

# BME Design-Spring 2026 - Roshan Patel

## Complete Notebook

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Tatiana Predko

on

Apr 29, 2026 @10:55 PM CDT

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**Team contact Information**

Tatiana Predko - Apr 29, 2026, 7:46 PM CDT

| Last Name | First Name | Role         | E-mail   | Phone        | Office Room/Building |
|-----------|------------|--------------|--|--------------|----------------------|
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## Project description

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Tatiana Predko - Apr 29, 2026, 7:49 PM CDT

**Course Number: BME 402**

**Project Name: Approximating Surface Matrix Band for Dental Patients**

**Short Name: Surface Matrix Band**

**Project description/problem statement:**

Surface matrix bands are devices used by dentists to separate adjacent teeth during restorations of interproximal cavities (cavities found in-between two teeth). The matrix band serves to support the restoration material, to provide shape and contour to the tooth being restored, and to protect the adjacent tooth. Ideally, the width of the space between the two adjacent teeth is just large enough to fit one matrix band in order to ensure close proximal contact area, which prevents food impaction and decay. In the case of two cavities on two adjacent teeth, this process is tedious, as the dentist must complete the process from start to finish for each adjacent tooth individually. The goal of this project is to create a dental matrix band that effectively partitions adjacent teeth for more efficient tooth restoration procedures on interproximal cavities by making it possible to complete two adjacent restorations simultaneously.

**About the client:**

Dr. Donald Tipple is a Doctor of Dental Surgery (DDS) and is the owner of his own practice at Nakoma Dental.



## 11/30/2025 - MTS Material Testing

---

Tatiana Predko - Dec 09, 2025, 10:31 PM CST

**Title:** MTS Material Testing

**Date:** 11/30/2025

**Content by:** Roshan Patel and Tatiana Predko

**Present:** Whole Team

**Goals:** Test procured materials for similarity to currently available dental matrices.

**Content:**

1. For a coupon of the purchased material, measure the length, width, and thickness of the sample. In the case of a sample of an existing circumferential matrix, cut the matrix in half at the bend.
2. Using the MTS located in the teaching lab with the 1kN load cell, load a sample into the two vices and elevate the top head till a positive load is displayed on the screen.
3. Load a stress-strain template test on the MTS machine at 0.1mm/s and begin.
4. Stop the test when the stress strain curve is visibly out of the linear portion of the curve, to minimize risk to the load cell.
5. Export the data to a known location on the computer.
6. Repeat the steps for each sample (three samples per material type).
7. Analyze data using MatLab in order to create graphs.

**Conclusions/action items:**

Complete the testing on every sample in addition to the currently used dental matrices.



## 12/10/2025 SolidWorks Simulation Protocol

JOSEPH KOCH - Dec 10, 2025, 8:58 PM CST

### Title: SolidWorks Simulation

Date: 12/10/2025

Content by: Joseph Koch

Present: --

Goals: Run Solidworks simulations on part

### Content:

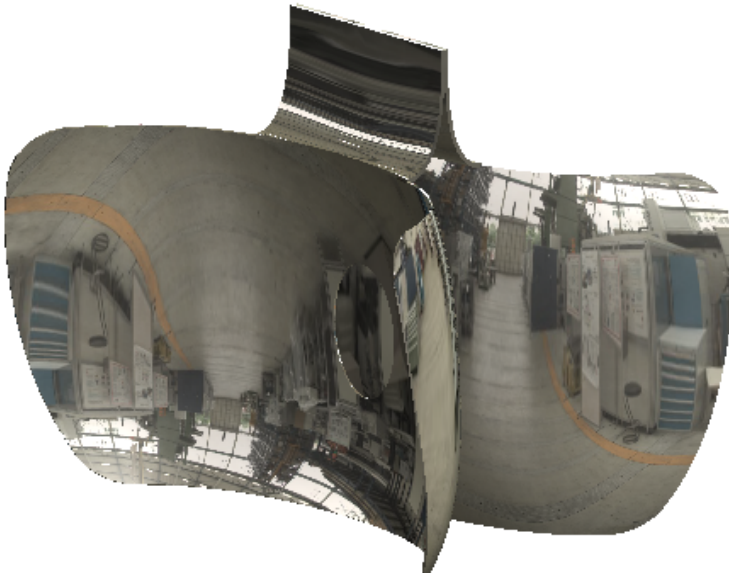
make model suitable for simulation - initial model not very realistic more for display especially in the tab section had overlapping bodies this presented some meshing problems. Revised model addressed this refined geometry of tabs of sectional matrix shown below. Much more realistic and was able to be meshed. Took a lot of trouble shooting. Generated two bodies because of mirror so need to define local interaction.

### Local interactions

- at tab in reality this is one piece of metal folded --> use bonded interaction with top edge of one side of tab to face of other side of tab after several unrealistic results (tabs pulling apart) need two interactions one for each edge and face

- at faces of matrix these are going to be in contact and need to be unbonded --> contact interaction between faces of matrix

Now SolidWorks knows how the model will interact with itself the top edge of the tab is bonded together and the faces are in contact



### Simulation

- two simulations - compressive simulation and tensile simulation

--- compression simulation - not including surface bodies only the two solid bodies

----- material - AISI 304 stainless steel from SolidWorks database

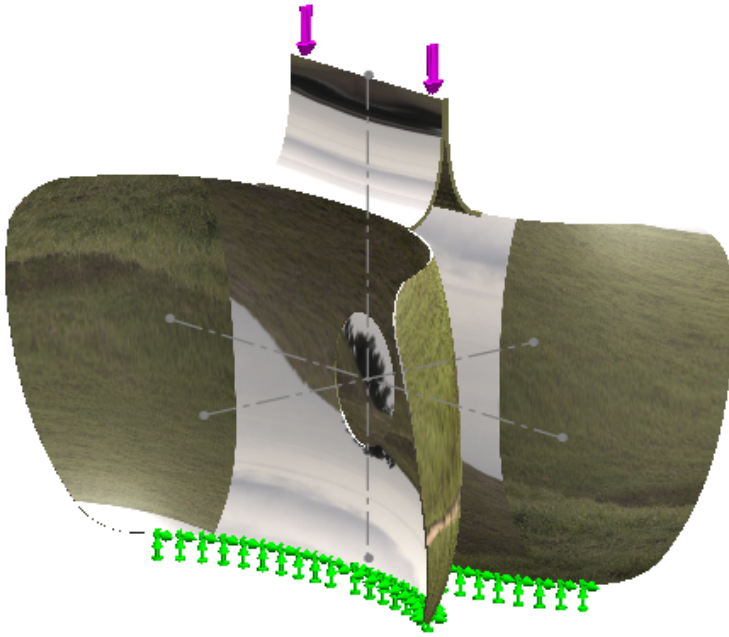
----- interactions - described above

----- Fixtures - bottom edge of matrix fixed geometry green arrows

----- Forces - 1lb 4.488 N forces in line with front plane onto tab (compressive) purple arrows

----- Mesh - finest mesh setting SolidWorks allows

----- Failure Criteria - deflection



--- tensile simulation - not including surface bodies only the two solid bodies

----- material - AISI 304 stainless steel from SolidWorks database

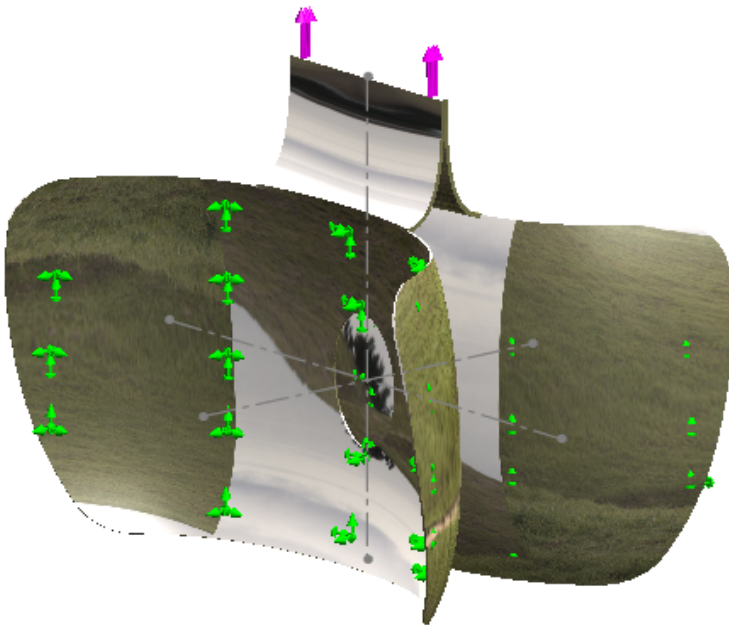
----- interactions - described above

----- Fixtures - Faces of matrix green arrows

----- Forces - 1lb 4.488 N forces in line with front plane onto tab (tensile) purple arrows

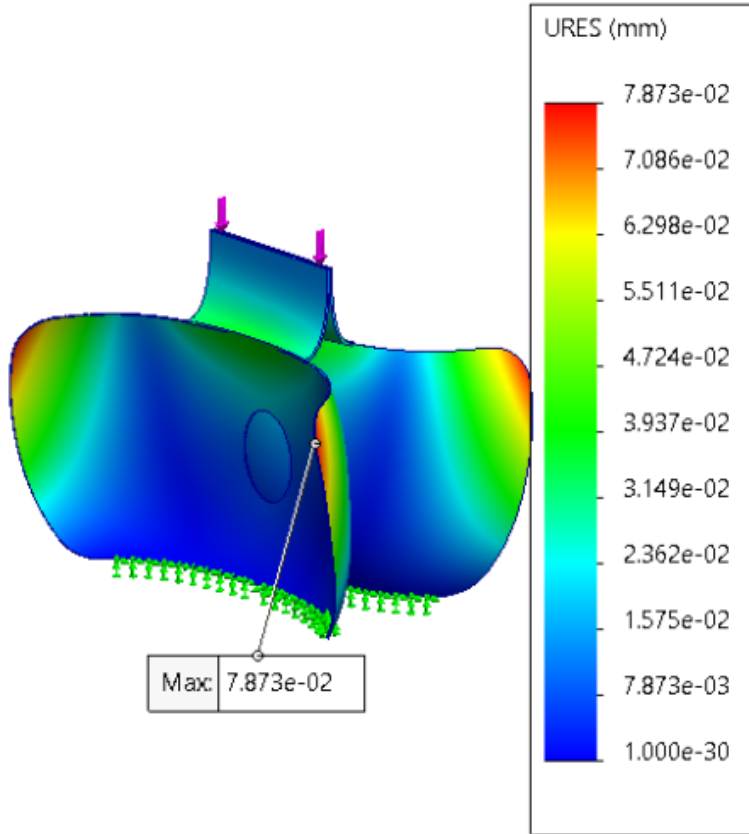
----- Mesh - finest mesh setting SolidWorks allows

-----Failure criteria - UTS (stress analysis)

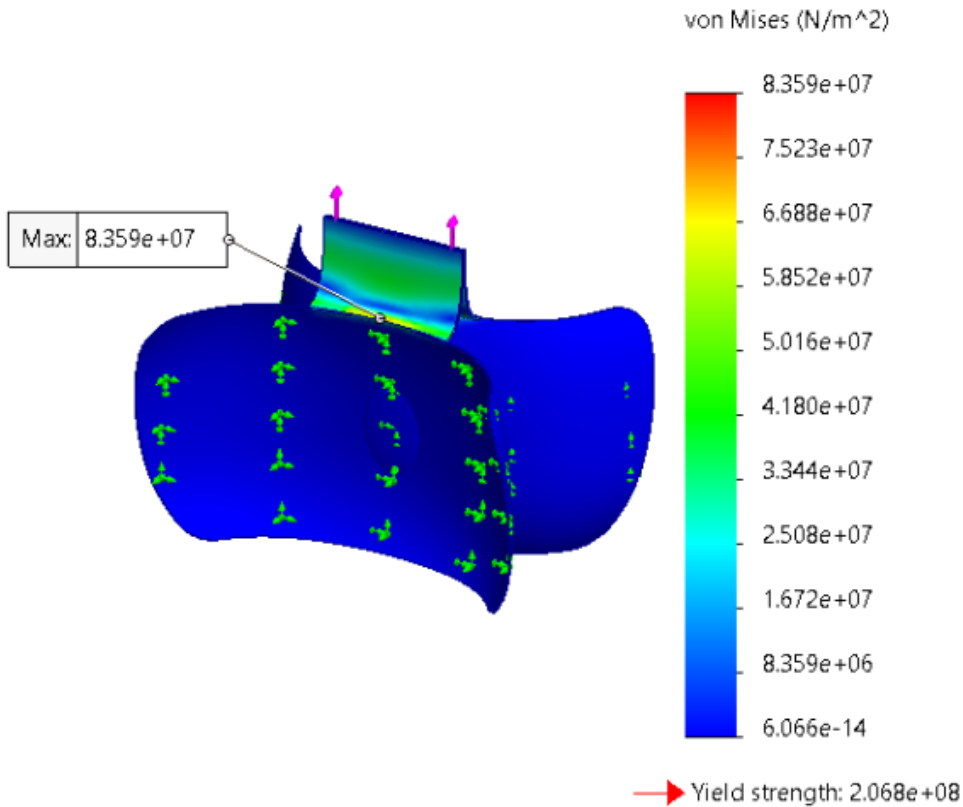


### Yielded Heat Maps

Compression - deflection (mm) largest deflection in non critical areas success!



Tension stress using von Mises - all stress below UTS of material success!



**Conclusions/action items:**

Model can probably be further optimized by experimenting with more interactions. These I think were pretty accurate though

Could do assembly modeling with teeth for tension simulation - problems with sim time because many faces on tooth models, assembly models harder to get accurate results

Verify sim data with mechanical testing with MTS machine clamp tooth model in bottom tip in top compress and pull to get forces to remove and insert would provide better estimates on forces required



## 04/12/2026 - Client Testing

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ANYA HADIM - Apr 29, 2026, 7:19 PM CDT

**Title: Testing Plan****Date:** 4/12/2026**Content by:** Anya Hadim**Present:** whole group**Goals:** conduct in person testing for full filling procedures with Dr. Tipple**Content:**Dental Matrix Band Testing Plan**Level 1: Tooth Preparation Testing**

Objective: Evaluate the efficiency, accuracy, and usability of the prototype during the tooth preparation stage before placement of restorative material.

## Procedures:

1. Simulate cavity preparation on model teeth.
2. Assess access and visibility while preparing the tooth.
3. Place the matrix band using the butterfly design prototype.
4. Insert wedge and evaluate fit, stability, and ease of placement.
5. Observe whether the system maintains proper tooth separation and contour.
6. Record preparation time and any difficulties encountered.

## Metrics to Evaluate:

- Ease of placement of matrix band
  - Easy placement
- Ease of wedge insertion
- Stability during preparation
- Visibility/access to working area
- Time required for setup
- User (dentist) feedback on ergonomics/usability

**Level 2: Full Fill Testing**

Objective: Evaluate prototype performance through the complete restorative filling procedure.

**Procedures:**

1. Perform tooth preparation on model tooth.
2. Place matrix band and wedge using butterfly prototype.
3. Apply bonding/restorative material according to standard filling protocol.
4. Cure material as required.
5. Remove the matrix band and wedge.
6. Evaluate final restoration contour, contact point, and marginal adaptation.
7. Check for excess material or finishing adjustments needed.

**Metrics to Evaluate:**

- Ease of complete workflow
- Time required for full restoration
- Quality of contact point achieved
- Final contour/anatomy of restoration
- Marginal seal/adaptation
- Ease of removal of device
- User satisfaction and recommendations

**Notes Section**

Test operator: Dr. Donald Tipple

Number of trials completed:

Level 1:

Level 2:

Key issues observed:

Suggested improvements:

- Pretty big
- Suedged open to put a wedge at the gingiva? Future work maybe
- Contact points arent that large
- Perforations at the bottom : future work

- The hole is down into the gingival : want it more toward the biting surface of the tooth and make it smaller , away from the gums
  - Want the hole 2 mm low
  - Right below where the tab ends
  - $\frac{2}{3}$  up from the gingival

Things to keep: Likes that the second is more flexible and that it is thinner

Likes the longer hand length - incorporate in all new designs

Future work:

Attach to a wedge

Limitations: model teeth so theres no flex of the gingiva which affects wedge placement

Teeth will flex apart in a mouth but less so in model teeth

Gums dont compress for dentist to be able to suege it molds more toward the curvature of the matrix

Notes:

Could eliminate the need for clamps

Looks like it worked well

Saves steps for post processing

- Eliminates first steps he doesnt have to polish the face of the first filling because were polishing it all at once

Able to floss the tooth with the new design (303)

Contact point may be more natural

- Making it smaller should increase the natural ability to floss

Clamp is helpful for adhering the band to the wall of the tooth but doesn't change much for seperating?

316 stainless steel dental matrix fence:

Trial 1:

Cut off 2 mm

Timing :

Preparation time:

Includes: drilling both teeth at a time 1 min 37 sec

Instead of doing one side polish then another fence in another direction

Fence placement 20 sec

Wedge placement 15 sec

Adding the clamp 8 sec

Curing and adding the filling 4 min

Pulling out the matrix band 1 min 15 sec

Post processing 1 min 31 sec

Notes after: easier to floss

Trial 2 (filling both teeth at the same time) “

Preparation time:

Drilling 1 minute

Fence placement 17 sec

Wedge placement 8 sec

Adding the clamp 4 sec

Curing and adding the filling 3 min 18 sec

Pulling out the matrix band didnt work becaus of hole position , didnt come out couldve been fixed with polishing of the hole

Post processing 1 min 21 sec

Notes after:

Future work:

Coating for easier removal

Perforation for pulling out

Limitations: teeth shifting, etching malleable gums

New Trial 1 (filling both teeth at the same time)

Drilling: 1 min 16s

Fence placement: 17sec

Wedge placement:18 sec

Adding the clamp: 16 sec

Bonding agent application: 28 sec

Curing and adding the filling: 5min 9sec

Post processing: 1 min 42 sec

Notes after: matrix breaks when trying to take it out

New Trial 2 (filling both teeth at the same time)

Drilling: 1min 47sec

Fence placement: 30 sec

Wedge placement: 30 sec

Adding the clamp: 15 sec

Bonding agent application: 20 sec

Curing and adding the filling: 4min 38 sec

Post processing: 1 min 35 sec

Notes after:

Control Trial 1

Drilling: 47 sec

Fence placement: 2 min 59 sec

Wedge placement: 34 sec

Adding the clamp: 20 sec

Bonding agent application: 22 sec

Curing and adding the filling: 4 min 33 sec

Post processing: 3 min 42 sec

Control Trial 2

Drilling: 1 min 23 sec

Fence placement: 2 min 50 sec

Wedge placement: 55 sec

Adding the clamp: 23 sec

Bonding agent application: 39 sec

Curing and adding the filling: 3 min 26 sec

Post processing 3 min 59 sec

**Conclusions/action items:**

Use this testing data to analyze and determine success of prototype in results.

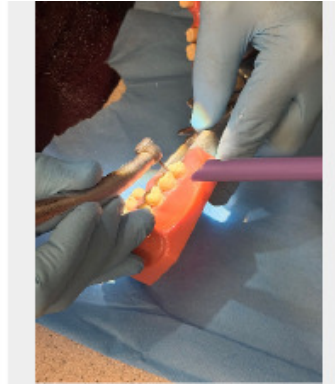


## 4/18/2026 - Testing procedure

ANYA HADIM - Apr 29, 2026, 7:20 PM CDT

### Removal of Decay

Decayed tooth structure is removed to prepare a clean cavity for restoration.



[Download](#)

