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ME127/227 | Winter 2025

Project Requirements

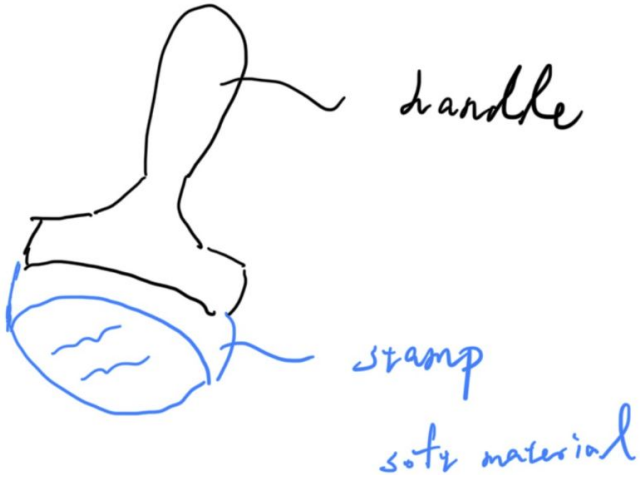
Stamp fulfils material requirements:

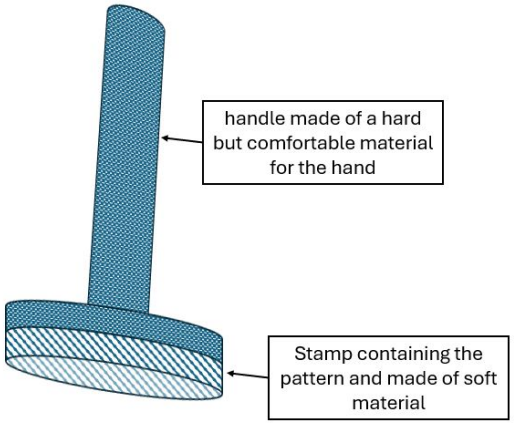
- **Soft, flexible stamp**
  - Rubber-like to transfer ink
  - High-resolution pattern

  → **Thermoset**

- **Rigid, ergonomic grip**
  - Must withstand press force
    - Repeated use
  - Good feel in hand

  → **Thermoplastic**





Purpose and Objectives

Our stamp will transfer ink onto paper as a decorative element.

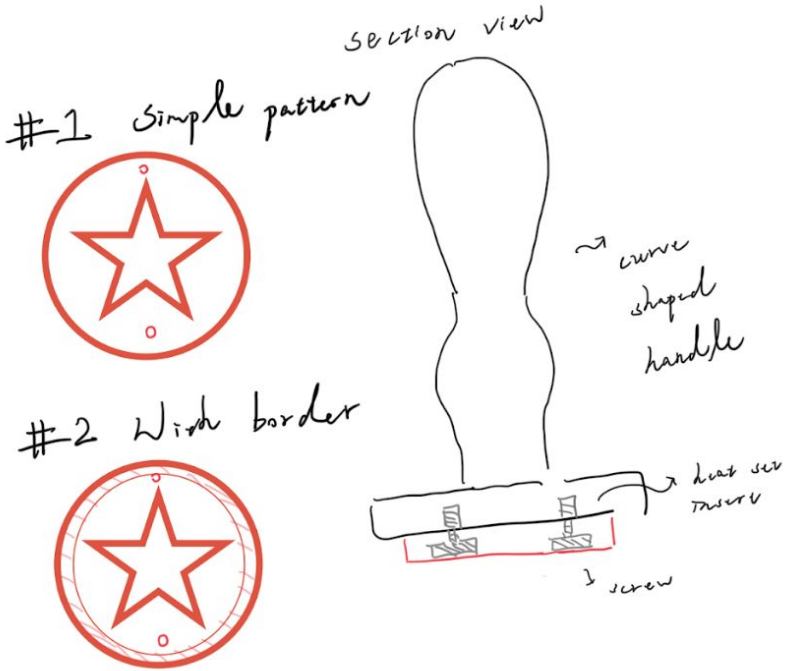
- Users: artists, writers, cafés

Design Objectives:

- Use both FDM and SLA printing
- Ensure effective ink transfer onto paper
- Interchangeable patterns
    - Easy assembly
- Able to withstand repeated use

