**F.1 Design** **constraints**

In the context of developing prototypes, non-functional design constraints are crucial as they influence the overall quality, performance, and usability of the product. Here are two important non-functional design constraints and their implications:

**Justification**: Portability is crucial for the nail file assist device since the target user, Jan, has reduced mobility. A portable design ensures that the device can be easily used and transported by Jan, enhancing her independence and convenience. Given Jan’s condition, a heavy or cumbersome device would be impractical and counterproductive to the goal of providing an accessible and user-friendly solution.

**Design Changes**: To satisfy the portability constraint, the design would need to incorporate the following changes:

* **Material Selection**: Use lightweight materials such as ABS-like resin for the main body of the device, as already considered in your prototypes. This material provides the necessary toughness while keeping the device light.
* **Compact Design**: Redesign the device to be more compact, reducing unnecessary bulk. This could involve optimizing the shape and size of the handle and support structures.
* **Modular Components**: Ensure that the device can be easily disassembled and reassembled if needed. This could involve using quick-release mechanisms or snap-fit joints instead of screws.
* **Integrated Storage**: Design the device to include or attach to a small carrying case or pouch that can be easily carried in a bag or pocket.

**2. Reliability**

**Justification**: Reliability is essential to ensure that the device consistently performs its intended function without failure, providing Jan with confidence in using it regularly. A reliable device minimizes the need for frequent repairs or adjustments, which is particularly important for someone with limited dexterity.

**Design Changes**: To meet the reliability constraint, the design would need to incorporate the following changes:

* **Robust Fastening Methods**: Use durable and secure fastening methods such as high-quality self-tapping screws and strong adhesives to ensure that parts stay securely attached. Conduct thorough testing to determine the optimal thread sizes and adhesive types.
* **Magnetic Components**: The use of Neodymium magnets, as mentioned in your prototype, should be carefully evaluated and tested to ensure they provide a consistent and strong hold without losing their magnetism over time.
* **Stress Testing**: Perform rigorous stress testing on all components to identify potential failure points. This includes testing the device under various conditions such as different angles, pressures, and usage durations.
* **Simplified Mechanisms**: Simplify the design to reduce the number of moving parts and potential points of failure. For example, redesigning the file locking mechanism to be more straightforward and robust.

**Detailed Examples of Design Changes**

**Material Selection**:

* Replace heavy materials with lightweight, durable plastics like the Anycbic ABS-like Resin Pro 2. This will maintain the device’s strength while reducing its weight, enhancing portability.

**Compact Design**:

* Redesign the handle to be ergonomically efficient while minimizing bulk. Consider a foldable handle design that allows the device to be stored more easily when not in use.

**Modular Components**:

* Implement snap-fit joints or magnetic attachments for components that need to be frequently assembled and disassembled. This makes the device easier to transport and reduces the reliance on screws which can become loose over time.

**Robust Fastening Methods**:

* Test different types of self-tapping screws and adhesives under various conditions to ensure they provide a reliable hold. Ensure that the chosen screws are not brittle and that the adhesive bonds effectively to the selected materials.

**Magnetic Components**:

* Use high-quality Neodymium magnets and ensure they are appropriately sized to provide a strong and reliable hold. Test the magnets for longevity to ensure they do not lose their strength over time.

By addressing these non-functional design constraints, the nail file assist device will be more user-friendly, reliable, and practical for Jan, ultimately enhancing her ability to perform nail care independently.

**Proof of Our Constraints**

**Portability**

This is a very important non-functional design constraint that we considered when designing the nail filer. Unfortunately for us we failed to consider it in our second design prototype, which was the hand clamp she requested. The hand clamp design will be very hard to make it portable as the weight, length and the construction of it will be of burden. At first it was created to fit in with the nail filer and be easy to move around with the straps. But since Jan refused and detested the straps, we tried avoiding it increasing the difficulty of creating the design.

**Reliability**

Although the materials we used are very strong and resistant down the line, we estimate that there might be issues with the structure of our prototype. We use resin very strong material, but it is not popular in the community of 3D printing. A more formidable one that lasts over time is FDM. Even our structural foundation of the material looks like it won't last over due to its length , we didn't make it scratch or fall resistant so that will also be a problem.

