BME 402

DEPARTMENT OF

Biomedical Engineering

UNIVERSITY OF WISCONSIN–MADISON

Improving the precision of small human tissue biopsy processing

February 6, 2026

Team Members

Team Leader: Ruhi Nagarkatte

Communicator: Ella Lang

BSAC: Gianna Inga

BWIG: Simon Nam

BPAG: Sarah Raubenstine

Advisor: Dr. Tracy Puccinelli

Client: Dr. Angela Gibson

Client Contact: Bailey Donahue

TECH: Grace Spiegelhoff

Overview of Presentation

- Client Description
- Problem Statement
- Broader Impact
- Design Constraints
- Fall 2025 Accomplishments
- Specific Goals & Timeline
- Packaging
- Documentation
- Budget

Client Description

- **Angela Gibson**, MD, PhD, FACS
- Specialties
  - General Surgery
  - Surgical Critical Care
  - Trauma Surgery
  - Burn & Wound Healing
- Performs research on epithelial regeneration of a burn injury and how to treat / expedite the healing process

Figure 1: Angela Gibson, MD, PhD, FACS [1]

Figure 2: Bailey A. Donahue, BS
Lab Technician/Manager [1]

Problem Statement

- **Objective:** fabricate a precise cutting device to shear fat off burn biopsy samples
- Gibson's lab creates burns in pig skin, to biopsy, and culture in media
  - Biopsies include, epidermis, dermis, and subcutaneous tissue
- Fat creates a hydrophobic layer that inhibits media absorption
  - Negatively affecting burn healing / tissue viability
- Current method is tedious, variable, and possibly damaging
  - Involves securing the sample with forceps and slicing with a scalpel

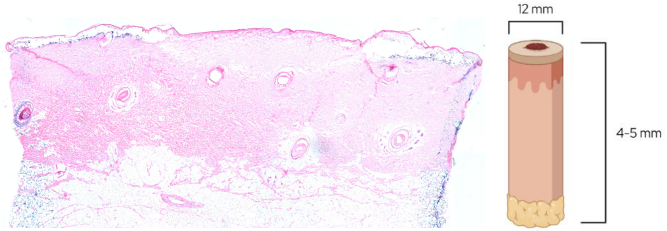


Figure 3: LDH stained pig skin sample *without* additional fat removal; lack of stain indicating poor viability [Bailey Donahue]

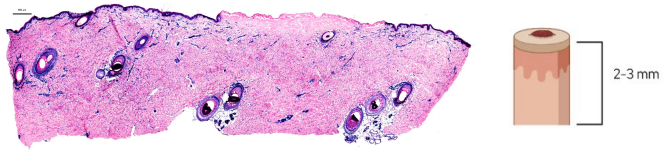


Figure 4: LDH stained pig skin sample *with* additional fat removal; blue LDH stain indicating viability [Bailey Donahue]

Motivation and Impact

- Burn injuries are the **leading cause of morbidity** worldwide [2]
- The Gibson Lab analyzes comparative pig skin models for **burn healing research** to better morbidity and mortality rates of burns [1]
  - Working to develop novel autologous burn wound regeneration technologies
- Removing additional fat from skin biopsy samples significantly **improves sample viability** and analysis capability
- Existing tissue slicing devices are not suitable for this process
  - High cost
  - Little adaptability

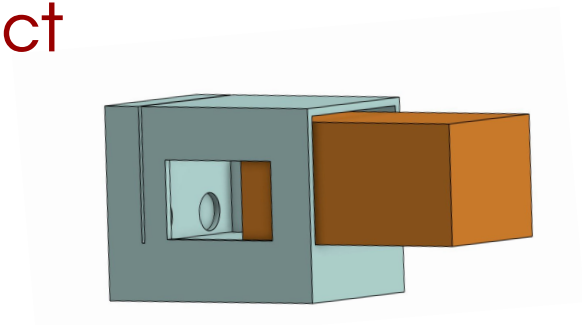


Figure 5: Client prototype OnShape assembly [Bailey Donahue]