Concept Sketch

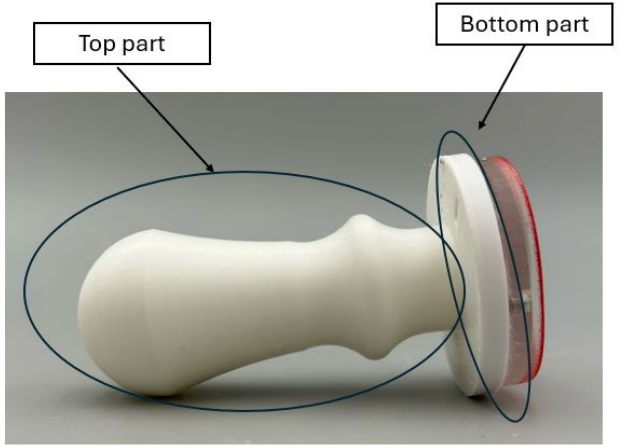
- Curved, ergonomic shape
  - Comfortable grip
- 2-part assembly
  - Screw connections
  - Heat-set inserts



Initial Designs:

- 1. Simple pattern
- 2. Pattern with border
  - Protect pattern from shear forces

Materials Research



For the handle:

1) Top part (Contact with the hand) :
   - Robust
   - Ergonomic grip
   - Tough
2) Bottom Part (Contact with stamp) :
   - Robust
   - Stiff
   - Tough
   - Low elasticity

Material to choose from :

	ABS	TPU	PETG
Robustness	High robustness	Deforms (medium)	High robustness
Strength	Rigid	Soft	Rigid
Flexibility	Stiff	Rubbery	Stiff
Elasticity	Low elasticity	High elasticity	Low elasticity
Toughness	Resistant to stress	Resistant to stress	Resistant to stress
Young's modulus	2.35 GPa	0.147 GPa	3.03 GPa
Yield strength	44.8 MPa	36.3 MPa	51.4 MPa
Poisson's ratio	0.364	0.5	0.4

Materials Research

For the stamp: Material properties looked for the design

- Withstands pressure
- Pattern resists to deformation
- Small deformation without breaking
- Absorbs impact

Material to choose from :

	Flexible 80A	Elastic 50A
Robustness	Robust (withstands pressure)	Deforms
Strength	Less rigid	Pliable
Flexibility	Moderate flexibility/Stiff	High flexibility
Elasticity	Moderate elasticity	High elasticity
Toughness	Resistant to stress	Very resistant to stress
Young's modulus	3-4 MPa	N/A
Yield strength	8.9 MPa	3.2 MPa
Poisson's ratio	0.49	0.5

FBD

The force analysis for this stamp project is relatively straightforward:

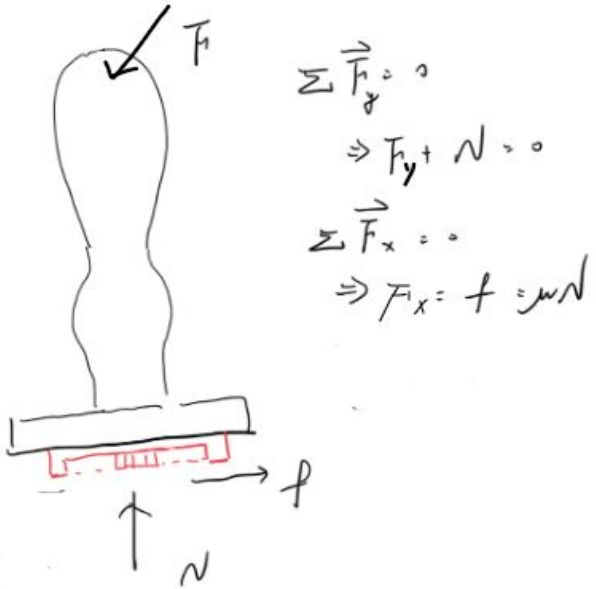
- It consists of the force applied on the handle to press the stamp and the corresponding normal force.

Normal use case:

- The user presses the stamp straight down, generating only normal force.

Worst-case analysis scenario:

