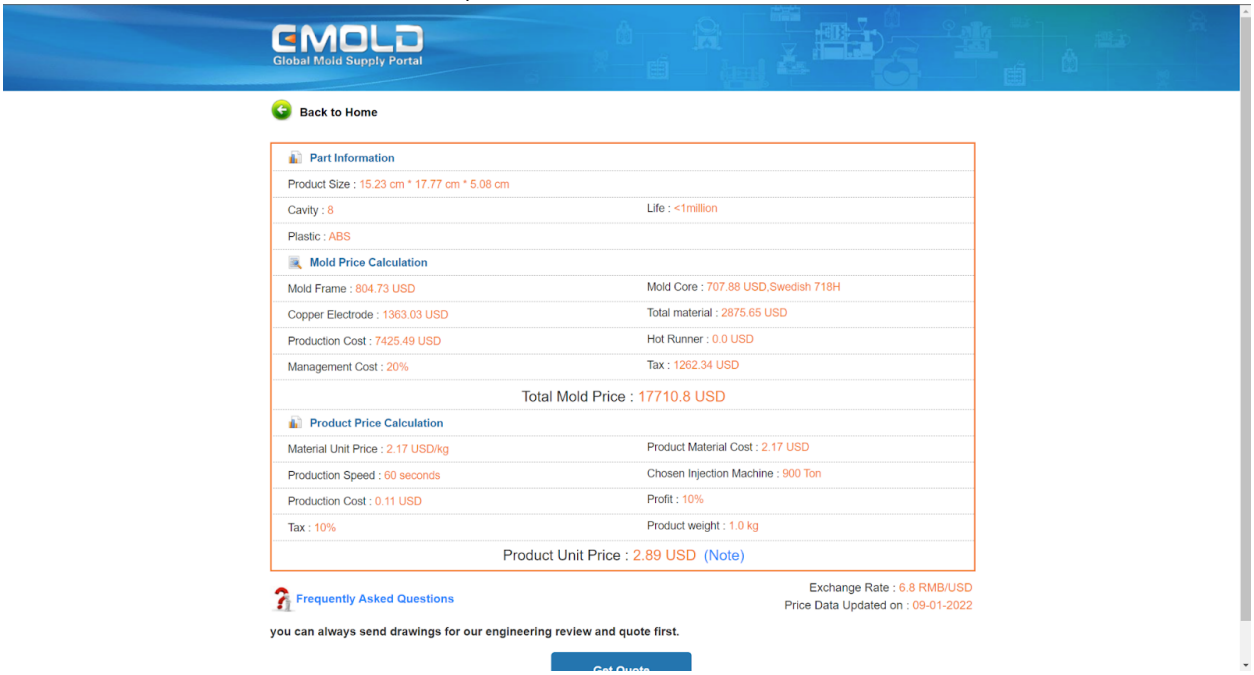


*Figure 5 Estimated cost*

In the present stage, this form indicates an example of ABS plastic molding and producing for a true exact price quoting. Pure CNC metalworking and assembly parts (plastic + metal) fabricating quoting requires the 3D format project file. More price details will be renewed in the further deliverable.

## Critical components

The tool has many essential components to function.

First, the nozzles. This is the part that will tell the worker where to drill and will keep the bit straight, the nozzle is metal coated so that it is able to withstand the pressure of the bit, this is important for the longevity of the product and to keep costs down. Secondly, the shank. This part is also important for the efficiency of the product as it makes it possible for the worker to hold the device with one hand. Third, the elastic component. This will make the device clamp to the door and prevent us from having to design different devices for each backset.

## Reflection

After analyzing the customer's feedback, we identified the following areas of importance: the robustness of the clamps and the size of the nozzles. The customer advised us to improve the aforementioned aspects, so we introduced the necessary changes to strengthen the clamping mechanism and increase the size of the nozzles by 1/16 inch in our 3D modeling software. As mentioned above, the preliminary design was well received by our customer, so we will focus on refining the product and applying corrections should any issues arise.

The prototype was completed by 3D printing PLA plastic. We have decided to use 3D printed material going forward, as it allows us to quickly create and modify different aspects of the design. In addition, 3D printing will reduce costs and weight (making it easier to use). It is important to note that because the prototype is made entirely of plastic, it will not serve as a ready-to-use product for durability reasons (at this time). However, we believe that once we can find the optimal print settings and material/filament, these durability concerns will be eliminated. Overall, the design process is progressing as planned and we expect to continue to refine our design until we can present the device to the customer.

## References

https://www.emold.net/emold/calculatesecond?sourceCold=