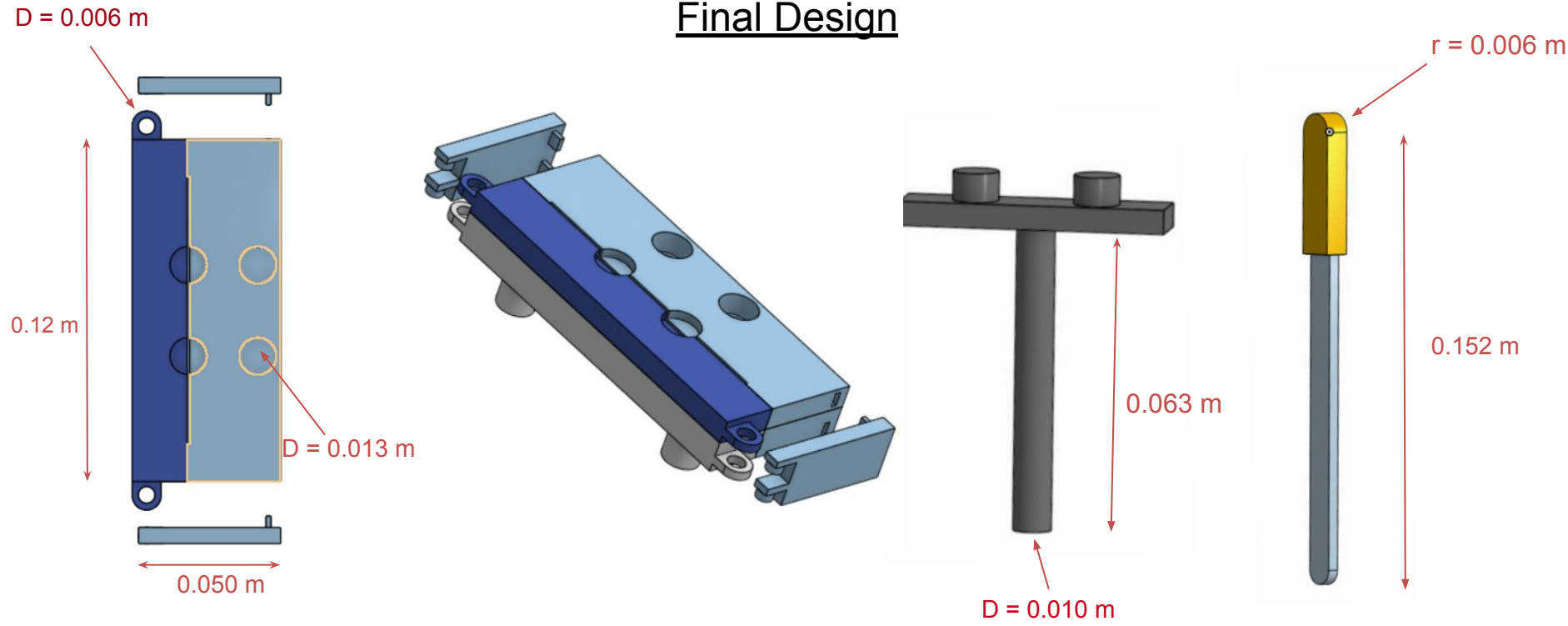
Figures 6 & 7: Tissue Slicing Systems from TedPella Inc. $1878.75 and $696-$3630 [3][4]

Design Constraints

- **Ease of Use:** Intuitive to use with a written protocol
- **Cut Accuracy & Precision:** Variability of the cut must be within 2.5±.2 mm
  - Straight cut
- **Maintenance:** Cleaned and sterilized with minimal material breakdown
  - Alcohol and bleach solutions
  - Autoclavable
- **Security of Biopsy:** Sample should be contained within the device while in use
  - Minimal movement
- **Ease of Fabrication:** 3D printable for replacement
- **Safety:** Minimize risk of injury to the user

