

Problem Definition

Project Motivation:

- Annually 1,000,000 burn related injuries in the US [1]
- Client's **RENEW Lab** studies wound healing to work towards advancing burn treatment therapies [2]
- Contact burns on **pig skin biopsy samples** are cultured, imaged, and analyzed for wound behavior
- **Removal of additional fat** from the biopsy samples dramatically **increases sample viability**

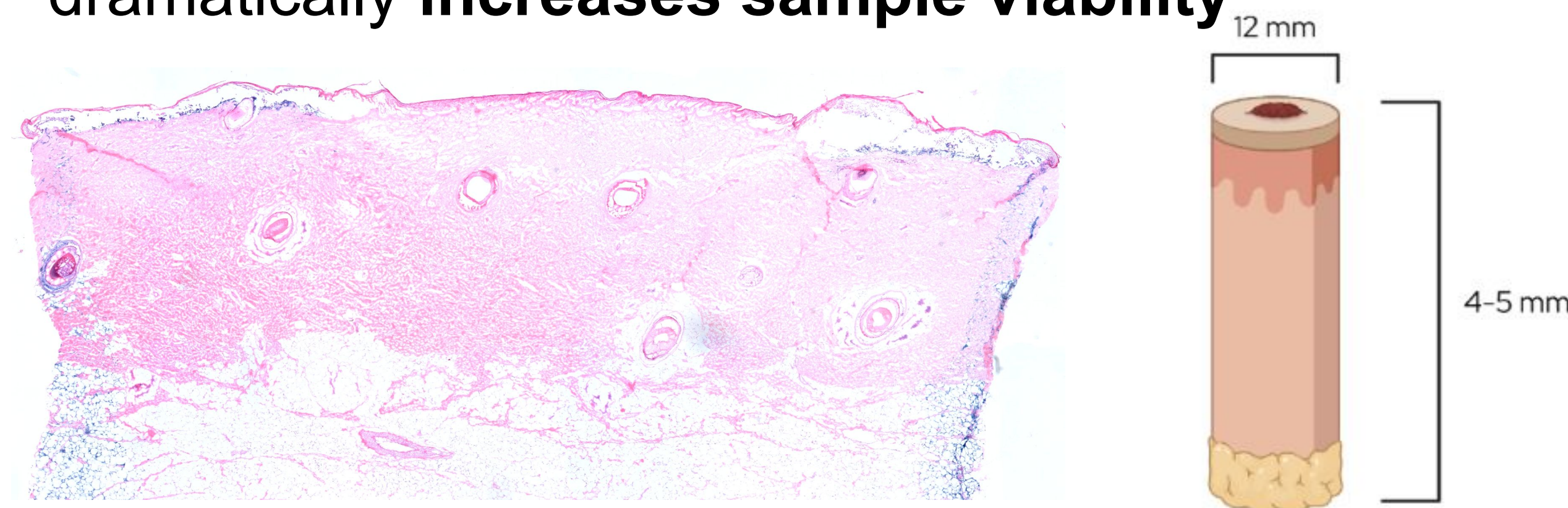


Figure 1. LDH stained pig skin sample without additional fat removal; lack of stain indicating poor viability [Bailey Donahue]