**BME\_402\_Final\_Slides.pptx (14.7 MB)**



## 4/22/2026 - Testing Results

ANYA HADIM - Apr 29, 2026, 7:24 PM CDT

**Title:** Testing Results

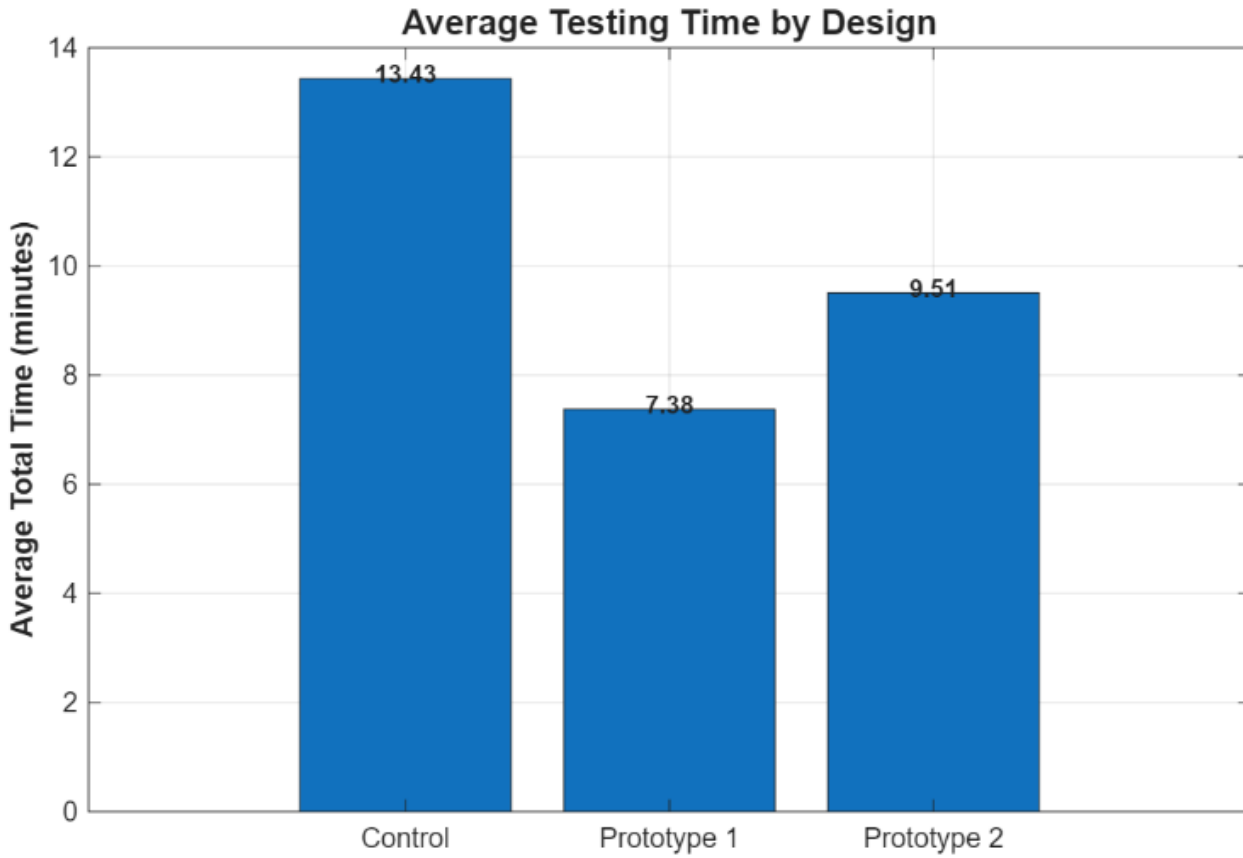
**Date:** 4/29/2026

**Content by:** Anya

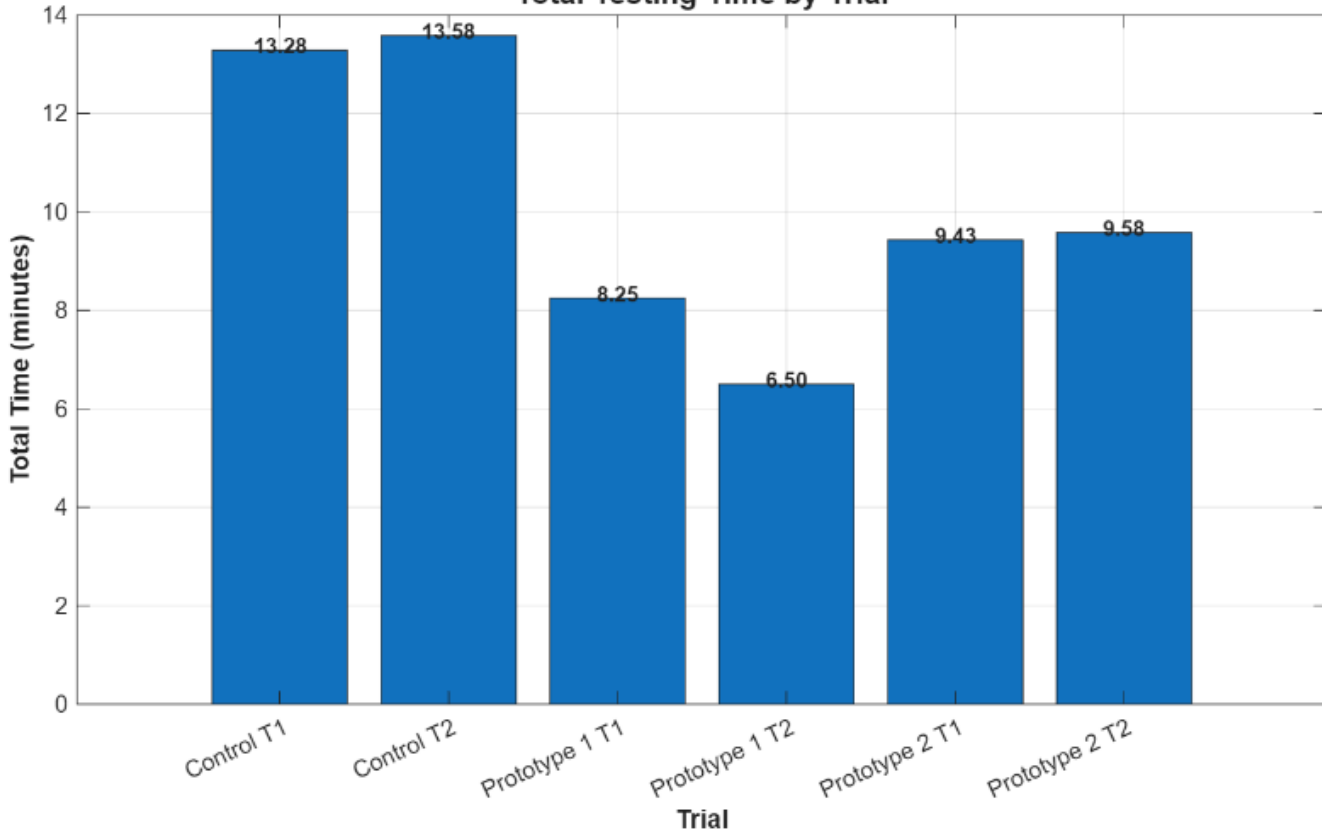
**Present:** Anya

**Goals:** Analyze testing data to draw results and conclusions about the success of our prototype

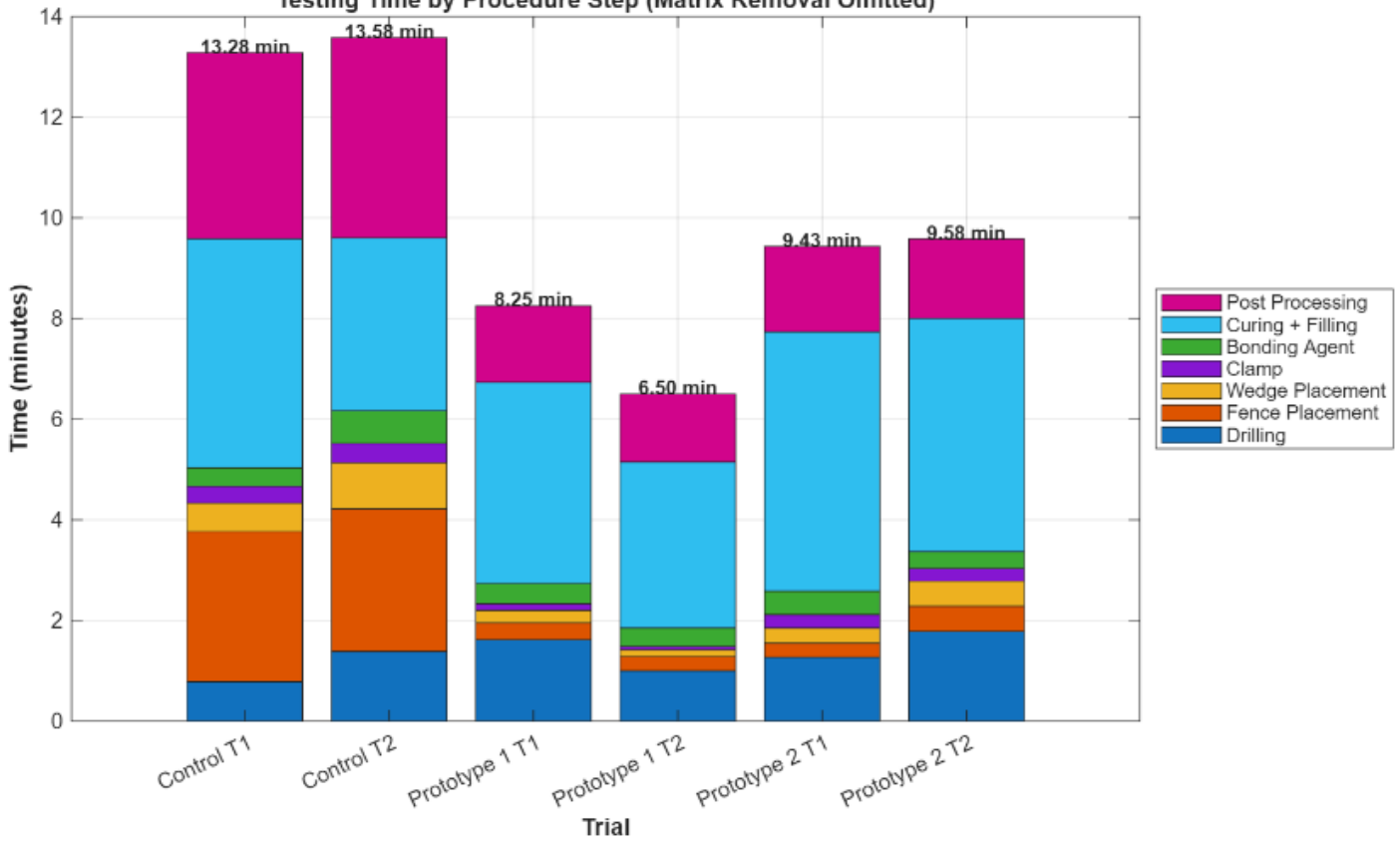
**Content:**



**Total Testing Time by Trial**



**Testing Time by Procedure Step (Matrix Removal Omitted)**



**Conclusions/action items:**

The prototype significantly reduced filling procedure time, especially in wedge placement and fence placement categories.



# 11/30/2025 MTS Testing

Tatiana Predko - Dec 09, 2025, 10:23 PM CST

**Title:** MTS Testing #1

**Date:** 11/30/2025

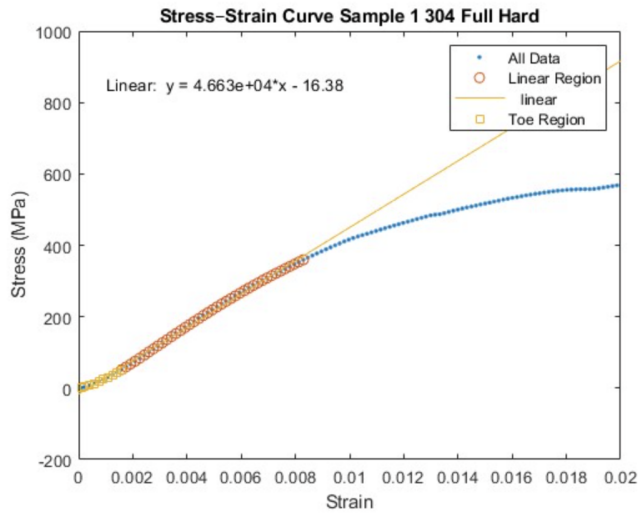
**Content by:** All group members

**Present:** Keleous, Roshan, and Joseph

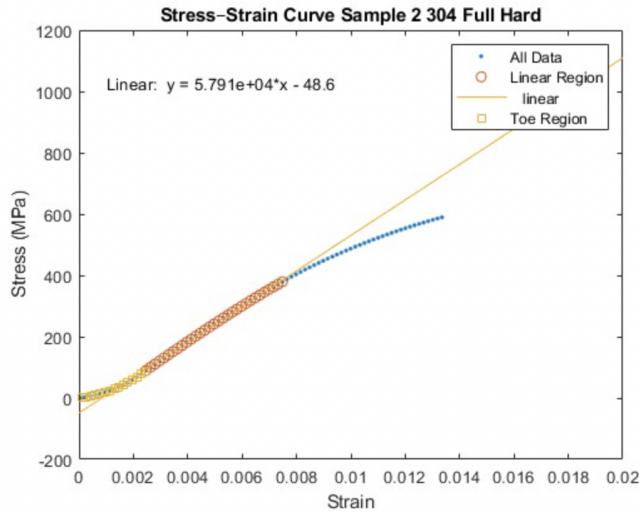
**Goals:** Test the mechanical properties of the two materials obtained from McMaster.

**Content:**

Test Run 2 304 Full Hard:  
 Extension rate: 0.1mm/s  
 Extension length: 59.60mm  
 Thickness: 0.1mm  
 Width: 11.75mm



Test Run 4 304 Full Hard:  
 Extension rate: 0.1mm/s  
 Extension length: 59.60mm  
 Thickness: 0.1mm  
 Width: 11.75mm



Test Run 5 304 Full Hard:  
 Extension rate: 0.1mm/s  
 Extension length: 59.60mm  
 Thickness: 0.1mm  
 Width: 11.75mm

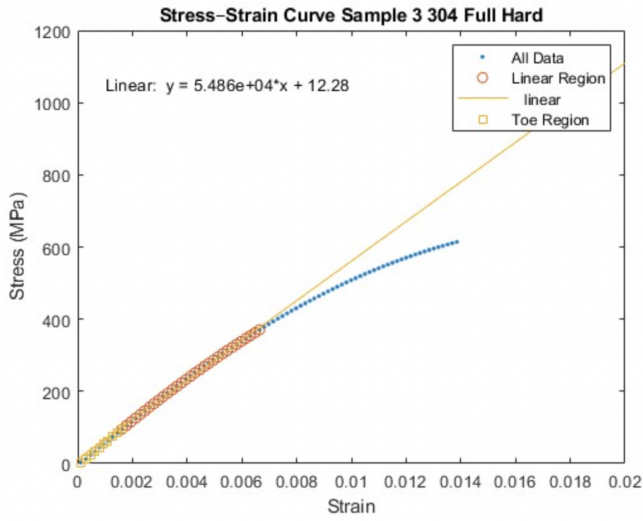
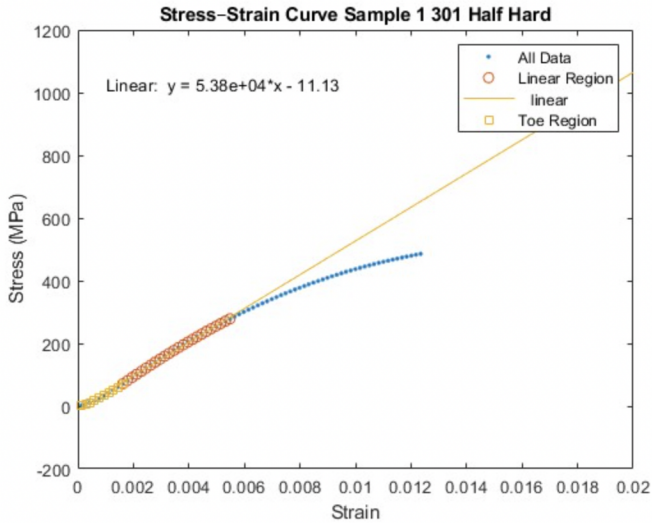
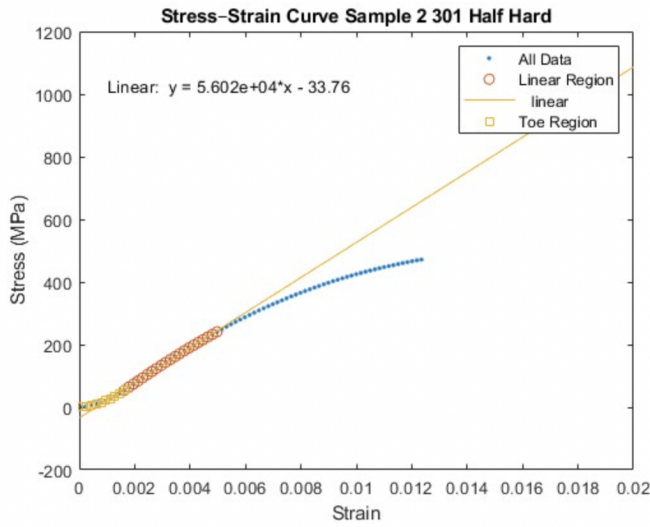


Fig. 1. Stress-strain curves of three samples of the 304 stainless steel.

Test Run 6 301 Half Hard:  
 Extension rate: 0.1mm/s  
 Extension length: 59.60mm  
 Thickness: 0.1mm  
 Width: 11.75mm



Test Run 7 301 Half Hard:  
 Extension rate: 0.1mm/s  
 Extension length: 59.60mm  
 Thickness: 0.1mm  
 Width: 11.75mm



Test Run 8 301 Half Hard:  
 Extension rate: 0.1mm/s  
 Extension length: 59.60mm  
 Thickness: 0.1mm  
 Width: 11.75mm

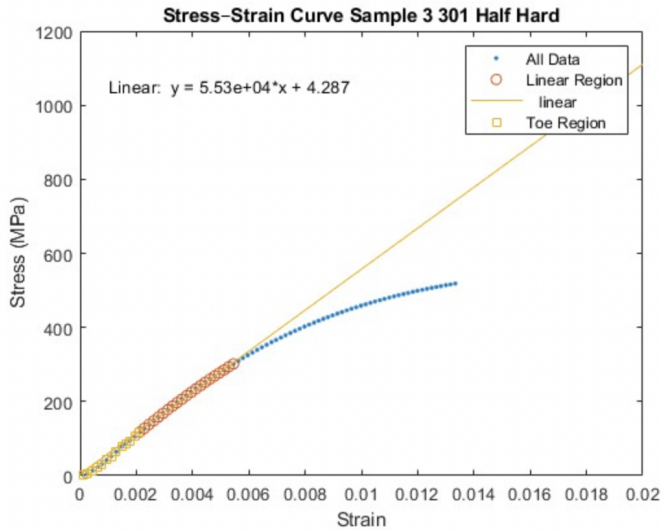


Fig. 2. Stress-strain curves of the 301 stainless steel.

**Conclusions/action items:**

- Calculate the average Young's Moduli from the two groups of samples.
- Conduct more MTS testing of the products provided by the client to compare to these results.



## 12/01/2025 MTS Testing (Original Product)

Tatiana Predko - Dec 09, 2025, 10:36 PM CST

**Title:** MTS Testing Continued

**Date:** 12/01/2025

**Content by:** All group members

**Present:** All group members

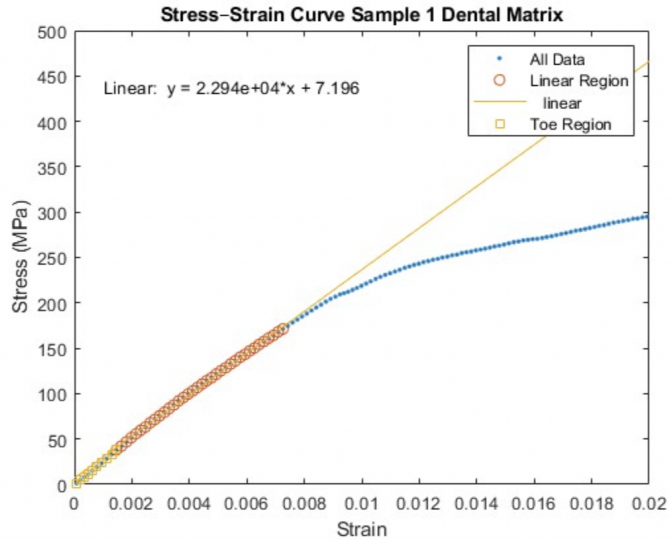
**Goals:** Conduct mechanical strength testing of the materials provided by the client.

**Content:**

- All of the following samples were from a circumferential matrix band provided by the client.

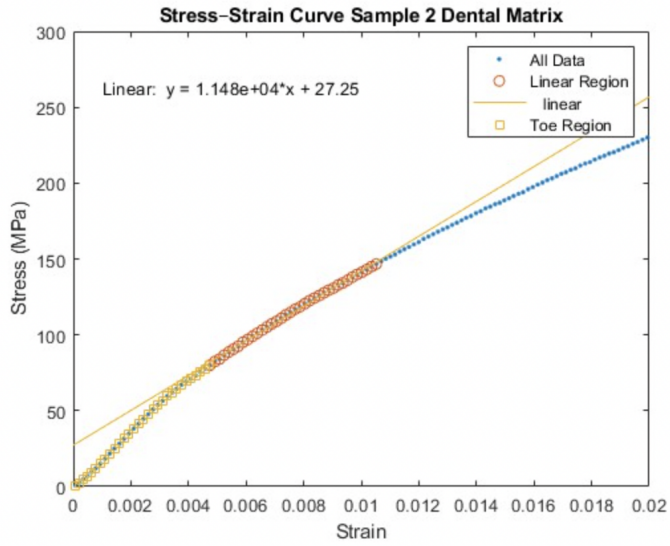
Sample 1:

- Width: 5.6 mm
- Thickness: 0.01 mm
- Crosshead length: 12.10 mm
- Extension rate: 0.2 mm/s



Sample 2:

- Width: 5.6 mm
- Thickness: 0.01 mm
- Crosshead length: 12.10 mm
- Extension rate: 0.2 mm/s



Sample 3:

- Width: 5.6 mm
- Thickness: 0.01 mm
- Crosshead length: 12.10 mm
- Extension rate: 0.2 mm/s

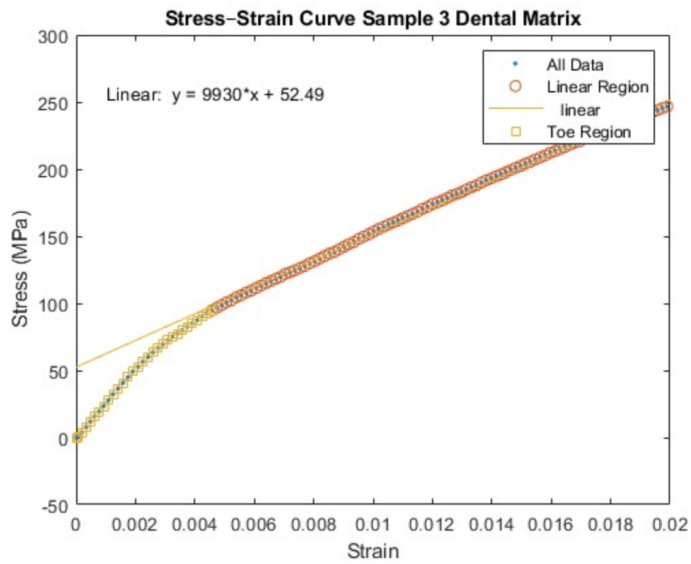


Fig. 1. Stress-strain curves of the circumferential matrix bands provided by the client.

Average 304 Full Hard:  $5.3133 \cdot 10^4$  MPa

Average 301 Half Hard:  $5.504 \cdot 10^4$  MPa

Average Dental Matrix:  $1.477 \cdot 10^4$  MPa



Fig. 2. Circumferential matrix sample loaded into the MTS machine.

**Conclusions/action items:**

- Use the average moduli to compare to our materials.



## 12/02/2025 SOLIDWORKS FEA

Tatiana Predko - Dec 09, 2025, 10:27 PM CST

**Title:** SOLIDWORKS FEA Analysis

**Date:** 12/02/2025

**Content by:** Tatiana and Joseph

**Present:** N/A

**Goals:** Perform an FEA analysis of the dual matrix band.

**Content:**

- Load applied to the matrix band by ring clamp: 5 lbs (2.2411 N)
- Thickness of overall, folded structure: 0.1 mm (as taken from MTS testing)
- Custom mesh size: in progress.

| Property                      | Value      | Units             |
|-------------------------------|------------|-------------------|
| Elastic Modulus               | 1.965e+11  | N/m <sup>2</sup>  |
| Poisson's Ratio               | 0.29       | N/A               |
| Tensile Strength              | 505000000  | N/m <sup>2</sup>  |
| Yield Strength                | 215000000  | N/m <sup>2</sup>  |
| Tangent Modulus               | 2100000000 | N/m <sup>2</sup>  |
| Thermal Expansion Coefficient | 17200000   | /K                |
| Mass Density                  | 1020       | kg/m <sup>3</sup> |
| Hardening Factor              | 0.45       | N/A               |

Table 1: custom material properties of 304 18-8 stainless steel.

| Property                      | Value      | Units             |
|-------------------------------|------------|-------------------|
| Elastic Modulus               | 1.855e+11  | N/m <sup>2</sup>  |
| Poisson's Ratio               | 0.28       | N/A               |
| Tensile Strength              | 1034000000 | N/m <sup>2</sup>  |
| Yield Strength                | 758000000  | N/m <sup>2</sup>  |
| Tangent Modulus               | 1.15e+11   | N/m <sup>2</sup>  |
| Thermal Expansion Coefficient |            | /K                |
| Mass Density                  | 7955       | kg/m <sup>3</sup> |
| Hardening Factor              |            | N/A               |

Table 2: custom material properties of 301 18-8 1/2 hard stainless steel.

**Conclusions/action items:**

**Use the material properties, load data, and thickness data to perform an FEA analysis via SOLIDWORKS.**



# 4/12/2026 - Control Testing Data

ANYA HADIM - Apr 29, 2026, 7:47 PM CDT

**Title:** Control Testing Data

**Date:** 4/12/2026

**Content by:** Anya

**Present:** whole group

**Goals:** time filling procedure time for a standardized dental matrix currently in market

**Content:**

See attached.

**Conclusions/action items:**

Use this data to compare to our timing with our prototypes.