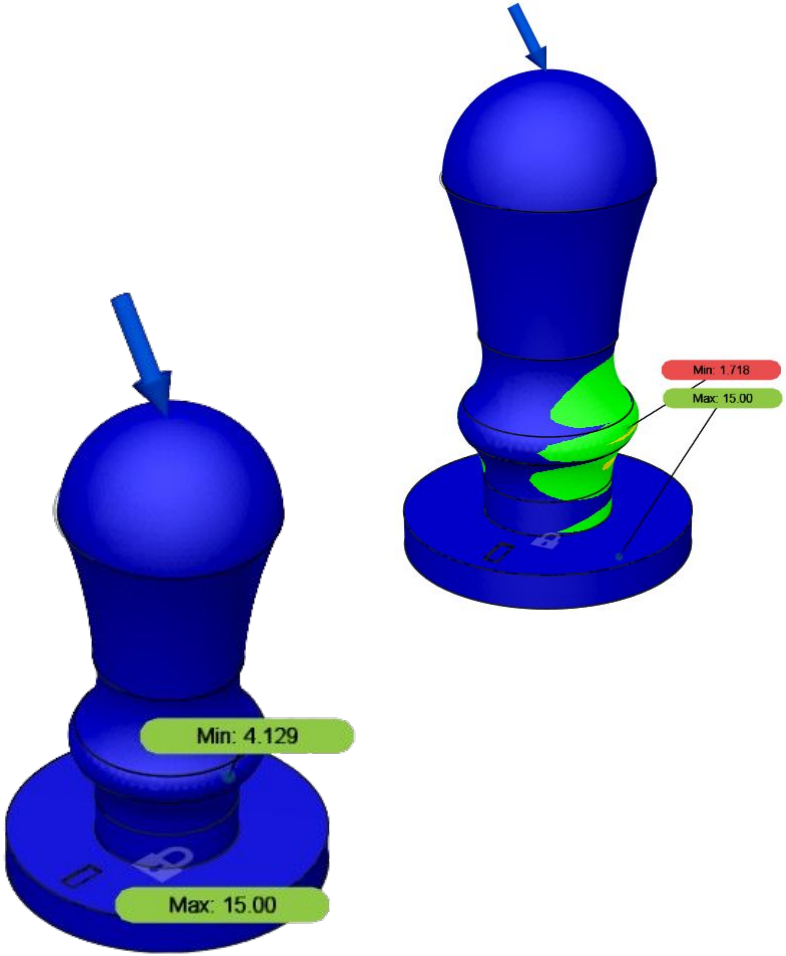
- The user presses the stamp at an angle, generating shear force and friction force in addition to the normal force.



Simulation

Primary concern: *Can the handle withstand applied force from the hand? → Determine suitable material.*

- FEA model resembles print conditions
  - Hollow handle (1.2mm shells)
  - Fixed constraint on bottom
  - Material: ABS vs. PETG.
- 80N (18 lbf) applied to handle top
  - Case: 30° from vertical
  - **PETG**: Min. FoS: **4.129**
  - **ABS**: Min. FoS: **1.718**
- Due to rigidity concerns, PETG is preferred over ABS.

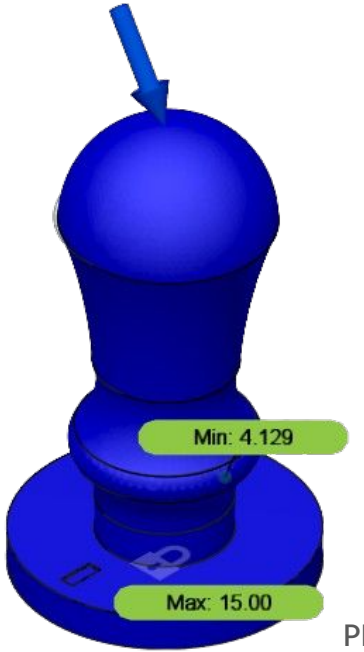


Simulation

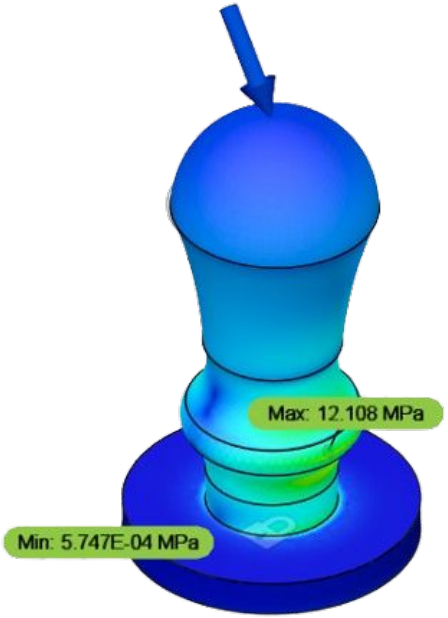
Primary concern: *Can the handle withstand applied force from the hand? → Detailed results*

- FEA model resembles print conditions
  - Hollow handle (1.2mm shells)
  - Fixed constraint on bottom
  - Material: PETG