Fall 2025 Accomplishments

Final Design



Figures 8-11: OnShape drawings of the biopsy press, applicator, and blade handle

Fall 2025 Accomplishments

Final Design

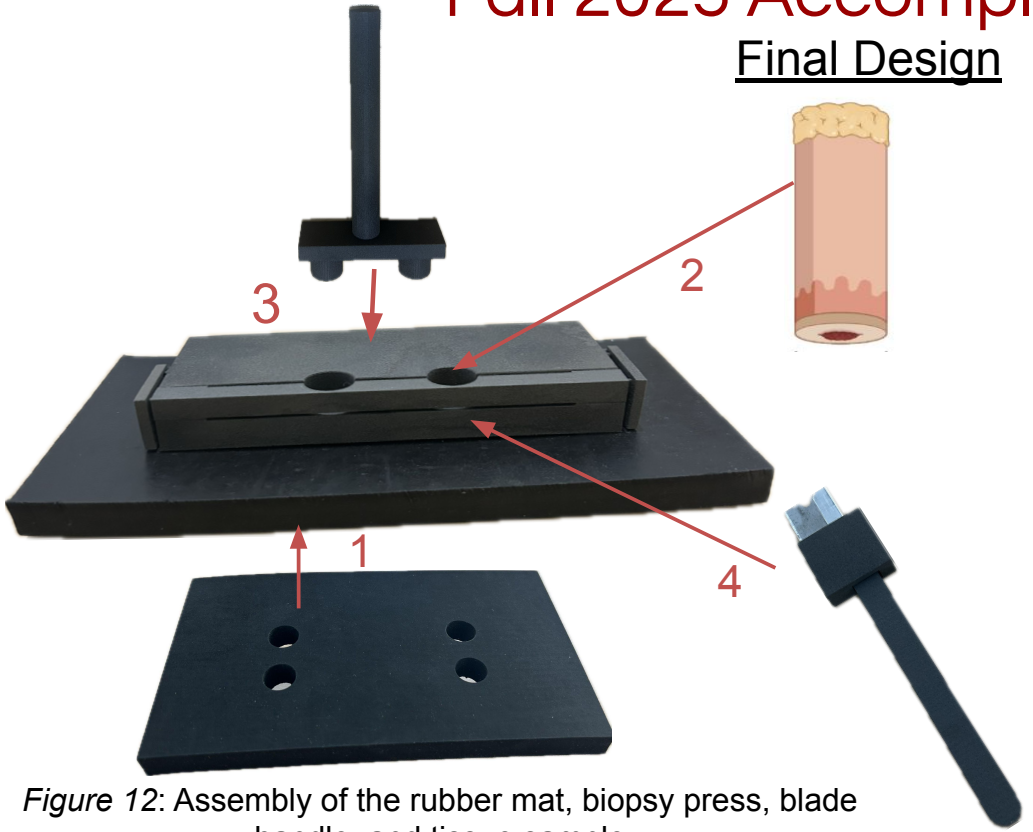


Figure 12: Assembly of the rubber mat, biopsy press, blade handle, and tissue sample