ANYA HADIM - Apr 29, 2026, 7:47 PM CDT

| Time (min) | Task  | Time (min) | Task  | Time (min) | Task  | Time (min) | Task  |
|------------|-------|------------|-------|------------|-------|------------|-------|
| 0          | Start | 0          | Start | 0          | Start | 0          | Start |
| 1          | ...   | 1          | ...   | 1          | ...   | 1          | ...   |
| 2          | ...   | 2          | ...   | 2          | ...   | 2          | ...   |
| 3          | ...   | 3          | ...   | 3          | ...   | 3          | ...   |
| 4          | ...   | 4          | ...   | 4          | ...   | 4          | ...   |

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**BME\_402\_Control\_Data.xlsx (5.95 kB)**



## 11/24/2025 - Final Mold Print

Tatiana Predko - Dec 10, 2025, 9:39 PM CST

**Title:** Final Printed Mold Pictures

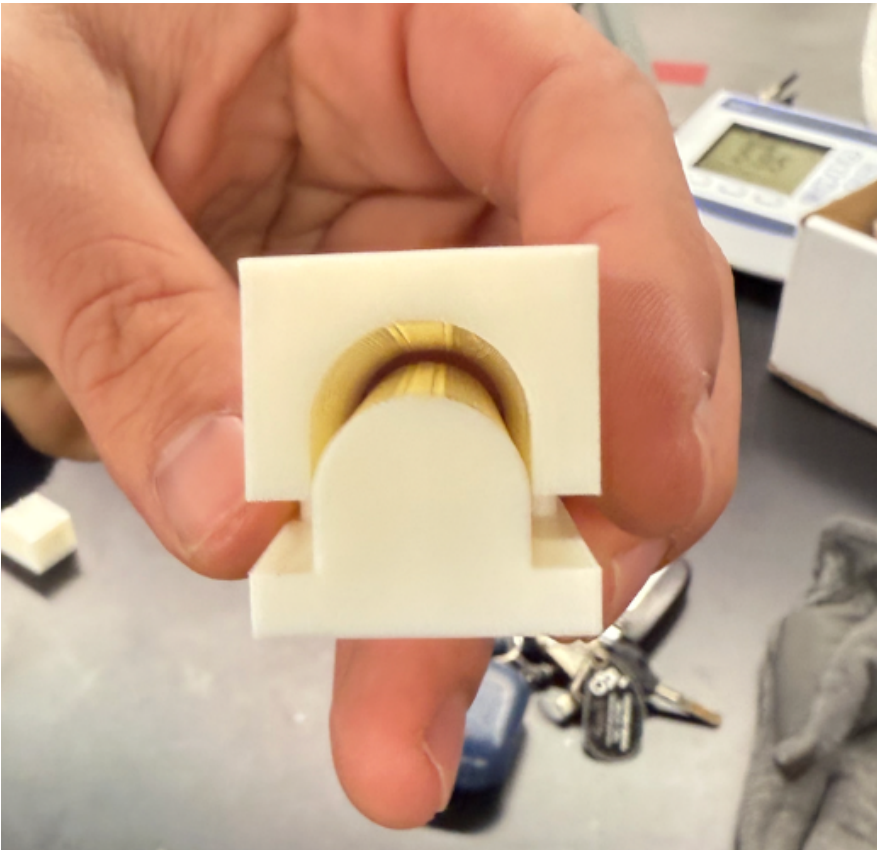
**Date:** 11/24/2025

**Content by:** Keleous Lange

**Present:** Keleous

**Goals:** To document the final mold print and evaluate next steps

**Content:**



- Mold image is attached to this entry
- Successful print worked, tolerances were perfect
- If mold was to be rebuilt, it would have to be with a material capable of conducting heat without melting, not ABS
- Mold doesn't work perfectly because elastic deformation makes up majority of deformation, making the "standard state" less permanent

**Conclusions/action items:**

Will need to hand bend the metal for these prototypes, can machine the mold next time to allow for heat forming

KELEOUS LANGE - Dec 07, 2025, 4:06 PM CST

 [IMG\\_1528.tiff](#)

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IMG\_1528.tiff (73.2 MB)



## 12/10/2025 Dremel Fabrication Protocol

---

JOSEPH KOCH - Dec 10, 2025, 6:44 PM CST

**Title:** Dremel Fabrication Protocol

**Date:** 12/10/2025

**Content by:** Joseph Koch

**Present:** --

**Goals:** Write protocol for making flats using dremel

**Content:**

1. Convert 3D SolidWorks model into 2D flattened surface
  1. Rolled back model to one sided 3D model
  2. Flattened surface using surface flatten tool
  3. Mirrored to create two surfaces
  4. Connected two surfaces with boundary surface
2. Prepare files for laser cutting templates
  1. Added tabs with holes for locating
  2. Created SolidWorks drawing file and layout all pieces to be cut
    1. A
  3. Exported as .pdf to Adobe illustrator
  4. Converted line color to RGD #FF0000 and line weight to 0.0001 mm
  5. Exported as .ai file
3. Print .ai file to Universal Laser System ILS9.150D-150 machine
  1. Placed  $\frac{1}{8}$  in HDF on cutting bed
  2. Calibrated laser
  3. Cut material
4. Prototype flat fabrication
  1. Covered both sides of metal shim stock with blue painters tape
  2. Glued one template onto tape
  3. Rough cut with scissors
  4. Drilled out alignment holes and part hole
  5. Used bolts and nuts attach second template to opposite side of shim stock and tighten
  6. Cut away extra tape using razor blade to improve visibility during grinding
  7. Used dremel  $\frac{1}{2}$ " drum sander bit to remove as much material as possible
  8. Finished with  $\frac{5}{64}$ " tip diamond wheel grinder to remove material up to template
  9. Took off one template
  10. Used dremel cut off wheel to rough cut off tab

11. Finished bottom surface off part with ½" drum sander and diamond wheel grinder

12. Repeated for all parts

**Conclusions/action items:**

**test parts**



## 12/10/2025 Creating 3D geometry of Matrices

---

JOSEPH KOCH - Dec 10, 2025, 7:01 PM CST

**Title:** Creating 3D geometry of Matrices

**Date:** 12/10/2025

**Content by:** Joseph Koch

**Present:** Keleous, Roshan, Tanya, Joseph

**Goals:** Turn flat matrices into 3D matrices

**Content:**

3D model fabrication

1. Design mold - Designed by Keleous Lange
2. Printed mold - Printed by Keleous Lange
3. Placed flat matrix between mold halves and compressed
4. Measured matrix to find halfway point which was marked
5. Used a razor blade to maintain square folding and folded matrix to create final geometry

**Conclusions/action items:**

**Test matrices**



## 12/10/2025 Waterjet fabrication

JOSEPH KOCH - Dec 10, 2025, 10:02 PM CST

**Title:** Waterjet Fabrication

**Date:** 12/10/2025

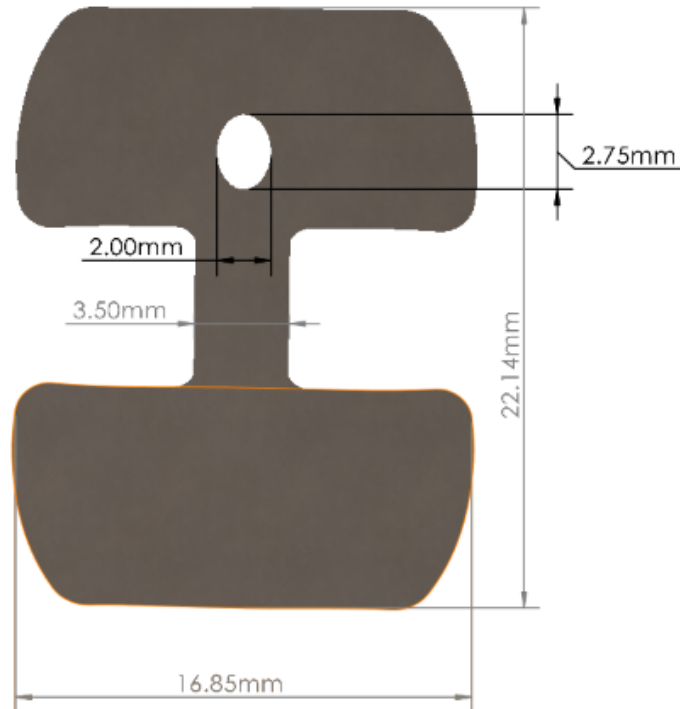
**Content by:** Joseph Koch

**Present:** All team members

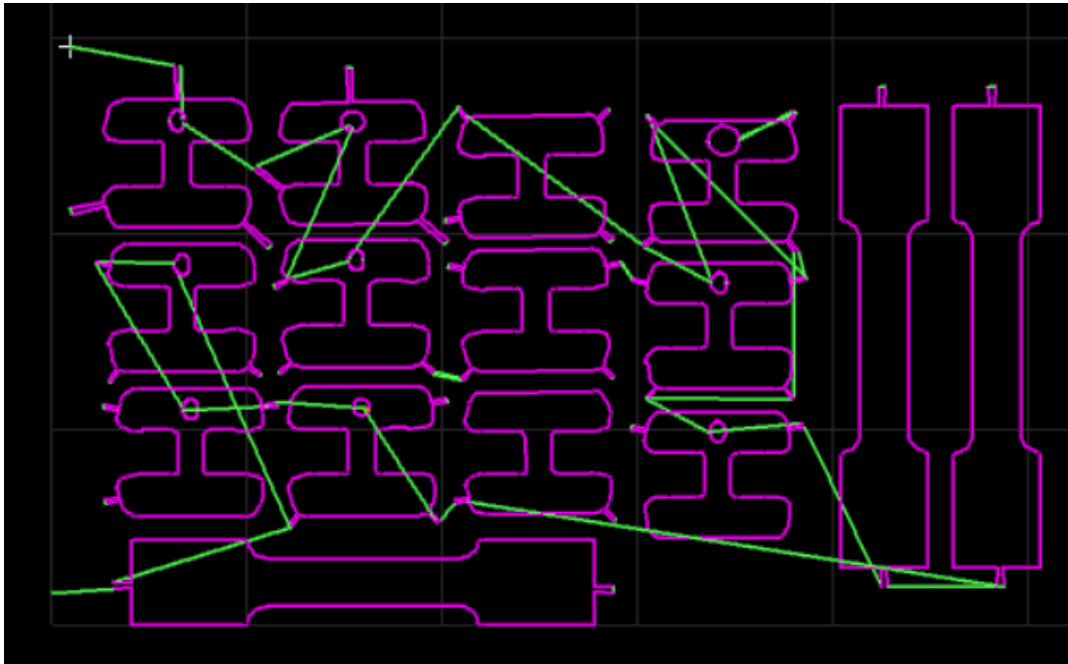
**Goals:** fabricate parts using water jet

**Content:**

Initially for prototyping, the parts were cut using water jet cutting. The water jet that was used was an Omax Protomax located in the UW Makerspace. For file preparation, the SolidWorks model in Figure 4 was rolled back to show only one body, which was flattened using the surface flattening tool. This flattened surface was mirrored, and the connecting tab was sketched and filled between the two bodies shown in Figure 6. This was exported into a SolidWorks drawing along with other design iterations and material test coupons, which was exported into a .dxf file. The .dxf file was run through the Protomax Layout software to refine the cut path and produce a .omx file (Figure 7). The .omx file was run on the Omax Protomax to cut the material. The 0.001" (0.025 mm) 316 stainless steel was sandwiched between two pieces of HDF to support the stock in the water jet. The water jet cutting was unsuccessful as it destroyed too many pieces with the high pressure water jet. The parts that were salvaged were left with significant burs unsuitable for further use in prototyping and testing.



**Figure 6:** Flattened SolidWorks model to be used for waterjet cutting



**Figure 7:** Cut path for Omax Protomax water jet cutter

**Conclusions/action items:**

new fabrication plan



## 4/29/2026 Final Design Fabrication Plan

JOSEPH KOCH - Apr 29, 2026, 6:54 PM CDT

**Title:** Template for final design

**Date:** 4/29/2026

**Content by:** Joseph Koch

**Present:** Joseph Koch, Roshan Patel

**Goals:** Report final design fabrication plan

**Content:**

1. Cut out small 1.5"x1.5" square from 316 stainless steel stock
2. Fold square in half and place between top template and bottom platform template folded end towards the fixing end of template and aligned with shoulders of bottom template (figure 1)
3. Apply pressure on top of template to hold in place, using very sharp pencil or exacto knife, scribe top template onto surface of metal stock
4. Remove from templates and cut out with scissors following scribed path
5. Unfold cut out
6. Place cut out between hole cutting template (figure 2)
7. Clamp cut out using vice grips
8. Using 0.02mm diamond dremel bit drill/grind out hole
9. remove burrs on hole with grinding tools or shear off
10. place cutout between forming molds and form metal to mold working one side at a time
11. fold cutout in half across tab



figure 1



figure 2

**Conclusions/action items:**

**test prototypes**



# Client Meeting 1

ANYA HADIM - Jan 30, 2026, 2:03 PM CST

**Title:** Meeting with Dr. Tipple

**Date:** 01/30/2026

**Content by:** Tatiana Predko

**Present:** All members

**Goals:** Discuss the design ideas with Dr. Tipple to gain insight on his expectations for the project and ask about Dr. Tipple's participation in the testing process.

**Content:**

- Design changes/expectations?
- Force gauge measurements?
- Fillings and MTS?
- Common modes of failure?

Explain cavity filling process with matrix

How he would test matrix for failure or what criteria he would test it on as a dentist

dentists wont use things that are hassle and will take time, dance between whats easy and economical and the best to use

if the fence is too thin it could rip from when you tighten it

as the cavity gets bigger the filling gets bigger, then you put a crown around it not a matrix band

Access to model teeth to perform procedure on

Dental network for sending out a form

Force gauge to measure the force required to remove

circular spot of the band - adding a serration from the top of the hole to a surface and then the same from the bottom of the hole so that its easy to just peel it

watch spellings - general feedback

the fence has to be a double thickness where the hole is wants a flare at the bottom for a wedge to go through - might be too much

when he does a filling he puts in a fence and then slides in a wedge to seal it so that when you fill it you dont get excess

when he does a filling he puts a fence around the took gum tissue gets compressed by the wedge

doesnt know if there will be enough room but it is worth trying

no shelf life

**Conclusions/action items:**

change design accordingly



## Client Meeting 2

---

ANYA HADIM - Mar 20, 2026, 3:04 PM CDT

**Title:** Client Meeting 2

**Date:** 3/20/2026

**Content by:** Anya

**Present:** Anya, Tanya, Joseph, Keleous

**Goals:** Update Dr. Tipple on the current design status

**Content:**

work on ideas to have the matrix band pull apart for easy removal

likes the round edges but its typically not slanted in the way we are looking at it

**Conclusions/action items:**

Have Dr. Tipple record the force gage measurements.



## Client Meeting 3

---

ANYA HADIM - Apr 29, 2026, 7:25 PM CDT

**Title:** Client Meeting 3

**Date:** 4/12/2026

**Content by:** Anya

**Present:** whole group

**Goals:** Time a filling procedure on a dental model using market sectional matrix

**Content:**

See testing and results.

**Conclusions/action items:**

Use the control timing to compare against our timing with the prototype



## Client Meeting 4

---

ANYA HADIM - Apr 29, 2026, 7:27 PM CDT

**Title:** Client Meeting 4

**Date:** 4/20/26

**Content by:** Anya

**Present:** Anya, Joseph, Tanya

**Goals:** time a full filling procedure with the client using our new prototype.

**Content:**

See testing and results. After this meeting we were given client feedback to make the hole smaller and push it up further to improve contact, as well as make the tab higher to make matrix removal easier.

**Conclusions/action items:**

Compare this data against the control.



## Client Meeting 5

---

ANYA HADIM - Apr 29, 2026, 7:29 PM CDT

**Title:** Client Meeting 4

**Date:** 4/25/26

**Content by:** Anya

**Present:** Anya, Joseph, Tanya

**Goals:** time a full filling procedure with the client using our new prototype after adding corrections using the client's feedback from last test session.

**Content:**

See testing and results.

**Conclusions/action items:**

Compare this data against the control data and the prototype 1 data.



## Advisor Meeting 1

---

ANYA HADIM - Jan 30, 2026, 1:13 PM CST

**Title:** Advisor Meeting 1

**Date:** 1/30/2026

**Content by:** Anya

**Present:** whole group

**Goals:** Meet with the advisor to discuss semester's plans

**Content:**

Preliminary presentation 1:

Walk Advisor through hypothetically how we would test our material by the end of the semester

develop a statistical test to measure the efficacy of a material or property

Dr. P will submit the materials to ABET

using a force gauge when pulling out a device? mechanical strength test based off that

just one material or property, one test, and one threshold for level of statistical significance

**Conclusions/action items:**

Prepare preliminary presentation for next week's meeting



## Advisor Meeting 2

---

ANYA HADIM - Apr 29, 2026, 7:33 PM CDT

**Title:** Advisor Meeting 2

**Date:** 2/6/2026

**Content by:** Anya

**Present:** whole group

**Goals:** Meet with the advisor to present testing plans

**Content:**

Presented preliminary presentations and updated Dr. Meyerand on the status of our project thus far.

**Conclusions/action items:**

Contact Dr. Williams for help with prototype.



## Advisor Meeting 3

---

ANYA HADIM - Apr 29, 2026, 7:33 PM CDT

**Title:** Advisor Meeting 3

**Date:** 2/13/2026

**Content by:** Anya

**Present:** whole group

**Goals:** Meet with the advisor to update on project.

**Content:**

Updated Dr. Meyerand on the status of our project thus far.

**Conclusions/action items:**

Contact Dr. Williams for help with prototype.



## Advisor Meeting 4

---

ANYA HADIM - Apr 29, 2026, 7:33 PM CDT

**Title:** Advisor Meeting 4

**Date:** 2/20/2026

**Content by:** Anya

**Present:** whole group

**Goals:** Meet with the advisor to update on project.

**Content:**

Updated Dr. Meyerand on the status of our project thus far.

**Conclusions/action items:**

Brainstorm solutions for laser cutter warping.



## Advisor Meeting 5

---

ANYA HADIM - Apr 29, 2026, 7:34 PM CDT

**Title:** Advisor Meeting 5

**Date:** 2/27/2026

**Content by:** Anya

**Present:** whole group

**Goals:** Meet with the advisor to update on project.

**Content:**

Updated Dr. Meyerand on the status of our project thus far.

**Conclusions/action items:**

Meet with Dr. Williams to give brass and tell him about the sandwiching and different material ideas for the laser cutting.



## Advisor Meeting 6

---

ANYA HADIM - Apr 29, 2026, 7:35 PM CDT

**Title:** Advisor Meeting 6

**Date:** 3/6/2026

**Content by:** Anya

**Present:** whole group

**Goals:** Meet with the advisor to update on project.

**Content:**

Updated Dr. Meyerand on the status of our project thus far.

**Conclusions/action items:**

Wait for contact from Dr. Williams to proceed with prototype. Cut samples for mechanical testing.



## Advisor Meeting 7

---

ANYA HADIM - Apr 29, 2026, 7:36 PM CDT

**Title:** Advisor Meeting 7

**Date:** 3/13/2026

**Content by:** Anya

**Present:** whole group

**Goals:** Meet with the advisor to update on project.

**Content:**

Updated Dr. Meyerand on the status of our project thus far.

**Conclusions/action items:**

Cut samples for mechanical testing.



## Advisor Meeting 8

---

ANYA HADIM - Apr 29, 2026, 7:38 PM CDT

**Title:** Advisor Meeting 8

**Date:** 3/20/2026

**Content by:** Anya

**Present:** whole group

**Goals:** Meet with the advisor to update on project.

**Content:**

Updated Dr. Meyerand on the status of our project thus far.

**Conclusions/action items:**

Brainstorm other fabrication beyond laser cutting for the prototype.



## Advisor Meeting 9

---

ANYA HADIM - Apr 29, 2026, 7:38 PM CDT

**Title:** Advisor Meeting 9

**Date:** 3/27/2026

**Content by:** Anya

**Present:** whole group

**Goals:** Meet with the advisor to update on project.

**Content:**

Updated Dr. Meyerand on the status of our project thus far.

**Conclusions/action items:**

Brainstorm other fabrication beyond laser cutting for the prototype.



## Advisor Meeting 10

---

ANYA HADIM - Apr 29, 2026, 7:39 PM CDT

**Title:** Advisor Meeting 10

**Date:** 4/10/2026

**Content by:** Anya

**Present:** whole group

**Goals:** Meet with the advisor to update on project.

**Content:**

Updated Dr. Meyerand on the status of our project thus far.

**Conclusions/action items:**

Proceed with client testing with Dr. Tipple and cut prototype out.



## Advisor Meeting 11

---

ANYA HADIM - Apr 29, 2026, 7:40 PM CDT

**Title:** Advisor Meeting 11

**Date:** 4/17/2026

**Content by:** Anya

**Present:** whole group

**Goals:** Meet with the advisor to update on project.

**Content:**

Updated Dr. Meyerand on the status of our project thus far.

**Conclusions/action items:**

Prepare final presentation and deliverables for poster presentation next friday.



## 1/23/2026 - Team Meeting 1

---

ANYA HADIM - Jan 23, 2026, 1:24 PM CST

**Title:** Team Meeting 1

**Date:** 1/23/2026

**Content by:** Anya Hadim

**Present:** full group

**Goals:** Establish goals for the semester and recap on project so far

**Content:**

email client and set up an in person meeting

send a when to meet to figure out when were all available

goals are to get access to a laser cutter and do a lot of testing on the prototype

cavity fillings included?

email Justin Williams about laser cutting

**Conclusions/action items:**

team meetings every Friday at 12, advisor meetings at 1, completed client questions



## 2/4/2026 - Team Meeting 2

---

ANYA HADIM - Feb 04, 2026, 5:05 PM CST

**Title:** Team Meeting 2

**Date:** 2/4/2026

**Content by:** Anya

**Present:** whole group

**Goals:** discuss design changes to be made for the semester, prepare testing presentation for friday

**Content:**

Testing plan:

- Dr tippie will fill and remove the matrix we make multiple times with a force gauge
- we will take the average of force to remove
- we use to make a Solidworks simulation to get the factor of safety
- MTS sample for a t test and measure force of failure
- see if our mean force falls within Dr tipples numbers

Critical Deadlines:

March 3rd: Testing started

April 19th: finished and analyzed testing

Created presentation to present to advisor on Friday

**Conclusions/action items:**

- get Dr. Williams attention for laser cutting
- present testing plan to advisor at meeting
- order new material that is less stiff than what we have now



## 3/2/2026 - Team Meeting 3

---

**Title:** Team Meeting 3

**Date:** 3/2/2026

**Content by:** Anya

**Present:** whole group

**Goals:** discuss material changes to mediate warping issue with laser cutting

**Content:**

- purchase brass sheet for proof of concept
- ask about what software hes using for svg issue
- reinforce the stainless steel then remove it?
- ask to meet over zoom to talk through different solutions
- say that we ordered brass (will drop it off at office unless he has issues with that/whatever is most convenient)
- send link to material

[https://www.mcmaster.com/9011K821/?utm\\_term=brass+shim+stock&matchtype=e&campaignid=23007402228&adgroupid=186947910404&location=9018948&gad\\_source=1&gad\\_campaignid=23007402228&utm\\_hasCjDwMYePckV9YZWiD1GE30CgSxhiN\\_UX3P19k\\_6XJTq1hRoCLHUQAvD\\_BwE](https://www.mcmaster.com/9011K821/?utm_term=brass+shim+stock&matchtype=e&campaignid=23007402228&adgroupid=186947910404&location=9018948&gad_source=1&gad_campaignid=23007402228&utm_hasCjDwMYePckV9YZWiD1GE30CgSxhiN_UX3P19k_6XJTq1hRoCLHUQAvD_BwE)

**Conclusions/action items:**

send Williams email and meet with him



## 3/13/2026 - Team Meeting 4

---

ANYA HADIM - Mar 13, 2026, 10:50 AM CDT

**Title:** Meeting with Dr. Williams

**Date:** 3/13/2026

**Content by:** Anya

**Present:** Anya and Roshan

**Goals:** meet with Dr. Williams about progress with the prototyping

**Content:**

Easy cad software - when the svg file comes it still has 3D information - fix this week , get a new vector map

fixtures are being used to tension the stainless steel

laser cutting the stainless steel causes warping from too much heat

get feedback from professor williams' wife

sandwiching - placed a larger stainless steel piece under, helped a little but didnt solve the problem

putting stainless steel between two pieces of brass

-laser cutter would cut through the brass when used as a heat sink

thinning the brass - could be possible with the laser cutter

creating a depth map from grayscale and convert it based on the intensity of the grayscale

**Conclusions/action items:**

send Dr. Williams vector map as soon as possible



## 09/25/2026 - Design Ideas

ANYA HADIM - Apr 29, 2026, 7:49 PM CDT

**Title:** Design Ideas

**Date:** 09/25/2026

**Content by:** Anya

**Present:** whole group

**Goals:** Share design ideas for the prototype.

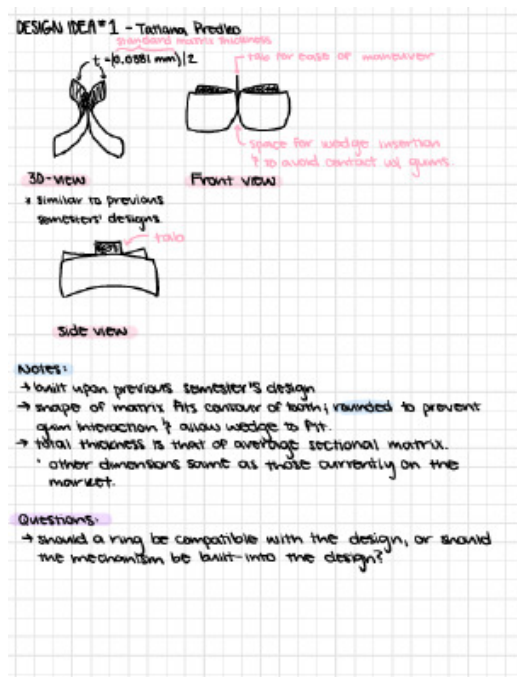
**Content:**

See attached.