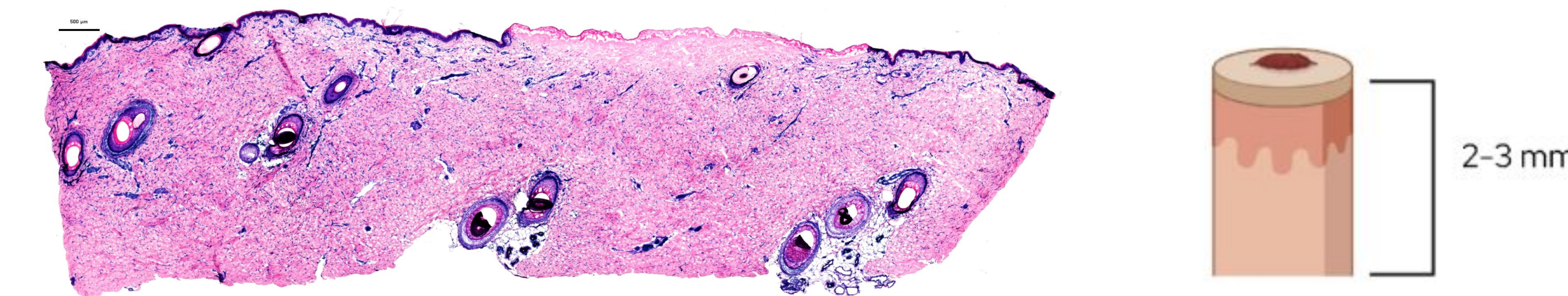


Figure 2. LDH stained pig skin sample with additional fat removal; blue LDH stain indicating viability [Bailey Donahue]

Competing Designs:

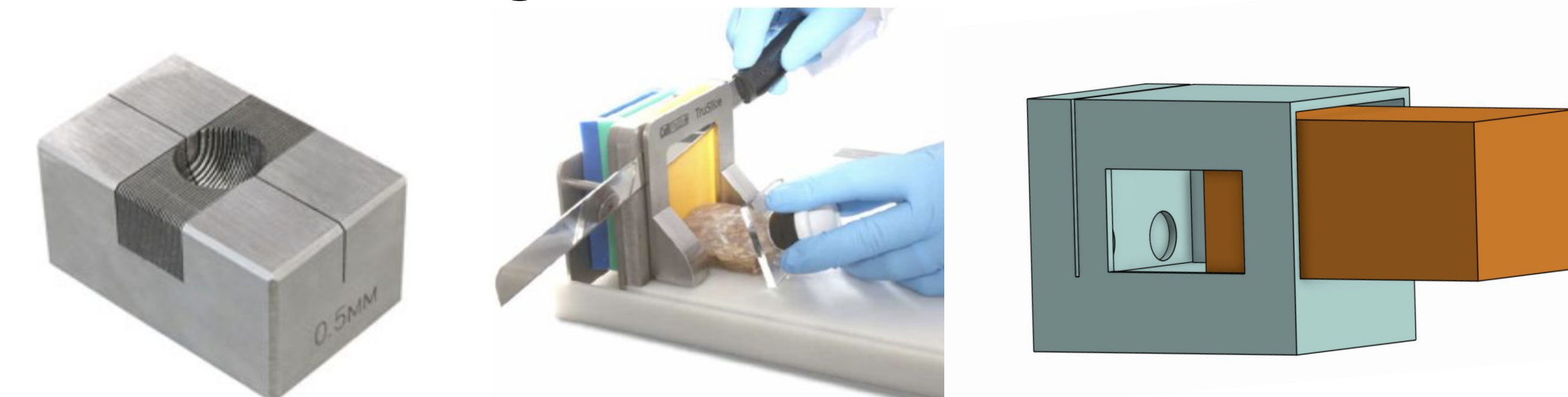


Figure 3. Ted Pella Inc. 12 mm tumor matrix, \$299 [3]
 Figure 4. Ted Pella Inc. TruSlice Specimen Cut-Up Grossing system \$1878.75 [4]
 Figure 5. OnShape CAD drawing of client initial prototype [Bailey Donahue]

Objective: Design a device to **efficiently and accurately slice** burn biopsy samples to improve their viability for further culturing, imaging, and analysis.