- 80N (18 lbf) applied to handle top
  - **Case 1:** Vertical
    - Min. FoS: **15**
    - Max. Stress: **2.775 MPa**
  - **Case 2:** 30° from vertical
    - Min. FoS: **4.129**
    - Max. Stress: **12.108 MPa**



PETG



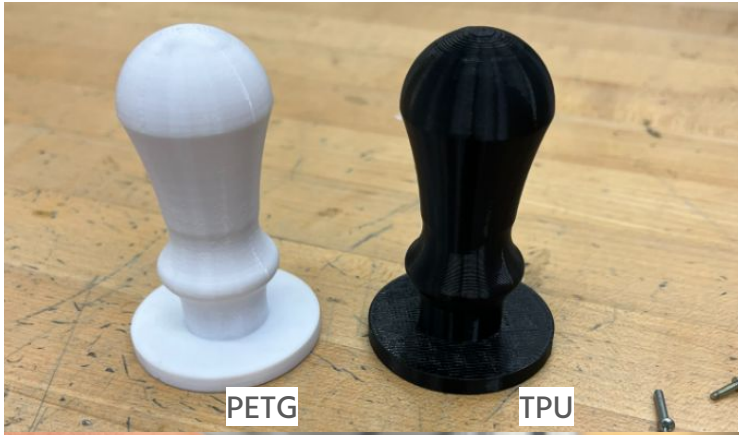
ABS

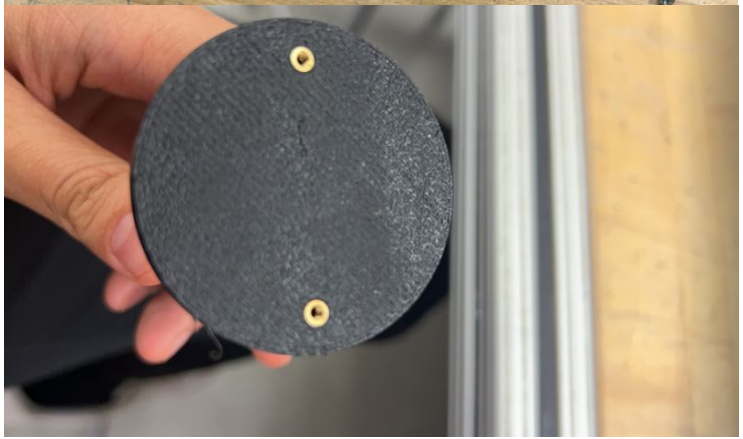
FEA results from Case 2

Prototyping - Handle

- Printed in **PETG** and **TPU (AMS)**

- **Testing:**
  - Hand comfort
  - Feasibility of heat inserts in TPU
- **Result:**
  - Handle is comfortable to use
    - PETG very rigid
    - TPU more comfortable, but susceptible to bending
  - Heat-set inserts possible in TPU
- **Next steps:**
  - Multimaterial print (TPU handle, PETG base)