**Conclusions/action items:**

Present design ideas to client and advisor to get their feedback

ANYA HADIM - Apr 29, 2026, 7:49 PM CDT



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DentalMatrix.SLDPRT (76.9 kB)

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Holeflatten1.1\_2\_.SLDPRT (558 kB)

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**Holeflatten1.1\_2\_.SLDPRT (558 kB)**



## 04/29/2026 - Expense Table

Roshan Patel - Apr 29, 2026, 9:13 PM CDT

**Title:** Expense Table

**Date:** 04/29/2026

**Content by:** Roshan

**Present:** whole group

**Goals:** Share the final expense table

**Content:**

| Item                         | Description                    | Manufacturer | Vendor        | Vendor Cat# | Date       | QTY | Cost Each | Total          |
|------------------------------|--------------------------------|--------------|---------------|-------------|------------|-----|-----------|----------------|
| <b>Fabrication Materials</b> |                                |              |               |             |            |     |           |                |
| 316 Stainless Steel          | 316 Stainless Steel Shim Stock | Trinity      | Mcmaster Carr | 2317K51     | 9/29/2025  | 1   | \$22.55   | \$22.55        |
| 301 Half Hard Steel          | 301 Half Hard Steel Shim Stock | Trinity      | Mcmaster Carr | 2316K327    | 11/19/2025 | 2   | \$8.94    | \$17.88        |
| 304 Full Hard Steel          | 304 Full Hard Steel Shim Stock | Trinity      | Mcmaster Carr | 9784K623    | 11/19/2025 | 2   | \$10.04   | \$20.08        |
| 260 Brass                    | 260 Brass Shim Stock           | Trinity      | Mcmaster Carr | 9011K821    | 3/09/2026  | 1   | \$19.53   | \$19.53        |
| <b>Total Spent</b>           |                                |              |               |             |            |     |           | <b>\$80.04</b> |

**Conclusions/action items:**

This is the final expense table for both semesters.



**Approximating Surface Matrix Band for  
Dentist to Use for Patients**

**Biomedical Engineering 402 - Preliminary Report, February 25th, 2026**

*Client: Dr. Donald Tipple  
Noboco Dental LLC.*

*Advisor: Prof. Beth Meyers  
University of Wisconsin-Madison - Department of Biomedical Engineering*

*Team Members:  
Kashia Patel (Team Leader)  
Anyu Hadim (CONTRIBUTOR)  
Katarina Lange (BPAC)  
Tanya Predko (BPAC)  
Joseph Koch (BPAC)*

1

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**Approximating Surface Matrix Band for Dentist to Use for Patients**  
Product Design Specifications | September 19th, 2025  
BME 400 Lab 305

**Client:** Dr. Donald Tippie

**Advisor:** Prof. Beth Meyers

**Team:** Roshan Patel - rypatel@wisc.edu (Team Leader)  
Eckeson Lange - eklange@wisc.edu (Consultant & Co-IPAC)  
Tanya Pradko - tpradko@wisc.edu (BIOIG & Co-IPAC)  
Joseph Koch - jkoch17@wisc.edu (BSAC)

**Function:**

Surface matrix bands are devices used by dentists to separate adjacent teeth during

1

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**F25\_PDS\_-\_Approximating\_Surface\_Matrix\_Band\_for\_Dentist\_to\_Use\_for\_Patients.docx (129 kB)**



## Executive Summary

---

ANYA HADIM - Apr 29, 2026, 7:45 PM CDT

**Tab 1**

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**402 - 13 - easy\_tooth\_contact - Executive\_Summary.docx (21 kB)**



## 10/09/2025 - Dental material sensitivities

---

Roshan Patel - Oct 09, 2025, 8:46 PM CDT

**Title:** Dental material sensitivities

**Date:** 10/09/2025

**Content by:** Roshan Patel

**Present:** Roshan Patel

**Goals:** Understand which dental materials commonly cause negative reactions in patients

**Content:**

gold, palladium, and nickel, followed by amalgam (a mixture of liquid elemental mercury and powdered silver, tin, copper, and zinc), ammoniated mercury, cobalt, and ammonium tetrachloroplatinate in that order are common sources of adverse dental reactions.

Sensitization rates were highest for metals, including nickel (29%), palladium (21.4%), and amalgam (11%)

Reactions to titanium and stainless steel are very low

**Citation:**

[1] K. A. Pacheco and J. P. Thyssen, "Contact dermatitis from biomedical devices, implants, and metals—trouble from within," *The Journal of Allergy and Clinical Immunology: In Practice*, vol. 12, no. 9, pp. 2280–2295, Sep. 2024.  
doi:10.1016/j.jaip.2024.07.016

**Conclusions/action items:**

We should focus on stainless steel or titanium to minimize allergic reactions to the device. Materials like plastics also do not cause this, but it is more frowned on as they usually do not have the correct mechanical properties and the recent increase in concern over microplastics.



## 10/16/2025 - Operators' Ease and Satisfaction in Restoring Class II Cavities With Sectional Matrix Versus Circumferential Matrix System at Qassim University Dental Clinics

Roshan Patel - Dec 06, 2025, 6:20 PM CST

### Title: Operators' Ease and Satisfaction in Restoring Class II Cavities With Sectional Matrix Versus Circumferential Matrix System at Qassim University Dental Clinics

**Date:** 10/16/2025

**Content by:** Roshan Patel

**Present:** Roshan Patel

**Goals:** Understand common complaints with dental matrix systems

**Content:**

#### Table 1. Reasons of difficulty for CMB and SMB.

CMB = circumferential matrix band; SMB = sectional matrix band.

| Reasons of difficulty for CMB    | Frequency | Percentage | Reasons of difficulty for SMB              | Frequency | Percentage |
|----------------------------------|-----------|------------|--|-----------|------------|
| Cumbersome instrument            | 6         | 5.7%       | Cumbersome instrument                      | 3         | 2.9%       |
| Lack of proper contour           | 3         | 2.9%       | Did not face any difficulty with sectional | 3         | 2.9%       |
| Lack of training or experience   | 12        | 11.4%      | Lack of training or experience             | 60        | 57.1%      |
| More time required for placement | 51        | 48.6%      | More time required for placement           | 12        | 11.4%      |
| Not easily manipulated           | 3         | 2.9%       | Need good adjacent contact                 | 3         | 2.9%       |
| Not very stable                  | 30        | 28.6%      | Not very stable                            | 24        | 22.9%      |
| Total                            | 105       | 100%       | Total                                      | 105       | 100%       |

Stability and time to use were the main complaints given by 105 dental students.

"Most of the students (60%) agreed that using the SMB system was easier than the CMB system but achieving the optimum position of SMB was unclear to the students due to the lack of training or experience. However, most of the students have good knowledge and experience with CMB but they agreed that it takes time to place (49%), and occasionally it is not stable (29%). Most of the operators were more comfortable with using the SMB in comparison to ones who were using CMB because of its deficiency in establishing optimum contact and recreating the shape of the natural tooth. Nevertheless, some operators have issues in the seal of proximal and gingival walls of the preparation during using SMB."

There was no significant difference between SMB and CMB.

**Citation:**

- [1] M. Almushayti and B. Arjumand, "Operators' ease and satisfaction in restoring class II cavities with sectional matrix versus circumferential matrix system at Qassim University Dental Clinics," *Cureus*, Jan. 2022.  
doi:10.7759/cureus.20957

**Conclusions/action items:**

We should focus on the time of implantation when testing the functionality of the matrix.



## 11/07/2025 - A survey of the use of matrix bands and their decontamination in general dental practice

---

Roshan Patel - Dec 06, 2025, 7:13 PM CST

**Title:** A survey of the use of matrix bands and their decontamination in general dental practice

**Date:** 11/07/2025

**Content by:** Roshan Patel

**Present:** Roshan Patel

**Goals:** Understand current dental practices with dental matrix use

**Content:**

This study documents the results of a survey given to Scottish dentists. 64% of the surveyed dentists only changed matrix bands when they were bent or damaged. Of those who reused dental matrices, 59% used ultrasonic baths for cleaning. The Siqveland matrix band was also the most popular matrix band used at the time. This survey was sent out in 1999, so it is likely that these trends have changed. Matrix bands are intended to be single use so the team should move forward with that assumption, even if some are reused and cleaned. This does not need to be a design requirement for the team.

**Citation:**

[1] A. H. Lowe, F. J. T. Burke, S. McHugh, and J. Bagg, "A survey of the use of matrix bands and their decontamination in general dental practice," *British Dental Journal*, vol. 192, no. 1, pp. 40–42, Jan. 2002.  
doi:10.1038/sj.bdj.4801286a

**Conclusions/action items:**

The team's design requirements do not need to change despite the possibility of reuse.



## 10/09/2025 - Halo sectional matrix

---

Roshan Patel - Oct 09, 2025, 8:30 PM CDT

**Title:** Halo sectional matrix

**Date:** 10/09/2025

**Content by:** Roshan Patel

**Present:** Roshan Patel

**Goals:** Understand Ultradent's sectional matrix device

**Content:**

- comes in five sizes (3.5mm, 4.5mm, 5.5mm, 6.5mm, and 7.5mm)
- 0.038mm thickness
- Anatomically shaped bands reduce time spent shaping and finishing
- Nonstick Teflon™ coating thickness 0.013 mm
- comes in original and firm varieties
- made of stainless steel

**Conclusions/action items:**

**We should base our dimensions on this to keep it consistent with the market leader.**



## 10/23/2025 - Digitized thermo-responsive shape memory matrix band for tooth restorations

Roshan Patel - Dec 06, 2025, 6:44 PM CST

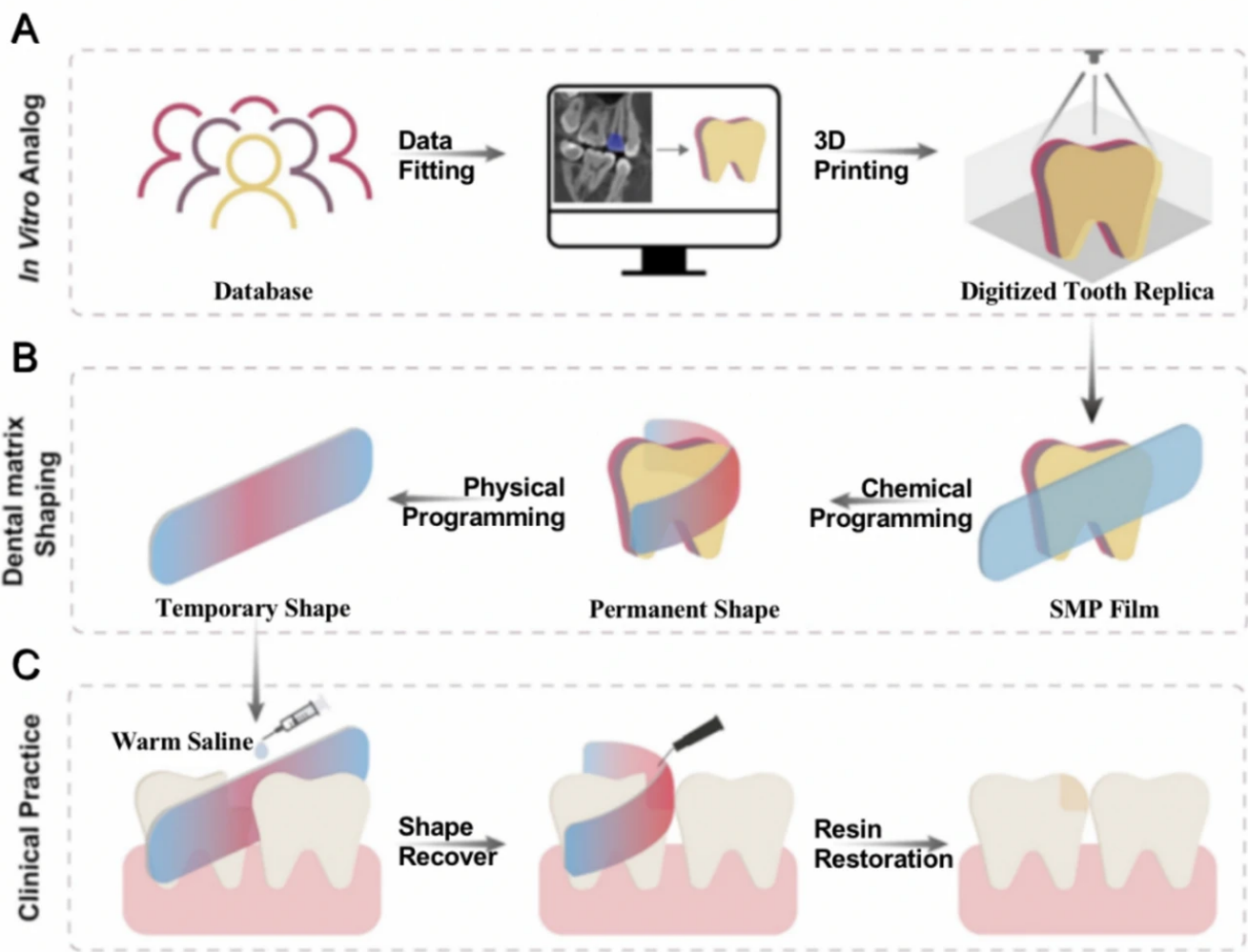
**Title:** Digitized thermo-responsive shape memory matrix band for tooth restorations

**Date:** 10/23/2025

**Content by:** Roshan Patel

**Present:** Roshan Patel

**Goals:** Understand the Digitized thermo-responsive shape memory matrix band



The material that was made by this team can be chemically programmed to fit anatomic shape and then be removed through the use of warm water for removal. This makes the fit of the dental matrix much better and allows for easier removal.

"Direct resin restoration follows the principle of minimally invasive medicine, which preserves more healthy dental tissue. However, the accuracy of the final outcome of restoration is often exquisitely associated with the selection and placement of traditional matrix, which is quite technique-sensitive, sometimes time-

consuming, especially for the beginners<sup>14</sup>. In clinical practice, improper proximal contact and overhangs may still exist due to the identical shape of traditional matrix band and improper operation, which could result in food impaction along with recurrent caries and periodontal problems<sup>4</sup>. Pre-contoured matrix band is more optimal for better supporting the marginal ridge than a straight matrix"

**Citation:**

[1] C. Liu *et al.*, "Digitized thermo-responsive shape memory matrix band for Tooth Restorations," *Scientific Reports*, vol. 15, no. 1, Jan. 2025. doi:10.1038/s41598-025-85459-4

**Conclusions/action items:**

Though this is not a direct competitor for an interproximal cavity, it is an interesting idea that could be included in future work.

# 10/21/2025 - Watercutting Manufacturing

Roshan Patel - Nov 20, 2025, 4:23 PM CST

**Title:** Dental material sensitivities

**Date:** 10/21/2025

**Content by:** Roshan Patel

**Present:** Roshan Patel

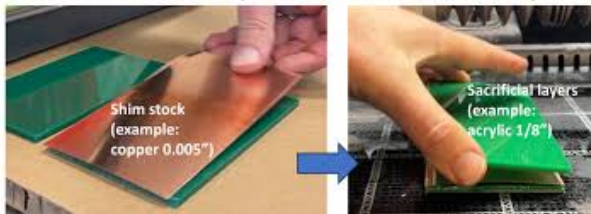
**Goals:** Understand the use of waterjet manufacturing for thin metal sheets

**Content:**



Water cutting is generally possible for steel at a minimum of 0.002" thick. This is right at the limit of what we are trying to do. The maker space's waterjet may not be as good as the one that I am researching so it's important to keep that in mind. To accomplish waterjetting of thin materials. Its advised to sandwich the thin material between two thicker pieces of material (Usually wood or plastic). This is to prevent movement and bending of the thin material.

1. Assemble a sandwich, with your shim stock between sacrificial layers



**Citation:**

[1] W. Team, "How to cut Thin Shim Stock using a WAZER waterjet cutter," WAZER, <https://wazer.com/learn/how-to/how-to-cut-thin-and-delicate-shim-stock-using-a-wazer/> (accessed Nov. 20, 2025).

**Conclusions/action items:**

Watercutting is our current best manufacturing option, but it is likely necessary to sandwich our material between two sacrificial sheets to get a better result.



## 11/30/2025 - MTS Data analysis

Roshan Patel - Dec 06, 2025, 5:57 PM CST

**Title:** Dental material sensitivities

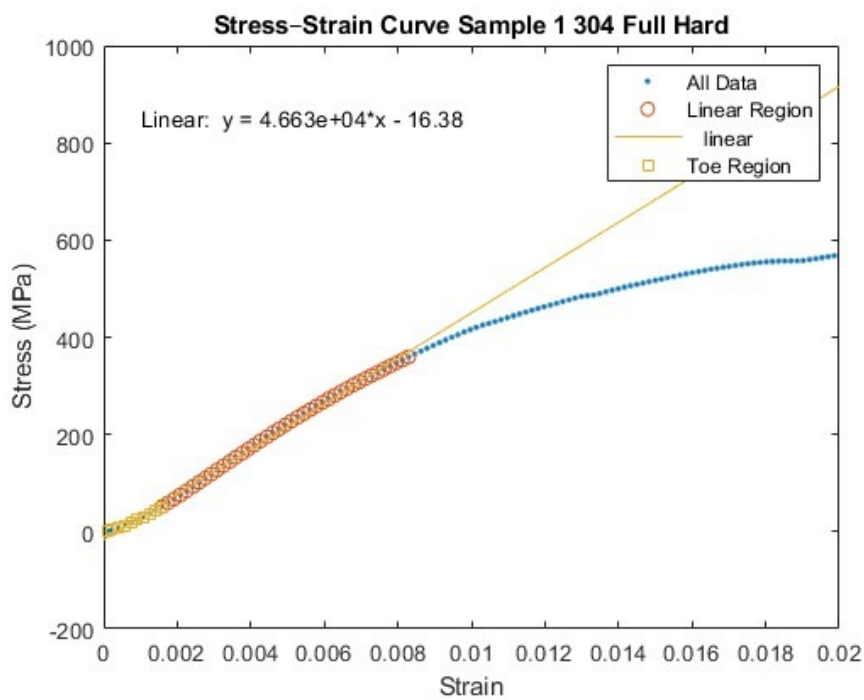
**Date:** 11/30/2025

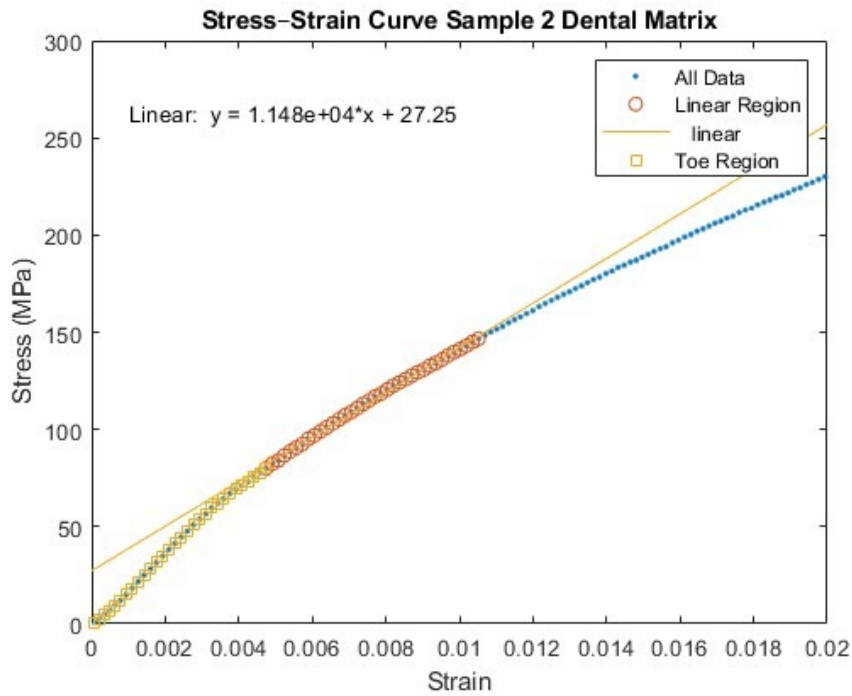
**Content by:** Roshan Patel

**Present:** Roshan Patel

**Goals:** Analyze MTS data to make conclusions

**Content:**





Matlab was utilized to create Stress-Strain plots for all samples of all of the materials

#### MATLAB Code:

% Close figures and clear out other variables that have been assigned

```
close all;
```

```
clear all;
```

% Load your data file, replacing the '...' below with your filename

```
file= "C:\Users\scarb\OneDrive\Desktop\MTS Testing\Test Run 11.txt";
```

```
data=load(file);
```

% Extract the columns of interest from your data

```
disp=data(:,1);
```

```
force=data(:,2);
```

```
time=data(:,3);
```

% Plot your raw data and inspect it to make sure it looks as you expect

```
figure;
```

```
plot(force);
```

```
title('Raw Force Data');
```

```
xlabel('Frame');
```

```
ylabel('Force (N)');

% Record the first and last frame of the linear region of the loading
curve

% Enter the gauge length and cross-sectional area for the specimen

j1=input("Enter first frame of the linear region of loading curve");
j2=input("Enter last frame of the linear region of the loading curve");

Lo=input("Enter the gauge length");

A=input("Enter the cross-sectional area of your specimen");

% Calculate tendon stress and strain, being careful to use consistent units.

stress = force ./ A;

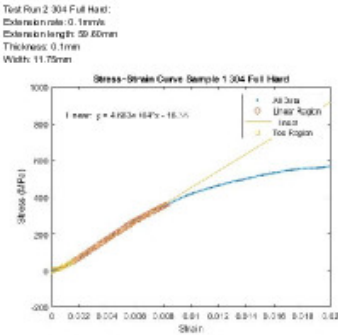
strain = disp ./ Lo;

% Plot tendon stress and strain, being careful to use consistent units

% Following would create two curves in your plot: one with all the data points, the second with only the linear region
figure;
plot(strain, stress, ".", strain(j1:j2), stress(j1:j2), "o", strain(1:j1), stress(1:j1), 's');
xlabel('Strain');
ylabel('Stress (MPa)');
title('Stress–Strain Curve');
legend('All Data', 'Linear Region', 'Toe Region');
xlim([0 0.02]);
```

### Conclusions/action items:

The two materials that we procured (304 Full Hard & 301 Half Hard) are significantly stiffer than the currently used dental matrices



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**MTS\_Testing.pdf (262 kB)**



## 04/11/2026 - Thermal Warping

---

Roshan Patel - Apr 27, 2026, 12:39 AM CDT

**Title:** Thermal Warping

**Date:** 04/11/2026

**Content by:** Roshan Patel

**Present:** Roshan Patel

**Goals:** Understand the causes and potential solutions to thermal warping during laser cutting

**Content:**

- Thermal warping is most common in thin pieces of stainless steel
- 304 and 316 steel are more prone to warping
- "Warping is strongly influenced by cutting speed, power level, and assist gas selection. Higher laser power combined with slower cutting speeds increases total heat input into the material. Excessive heat buildup can enlarge the heat-affected zone and increase distortion risk.
- "Strategic cut sequencing such as cutting internal features before releasing the outer perimeter can help maintain stability during processing"

**Source:**

<https://www.actionstainless.com/how-to-prevent-warping-during-stainless-steel-laser-cutting>

**Conclusions/action items:**

Our design is very prone to thermal warping but the material type and thinness are non-negotiable, so other options will have to be looked into.