Design Criteria

- **Ease of Use:** Device use should be intuitive to use with a written protocol
- **Cut Accuracy & Precision:** Variability of the cut must be within 2.5 ± 0.2 mm and $\pm 2^\circ$
- **Maintenance:** Must be cleaned and sterilized with minimal material breakdown
- **Security of Biopsy:** Sample should be contained within the device while in use
- **Ease of Fabrication:** Device should be easily fabricated by the user for future replacement
- **Safety:** Minimize risk of injury to the user

Final Design

Figure 6. Exploded CAD Device assembly layout

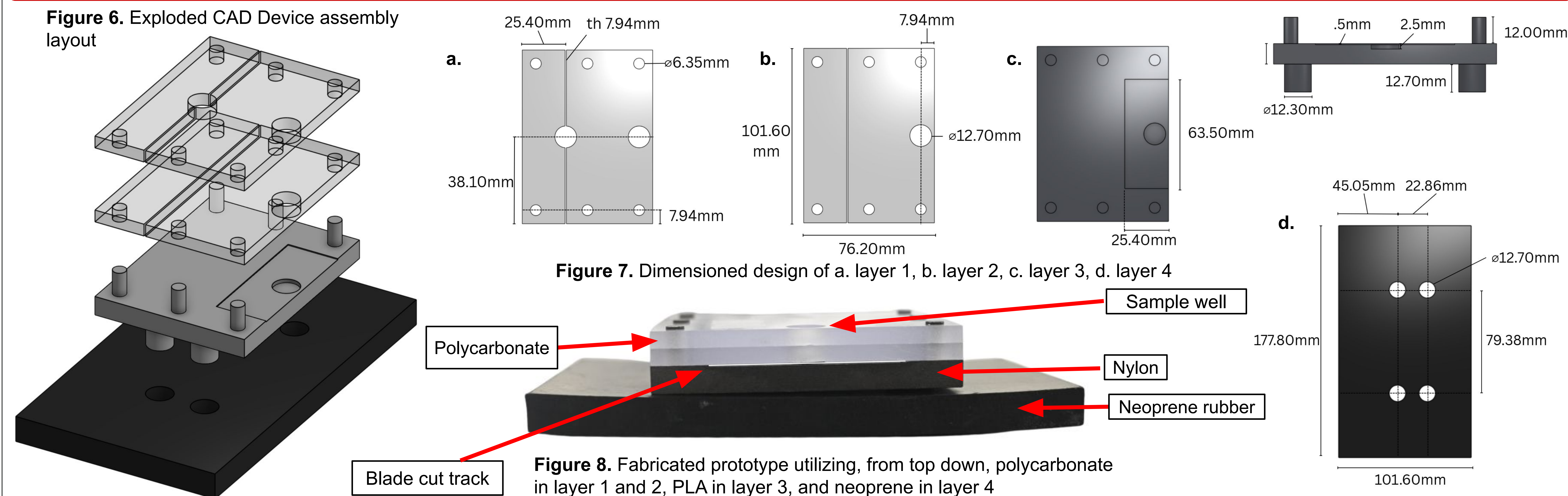


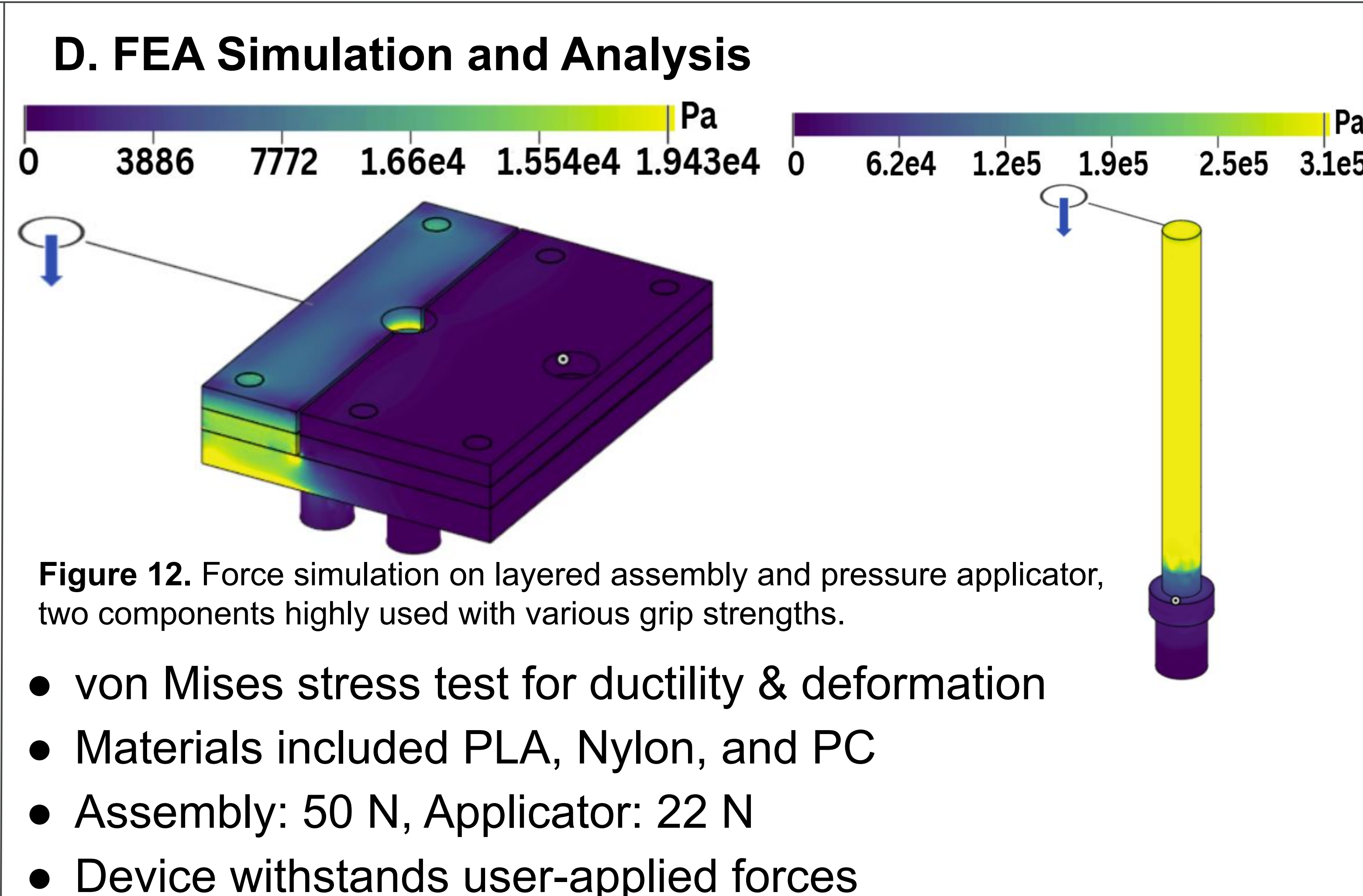