**Description of our second design prototype:**

Two iron partitions with finger holes – 10g for each

Nails -- 0.0180kg for each

ABS-Like Resin Pro 2 -- Unknown

**Cyanoacrylate Glue --less than**

**Screws --** 0.0180kg for each

**Description of our first prototype:**

#### **1. Handle Assembly:**

* **Custom Parts**:
  + Description: The parts used for the handle assembly will be custom made and 3D printed using an AnyCubic Photon Mono M5s resin printer.
  + Material: AnyCubic ABS-Like Resin Pro 2
  + Source: Amazon
  + Cost: $39.99 (1000 mL)
  + Quantity: 1
  + Link: Amazon - [https://www.amazon.ca/ANYCUBIC-Toughness-UV-Curing-HighSuccessPhotopolymer/dp/B0CJ2FP5ZR/ref=asc\_df\_B0CJ2FP5ZR/?tag=googleshopc0c20&linkCode=df0&hvadid=683221985005&hvpos=&hvnetw=g&hvrand=3249169428822237820&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9000717&hvtargid=pla2298964755495&mcid=03551c0ea2a93ceaadd77364dcbd6ea0&gad\_source=1&th=1](https://www.amazon.ca/ANYCUBIC-Toughness-UV-Curing-HighSuccessPhotopolymer/dp/B0CJ2FP5ZR/ref=asc_df_B0CJ2FP5ZR/?tag=googleshopc0c20&linkCode=df0&hvadid=683221985005&hvpos=&hvnetw=g&hvrand=3249169428822237820&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9000717&hvtargid=pla-2298964755495&mcid=03551c0ea2a93ceaadd77364dcbd6ea0&gad_source=1&th=1)

#### **2. Fasteners:**

* **Cyanoacrylate Glue**:
  + Description: Adhesive we will use to join 3D printed plastics.
  + Source: Amazon
  + Cost: $9.97 (15 g)
  + Quantity: 1
  + Link: Amazon – <https://www.amazon.ca/Gorilla-Fast-Setting-Controlled-Cyanoacrylate-112441/dp/B0BZ9YWN35/ref=asc_df_B0BZ9YWN35/?tag=googleshopc0c20&linkCode=df0&hvadid=578815767342&hvpos=&hvnetw=g&hvrand=15601281954888956477&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9000717&hvtargid=pla2255129543927&psc=1&mcid=73bd5fc73d2b3473ab3e8f9ee2f7ea9b>
* **Screws**:
  + Description: For assembling structurally important 3D printed components.
  + Type: Witlans Phillips flat head self-tapping screws assortment kit
  + Material: Stainless steel
  + Dimensions: M2 M3 M4/ 15 sizes
  + Source: Amazon
  + Cost: $16.99 (460 Pcs)
  + Quantity: 6
  + Link: Amazon - <https://www.amazon.ca/Witlans-Self-Tapping-Assortment-StainlessCountersunk/dp/B08G52RSBL/ref=sr_1_1?crid=2UTVPRMP970FI&dib=eyJ2IjoiMSJ9.6Ck4PcFbbf2QvFI2z7p5cQ._oRX1q4hiSYQe6A2aLiOrVQqGO7RWWgvgCiQzKYFK00&dib_tag=se&keywords=philips+460pcs&qid=1717627581&s=hi&sprefix=phillips+460pcs%2Ctools%2C70&sr=1-1>
* **Magnets**:
  + Description: Used for the file locking mechanism.
  + Type: Neodymium magnets
  + Dimensions: 3 x 1 mm
  + Source: Amazon
  + Cost: $14.92 (300 Pcs)
  + Quantity: 2

**Reliability**

Although the materials we used are very strong and resistant down the line, we estimate that there might be issues with the structure of our prototype. We use resin very strong material, but it is not popular in the community of 3D printing. A more formidable one that lasts over time is FDM. Even our structural foundation of the material looks like it won't last over due to its length, we didn't make it scratch or fall resistant so that will also be a problem.

**F.2** Prototype 2

The most critical product assumption that we have not tested yet is that the hand holder stabilizer will fit the client’s hand and properly stabilize it with the least discomfort possible. This assumption is closely related to the DFX factor of ease of use. The client has limited mobility in her hands, particularly with her right-hand curling into a claw motion, so the device must fit her hand shape comfortably and allow her to stabilize it without forcing her fingers into uncomfortable positions. Additionally, the device should be easy to operate with her left hand, as she struggles to use both hands simultaneously. This means that the design should simplify the setup and usage processes, accommodating her limited dexterity and minimizing physical effort. We also need to test the latching mechanism, as the client has indicated that she might have difficulty with most mechanisms due to her limited strength and dexterity. Therefore, we are considering using hinges like door hinges and must ensure this approach is the easiest and most effective for her. Ensuring that the device is easy to put on, adjust, and remove with one hand, while fitting comfortably and stabilizing effectively, are key aspects that need to be tested and validated.