## 9/7/2025 dental filling background

---

JOSEPH KOCH - Sep 07, 2025, 5:33 PM CDT

**Title:** Cleveland Clinic Dental Fillings

**Date:** 9/7/2025

**Content by:** Joseph Koch

**Present:** --

**Goals:** Learn more about the project and goals

**Source:** <https://my.clevelandclinic.org/health/treatments/17002-dental-fillings>

**Content:**

Dental fillings used to treat cavities or minor cracks and chips. Area is numbed and damaged area of tooth is removed. void is filled and cured. Tooth is polished

Two tips of fillings direct and indirect - direct one appointment uses amalgam - mercury with silver tin zinc and copper, resin composite with silica and powdered quartz, and glass ionomer made of silica glass powder

indirect - dental impression is used uses inlays or onlays fit onto tooth like puzzle piece

**Conclusions/action items:**

learn more about the procedure



## 9/7/2025 What is a dental matrix band

---

JOSEPH KOCH - Sep 12, 2025, 9:07 AM CDT

**Title:** what is dental matrix band

**Date:** 9/7/2025

**Content by:** Joseph Koch

**Present:** --

**Goals:** Learn more about the project

**Source:** <https://www.youtube.com/watch?v=zqpCmZRqQ3g>

**Content:**

Used like concrete form for teeth fillings for fillings near other teeth or under the gums

toeflymeyer band - historically most common band used thin strip of stainless steel placed in retainer forming loop - different sizes for pediatrics and for fillings under the gums. band is placed around the tooth in the retainer. wedges are placed around bottom edge of band to ensure that the band is tightly placed around the tooth. Helps with silver filling because silver has to packed into tooth. Band allows for better packing.

Sectional matrices - used with white fillings small pieces of thin metal placed between teeth being filled. placed between teeth being restored. wedges are placed and spring ring forcing it against the next tooth.

current bands have large curve which allows for the band to seal tighter

**Conclusions/action items:**



## 9/12/2025 Dentalix The definitive guide to dental matrices

JOSEPH KOCH - Sep 15, 2025, 8:59 PM CDT

**Title:** The definitive guide to dental matrices

**Date:** 9/12/2025

**Content by:** Joseph Koch

**Present:** --

**Goals:** Continue to learn more about dental matrices what works and what doesn't

**Source:** [https://www.dentalix.com/en/blog/definitive-guide-dental-matrices-choose-best-one-each-case?srsltid=AfmBOorPRSYzbAYdJNgjC\\_K7MnfyVNXpRHoVzuDVmVn6rQn-DEb0NscD](https://www.dentalix.com/en/blog/definitive-guide-dental-matrices-choose-best-one-each-case?srsltid=AfmBOorPRSYzbAYdJNgjC_K7MnfyVNXpRHoVzuDVmVn6rQn-DEb0NscD)

**Content:**

Functions

1. Preserve restorative material and prevent spill over
2. restore anatomy of tooth help reconstruct contact relationship and lost contour
3. restore biological function of tooth and protect supporting tissues
4. contribute to surface finish
5. reduce probabilities of secondary caries
6. increase useful life of composite restorations
7. protect neighboring tooth during cavitory preparation

touch points - interdental or interproximal area - area between teeth - contact area

- interproximal niche and interdental papilla occupies this space in form of a triangle.

- contact between teeth called interproximal contacts protects soft tissue when contact not present food packing occurs damaging the gingival tissues - causes gingivitis and periodontitis

- contact also favors stability of arches through combined anchorage

Materials - steel bronze titanium or plastic - acetate or celluloid - tofflemire matrices standardize universal matrix

Must be rigid to allow for proper insertion into interproximal areas, must be compatible with restorative materials

easy to adapt to contour of tooth functionality linked to flexibility of dental matrix to envelop tooth with minimum pressure allows for adaptation to edges of restoration

resistant to condensation pressure must not slip

easy to remove and have the minimum thickness to avoid excessive separation between teeth

-

**Conclusions/action items:**

**continue research and turn these into design specifications**



## 9/15/2025 The effectiveness of circumferential and sectional matrix systems

JOSEPH KOCH - Sep 16, 2025, 7:52 PM CDT

**Title: The effectiveness of circumferential and sectional matrix systems in obtaining optimum proximal contact in class II composite restorations: a systematic review**

**Date:** 9/15/2025

**Content by:** joseph koch

**Present:** --

**Goals:** learn more about different types of matrix systems what works what doesn't

**Source:** <https://pmc.ncbi.nlm.nih.gov/articles/PMC12204051/>

**Content:**

review of effectiveness of circumferential matrix bands and sectional matrix bands

sectional matrix band systems were superior and provided better results as compared to circumferential matrix band systems

sectional matrix more effective in achieving optimal proximal contact in class II posterior composite restorations

**Dental Caries** - pit, fissure, and smooth surface caries among smooth surface class II lesions most frequent of smooth surface caries because interdental space fosters bacterial colonization and is more challenging to clean

- class II caries form on smooth proximal surface of posterior teeth cervical to the proximal contact these make them more difficult to fill because proximal contact must be maintained post filling

pit and fissures caries occur on bottoms and tops of teeth the occlusal surfaces pits are small and isolated fissure caries occur in the nature valleys of the teeth

smooth surface caries occur on the flat smooth surfaces these commonly require matrix systems because of their location

CMB traditionally favored because its stability and user friendliness range in thickness from 0.038 to 0.05 mm

- poor adaptation to neighboring teeth challenges in recreating natural anatomical contours and developing of marginal overhangs

SMB - more technique sensitivity, concave contact formation, placement distortion, - creates tighter proximal contact points facilitates faster tooth separation and enhances anatomical emergence (natural anatomy of tooth)

Criteria in review - population, teeth affected by proximal caries, intervention, circumferential matrix system, comparison, sectional matrix system, outcome, clinical effectiveness in achieving proximal contact, 1990 - 2024\

using dental floss test to test proximal contact point CMB shown to have more overhanging proximal borders and defective contact points than SMB however majority of students favored CMB because of ease of use and lack of training for SMB

operator's experience with SMB is more important

One study showed SMB system outperformed CMB in men but was not statistically significant different in women male teeth are large and have greater proximal contact points which are harder to reconstruct

**Conclusions/action items:**

**create design specifications from research**



## 1/24/2026 filling type 2 cavities

---

JOSEPH KOCH - Jan 24, 2026, 10:04 AM CST

**Title:** Study on restoration of class 2 carious cavities

**Date:** 1/24/2026

**Content by:** Joseph Koch

**Present:** --

**Goals:** learn more about procedures in filling class 2 cavities

**Content:**

Study looked at three filling techniques snow plow, injection molded, and bichacho technique

combination of filling materials were used - admira fusion and admira fusion flow, grandio and grandio flow, filtek supreme xt and filtek supreme flow.

loss of marginal ridge a challenge in fillings

class II restorations more prone to clinical complications shorter life

Bruxism - grinding and clenching of teeth increasing in frequency amongst patients causes mechanical overloading of restorations

some suggest use of elastic liner as stress absorber

snow plow and injection molded - two layers of different materials paste and fluid are cured simultaneously decrease in both internal stress and number of clinical steps

filled and scanned after each step allowed them to isolate the composite layers defined model in SW then loaded into ansys workbench

**Citation:** <https://pmc.ncbi.nlm.nih.gov/articles/PMC10381501/>

**Conclusions/action items:**

need to develop testing plan for filling and filling analysis

INTERNATIONAL  
STANDARD

**ISO  
18556**

First Edition  
2018-04-01

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**Dentistry — Intraoral spatulas**

Médecine bucco-dentaire — Spatules intra-orales

**iTech STANDARD PREVIEW**  
(standards.itech.ai)

ISO 18556:2018  
<https://standards.itech.ai/standards/18556-18556-2018-04-01-04-01-01>



Reference number  
www.iso.org/iso/standards

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ISO-18556-2016\_intraoralSpatula\_.pdf (380 kB)



## 11/7/2025 Tong entrepreneurship Lecture

JOSEPH KOCH - Nov 07, 2025, 11:57 AM CST

**Title:**

**Date:**

**Content by:**

**Present:**

**Goals:**

**Content:**

**Conclusions/action items:**

JOSEPH KOCH - Nov 07, 2025, 12:42 PM CST

Title: Tong lecture

Date: 11/7/2025

Goals: learn about why health care needs more engineers

Content

Kristin Myers BME class of 2002, MBA at Harvard - COO at blue cross/blue shield Health care provider. Uw Madison - Medtronic engineering marketing/product launch technical sales - Harvard MBA - skyline ventures - investment in healthcare startups - arboretum ventures - venture capital investing in patents from universities and convert to companies

Chapter 2 of career - Aetna - Chief of staff to CEO president student health president, Great Lakes region - worked through pandemic challenges - Unified Women's healthcare president and chief operating officer -

Chapter 3 - Hopscotch health - founder and CEO - advanced primary care for rural communities - challenges with sociodemographic differences and getting care to small communities - Blue cross Blue shield - COO

"Follow hard problems and build skills that allow you to make an impact"

Healthcare system - improved patient outcomes, experience, provider experience, lower cost of care quadruple aim of great healthcare. US spends 5.3 trillion dollars 18% of GDP. US spends large amounts of money with high rates of skipped care and high clinician burnout. >900 insures 1.2 T dollars in waste. Challenges - misaligned incentives - fee for service, fragmented financing and regulation, data silos & legacy IT, inequities zip code born into can determine life expectancy and outcomes.

Aligned incentives - incentivize outcomes not activities, performance must be transparent.

Work hard and build range - hard projects, classes, and experiences

Diverse exposure - different sectors, teams, and geographies. Gain more perspective and learn how systems connect

Choose your people wisely

Know your values

Embrace challenge and keep growing

Conclusion

Continue to seek new experiences and learning opportunities



## 12/6/2025 Slot Design

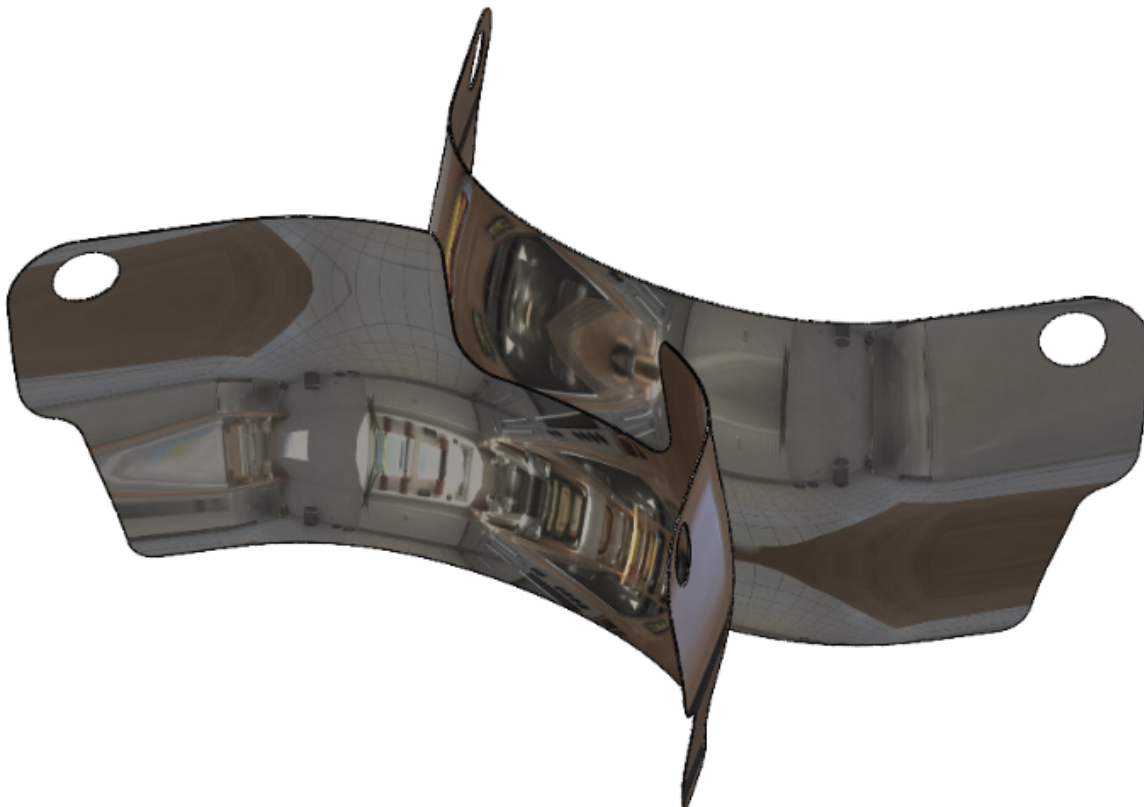
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JOSEPH KOCH - Dec 06, 2025, 5:08 PM CST

**Title: Slot Design****Date:** 12/6/2025**Content by:** Joseph Koch**Present:** --**Goals:** Report models and concepts behind preliminary design ideas**Content:**

The preliminary design is the slot design This design allows for great interproximal gap reduction, however will be difficult to reconstruct the top geometry of the tooth. The design will be fabricated using two separate pieces of metal that will be bonded together. Bonding will either be done using solder or an epoxy adhesive

Below is 3D model of the design.

**Conclusions/action items:**

Evaluate this design compared to other preliminary designs

JOSEPH KOCH - Dec 06, 2025, 5:09 PM CST

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**SurfaceMatrixGap.SLDPRT (1.51 MB)**



## 12/6/2025 Hole Design

---

JOSEPH KOCH - Dec 06, 2025, 5:16 PM CST

**Title:** Hole Design

**Date:** 12/6/2025

**Content by:** Joseph Koch

**Present:** --

**Goals:** Report hole preliminary design idea

**Content:**

The hole design uses a two sided matrix design. The design will be fabricated from one piece of material which will be folded at the tab to create the two sided geometry. The design incorporates a hole through one side of the matrix. This should permit for tight interproximal contact at the expense of surface finish. The hole size will need to be variable to accommodate different filling sizes.



**Conclusions/action items:**

**evaluate the design in the design matrix against other designs.**

---

JOSEPH KOCH - Dec 06, 2025, 5:16 PM CST



[Download](#)

**Hole.SLDPRT (1.06 MB)**



## 12/6/2025 Waterjet design iteration 2

JOSEPH KOCH - Dec 06, 2025, 5:40 PM CST

**Title:** Water jet design iteration 2

**Date:** 12/6/2025

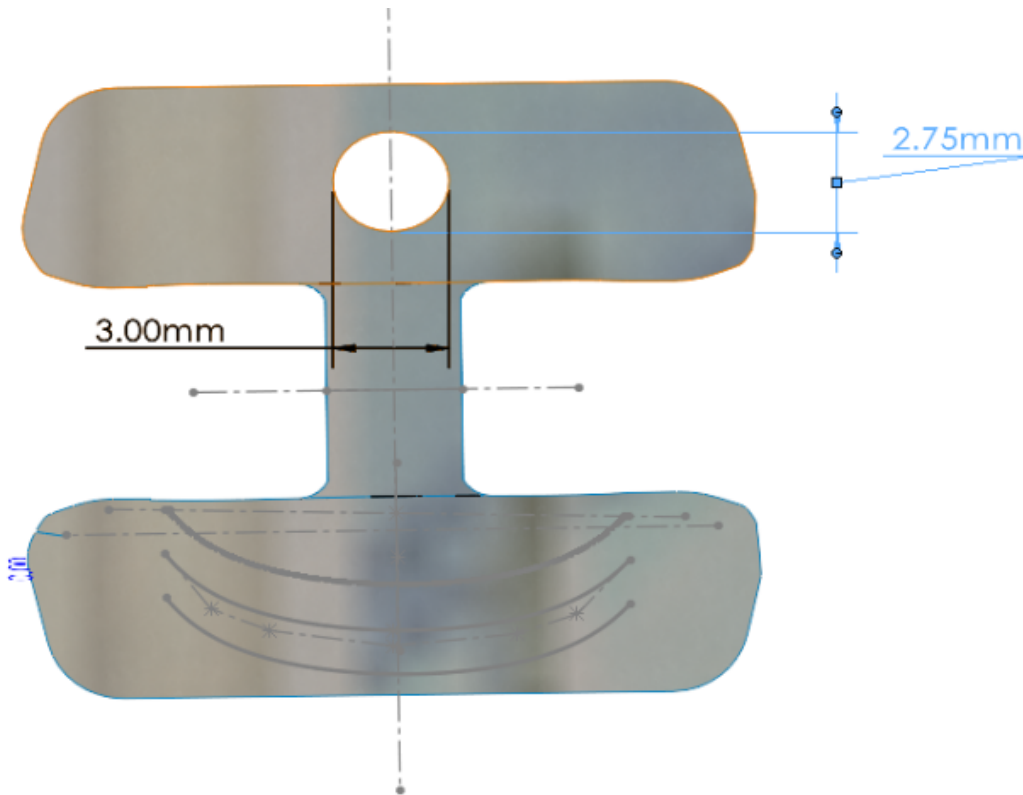
**Content by:** Joseph Koch

**Present:** --

**Goals:** Create multiple iteration to determine how different hole sizes will work

**Content:**

This design is the same as the hole design flattened except it uses a width of 3.00 mm to target cavities that take up a wider area on the tooth face.



**Conclusions/action items:**

Add this to water jet fabrication plan



## 12/6/2025 Waterjet design iteration 3

JOSEPH KOCH - Dec 06, 2025, 5:47 PM CST

**Title:** Waterjet design iteration 3

**Date:** 12/6/2025

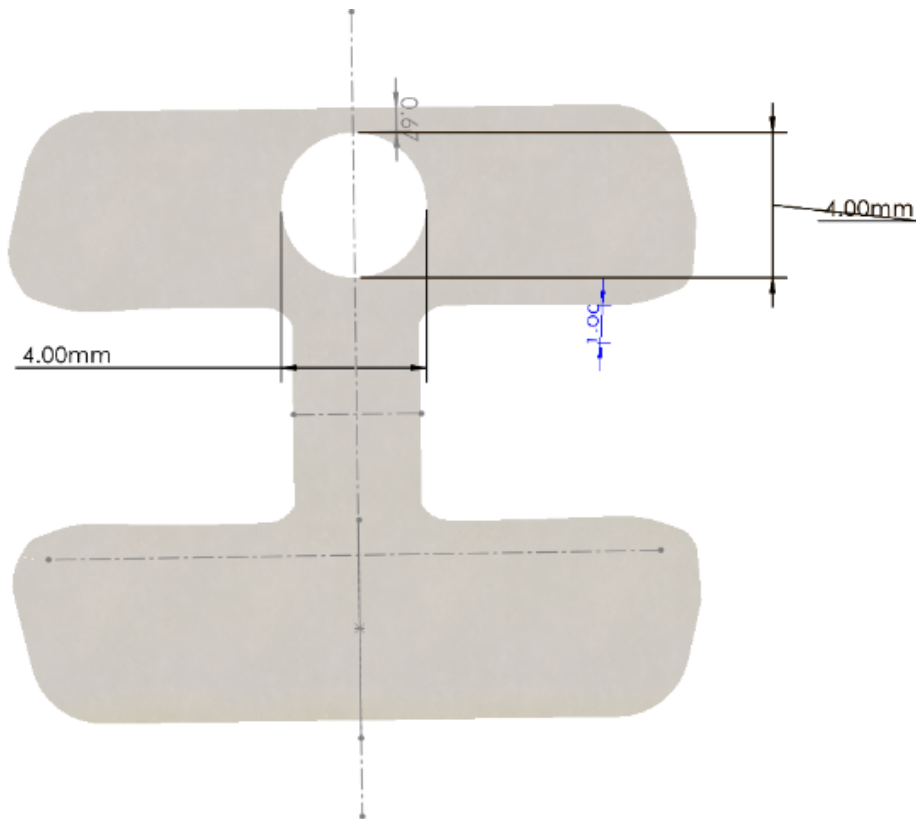
**Content by:** Joseph Koch

**Present:** --

**Goals:** create design iterations for waterjet cutting

**Content:**

This design uses a 4mm width and 4mm height hole to accommodate cavities that take up a large amount of the tooth face.



**Conclusions/action items:**

Add this design to waterjet cutting files.

JOSEPH KOCH - Dec 06, 2025, 5:48 PM CST



[Download](#)

Holeflatten4.SLDPRT (557 kB)



## 12/6/2025 Blank two sided control Matrix

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JOSEPH KOCH - Dec 06, 2025, 6:04 PM CST

**Title:** Blank two sided control matrix

**Date:** 12/6/2025

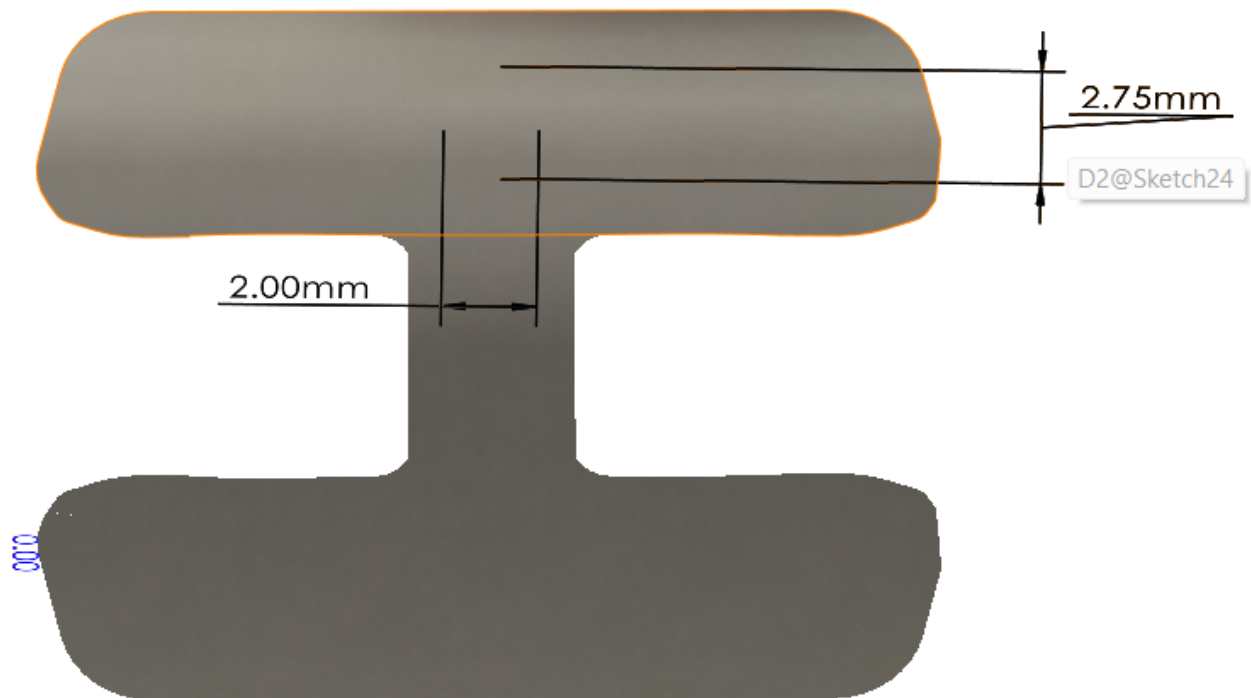
**Content by:** Joseph Koch

**Present:** --

**Goals:** Create control matrix to compare to sectional matrix with hole

**Content:**

We will need control matrices to compare the hole design to during filling and mechanical testing, so I just suppressed the hole features in the flatten and 3D models. These will also be using the waterjet. Below are the 3D and flattened models.