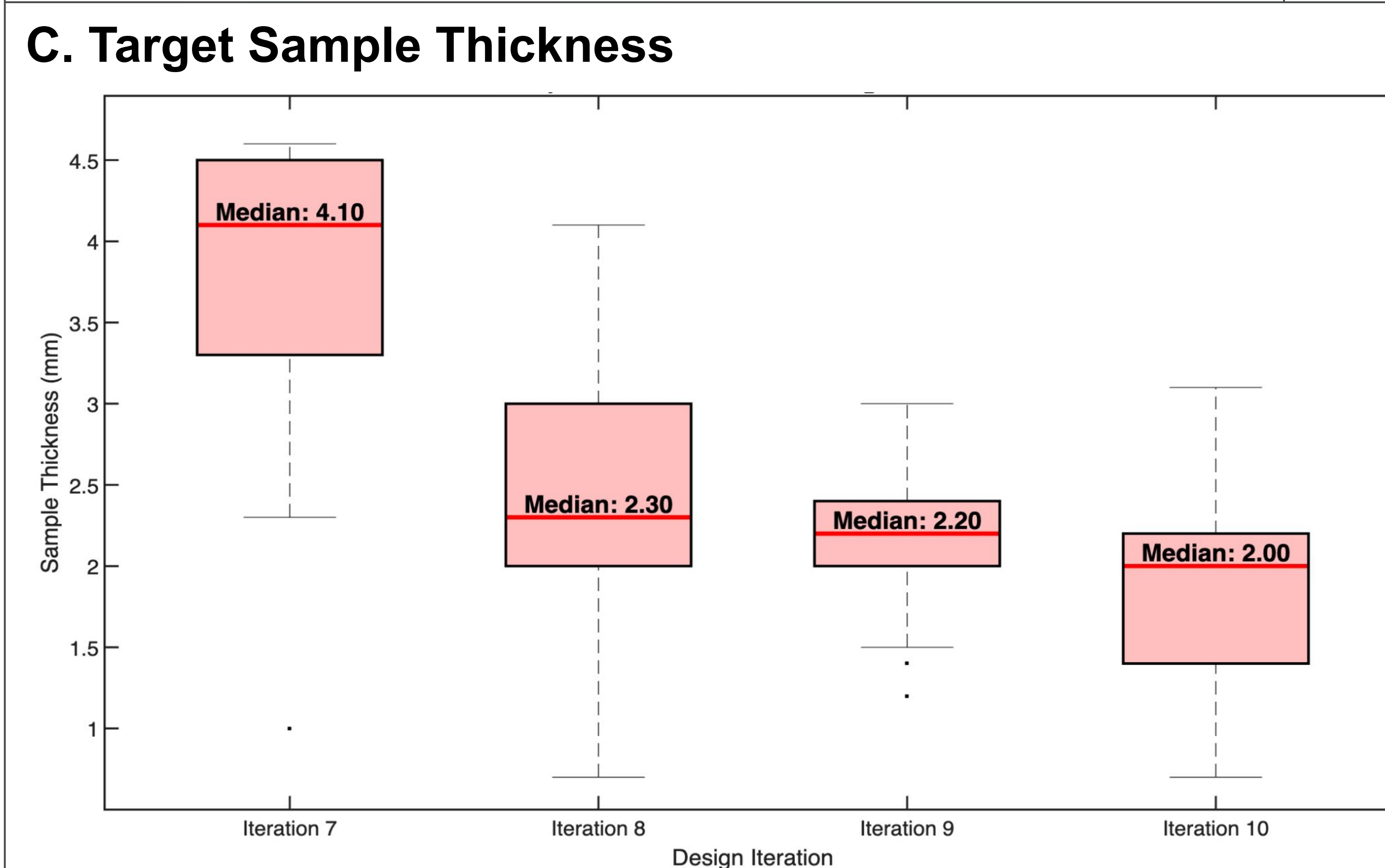
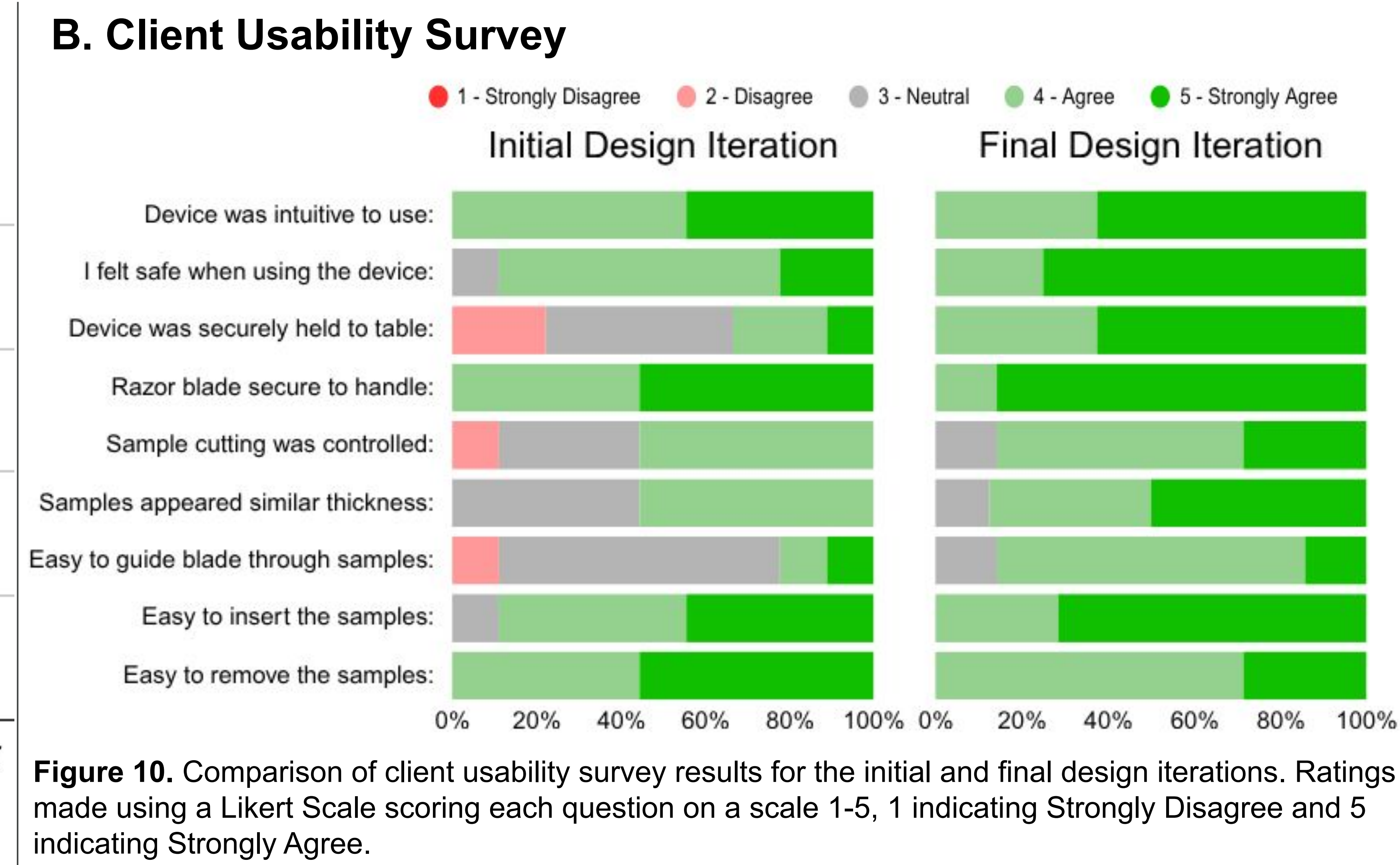
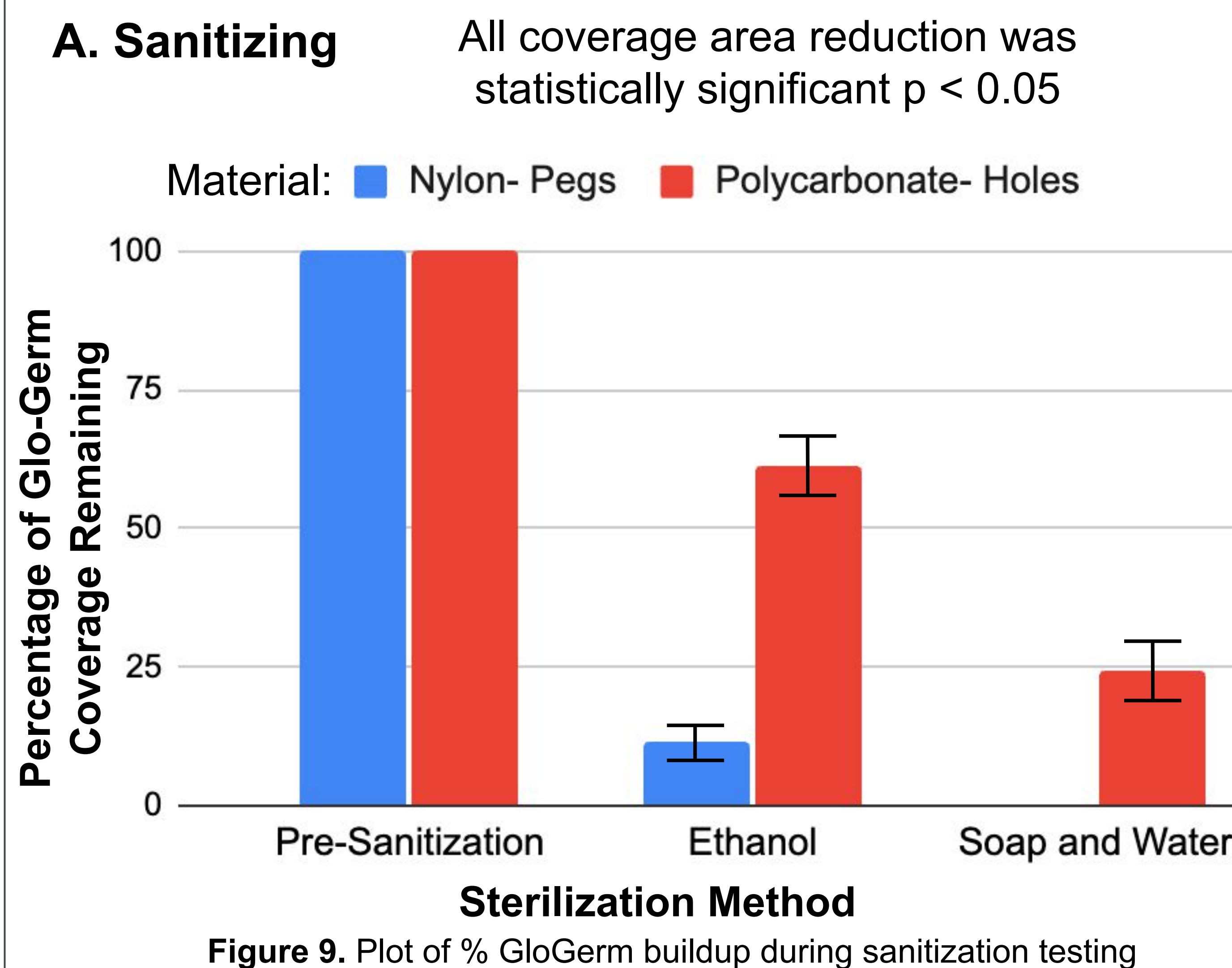
Figure 7. Dimensioned design of a. layer 1, b. layer 2, c. layer 3, d. layer 4