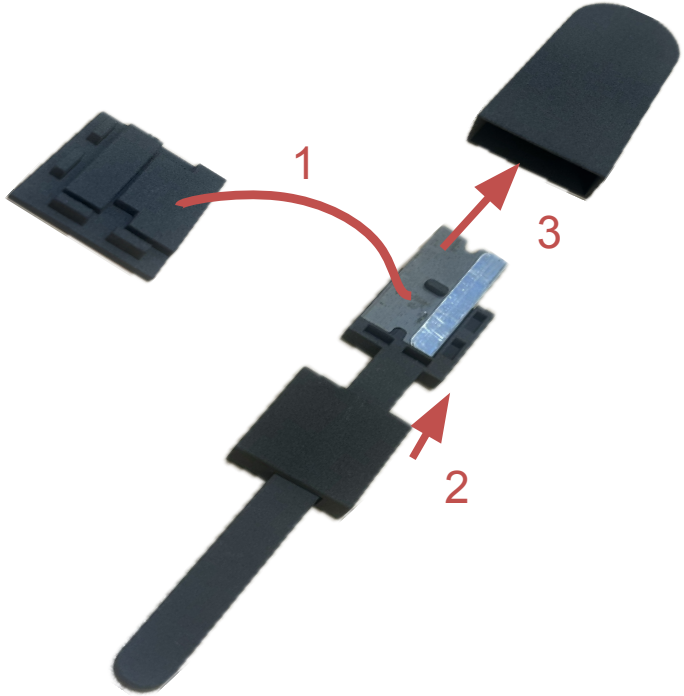


Figure 13: Assembly of the blade handle

Fall 2025 Accomplishments

Testing & Results

- **Sanitization**
  - Residual fat in connectors & edges
  - Soap and water more effective than ethanol

- **Usability**
  - Yielded > 80% positive experiences in intuitiveness, device security, blade handle safety, thickness consistency, & overall effectiveness

- **FEA Simulation**
  - von Mises test applied substantial forces to the press and blade handle (>22N, >9N, respectively); no risk of deformation

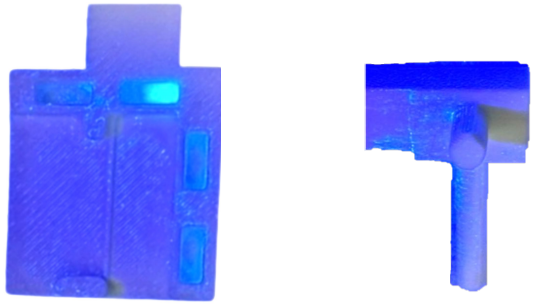


Figure 14: Sanitization test with UV light

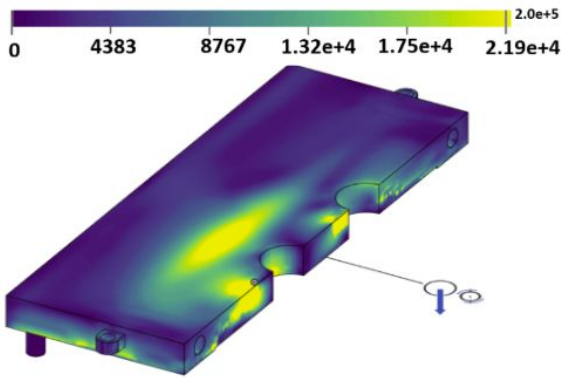


Figure 15: FEA simulation results [MPa]

Fall 2025 Accomplishments

Lessons Learned

- Nylon 12 (~$20) vs PLA (~$2) is a better option for longevity and demonstrates improved tissue preservation

- Overall design performs well
  - The blade fits in the cutting track and slice the sample evenly
  - FEA analysis validates the structural integrity of the biopsy press and handle

- Area for improvement: the pressure applicator
  - Hinders slicing when force is applied, leading to uneven cuts in the tissue

Specific Goals & Timeline

February

- Obtain more tissue (pig-skin) sample data from the clients (Feb. 20 & 27)
- Gather and analyze histology measurements received from clients
- Begin drafting the journal article

March

- Improvise the latest design with feedbacks and further consultations with clients
- Conduct more testing with new design to test compatibility with #11 scalpel blade
- Process the IP in design and patent process
- Revise the draft of journal article

April

- Final Poster Presentation
- Finalize & submit the journal article
- Deliver the final design to client

Packaging

- Autoclave sterilization
  - Pieces must be disassembled [5]
- Tyvek sterilization pouches [6]
- Tray [7]
  - Plastic
  - Aluminum
- Sterilizable wraps [8]
  - SMS

Figure 16: Sterilization wrapping of large medical devices [9]

Figure 17: Plastic Sterilizable Tray Case [10]

Figure 18: Tyvek sterilization pouches [11]

Documentation

User Manual

- Sample insertion
- Sample containment
- Blade insertion into cutline
- Cutting best practices
- Safety Warning - For the blade!