**Conclusions/action items:**

Add these to the water jet cutting file



## 12/6/2025 Hole Design flat

---

JOSEPH KOCH - Dec 06, 2025, 5:35 PM CST

**Title:** Flattened hole design

**Date:** 12/6/2025

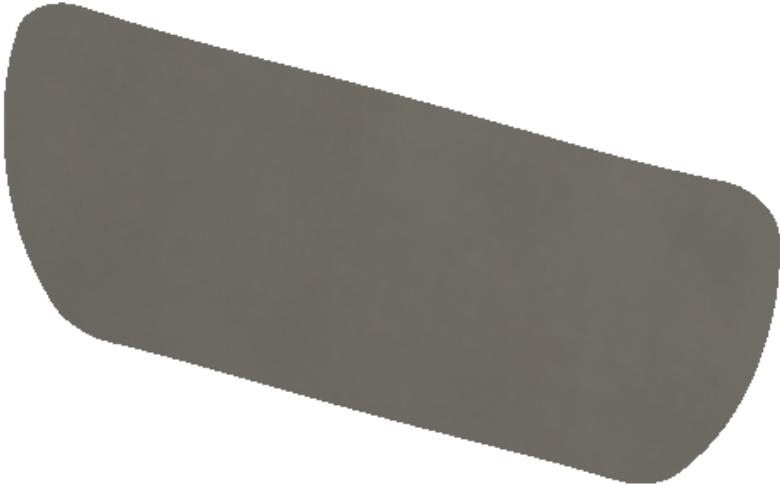
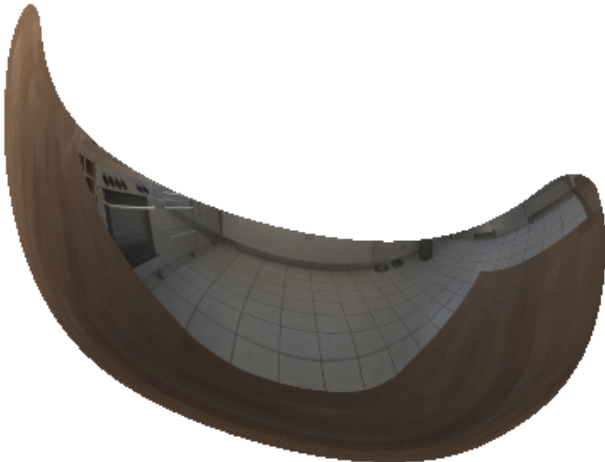
**Content by:** Joseph Koch

**Present:** --

**Goals:** Create and report the flattened model of the hole design

**Content:**

In order to fabricate the hole design a flat version must be cut out from stock metal. To do this the initial model was rolled back to only present the one side of the sectional matrix without the tab. The surface flatten feature on SolidWorks was used to flatten the 3D model. This flat was mirrored to create a two side flat. The flat was connected using a surface fill feature. The dimensions of the model were then edited using surface extend and surface trim to match current sectional matrices that were provided by the client.





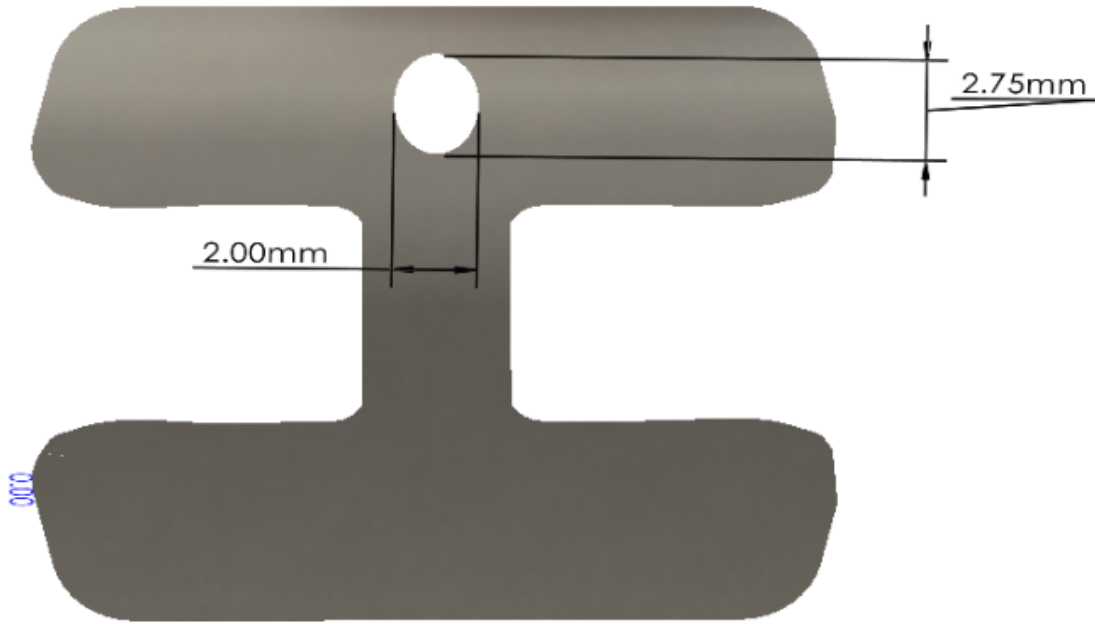
0.00



0.00



Surface-Flatten2



**Conclusions/action items:**

Check with rest of team to confirm design, create iterations for testing, and make water jet cutting plans.

---

JOSEPH KOCH - Dec 06, 2025, 5:36 PM CST



[Download](#)

Holeflatten.SLDPRT (556 kB)



# 12/6/2025 Waterjet design iteration 1

JOSEPH KOCH - Dec 06, 2025, 5:43 PM CST

**Title:** waterjet design iteration 1

**Date:** 12/6/2026

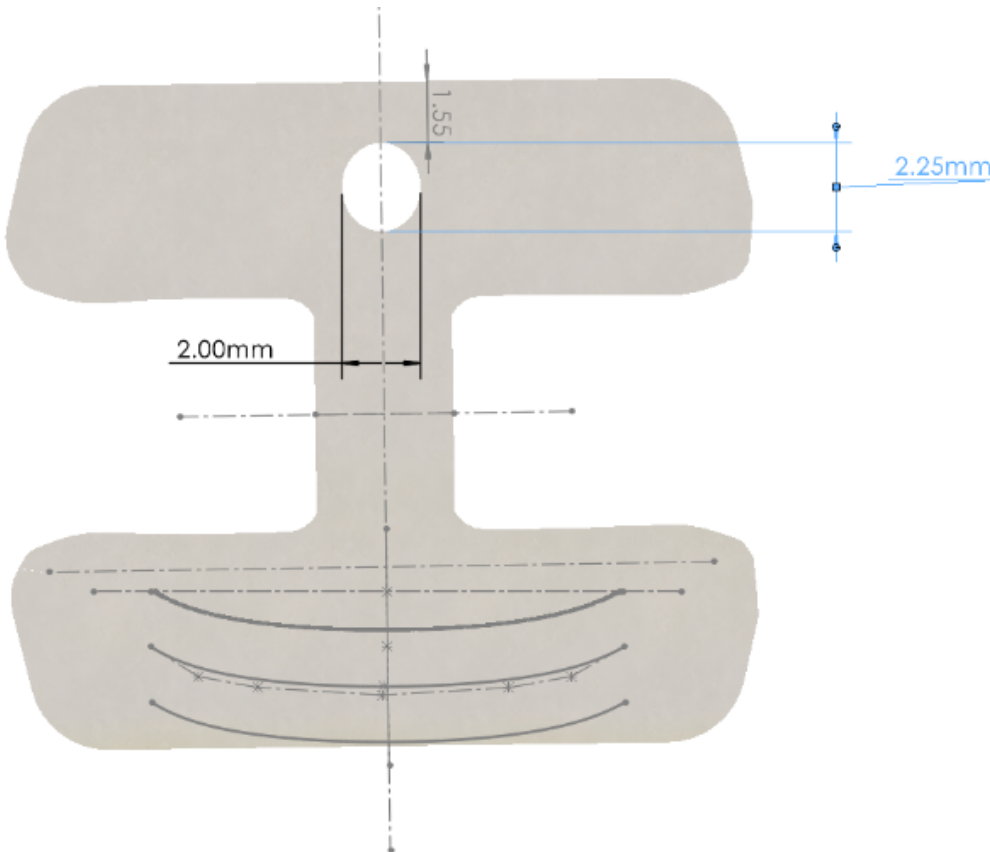
**Content by:** Joseph Koch

**Present:** --

**Goals:** create design iterations for prototyping with water jet

**Content:**

**This design uses a hole with a 2mm width and 2.25 mm height to allow for filling of smaller cavities.**



**Conclusions/action items:**

Add file to water jet cutting plans



## Waterjet cutting Plans

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JOSEPH KOCH - Dec 06, 2025, 6:21 PM CST

**Title:** Waterjet cut plans

**Date:** 12/6/2025

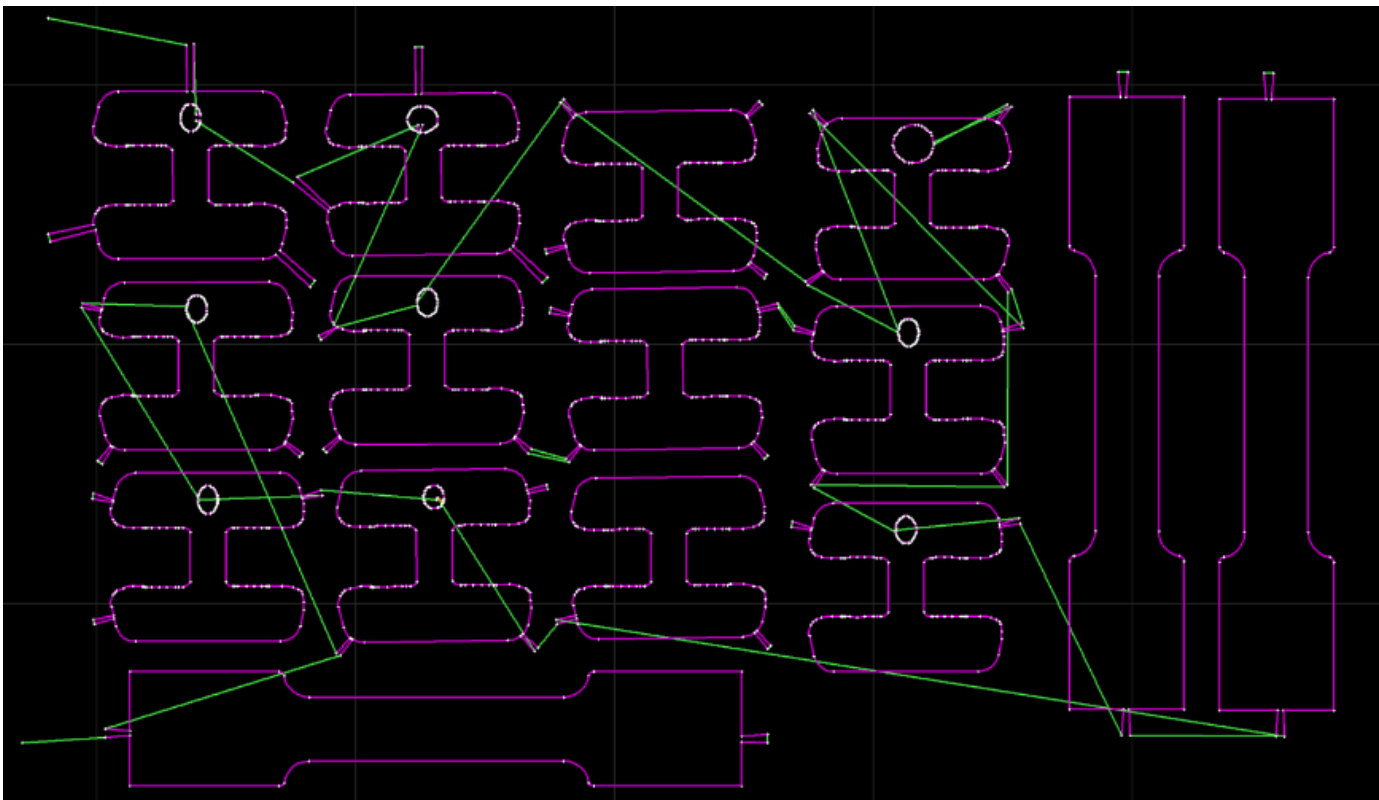
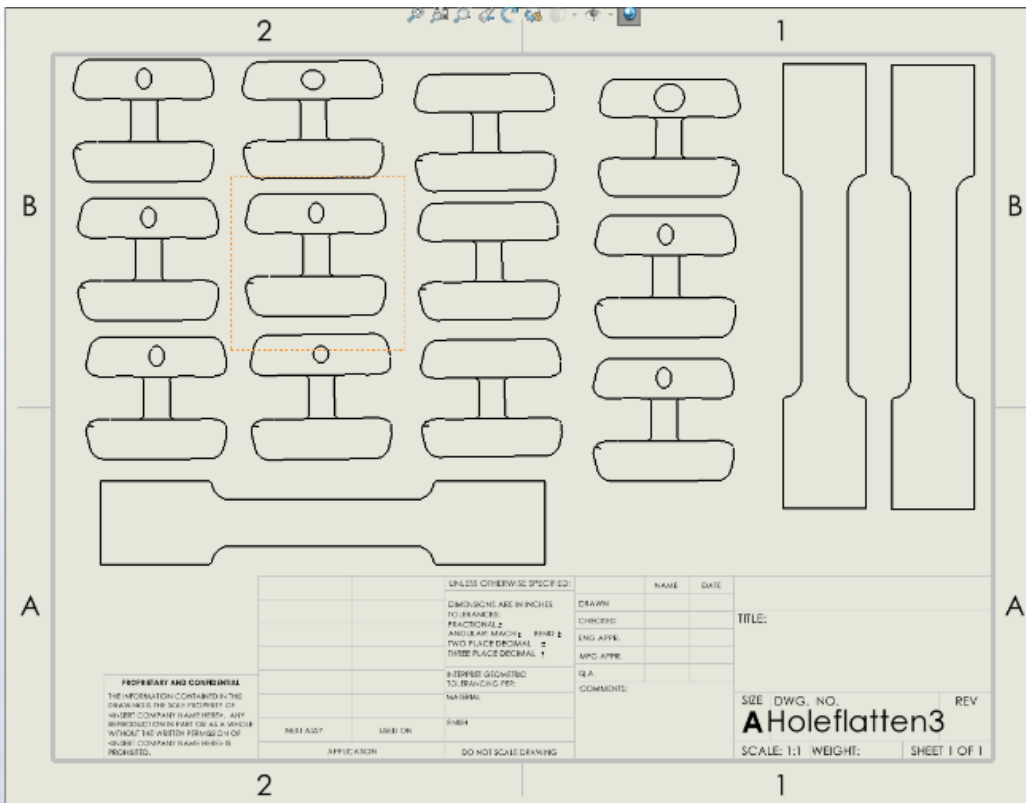
**Content by:** joseph koch

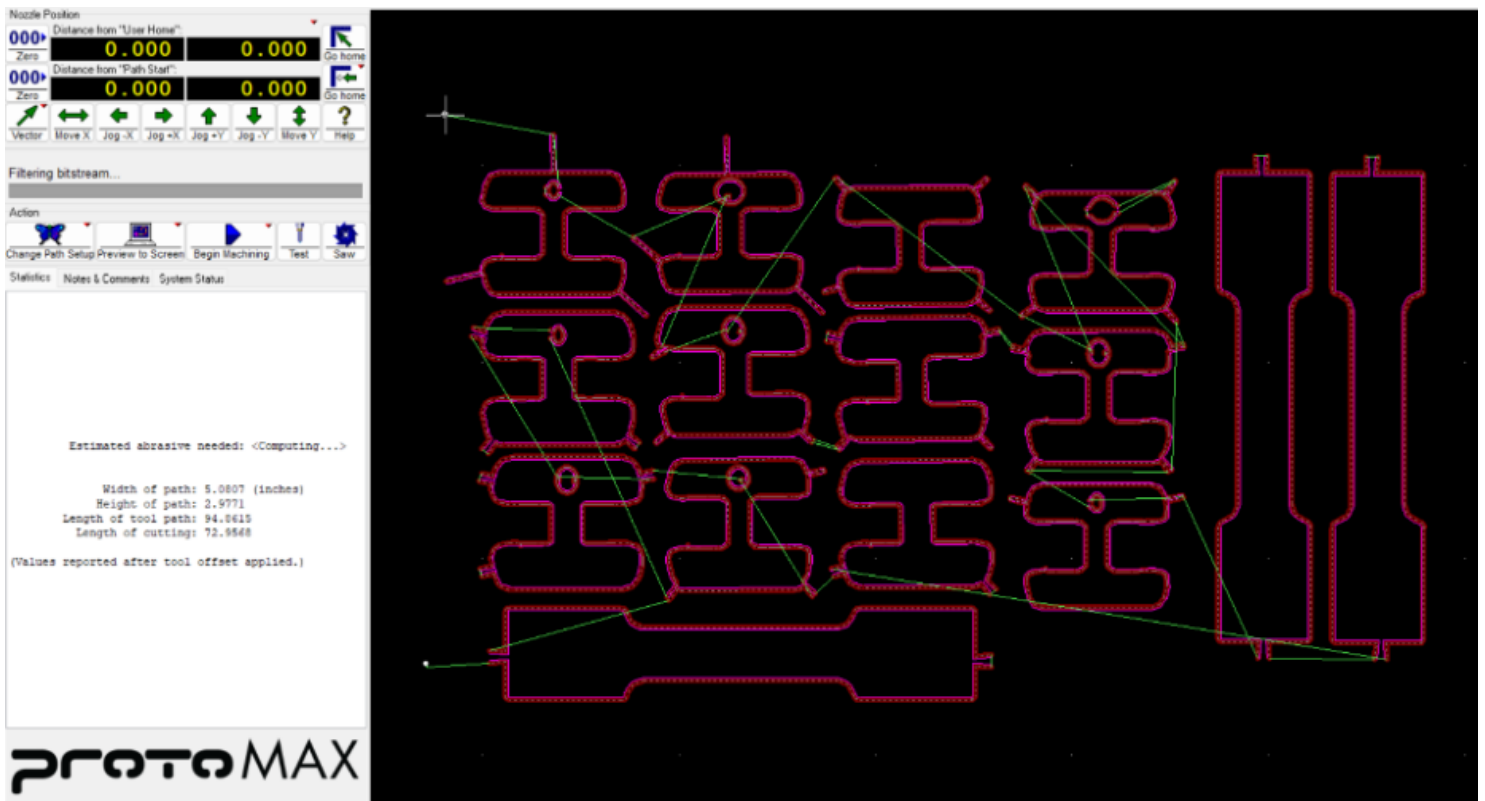
**Present:** --

**Goals:** report waterjet cutting path

**Content:**

Included below are the solidworks drawing file that was exported to a dxf file which is accepted by protoMAX Layout the water jet cutting software. ProtoMAX LAYOUT the drawing was refined for waterjet cutting by removing lines that should not be cut. The cut path was created with lead in and out lines. Tabs were added to try and hold the pieces in place during cutting. The dxf file was exported after checking cut path with the software and choosing path start to protoMAX MAKE software where it was converted to an .omx file which is read by the water jet cutting machine. This process was not very easy. The software is not very intuitive and there were a lot of challenges making sure the scaling was correct. This might have lead to small distortions in the holes and round edges of the matrices. 12 matrices in total will be cut. 3 control blanks, 6 of the original matrix, and 1 of each iteration. Additionally 3 material test coupons were cut to compare to current sectional matrix material that was provided by the client.





**Conclusions/action items:**

Schedule waterjet cutting time and cut parts.



## 12/6/2025 Dremel Fabrication plan

---

JOSEPH KOCH - Dec 10, 2025, 6:56 PM CST

**Title:** Dremel Fabrication plan

**Date:** 12/6/2025

**Content by:** Joseph Koch

**Present:** --

**Goals:** Report dremel fabrication and problems

**Content:**

1. Convert 3D SolidWorks model into 2D flattened surface
  1. Rolled back model to one sided 3D model
  2. Flattened surface using surface flatten tool
  3. Mirrored to create two surfaces
  4. Connected two surfaces with boundary surface
2. Prepare files for laser cutting templates
  1. Added tabs with holes for locating
  2. Created SolidWorks drawing file and layout all pieces to be cut
    1. A
  3. Exported as .pdf to Adobe illustrator
  4. Converted line color to RGD #FF0000 and line weight to 0.0001 mm
  5. Exported as .ai file
3. Print .ai file to Universal Laser System ILS9.150D-150 machine
  1. Placed  $\frac{1}{8}$  in HDF on cutting bed
  2. Calibrated laser
  3. Cut material
4. Prototype flat fabrication
  1. Covered both sides of metal shim stock with blue painters tape
  2. Glued one template onto tape
  3. Rough cut with scissors
  4. Drilled out alignment holes and part hole
  5. Used bolts and nuts attach second template to opposite side of shim stock and tighten
  6. Cut away extra tape using razor blade to improve visibility during grinding
  7. Used dremel  $\frac{1}{2}$ " drum sander bit to remove as much material as possible
  8. Finished with  $\frac{5}{64}$ " tip diamond wheel grinder to remove material up to template
  9. Took off one template

10. Used dremel cut off wheel to rough cut off tab

11. Finished bottom surface off part with ½" drum sander and diamond wheel grinder

12. Repeated for all parts

Problems: visibility was challenging with shadows and nonoptimal lighting. Also tape wasn't ground away so I had to cut it to see the part.

**Conclusions/action items:**

Create 3D geometry

 **12/6/2025 Material Test Coupon template**

JOSEPH KOCH - Dec 10, 2025, 6:54 PM CST

**Title:** Material Test Coupon template

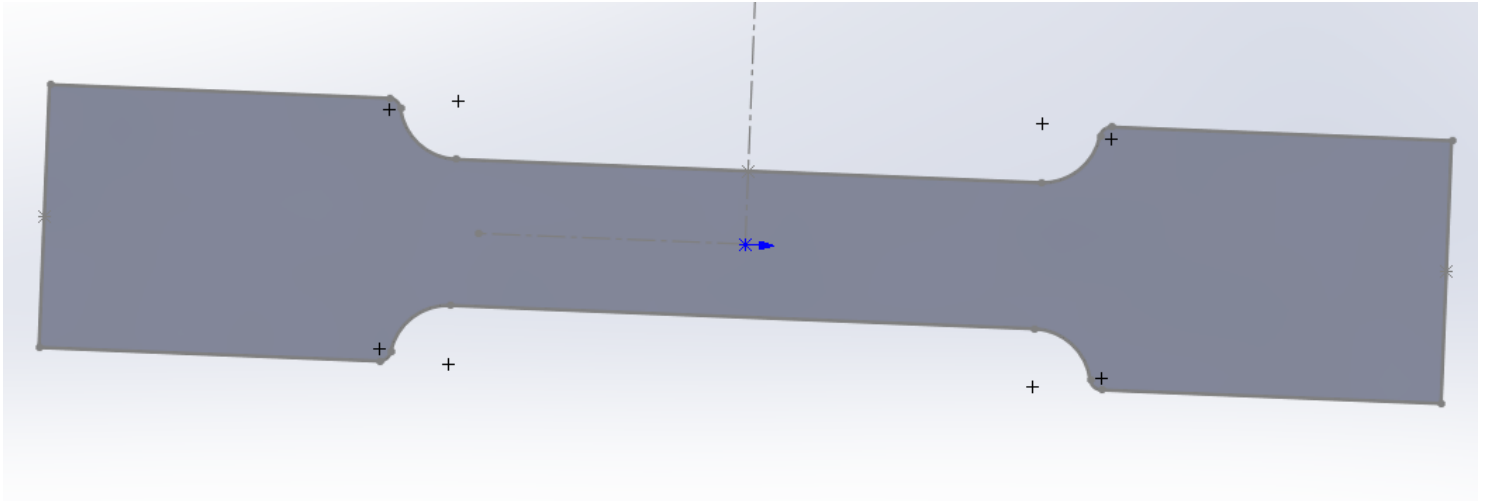
**Date:** 12/10/2025

**Content by:** Joseph Koch

**Present:** --

**Goals:** Create model that can be used to cut out templates of material test coupons used in material testing

**Content:**



**Conclusions/action items:**

add these to laser cutter template



# 12/6/2025 Laser cutter template for dremel fabrication

---

JOSEPH KOCH - Dec 10, 2025, 6:56 PM CST

**Title:** laser cutter template

**Date:** 6/12/2025

**Content by:** joseph koch

**Present:** --

**Goals:** create a cut path for laser cutter to make templates for dremel fabrication

**Content:**

The parts were initially modeled on SolidWorks these were added to a SolidWorks drawing file. This was exported as .dxf file to adobe illustrator to change the line weights and line color. The .ai file can be directly printed to the laser cutter.