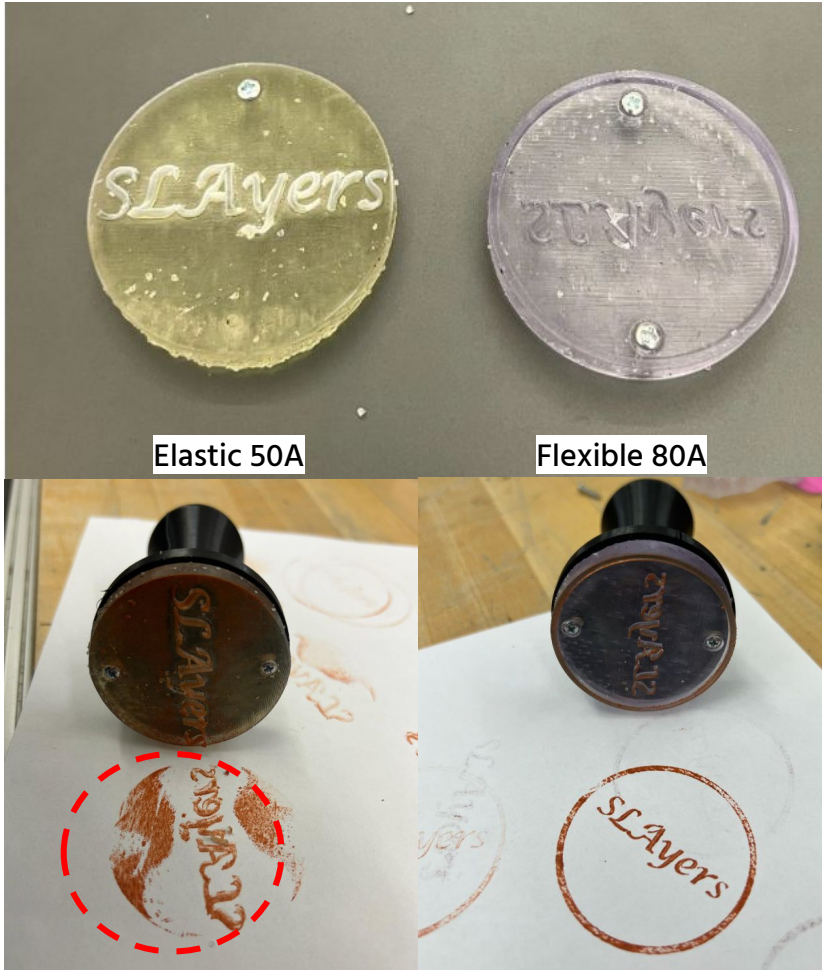




Prototyping - Stamp

- Printed in **Elastic 50A** and **Flexible 80A**

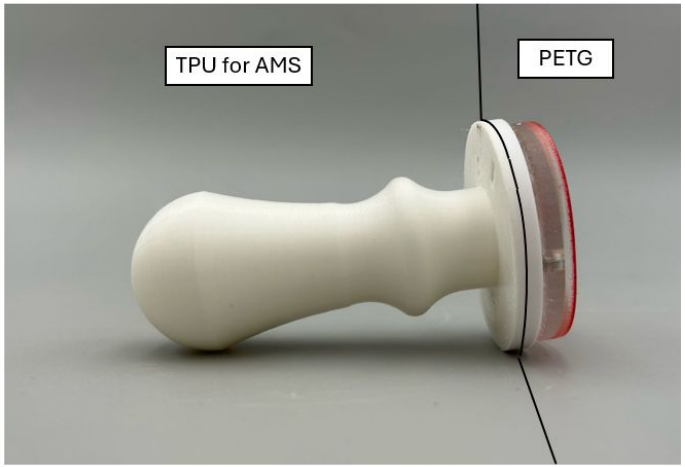
- **Testing:**
  - Effective ink transfer
- **Result:**
  - Elastic 50A warped/broke
  - Flexible 80A more effective
  - Some letters delaminated from stamp
- **Next steps:**
  - More screw connections (2 → 3)
  - Sink to accommodate screw head
  - Thicker pattern elements
    - Bolder letters



Prototypes 2

- Printed stamp in **Flexible 80A**
- Printed handle in **PETG** for base **and TPU (for AMS)** for top
- Used multi material print on Bambu
- Increased number of screw connections from two to three

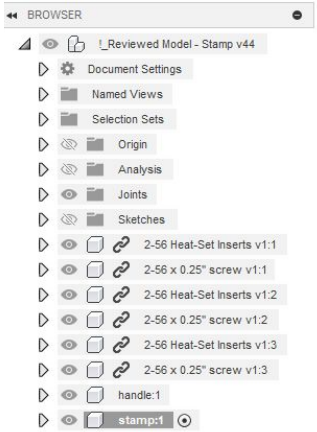
- **Testing:**
  - Adequacy of TPU layers on the base to ensure a strong bond with the PETG
  - Detachment prevention under applied force
- **Result:**
  - 1 layer is sufficient to ensure a strong bond
  - Loss of the ergonomic grip when changing from TPU to TPU for AMS
- **Next steps:**
  - Change the infill of the TPU to 0% to ensure ergonomic grip