**Prototype 2**

Our second prototype focuses on 2 of our first prototype’s sub systems. First, we have prepared a selection of 3 handles for our client to try in order to optimize the devices stability during use.

Une image contenant tuyau, sol, cylindre, bleu

Description générée automatiquement

Figure 1: Handle 1

Une image contenant sol, tuyau, outil, bleu

Description générée automatiquement

Figure 2: Handle 2

Une image contenant outil, sol, bleu

Description générée automatiquement

Figure 3:Handle 3

The next part of our second prototype focuses on the magnetic latching mechanism used

to secure the file in place.

Une image contenant plein air, vélo, sol, pôle

Description générée automatiquement

Figure 4: Magnetic latch view 1

Une image contenant outil, sol, plein air, rue

Description générée automatiquement

Figure 5: Magnetic latch side view

Une image contenant sol, plein air

Description générée automatiquement

Figure 6: Magnetic latch rear view

**Testing and results:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Metric** | **Unit** | **Ideal** | **Marginally Acceptable** | **Actual values** |
| Stability | Arbitrary (Yes or No) | Yes | N/A | Up to client |
| Ease of setup | Time (S) | <60 | <90 | Will see with client |
| Ergonomics | Sliding Scale (1-10) | 9/10 | 7/10 | Up to client |
| Durability | # of Uses | >500 | >300 | ? |
| Weight (with file) | Grams (g) | <100 | <150 | 60 |
| File insertion force | Grams (g) | <45 | <90 | 13 |

File insertion test explanation:

By standing the file straight up on the scale and zeroing its weight, we were able to see how much force was needed to insert our file by sliding the file holder over the file.

* 1. Stand file on the scale

Une image contenant texte, personne, sol, balance

Description générée automatiquement

Figure 7: Stand file on the scale

* 1. Zero out the files weight

Une image contenant texte, personne, distant, sol

Description générée automatiquement

Figure 8: Weight zeroed out

* 1. Slide file support over the file and register value

Une image contenant outil, sol, personne, balance

Description générée automatiquement

Figure 9: File support sliding over the file on the scale

For this upcoming client meeting, our team plans to present the first prototype of the "nail file assist" project. This initial demonstration will focus on various handle designs to determine which type is most comfortable for the client in addition to the showing of the first complete prototype.

**Here is an Outline of how we wish the meeting will go:**

1. **Introduction and Project Overview:**
   * Recap the project's goals and the specific requirements discussed in previous meetings.
   * Highlight the importance of ergonomics and usability in the design.
2. **Prototype Demonstration:**
   * Showcase different handle designs for the nail file assist.
   * Explain the materials used and the rationale behind each design choice.
   * Discuss all preliminary feedback or testing results.
3. **Feedback on Handle Designs:**
   * Invite the client to handle each prototype and provide feedback.
   * Observe and note how the client interacts with each design to understand preferences and any potential issues.
4. **Discussion on Support for Hands:**
   * Address the client’s initial request for a hand support feature.
   * Explain the technical and design challenges that led to not including this feature in the prototype.
   * Discuss alternative solutions or adjustments that could meet the client’s needs.
5. **Transition to Analytical Prototype:**
   * Explain the shift from a physical to an analytical prototype.
   * Discuss what this means for the project timeline and deliverables.
   * Outline the benefits of an analytical approach, such as detailed performance data and cost-effectiveness.

### **At the end of the meeting, we are expecting to have gained this information:**

* **Client’s Comfort and Usability Feedback:**
  + What are the client's thoughts on the feel, balance, and grip of each handle design?
  + Are there any specific features or adjustments that would enhance comfort or usability?
* **Preferences and Priorities:**
  + Which aspects of the nail file assist are most important to the client (e.g., weight, grip texture, ease of use)?
* **Feedback on Lack of Physical Support:**
  + How does the client feel about the omission of the hand support feature?
  + Would alternative ergonomic adjustments be acceptable?
* **Reactions to Analytical Prototype Approach:**
  + Does the client understand and agree with the decision to use an analytical prototype?
  + Are there particular analyses or data points that the client is interested in seeing from this approach?

### **Over all goals for the Meeting:**

* Ensure the client feels involved and heard throughout the prototype review process.
* Gather clear and actionable feedback that can guide the next stages of product development.
* Align on expectations and deliverables for the remainder of the project to ensure both parties are satisfied with the projected outcomes.

**Updated Gant-chart**

