Department of Biomedical Engineering
University of Wisconsin - Madison

Graduated Bowman Probes

February 20, 2026
Client: Dr. James Law
Advisor: Dr. Monica Ohnsorg

Team Members: Neel Srinivasan, Caden Robinson, Cole Miller, Caleb White

Overview

- Problem statement
- Background
- Summary of product design specifications
- Designs considered
- Design matrix
- Final design
- Fabrication and future work
- References and acknowledgements

Client Description and Problem Statement

Client

- Dr. James Law, MD
- Oculofacial Plastic Surgery Fellow in the UW Madison Department of Ophthalmology and Visual Sciences

Figure 1 [1]: Dr. James Law

Problem Statement

- Currently, there are no available graduated bowman probes available on the market
- Bowman probes are essential for gauging nasolacrimal duct obstruction depth, but current probes remain inaccurate without graduation markers

Background Information

- Nasolacrimal Duct Obstruction (NLDO) impacts 6-20% of newborns[2]
- Duct obstruction leads to improper fluid drainage and eye irritation[3]
- Treatment for NLDO utilizes a Bowman's probe that is inserted into the punctum for 60 seconds
- A graduated Bowman's probe allows for increased accuracy in duct insertion procedures
- Typical Bowman's probes are made of stainless steel with chromium or nickel alloys

Existing Designs

- Calibrated Bowman's Lacrimal Probe
  - Laser engraved number markings at varying intervals
  - Device maintains IS0-10993-1 standards for biocompatibility
  - Design features easily distinguishable millimeter markings
- No clinical graduated Bowman's probes on the market

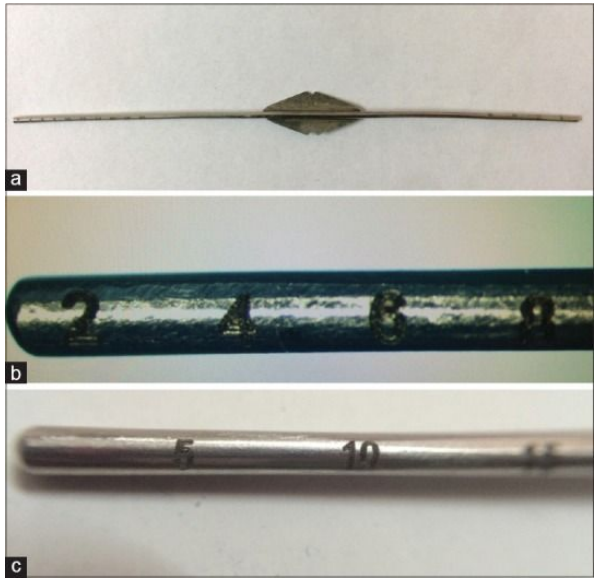


Figure 2 [4]: Calibrated Bowman Lacrimal Probe

Product Design Specifications

Design Requirements

- Must comply with ISO-13485:2016 and ISO-10993-1 [5]
- Markings every 5 millimeters along the probe
- The measured values must be within a 5% range of the correct nasolacrimal duct obstruction millimeter length
- Capable of withstanding autoclave environment (135C and 15-20 psi) [6]
- Have a range of sizes, 00, 0, and ½, representing 0.7 mm, 0.8 mm and 1 mm diameters, respectively
- Length ranging from 130-150 mm
- Weigh roughly 45 grams
- Target product cost $100