**Conclusions/action items:**

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JOSEPH KOCH - Dec 10, 2025, 6:57 PM CST

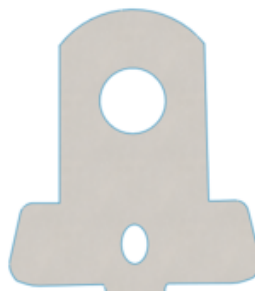


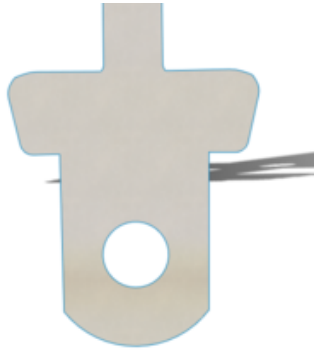
[Download](#)

Screenshot\_2025-12-10\_100759.png (59 kB)

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JOSEPH KOCH - Dec 10, 2025, 6:57 PM CST





[Download](#)

**Screenshot\_2025-12-10\_100926.png (131 kB)**

JOSEPH KOCH - Dec 10, 2025, 6:57 PM CST



[Download](#)

**TemplatePictures.jpg (1.05 MB)**

JOSEPH KOCH - Dec 10, 2025, 6:58 PM CST

above is the template file the line weight is really small so its hard to see. The flat model of the matrix with alignment tabs and the cut pieces.



## 4/29/2026 Template for final design 1

---

JOSEPH KOCH - Apr 29, 2026, 7:00 PM CDT

**Title:** Template for final design

**Date:** 4/29/2026

**Content by:** Joseph Koch

**Present:** --

**Goals:** Report template used for final design 1

**Content:**



**Conclusions/action items:**

make prototypes using template



## 4/29/2026 templates used for Design 2 fabrication

---

JOSEPH KOCH - Apr 29, 2026, 6:58 PM CDT

**Title:** other Templates for final design

**Date:** 4/29/2026

**Content by:** Joseph Koch

**Present:** --

**Goals:** Report template used for final design

**Content:**

The first template was used to clamp the design with a bottom platform for scribing the template onto the metal

Second template was used to align the cut metal flat with the hole to allow for accurate hole drilling





Conclusions/action items:

**make prototypes using template**



## 4/29/2026 Template for 3D form of matrix

---

JOSEPH KOCH - Apr 29, 2026, 6:59 PM CDT

**Title:** form for final design

**Date:** 4/29/2026

**Content by:** Joseph Koch

**Present:** --

**Goals:** Report form used for final design

**Content:**



Conclusions/action items:

**make prototypes using template**



## 9/22/2025 - Toffelmire Bands

KELEOUS LANGE - Dec 07, 2025, 2:51 PM CST

**Title:** Toffelmire Bands

**Date:** 9/22/2025

**Content by:** Keleous Lange

**Present:** Keleous

**Goals:** To learn more about one of the current devices used to fill cavities

**Content:**

Device Components:

The system consists of two main parts:

- The Band: A flat metal strip folded into a loop. When folded, it creates a funnel shape with a smaller circumference (gingival edge) and a larger circumference (occlusal edge).
- The Retainer:
  - Head (U-shaped): Contains slots to guide the band.
  - Locking Vise: A sliding block that holds the band ends.
  - Long Knob: Adjusts the loop diameter (tightens/loosens the band on the tooth).
  - Short Knob: Locks the band into the vise.

Orientation when using:

Proper orientation is critical for stability and patient safety. The guide emphasizes two rules:

1. Retainer Orientation: The open end of the retainer head must always face toward the gums. This allows the retainer to be removed easily in an occlusal direction.
2. Band Orientation: The smaller circumference of the band loop must always face toward the gingiva to match the anatomy of the tooth neck.

Placement:

1. Burnishing: The flat band must be rubbed with a burnisher on a paper towel *before* placement. This imparts a concave contour, helping it adapt to the convex tooth surface (a step often skipped but necessary for Toffelmire bands, unlike pre-contoured sectional bands).
2. Assembly: The band is bent into a loop and locked into the retainer with the occlusal edge facing the retainer body.
3. Seating: The band is placed over the tooth. It should extend 1.5–2.0 mm above the marginal ridge (to allow for overfilling/carving) and 0.5 mm below the gingival margin (to ensure a seal).
4. Wedging: A wooden wedge is inserted into the gingival embrasure.
  - *Critical Tip:* After wedging, the operator should loosen the band slightly (1/4 turn). If the band is too tight, it creates a flat contour and prevents the restorative material from creating a tight contact with the adjacent tooth.

**Conclusions/action items:**

Toffelmire bands are a very old, very established process that uses a specific set of tools that we should largely adhere to to make sure that our device can be entered into the dental industry without excessive training.

[1] "Matrix Placement for Class II Amalgam Restoration," *Columbia University College of Dental Medicine*. [Online]. Available:



## 10/29/2025 - MTS Testing Research

---

KELEOUS LANGE - Dec 07, 2025, 2:34 PM CST

### **Title: Tensile Testing of Flat Sheets**

**Date:** 10/20/2025

**Content by:** Keleous Lange

**Present:** Keleous

**Goals:** To gain background information about the testing of thin metal sheets

### **Content:**

Problems with standard testing

- Standard round specimens are impossible to use for our material because the thickness (0.0015") is too small to machine into a cylinder.
- Flat tensile specimens are the required standard for sheet metals, alloys, and composite laminates produced in flat form.

Relevance

- Testing flat specimens allows us to replicate the directional properties of rolled sheet metal. This is crucial for our matrix bands, which would be stamped from a rolled coil.
- The article highlights that industries like aerospace and automotive rely on these tests to understand how a panel will deform under tension, which is directly applicable to our band deforming around a tooth.

Prepping the material

- Precision: The article notes that laboratories rely on specialized preparation machines.
- Edge Quality: For thin foils, even microscopic nicks or burrs on the edges of the specimen will cause premature failure, leading to inaccurate yield strength data

### **Conclusions/action items:**

It's going to be tough to test the material that we're using, unless we get slightly thicker strips, as we can't roll the metals because it would fail to test the directional properties.

[1] "Flat Tensile Specimens: Why Thin-Sheet Testing Matters," *North Penn Now*, Nov. 17, 2025. [Online]. Available: <https://northpennnow.com/news/2025/nov/17/flat-tensile-specimens-why-thin-sheet-testing-matters/>



## 10/22/2025 - Laser Cutting

KELEOUS LANGE - Dec 06, 2025, 4:53 PM CST

### Title: Laser Cutting Thin Metals

Date: 10/22/2025

Content by: Keleous Lange

Present: Keleous

Goals: To figure out if laser cutting is a feasible route to create a prototype.

### Content:

Based on the metal laser cutting guide from Longxin Laser, laser cutting utilizes a highly concentrated beam of light to melt or vaporize metal. The process offers distinct advantages and constraints for our Dual Sectional Matrix Band project.

Fiber Lasers vs CO2:

Fiber Lasers: The industry standard for metal cutting. They use optical fibers to amplify energy.

- *Relevance:* Best suited for stainless steel (our material). They offer high speed and low maintenance.
- *Power:* For thin materials (< 1mm), a lower power unit (500W - 1000W) is sufficient and offers better control than high-power units used for thick plates [1].

Advantages:

- High Precision: Tolerances can be as tight as  $\pm 0.01$  mm, significantly better than the waterjet's  $\pm 0.1$  mm [1].
- Zero Distortion: The "non-contact" nature of the beam means no physical force is applied to the thin foil, reducing the risk of tearing that we feared with waterjet cutting.
- Fine Features: The cut width (kerf) is minimal (0.01mm - 0.1mm), allowing for the intricate tab and contour shapes required for the matrix band design [1].

Disadvantages:

- Heat Affected Zone (HAZ): Unlike waterjet, laser cutting *does* generate heat.
- Risk: For the 0.0015" Stainless Steel Bands, the heat could cause warping or slight discoloration on such thin foil.
  - *Mitigation:* Use "Nitrogen Assist Gas." The guide notes that nitrogen cools the cut and suppresses oxidation, leaving a clean, silver edge rather than a blackened, oxidized one [1].

Thin Steel process adjustments:

- Speed: High cutting speeds (up to 35m/min for thin sheets) prevent heat from building up in one spot, minimizing the HAZ [1].
- Safety: Fiber lasers require an enclosed cutting bed to protect operators from reflected light [1].

### Conclusions/action items:

We should use laser cutting if possible, because it is better than waterjet, but it might not work with our budget and timeline. If we were to do this in industry, we'd order a test batch of bands cut on a low-power (500W) fiber laser using nitrogen assist gas to test for warping

Longxin Laser. "Metal Laser Cutting Guide: Types, Power & Thickness Explained," *Longxin Laser*. [Online]. Available: <https://longxinlaser.com/metal-laser-cutting-guide/>. [Accessed: Dec. 11, 2024].



## 10/16/2025 - Waterjet Cutting

KELEOUS LANGE - Dec 06, 2025, 4:42 PM CST

### Title: Waterjet Cutting

Date: 10/16/2025

Content by: Keleous Lange

Present: Keleous

Goals: To learn more about waterjet cutting and the relevance to our project. Evaluate it as a solution for prototype fabrication

### Content:

Based on the specs outlined in the article, waterjet cutting utilizes a high-pressure stream of water (up to 60,000 PSI) mixed with an abrasive (garnet) to erode material.

Advantages:

- No Heat Affected Zone (HAZ): unlike laser cutting, waterjet is a "cold" process.
  - *Relevance*: This is critical for the stainless steel bands. Heat from a laser could anneal the metal, causing it to lose the spring temper required to separate teeth. Waterjet ensures the material retains its original mechanical properties.
- Material Versatility: It can cut virtually any metal, including the specific 304/316 stainless steel and Nickel Titanium alloys we are testing.
- Edge Quality: The process leaves a satin-smooth finish with no slag or heavy burrs, potentially reducing the post-processing time needed to make the bands safe for gingival insertion.

Disadvantages (mostly based on width):

While the article highlights the ability to cut thick steel (up to 25cm), cutting extremely thin shim stock presents challenges:

- Kerf Width: The stream diameter (kerf) is typically ~0.020" to 0.040" (0.5mm - 1mm). This is significantly wider than a laser (0.006"), limiting the intricacy of the tab features on the matrix band.
- Material Integrity: A high-pressure stream can tear or bend a single sheet of 0.0015" foil rather than cutting it cleanly.
- Solution - Stack Cutting: To overcome this, we would need to stack multiple layers of the matrix material (e.g., 50-100 sheets) and cut them simultaneously. This stabilizes the foil and makes the process economical. This could also be achieved by sandwiching it with another material, such as wood or polycarbonate.

Comparison to Laser:

- Waterjet: No heat damage, lower precision (+/- 0.005"), requires stacking for thin sheets.
- Laser: High heat (risk of warping/tempering), high precision (+/- 0.001"), excellent for single thin sheets.

### Conclusions/action items:

Waterjet will not be as good at cutting as laser jet, as it's not nearly as precise for our super precise requirements, but it will have to do for the first prototype, as laser cutting is out of our current budget. This could cause issues in the future as well.

References: [1] Techni Waterjet. "Cutting Steel with Water," *Techni Waterjet*. [Online]. Available: <https://www.techniwaterjet.com/cutting-steel-with-water/>. [Accessed: Dec. 10, 2024].



## 10/10/2025 - Stainless Steels

KELEOUS LANGE - Dec 06, 2025, 4:34 PM CST

### Title: Stainless Steel Research

Date: 10/10/2025

Content by: Keleous Lange

Present: Keleous

Goals: To discern the difference between two common types of stainless steel: 304 and 316

### Content:

**Content:** Based on the Unified Alloys comparison of 304 and 316 stainless steel [1], the key differences lie in their alloy composition, which dictates their performance in corrosive environments.

#### Chemical Composition

- Grade 304: The most common stainless steel. Contains 18% chromium and 8% nickel. It does *not* typically contain molybdenum.
- Grade 316: Contains less chromium (~16%) and higher nickel (10%), but crucially adds 2-3% molybdenum.
  - *Significance:* The addition of molybdenum is the primary differentiator, drastically enhancing corrosion resistance, especially against chlorides (salts) and acids.

#### Performance comparison

- Corrosion Resistance:
  - 304: Offers standard resistance suitable for indoor and mild outdoor environments (e.g., kitchen equipment, water piping).
  - 316: Superior resistance to chlorides and acids. It is considered "marine grade" and is preferred for medical equipment, pharmaceutical processing, and environments with high salt levels.
- Mechanical Properties:
  - Formability: 304 is generally easier to form and maintain, making it standard for general manufacturing.
  - Strength: Both have excellent formability and strength, but 316 can offer better resistance to pitting in harsh chemical environments.
- Cost: 304 is the more economical choice. 316 is more expensive due to the addition of molybdenum and higher nickel content, but it offers a longer functional lifespan in aggressive conditions.

#### Relevance to matrix band

The matrix band will be used in the oral cavity (a wet, potentially acidic environment with saliva) and may be exposed to dental chemicals (etchants, bonding agents).

- 304: Likely sufficient for disposable bands or short-term prototypes due to lower cost and good general resistance.
- 316: The "Medical equipment" application listed for 316 suggests it is the industry standard for reusable dental instruments or devices requiring sterilization and high chemical resistance.

### Conclusions/action items:

While Grade 304 is cost-effective for initial *disposable* prototypes, Grade 316 is the superior choice for the final product or any reusable components (like the ring) due to its resistance to chlorides (saliva) and chemicals. If the matrix bands are strictly single-use disposables, the cost premium of 316 may not be necessary. 304 provides adequate corrosion resistance for a single procedure.

Action Item: Source 0.0015" thickness shim stock in both 304 and 316 grades to compare their dead-soft qualities and ability to hold a burnished contour.

[1] Unified Alloys. "304 vs 316 Stainless Steel: What You Need to Know," *Unified Alloys Blog*. [Online]. Available: <https://www.unifiedalloys.com/blog/304-316-stainless>. [Accessed: Dec. 9, 2024].



## 10/04/2025 - Cavity Filling

KELEOUS LANGE - Dec 06, 2025, 4:30 PM CST

### Title: Cavity Filling

Date: 10/04/2025

Content by: Keleous Lange

Present: Keleous

Goals: Map the standard procedure for dental fillings to identify exactly when and how the matrix band interacts with the tooth.

### Content:

Based on the Cleveland Clinic overview of dental fillings [1], the procedure for restoring a decayed tooth involves several critical steps that dictate the requirements for our device design.

### Purpose and Materials:

A filling is used to repair small to medium areas of decay or damage (e.g., cracks).

- Composite Resin (Tooth-colored): The most relevant material for our project. It bonds chemically to the tooth structure and is hardened (cured) using a special light.
  - *Relevance*: Our matrix band must be thin enough to not interfere with the bond but rigid enough to hold the semi-liquid resin in shape before curing.
- Amalgam (Silver): Durable, made of mixed metals. Packed into the cavity
- Others: Gold, Porcelain, Glass Ionomer (often for children/temporary).

### Step By Step Procedure:

1. Numbing: Local anesthesia is applied to the area.
2. Decay Removal: The dentist uses a drill or laser to remove decayed tissue.
3. Cleaning: The cavity is cleaned of debris and bacteria.
4. Filling Placement (Critical Step for Project):
  - For Composite: The material is applied in layers. A special light is used to harden each layer.
  - *Device Integration*: In Class II restorations (involving the side of the tooth), this is where the matrix band must be placed *before* the filling material. It acts as a temporary wall.
5. Polishing: The dentist shapes the material to match the natural tooth contour and checks the bite to ensure it isn't too high.

### Key Design Findings:

- Layering: Since composites are placed in layers, the matrix band must remain stable for several minutes and allow access for the curing light.
- Contour: The article notes that the dentist "shapes and molds" the material. Our device must *pre-shape* the material as much as possible to reduce the manual finishing time mentioned in step 5.

### Conclusions/action items:

The dual sectional matrix band is inserted after "Decay Removal" and before "Filling Placement." It must be easy to place on a numb patient who may have limited jaw control. The design must not block the curing light from reaching the deep layers of the composite box, suggesting the use of

translucent or very thin metal materials. An action item could be to investigate "light curing depth" and how matrix band thickness/translucency affects the polymerization of the bottom layer of the filling.

[1] Cleveland Clinic. "Dental Fillings: Types, Materials & What They're For," *Cleveland Clinic*. [Online]. Available: <https://my.clevelandclinic.org/health/treatments/17002-dental-fillings>. [Accessed: Dec. 8, 2024].



## 09/29/2025 - Cavities

KELEOUS LANGE - Dec 06, 2025, 4:23 PM CST

### Title: Cavity Research

Date: 09/29/2025

Content by: Keleous Lange

Present: Keleous

Goals: To learn more about cavities and how they're caused so that I can better design the matrix.

### Content:

Cavities are caused by a combination of factors, primarily bacteria in the mouth, frequent snacking, and sipping sugary drinks. The process generally follows these steps:

- Plaque Forms: Bacteria feed on sugars and starches, forming a sticky film (plaque) that coats the teeth.
- Plaque Attacks: Acids in the plaque remove minerals from the tooth's hard, outer enamel (demineralization).
- Destruction Continues: Once the enamel is worn away, bacteria and acid reach the next layer (dentin), which is softer and less resistant to acid. This leads to the physical cavity that requires restoration

As decay expands, symptoms may include:

- Toothache or spontaneous pain.
- Tooth sensitivity.
- Visible holes or pits in the teeth.
- Brown, black, or white staining on any surface of a tooth.
- Pain when biting down (indicates need for structural restoration).

Relevant cavity information to this project and sectional matrix bands:

- Tooth Location: Decay most often occurs in molars and premolars. These teeth have multiple roots and grooves that collect food particles.
  - *Relevance:* The Dual Sectional Matrix Band must be specifically designed to fit the anatomy of molars and premolars.
- Inadequate Cleaning: Failure to clean teeth effectively leads to plaque buildup.
  - *Relevance:* Restorations must be contoured perfectly to prevent food traps and plaque accumulation post-procedure.
- Worn Fillings: Dental fillings can weaken and break down over time, allowing decay to begin underneath them.
  - *Relevance:* A high-quality initial restoration facilitated by a good matrix system is crucial to longevity.

### Conclusions/action items:

- Target Anatomy: Since cavities are most prevalent in molars and premolars due to their grooves and difficulty to clean, the Dual Sectional Matrix Band design must prioritize fit for these posterior teeth.
- Restoration Quality: The primary function of the matrix band is to facilitate a restoration that seals the cavity and restores the natural contour, preventing secondary decay caused by plaque accumulation in poorly shaped contact points.
- Next Step: Investigate the average interproximal dimensions of molars to determine the necessary curvature for the matrix band prototypes.





## 10/06/2025 - Sectional Matrices

KELEOUS LANGE - Dec 07, 2025, 3:06 PM CST

### Title: Sectional Matrices

Date: 10/06/2025

Content by: Keleous Lange

Present: Keleous

Goals: To learn about sectional matrices and how they're used in the field.

### Content:

Reason for using sectional matrices

- Superiority: Sectional matrices with rings provide more anatomical and stronger contact areas than circumferential matrices.
- Health Impact: A proper contact prevents food impaction and periodontal disease, maintaining papillary health.

Procedure on sectional matrix use and clinical implications

#### 1. Pre-wedging

- Technique: A wedge is inserted *before* cavity preparation.
- Purpose: It achieves a tooth separation greater than the matrix thickness, which prevents the matrix from deforming during insertion later.
- *Design Note*: The Dual Sectional system must account for this separation. If the band is thicker than standard (0.038 mm), more separation force is required.

#### 2. Matrix Placement

- No Pressure: The matrix must be placed without force. Standard bands are very thin (0.038 mm) and deform easily if forced through a tight contact.
- Vertical Position: The matrix cannot rest on the cavity floor; it must extend below the gingival margin of the preparation to ensure a seal.
- Wedge Position: A wooden wedge is inserted to adapt the matrix to the gingival contour. Crucially, the wedge must remain below the cavity floor. If it sits too high, it pushes the matrix inward, creating a convex contour that invades the restoration space.

#### 3. Ring Application

- Sealing: The separation ring (e.g., Composit-Tight Soft-Face 3D) is placed to seal the buccal and lingual embrasures.
- Overhang Prevention: The ring ends should be wedge-shaped to adapt the matrix against the tooth structure, preventing composite overhangs.

#### 4. Polishing

- Tools: Diamond-metal finishing strips are preferred for the interproximal area as they pass through the contact without breaking.

### Conclusions/action items:

Sectional matrices are the current standard for filling cavities because they're very consistent and easier to use than other tools in the field.

[1] V. Alonso de la Peña, R. Pernas García, and R. Pérez García, "Sectional matrix: Step-by-step directions for their clinical use," *British Dental Journal*, vol. 220, no. 1, pp. 11-14, 2016.



## 10/06/2025 - Sectional Matrices

KELEOUS LANGE - Dec 07, 2025, 3:06 PM CST

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Date: 10/06/2025

Content by: Keleous Lange

Present: Keleous

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## 12/02/2025 - Advanced Laser Cutter Ideas

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KELEOUS LANGE - Dec 07, 2025, 4:31 PM CST

**Title:** Advanced Laser Cutter Ideas

**Date:** 12/02/2025

**Content by:** Keleous Lange

**Present:** All

**Goals:** To outline a possible idea for laser cutting the material

**Content:**

- Ran into a professor at poster presentations who has access to a laser cutter and provided some expertise on how it could be used
- Laser cutter has 1 micron tolerances so step-wise cutting can occur to make the outline less sharp in the gums.
  - This could also increase the softness of the material if done properly
- Need to consider the leveled curing that Dr. tipple referenced

**Conclusions/action items:**

Need to have an outline ready to send over so that we can cut our project over winter break.



## 2026/03/06 - Tong Lecture

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KELEOUS LANGE - Mar 06, 2026, 1:08 PM CST

**Title:** Tong Lecture

**Date:** 03/06/2026

**Content by:** Keleous Lange

**Present:** Justin Williams

**Goals:** To learn about brain implantation

**Content:**

- Can we repair damaged tissues and make someone better than usual
- Grew up in Rural South Dakota
- Ran track in college
- Had two different startups that were bought out and shelved
- NeuroOne: Less is more, incremental technologies are also effective
- Spent a lot of time in the OR looking over epilepsy surgery
- Emerging technology at the time was thin-film electrodes that are now seen in most electronic devices
- Mesh devices led to far less inflammation than solid devices in animals
- NeuroOne went public
- Patent image stolen for Grey's Anatomy
- Brainsync is a different company he was a part of
- Idea of using the mind as a mouse through implants, tried doing it without an implant using surface EGG
- Put together a program that makes it so you can type with your mind
- Used to help with ALS
- Brainsync is used for stroke rehabilitation

**Conclusions/action items:**

Justin Williams is a successful entrepreneur and faculty member at UW-Madison. He works on biotechnology that help many different disorders.