Figure 8. Fabricated prototype utilizing, from top down, polycarbonate in layer 1 and 2, PLA in layer 3, and neoprene in layer 4

Discussion

- Usability survey yielded **>80% positive**
- **Issues in usability testing:**
 - Cut slot too tight for initial blade insertion
 - Inconsistent pressure application
 - Blade housing is not secure
- **Soap and water is effective for cleaning**
- **FEA confirms device withstands large forces** without plastic deformation
 - Validates structural **reliability of layered assembly**
- Autoclave caused nylon to swell
- **Improved preservation of sample**
- Cost: Nylon print~ \$20, PLA~ \$2

Testing & Results



Future Work

- Incorporate **adjustable components** to accommodate different biopsy sizes
- Refine blade track geometry
- Improve component fit and tolerance
- Integrate **standardized blade mounting system**
- Expand validation with larger sample sizes
- Perform **durability testing** of Nylon 12
- Gather more **user feedback** from broader clinical/researcher population
- Add a **resin coating** to Nylon 12 to increase surface smoothness

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References

[1] M. G. Jeschke, M. E. van Baar, M. A. Choudhry, K. K. Chung, N. S. Gibran, and S. Logsetty, "Burn injury," Nat. Rev. Dis. Primer, vol. 6, no. 1, p. 11, 2020, doi: 10.1038/s41572-020-0145-5.
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