Designs Considered

Laser Engraving

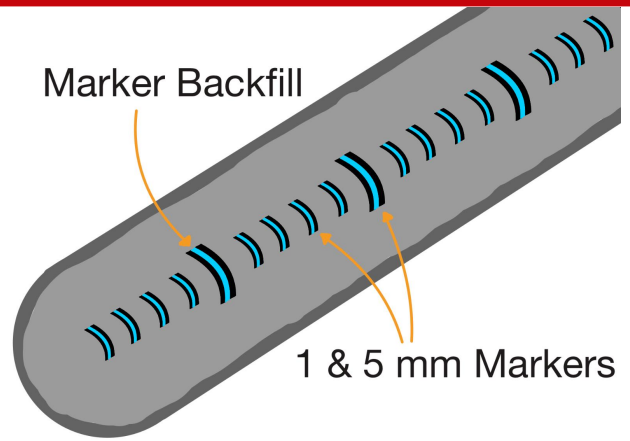


Figure 3: Laser Engraving Design

- Physical markings engraved into probe
- Polymers used to fill in engravings

Laser Annealing

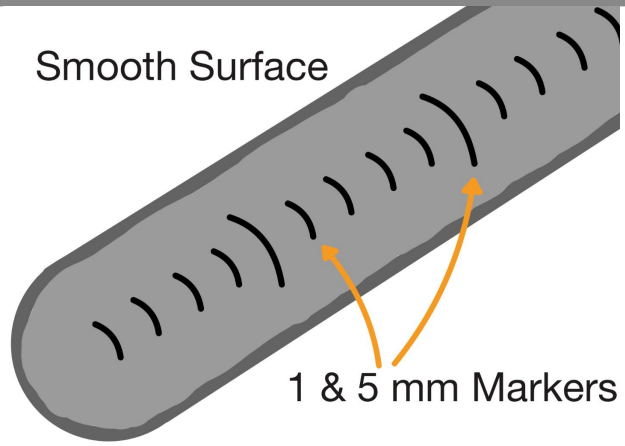


Figure 4: Laser Annealing Design

- Doesn't remove any material from surface
- Easiest to fabricate

Designs Considered

Electroplating

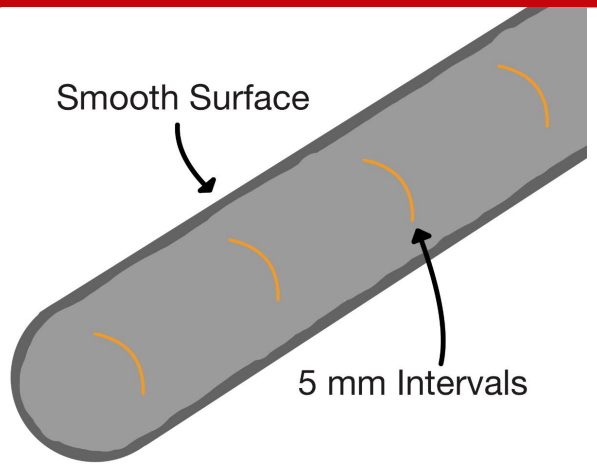


Figure 4: Electroplating Design

- Chemically changes the color of the probe
- Safest for patient

Thermochromism

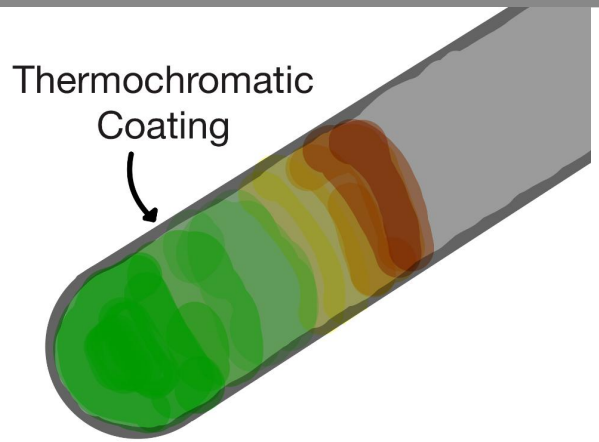


Figure 5: Thermochromism Design

- Rapidly changes color to the length inserted inside the patient
- Changes to normal color just as quickly

Design Matrix Criteria

Accuracy	Precision and Accuracy of Markings	**25**
Patient Safety	No hazard to patient during use	**25**
Ease of Use	How easy it is to measure depth	**20**
Durability	Withstands normal use and sterilization cycles	**15**
Ease of Fabrication	How easy it is to fabricate	**10**
Cost	How much does it cost to develop/make	**5**