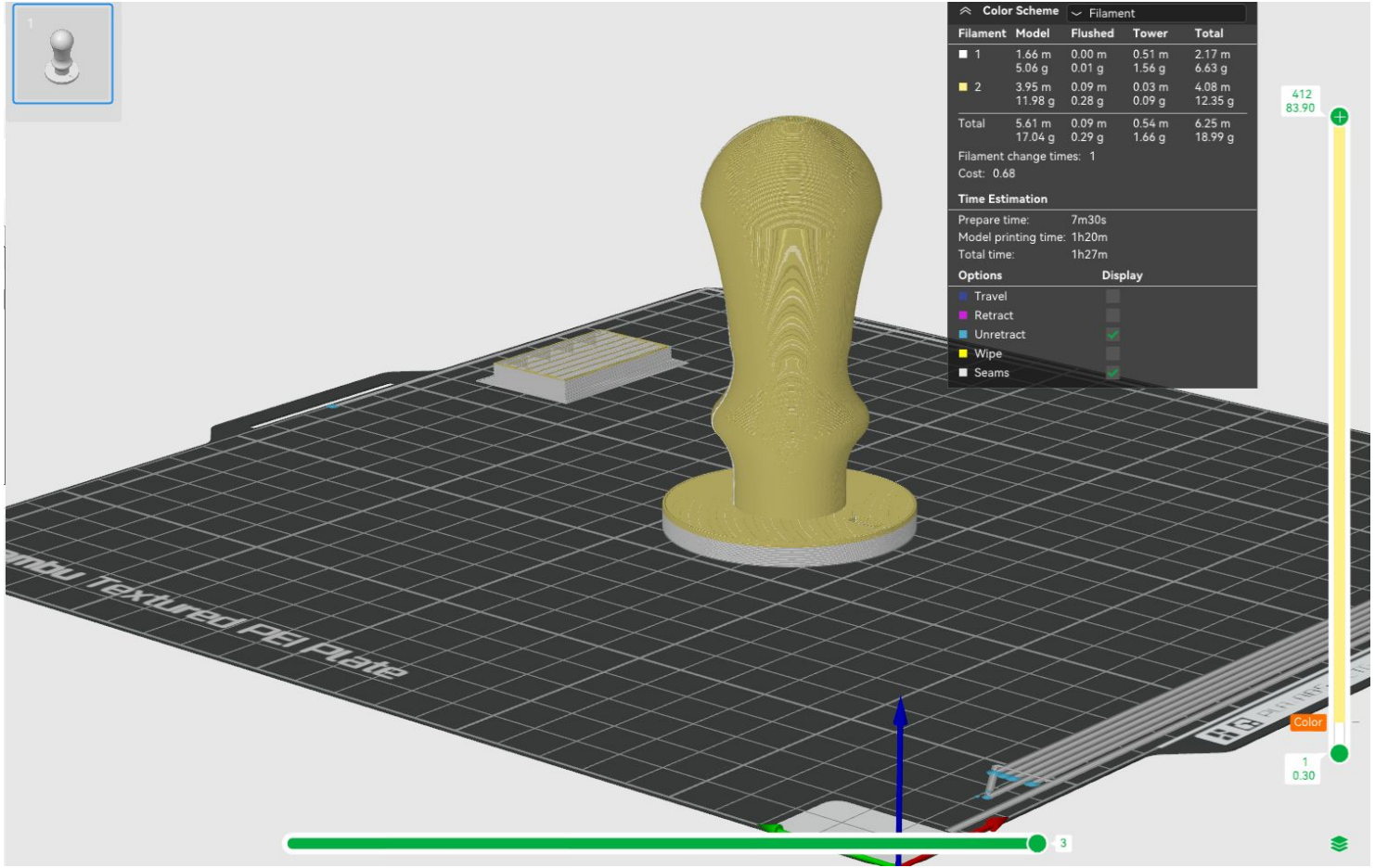
Final Model

- 3-screw connection
  - Reduces stamp warping
- Raised border around stamp
  - Reduces unwanted ink transfer
- Multimaterial handle
  - PETG base
    - Rigid connection to stamp
  - TPU (for AMS) handle
    - More comfortable