Sanitization instructions

Nylon 12 [12]:

- Alcohol resistance
- Ethylene oxide and formaldehyde solution
- Autoclave

Biomed Clear Resin [13]:

- Autoclave
- E-beam, gamma, and ethylene oxide

Material Expenditures

- **Last Semester: $129.15**
- Largest sources of previous spending
  - Nylon 3D printed prototypes
  - Rubber base
- **Expected spending for this semester: ~ $200**
- Largest anticipated expenditures
  - Further 3D printing with Nylon
  - Biomed clear resin
- Client has expressed preference for longevity over affordability

References

[1] L. Staff, “Lab Staff - Department of Surgery,” Department of Surgery, Jul. 11, 2025. https://www.surgery.wisc.edu/research/researchers-labs/dr-gibsons-lab/lab-staff/

[2] S. Tasleem *et al.*, “Mortality patterns and risk factors in burn patients: A cross-sectional study from Pakistan,” *Burns Open*, vol. 8, no. 1, pp. 13–18, Jan. 2024, doi: 10.1016/j.burnso.2023.11.003.

[3] “TruSlice Tissue Slicing Systems,” *Tedpella.com*, 2015. https://www.tedpella.com/dissect_html/TruSlice.aspx#TruSlice (accessed Oct. 03, 2025).

[4] “Brain Matrices, Brain Matrix - for sectioning,” *Tedpella.com*, 2025. https://www.tedpella.com/section_html/brain-matrices.aspx#anchor_ssmatrices

[5] CDC, “Sterilizing Practices,” Infection Control. Accessed: Feb. 04, 2026. [Online]. Available: https://www.cdc.gov/infection-control/hcp/disinfection-sterilization/sterilizing-practices.html

[6] K. Daugharty, “Types of Sterile Packaging,” Medical Waste Pros. Accessed: Feb. 04, 2026. [Online]. Available: https://www.medicalwastepros.com/blog/types-of-sterile-packaging/

[7] Admin, “Types of Medical Device Packaging Formats and Materials,” HIGHPOWER Validation Testing & Lab Services. Accessed: Feb. 04, 2026. [Online]. Available: https://highpowervtls.com/2024/10/types-of-medical-device-packaging-formats-and-materials/

[8] Admin, “Types of Medical Device Packaging Formats and Materials,” HIGHPOWER Validation Testing & Lab Services. Accessed: Feb. 04, 2026. [Online]. Available: https://highpowervtls.com/2024/10/types-of-medical-device-packaging-formats-and-materials/

[9] M. S. Bahk, “Smart Sterilization Container Technology: Blue Wrap Innovation,” J Orthopaedic Experience & Innovation, vol. 5, no. 1, Feb. 2024, doi: 10.60118/001c.87966.

[10] “Amazon.com.” Accessed: Feb. 04, 2026. [Online]. Available: https://www.amazon.com/Plastic-Autoclavable-Instruments-Sterilization-Silicone/dp/B0D5R5P3V5?th=1

[11] “Low Temperature Sterilization Pouch View-Pack - McKesson.” Accessed: Feb. 04, 2026. [Online]. Available: https://mms.mckesson.com/product/407471/Medical-Action-Industries-661

[12] “Nylon Chemical Compatibility Chart,” Foxx Life Sciences, 2026. https://www.foxxlifesciences.com/pages/nylon-chemical-compatibility?srsltid=AfmBOoqOdA4pvEx_p15bjDppN5N4x76WFlN4wTKGkiMhA6dh2EX2TvqS

[13] “Formlabs Customer Support,” Formlabs Customer Support, 2026. https://support.formlabs.com/s/article/Using-BioMed-Clear-Resin?language=en_US#finishing

Questions?