Design Matrix

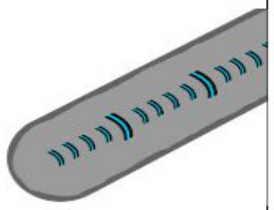
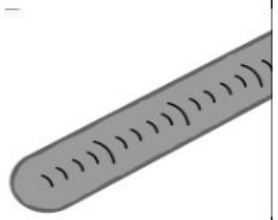
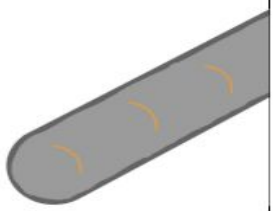
		Laser Engraving		Laser Annealing		Electroplating		Thermochromism	
									
Criteria	**Weight**	**Score**	**Weighted Score**	**Score**	**Weighted Score**	**Score**	**Weighted Score**	**Score**	**Weighted Score**
Accuracy	25	5/5	25	5/5	25	5/5	25	3/5	15
Patient Safety	25	3/5	15	4/5	20	4/5	20	2/5	10
Ease of Data Acquisition	20	5/5	20	4/5	15	3/5	12	2/5	10
Durability	15	2/5	6	5/5	15	5/5	15	5/5	15
Ease of Fabrication	10	4/5	8	2/5	4	2/5	4	3/5	6
Affordability	5	5/5	5	2/5	2	2/5	2	2/5	2
Total	**100**	SUM	**79**	SUM	**81**	SUM	**78**	SUM	**58**

Table 1: Design Matrix

Fabrication and Testing

Chosen Design

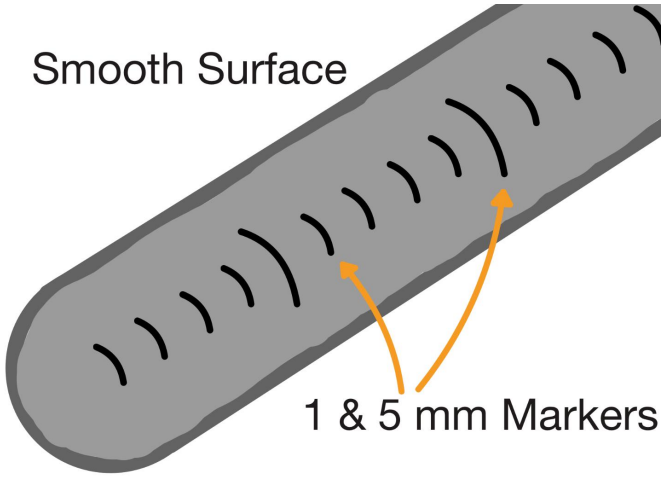


Figure 6: Laser Annealing Design

Chosen for its:

- Accuracy
- Safety
- Durability

Fabrication Plan

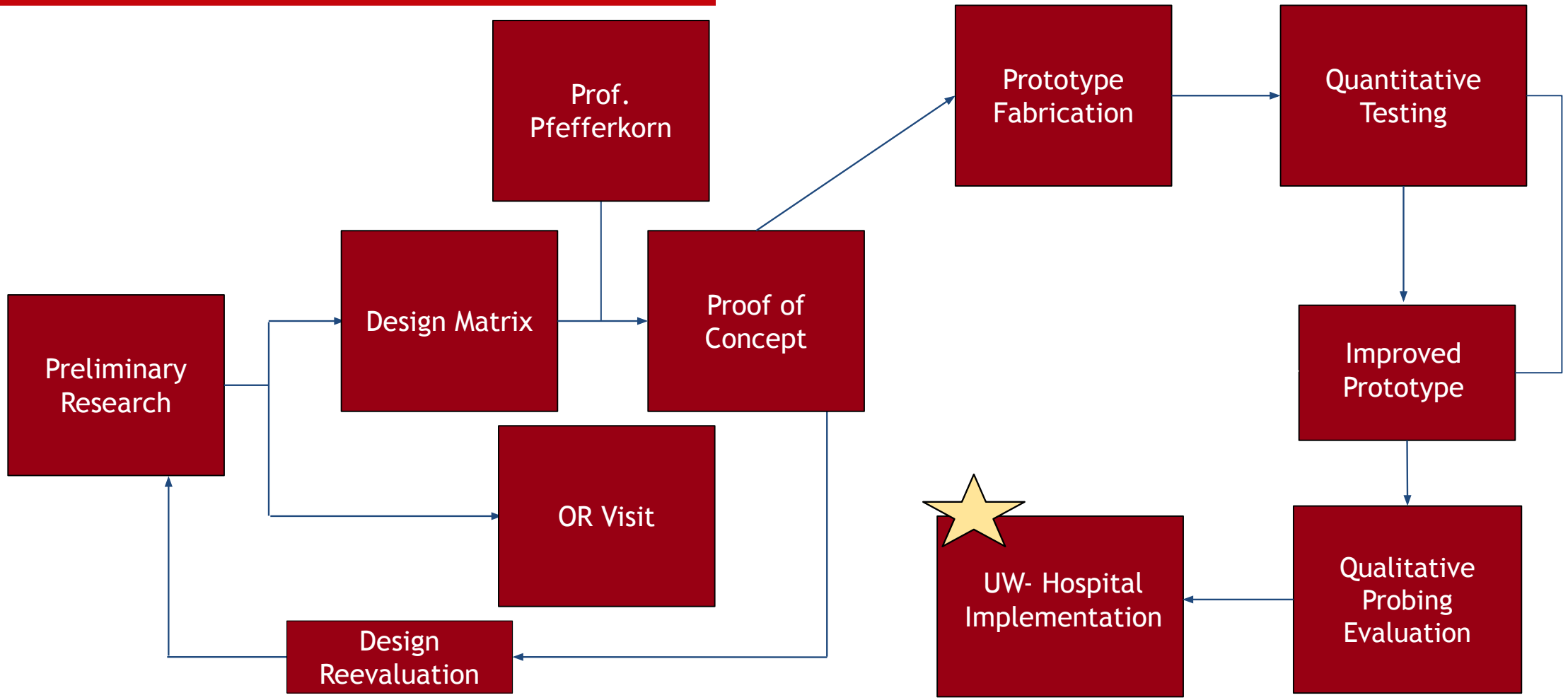
- DXF. Vector Design File for graduation [7]
- Meeting with Prof. Pfefferkorn next week
- Laser Annealing Test Prototype

Testing Methods

- Human cadaveric lacerations
- Bioreactor material deposition
- Autoclave material deposition
- Qualitative nasolacrimal probing

Future Work

Project Timeline



Acknowledgements

Our team would like to thank:

- Dr. Monica Ohnsorg
- Dr. James Law
- Dr. Suzanne van Landingham
- Dr. Puccinellis
- BME Department

Figure 7: Team Picture, team members from left to right: Caleb White, Neel Srinivasan, Caden Robinson, Cole Miller

References

[1] U. of Wisconsin, “Law, MD, james,” Ophthalmology and Visual Sciences, https://www.ophth.wisc.edu/blog/staff/law-james/ (accessed Feb. 17, 2026).

[2] Y. Perez, “Nasolacrimal duct obstruction,” StatPearls [Internet]., https://www.ncbi.nlm.nih.gov/books/NBK532873/ (accessed Jan. 27, 2026).

[3] M. Clinic, “Blocked tear duct,” Mayo Clinic, https://www.mayoclinic.org/diseases-conditions/blocked-tear-duct/symptoms-causes/syc-20351369 (accessed Jan. 28, 2026).

[4] A. Pujari, M. S. Bajaj, and P. Sharma, “Calibrated Bowman’s lacrimal probe,” Indian journal of ophthalmology, https://pmc.ncbi.nlm.nih.gov/articles/PMC5859621/ (accessed Jan. 27, 2026).

[5] I. O. Standardization, “ISO-13485:2016,” ISO, https://www.iso.org/obp/ui/en/#iso:std:iso:13485:ed-3:v1:en (accessed Feb. 4, 2026).

[6] D. F. Chang, N. Mamalis, and Ophthalmic Instrument Cleaning and Sterilization Task Force, “Guidelines for the cleaning and sterilization of intraocular surgical instruments,” Journal of Cataract and Refractive Surgery, vol. 44, no. 6, pp. 765–773, Jun. 2018, doi: https://doi.org/10.1016/j.jcrs.2018.05.001.

[7] “Laser Annealing | KEYENCE America.” Accessed: Feb. 19, 2026. [Online]. Available: https://www.keyence.com/products/marker/laser-marker/applications/laser-marking/laser-annealing.jsp

Questions?