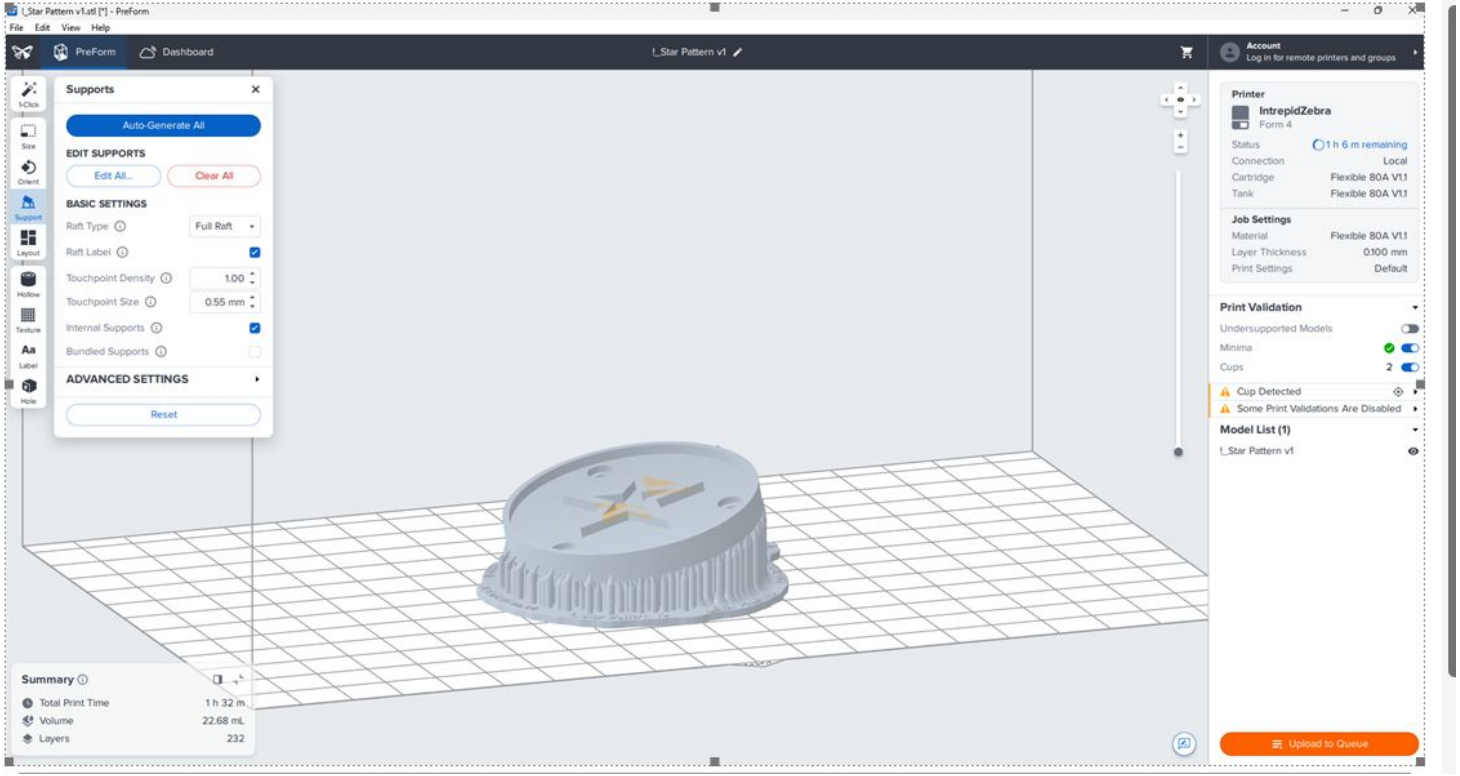
CAD


BROWSER
!_Reviewed Model - Stamp v44
Document Settings
Named Views
Selection Sets
Origin
Analysis
Joints
Sketches
2-56 Heat-Set Inserts v1:1
2-56 x 0.25" screw v1:1
2-56 Heat-Set Inserts v1:2
2-56 x 0.25" screw v1:2
2-56 Heat-Set Inserts v1:3
2-56 x 0.25" screw v1:3
handle:1
stamp:1

Slicer


Color Scheme
Filament
Filament Model Flushed Tower Total
1 1.66 m 5.06 g 0.00 m 0.01 g 0.51 m 1.56 g 2.17 m 6.63 g
2 3.95 m 11.98 g 0.09 m 0.28 g 0.03 m 0.09 g 4.08 m 12.35 g
Total 5.61 m 17.04 g 0.09 m 0.29 g 0.54 m 1.66 g 6.25 m 18.99 g
Filament change times: 1
Cost: 0.68
Time Estimation
Prepare time: 7m30s
Model printing time: 1h20m
Total time: 1h27m
Options
Display
Travel
Retract
Unretract
Wipe
Seams
412
83.90
Color
1
0.30
3

Slicer - FormLab



Performance Analysis

This stamp meets all design requirements! Recall our design objectives:

- Use both FDM and SLA printing:
  - FDM: TPU and PETG for the handle to ensure rigidity.
  - SLA: Flexible 80A resin for the stamp pattern to achieve high resolution.
- Ensure effective ink transfer onto paper:
  - Add a circular border around the stamp pattern to prevent unwanted ink transfer.
  - Implement a 3-screw design to ensure the stamp pattern mates well with the handle.
- Interchangeable patterns and easy assembly:
  - Use heat-set inserts in the handle.
  - Secure the stamp pattern to the handle with screws.
- Withstand repeated use:
  - Use simulations to ensure maximum stress does not exceed the ultimate tensile strength..
  - Use a circular border around the pattern to protect it from shear forces.

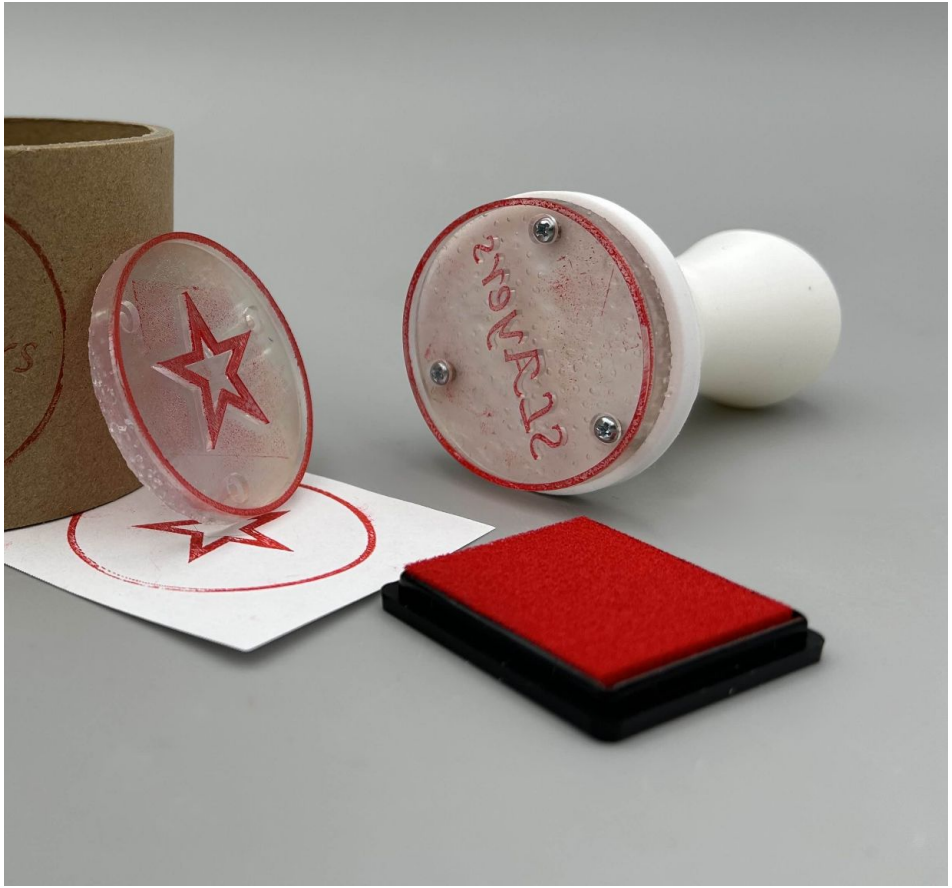
Challenges & Next Steps

Challenges:

- Preventing warp of flexible stamp
- Proper connection between TPU/PETG
- Overhangs with hollow print
- Complex stamp designs

Next Steps:

- More robust connection to stamp
- More stamp designs!



Reflection

Chia-Ling:
This was my first time using resin printing, and it was a great learning experience to see how it differs from FDM printing in terms of print time, cost, and post-processing steps. A key takeaway from this project is the importance of starting early when using resin printing, as the process involves longer print times and additional post-processing. Additionally, since the print time for parts at the same level is the same, it is more efficient to print multiple parts in a single batch whenever possible.

Yasmina:
I think this was a great learning experience where I had an opportunity to manipulate and process resin. I appreciated a lot the fact that we had to use both thermosets and thermoplastics. We also had to be mindful of the material we wanted to use in order to select the ones that fit our design. The process of thermoplastics is very different from that of thermosets. It requires a lot of conception and thinking before printing because this could cost a lot of time, money, and lab hours for nothing (we made this mistake when printing our first stamp).

Mathieu:

This is the first project where I really had to think about material selection and SLA printing. Usually, projects in both this and other classes have been fine to operate under the assumption that PLA or PETG would be sufficient. Additionally, this was my first time dealing with SLA (and I think it is the same for the other two on the team), so it was a good experience to work through the complications together. Overall, I'm very happy with how this project turned out!

Total Time & Budget

Item	Cost
Prototype 1 - handle - PETG	0.70
Prototype 1 - handle - TPU	0.90
Prototype 1 - stamp - Elastic 50A	8.83
Prototype 1 - stamp - Flexible 80A	6.79
Prototype 2 - handle - PETG + TPU for AMS	5.59
Star Pattern	4.62
Total	$27.43

Total time: 20 hr