## 09/10/2025 Matrix Band Background

Tatiana Predko - Sep 10, 2025, 7:29 PM CDT

**Title:** Dental Matrix Band Background Research

**Date:** 09/10/2025

**Content by:** Tatiana Predko

**Present:** N/A

**Goals:** Conduct background research on surface matrix bands to gain insight on their function.

**Content:**

- Matrix band systems are used in treatment of posterior teeth in order to avoid overhanging proximal margins and poor proximal contact points [2].
- In one study on Class 2 restorations, it was found that a sectional matrix band system was more effective than a circumferential matrix band system due to better contacts [2]. In another study with Class 2 restorations with composite resin, there were similar findings that a sectional matrix with rings would provide more anatomically-accurate and stronger contact areas than those resulting from a circumferential matrix [4].
- In a Class 2 restoration (cavity between the contact points of two teeth), its important to ensure a large proximal contact area in order to prevent food from inserting between the teeth and periodontal disease; additionally, this prevents dental migration and decay [4].
- The steps of using a sectional matrix band for a Class 2 restoration are as follows: first, the operatory field must be isolated (often by use of a rubber dam, but can also be done with cotton rolls and aspiration). A wide isolation allows for more room for the dentist to work and to see. Then, to ensure close proximal contact between teeth, a technique called 'pre-wedging' is often used, in which a protective wedge is placed between the teeth before drilling the decayed tooth in order to prevent accidental drilling/damage to the adjacent tooth. In order for the matrix to be properly placed, there must be a wider separation between the teeth than the width of the matrix, which is why wide wedges are used. Another method to achieve this is to use an orthodontic separator. Then, it is time to prepare the cavity. Once the cavity preparation is complete, the wedge can be removed, and the matrix can be placed without any pressure. A ring can be placed on the matrix to adapt it to the drilled openings to avoid overhang of the filling. Finally, the tooth can be filled [4].
- The matrix needs to exceed the gingival margin of the preparation, and cannot be placed on the cavity floor [4].

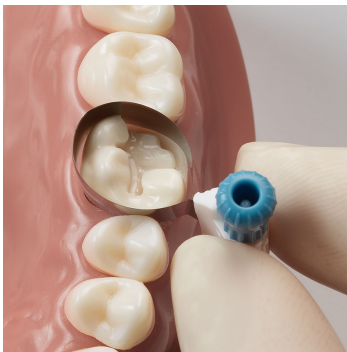


Fig. 1. Circumferential matrix band [3].



Fig. 2. Sectional matrix band [1].

**Conclusions/action items:**

**Begin brainstorming design ideas, preferably with a sectional matrix band, since multiple studies show the design allows for tighter proximal contact which prevents food impaction and subsequent decay.**

**References:**

- [1] Community, "How to use a sectorial matrix in order to achieve a functional proximal surface," Styleitaliano.org, <https://www.styleitaliano.org/how-to-use-a-sectorial-matrix-in-order-to-achieve-a-functional-proximal-surface/> (accessed Sep. 10, 2025).
- [2] M. Ahmad, Durr-E-Sadaf, R. Gaikwad, and B. Arjumand, "Comparison of two different matrix band systems in restoring two surface cavities in posterior teeth done by senior undergraduate students at Qassim University, Saudi Arabia: A randomized controlled clinical trial," *Indian Journal of Dental Research*, vol. 29, no. 4, p. 459, 2018. doi:10.4103/ijdr.ijdr\_26\_17
- [3] "Palodent 360: Circumferential Matrix System: Dentsply Sirona," Palodent 360: Circumferential Matrix System | Dentsply Sirona USA, <https://www.dentsplysirona.com/en-us/discover/discover-by-brand/palodent-family/palodent-360.html> (accessed Sep. 10, 2025).
- [4] V. A. de la Peña, R. P. García, and R. P. García, "Sectional matrix: Step-by-step directions for their clinical use," *British Dental Journal*, vol. 220, no. 1, pp. 11–14, Jan. 2016. doi:10.1038/sj.bdj.2016.18

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Tatiana Predko - Oct 05, 2025, 9:47 PM CDT

**Title: Sectional vs. Circumferential Matrix**

**Date:** 10/05/2025

**Content by:** Tatiana Predko

**Present:** N/A

**Goals:** Collect information on matrix bands.

**Content:**

- Class 2 cavities common because bacterial growth is fostered in tight, hard-to-clean spaces [1].

**Conclusions/action items:**

- Add this information into the introductory section of the preliminary report.

**References:**

- [1] S. Kamble *et al.*, "The effectiveness of circumferential and sectional matrix systems in obtaining optimum proximal contact in class II composite restorations: A systematic review," *Cureus*, May 2025. doi:10.7759/cureus.84967





## 09/17/2025 Additional Matrix Band Research

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Tatiana Predko - Sep 17, 2025, 4:57 PM CDT

**Title:** Additional Sectional Matrix Band Research

**Date:** 09/17/2025

**Content by:** Tatiana Predko

**Present:** N/A

**Goals:** To gain more insight into the size, weight, aesthetics, appearance, and finish of typical sectional matrix bands for the PDS document.

**Content:**

- According to an article, sectional matrices are better than circumferential matrices at being able to recreate an anatomically-accurate interproximal wall during a Class 2 dental restoration [1].

**Conclusions/action items:**

**References:**

[1] O. Bailey, "Sectional matrix solutions: The distorted truth," British dental journal, <https://pmc.ncbi.nlm.nih.gov/articles/PMC8589656/#Sec13> (accessed Sep. 17, 2025).



## 09/26/2025 Dental Caries

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Tatiana Predko - Sep 26, 2025, 8:58 PM CDT

**Title: Dental Caries Background Research**

**Date:** 09/26/2025

**Content by:** Tatiana Predko

**Present:** N/A

**Goals:** Conduct background research on dental caries.

**Content:**

- Caries are a widespread disease which affects both children and adults [1].
- Caries are caused by the conversion of fermentable carbohydrates by plaque bacteria into acids on the tooth surface; contributing factors include sugar consumption and plaque buildup [1].
- Composite resins with amalgam (containing mercury) can be used as filling material for Class 2 restorations [2].

**Conclusions/action items:**

- Add information into the background section of the preliminary presentation.

**References:**

- [1] Meyer F;Schulze Zur Wiesche E;Amaechi BT;Limeback H;Enax J;, "Caries etiology and preventive measures," European journal of dentistry, <https://pubmed.ncbi.nlm.nih.gov/38555649/> (accessed Sep. 26, 2025).
- [2] Observations on a composite resin for class II restorations: Three-year report - sciencedirect, <https://www.sciencedirect.com/science/article/abs/pii/0022391373902837> (accessed Sep. 26, 2025).

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Tatiana Predko - Sep 30, 2025, 5:15 PM CDT

**Title: Additional Background Research**

**Date:** 09/30/2025

**Content by:** Tatiana Predko

**Present:** N/A

**Goals:** Conduct background research for preliminary presentation.

**Content:**

- Approximately 90% of adults between the ages of 20 to 64 years have had decay in their teeth [1].

**Conclusions/action items:**

- Add background information into slides.

**References:**

[1] "Dental caries (tooth decay) in adults (ages 20 to 64 years)," National Institute of Dental and Craniofacial Research, <https://www.nidcr.nih.gov/research/data-statistics/dental-caries/adults> (accessed Sep. 30, 2025).



## 10/05/2025 Untreated Caries

Tatiana Predko - Oct 05, 2025, 6:44 PM CDT

**Title:** Consequences of Untreated Caries

**Date:** 10/05/2025

**Content by:** Tatiana Predko

**Present:** N/A

**Goals:** Collect information on untreated cavities and their consequences.

**Content:**

- One study found that untreated caries are associated with 26% increased risk of all-cause mortality, and a 48% increased risk of heart disease mortality [1].
- Caries is an infectious and transmissible disease characterized by gradual breakdown of the crown and root structures of the tooth due to microbial activity [2]; the primary pathogen responsible for this is *Streptococcus mutans* bacteria [2].
- Caries develops due to the interaction between the cariogenic oral flora (also known as biofilm) with fermenting dietary carbohydrates (carbs) [2]; bacteria within the biofilm metabolize carbs, producing lactic acid as a byproduct [2]. Over time, lactic acid on the surface of the tooth lowers the pH of plaque, initiating the removal of phosphate and calcium from the tooth (de-mineralization), causing a cavity [2].
- Untreated caries can lead to meningitis, cavernous sinus thrombosis, or chronic maxillary sinusitis, which are all lethal complications [2]. They can also cause a secondary infection within the mandible and throat [2].
- Childhood caries have been linked to delayed growth, chronic medical conditions, and cardiovascular disease [2].
- Untreated dental caries can lead to pain, infection, swelling requiring emergency hospitalizations, and dental extractions under general anesthesia [3].

**Conclusions/action items:**

- Add this information into the introductory section of the preliminary report.

**References:**

- [1] J. Liu *et al.*, "Tooth count, untreated caries and mortality in US adults: A population-based Cohort Study," *International Journal of Epidemiology*, vol. 51, no. 4, pp. 1291–1303, Apr. 2022. doi:10.1093/ije/dyac072
- [2] Dental caries - an overview | sciencedirect topics, <https://www.sciencedirect.com/topics/medicine-and-dentistry/dental-caries> (accessed Oct. 5, 2025).
- [3] R. P. Anthonappa and N. M. King, "Oral and dental manifestations in Noonan syndrome," *Noonan Syndrome*, pp. 135–158, 2019. doi:10.1016/b978-0-12-815348-2.00009-8



## 10/05/2025 Class 2 Restoration Steps

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Tatiana Predko - Oct 05, 2025, 9:17 PM CDT

**Title:** Class 2 Restoration Steps

**Date:** 10/05/2025

**Content by:** Tatiana Predko

**Present:** N/A

**Goals:** Collect information on Class 2 restorations.

**Content:**

[Steps of a Class 2 Restoration \[1\]](#):

1. Local Anesthesia:

- Topical gel on gum tissue, followed by an injection into the gums to numb the deep tissues.

2. Preparation:

- Burring to remove the decayed portions of the tooth.

- Dye to stain decayed tissue.

3. Matrix Isolation:

- Sectional matrix used to isolate the workspace.

4. Bonding Agent:

- Bond helps the composite filling material to adhere to the tooth.

- Bonding involves a light to cure.

5. Composite:

- Composite material is packed into the cavity.

- Process is layer-by-layer with intermittent light curing; ensures that composite is thoroughly-cured to reduce risk of shrinkage and voids.

6. Finishing:

- Shaping and polishing of restored tooth.

7. Verification of Occlusion

- Check the bite surface and adjust the filling as needed to ensure a comfortable bite for the patient.

**Conclusions/action items:**

- Add this information into the introductory section of the preliminary report.

**References:**

[1] "The steps of a class II dental restoration," Benco Dental, <https://www.benco.com/benco-dental-u/article/class-ii-procedure-steps/> (accessed Oct. 5, 2025).



## 12/01/2025 Matrix Material Properties

Tatiana Predko - Dec 02, 2025, 5:45 PM CST

**Title:** Matrix Material Properties

**Date:** 12/01/2025

**Content by:** Tatiana Predko

**Present:** N/A

**Goals:** Determine the mechanical properties of the materials used in our matrix prototype to be used as a custom material for a finite element analysis in SOLIDWORKS.

**Content:**

304 18-8 Stainless Steel (full-hard):

Average Young's Modulus =  $((5.486e4)+(5.791e4)+(4.663e4))/3 = 5.313e4$  MPa; calculated from testing data.

| Mechanical Properties      |   |   |
|----------------------------|---|---|
| Hardness, Brinell          | 123                                       | 123   |
| Hardness, Knoop            | 138                                       | 138   |
| Hardness, Rockwell B       | 70  | 70  |
| Hardness, Vickers          | 129                                       | 129   |
| Tensile Strength, Ultimate | 505 MPa                                   | 73200 psi                                   |
| Tensile Strength, Yield    | 215 MPa                                   | 31200 psi                                   |
| Elongation at Break        | 70 %                                      | 70 %  |
| Modulus of Elasticity      | 193 - 200 GPa                             | 28000 - 29000 ksi                           |
| Poisson's Ratio            | 0.29                                      | 0.29  |
| Charpy Impact              | 325 J                                     | 240 ft-lb                                   |
| Shear Modulus              | 86 GPa                                    | 12500 ksi                                   |
| Electrical Properties      |   |   |
| Electrical Resistivity     | 7.2e-005 ohm-cm                           | 7.2e-005 ohm-cm                             |
| Magnetic Permeability      | 1.008                                     | 1.008                                       |
| Thermal Properties         |   |   |
| CTE, linear 20°C           | 17.3 $\mu\text{m}/\text{m}\cdot\text{°C}$ | 9.61 $\mu\text{in}/\text{in}\cdot\text{°F}$ |
| CTE, linear 250°C          | 17.8 $\mu\text{m}/\text{m}\cdot\text{°C}$ | 9.89 $\mu\text{in}/\text{in}\cdot\text{°F}$ |
| CTE, linear 500°C          | 18.7 $\mu\text{m}/\text{m}\cdot\text{°C}$ | 10.4 $\mu\text{in}/\text{in}\cdot\text{°F}$ |
| Specific Heat Capacity     | 0.5 J/g·°C                                | 0.12 BTU/lb·°F                              |
| Thermal Conductivity       | 16.2 W/m·K                                | 112 BTU-in/hr-ft <sup>2</sup> ·°F           |
| Melting Point              | 1400 - 1455 °C                            | 2550 - 2650 °F                              |
| Solidus                    | 1400 °C                                   | 2550 °F                                     |
| Liquidus                   | 1455 °C                                   | 2650 °F                                     |

Table 1: mechanical properties of 304 stainless steel [1].

301 18-8 Stainless Steel (half-hard):

Average Young's Modulus =  $((5.53e4)+(5.602e4)+(5.38e4))/3 = 5.504e4$  MPa; calculated from testing data.

| Physical Properties          | Metric                 | English                           |
|------------------------------|------------------------|-----------------------------------|
| Density                      | <u>8.03 g/cc</u>       | 0.29 lb/in <sup>3</sup>           |
| <b>Mechanical Properties</b> |                        |                                   |
| Hardness, Brinell            | 297                    | 297                               |
| Hardness, Rockwell C         | 32                     | 32                                |
| Tensile Strength, Ultimate   | <u>Min 1034 MPa</u>    | Min 150000 psi                    |
| Tensile Strength, Yield      | <u>Min 758 MPa</u>     | Min 110000 psi                    |
| Elongation at Break          | <u>Min 18 %</u>        | Min 18 %                          |
| Modulus of Elasticity        | <u>185 GPa</u>         | 26800 ksi                         |
| Modulus of Elasticity        | <u>186 GPa</u>         | 27000 ksi                         |
| Compressive Yield Strength   | <u>621 MPa</u>         | 90100 psi                         |
| Compressive Yield Strength   | <u>979 MPa</u>         | 142000 psi                        |
| Charpy Impact                | <u>150 J</u>           | 111 ft-lb                         |
| Fatigue Strength             | <u>379 MPa</u>         | 55000 psi                         |
| <b>Electrical Properties</b> |                        |                                   |
| Electrical Resistivity       | <u>7.2e-005 ohm-cm</u> | 7.2e-005 ohm-cm                   |
| Magnetic Permeability        | Max 1.02               | Max 1.02                          |
| <b>Thermal Properties</b>    |                        |                                   |
| CTE, linear 20°C             | <u>16.6 μm/m-°C</u>    | 9.22 μin/in-°F                    |
| CTE, linear 250°C            | <u>17.6 μm/m-°C</u>    | 9.78 μin/in-°F                    |
| CTE, linear 500°C            | <u>18.6 μm/m-°C</u>    | 10.3 μin/in-°F                    |
| Specific Heat Capacity       | <u>0.5 J/g-°C</u>      | 0.12 BTU/lb-°F                    |
| Thermal Conductivity         | <u>16.3 W/m-K</u>      | 113 BTU-in/hr-ft <sup>2</sup> -°F |
| Melting Point                | 1399 - 1421 °C         | 2550 - 2590 °F                    |
| Solidus                      | <u>1399 °C</u>         | 2550 °F                           |
| Liquidus                     | <u>1421 °C</u>         | 2590 °F                           |

**Table 2: mechanical properties of 301 stainless steel [2].**

- Ni-Ti rings typically apply 5 pounds of force onto a sectional matrix band [3].

#### References:

[1] ASM material data sheet, <https://asm.matweb.com/search/specificmaterial.asp?bassnum=mq304a> (accessed Dec. 2, 2025).

[2] ASM material data sheet, <https://asm.matweb.com/search/SpecificMaterial.asp?bassnum=NL3012> (accessed Dec. 2, 2025).

[3] Clinicianschoice.com, <https://www.clinicianschoice.com/product/dualforce-sectional-matrix-system/01tV50000098wJNIAy> (accessed Dec. 2, 2025).

#### Conclusions/action items:

- Use this data to create a custom material in SOLIDWORKS prior to the FEA analysis.



## 04/06/2026: Marketability of Dual Matrix Band

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Tatiana Predko - Apr 06, 2026, 8:10 PM CDT

**Title:** Marketability of Dual Matrix Band Research

**Date:** 04/06/2026

**Content by:** Tatiana Predko

**Present:** N/A

**Goals:** Conduct research for the executive summary.

**Content:**

- Approximal (interproximal) tooth surfaces of all teeth demonstrated the highest rates of caries, ranging from 58.5-77.5% [1]. These rates are the highest in both sexes.

- Caries were most common among individuals aged 17-25 years [1].

- Takes 30-60 minutes to do one interproximal filling [2].

- Around 202,000 practicing dentists in the United States alone (as of 2024) [3].

**Conclusions/action items:**

**References:**

[1] M. Demirci, Safa Tuncer, and Ahmet Ayhan Yuceokur, "Prevalence of Caries on Individual Tooth Surfaces and its Distribution by Age and Gender in University Clinic Patients," *European Journal of Dentistry*, vol. 4, no. 3, p. 270, Jul. 2010, Available: <https://pmc.ncbi.nlm.nih.gov/articles/PMC2897860/>

[2] "River Family Dentistry - Gold River," *River Family Dentistry - Gold River*, Aug. 22, 2024. <https://www.riverfamilydentist.com/how-long-to-fix-a-cavity-between-teeth/> (accessed Apr. 07, 2026).

[3] "Dentist Workforce | American Dental Association," *www.ada.org*. <https://www.ada.org/resources/research/health-policy-institute/dentist-workforce>



## 09/17/2025 Current Sectional Matrix Bands on the Market

---

Tatiana Predko - Sep 17, 2025, 5:33 PM CDT

**Title:** Current Sectional Matrix Band Designs

**Date:** 09/17/2025

**Content by:** Tatiana Predko

**Present:** N/A

**Goals:** To explore the different sectional matrix designs currently on the market to gain more insight into the size, weight, aesthetics, appearance, and finish of typical sectional matrix bands for the PDS document.

**Content:**

- One brand of sectional matrices has a design called "Composi-Tight B-Series Sectional Matrix Bands". The dimensions of the bands vary by the classification; the B050 has a 3.2 mm height, 1.64 mm width, 12.57 mm length, and a 0.0015" (0.0381 mm) thickness. The B100 and B150 both have the same dimensions: 3.8 mm height, 1.54 mm width, 12.73 mm length, and a 0.0015" thickness [1].

- The typical thickness of sectional matrix bands currently on the market is 0.0381 mm, and in previous semesters, a thickness of 0.0254 - 0.0508 mm was used for the matrix band design [1]. Typically, current sectional matrices on the market have lengths between 12.57 - 14.33 mm, heights between 3.2 - 6.4 mm, and widths varying between 1.24 - 1.64 mm [1].

- The typical materials which comprise sectional matrix bands include stainless steel and PTFE [2].

**Conclusions/action items:**

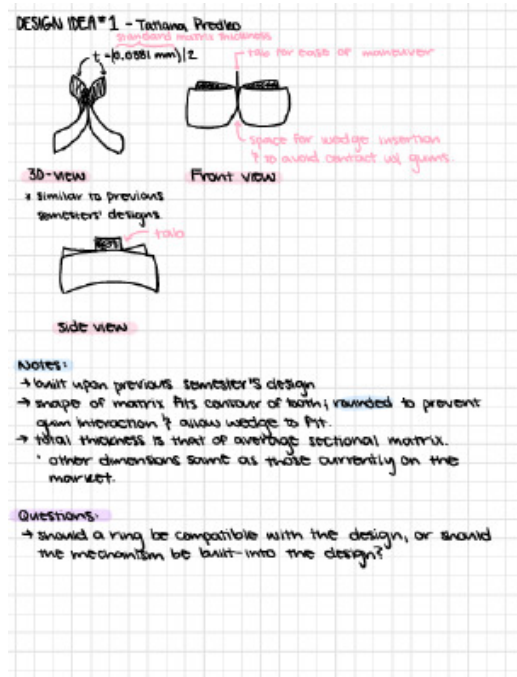
**References:**

- [1] "Composi-Tight® B-series sectional matrix bands," Garrison Dental, <https://www.garrisondental.com/products/composi-tightr-b-series-sectional-matrix-bands?srsId=AfmBOooQZOQIuIMYhS8BoJICJUWVokTabGa0t0R7I7e0M3dT2fxLu6Z4#product-details> (accessed Sep. 17, 2025).
- [2] "Strata-GTM Matrix Bands," Garrison Dental, <https://www.garrisondental.com/products/strata-gtm-matrix-bands?srsId=AfmBOorR5JSMXuJChJg-ANY6tqkNWEkMgfJcwGAIDOISdTRBD0IQrE-y#product-details> (accessed Sep. 17, 2025).



# 09/24/2025 Design Idea #1

Tatiana Predko - Sep 25, 2025, 11:57 AM CDT



[Download](#)

BME\_400.pdf (2.27 MB) Design Idea #1: "Altered Butterfly".



**Title:** CITI Training - Human Subjects Testing

**Date:** 10/21/2025

**Content by:** Tatiana Predko

**Present:** N/A

**Goals:** Complete the CITI training modules to obtain the certificate.

**Content:**



Completion Date 21-Oct-2025  
Expiration Date 21-Oct-2028  
Record ID 73104560

This is to certify that:

**Tatiana Predko**

Has completed the following CITI Program course:

**Basic/Refresher Course - Human Subjects Research**  
(Curriculum Group)  
**UW Human Subjects Protections Course**  
(Course Learner Group)  
**1 - Level 1**  
(Stage)

Not valid for renewal of certification through CME.

Under requirements set by:

**University of Wisconsin - Madison**



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**COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM)**  
**COMPLETION REPORT - PART 1 OF 2**  
**COURSEWORK REQUIREMENTS\***

\* Scores on this [Requirements Report](#) (Part 1) reflect quiz completions at the time all requirements for the course were met. The Transcript Report (Part 2) lists more recent quiz scores, including those on optional (supplemental) course elements.

- **Name:** Tatiana Predko (ID: 15004943)
- **Institution Affiliation:** University of Wisconsin - Madison (ID: 1160)
- **Institution Email:** tpredko@wisc.edu
  
- **Curriculum Group:** Basic/Refresher Course - Human Subjects Research
- **Course Learner Group:** UW Human Subjects Protections Course
- **Stage:** Stage 1 - Level 1
  
- **Record ID:** 73104560
- **Completion Date:** 21-Oct-2025
- **Expiration Date:** 21-Oct-2028
- **Minimum Passing:** 85
- **Reported Score\*:** 97

**REQUIRED AND ELECTIVE MODULES ONLY**

|  | <b>DATE COMPLETED</b> | <b>SCORE</b> |
|--|-----------------------|--------------|
| UW-Madison Human Subjects Research Infrastructure (ID: 16392)                              | 21-Oct-2025           | No Quiz      |
| Investigator Responsibilities (ID: 16391)  | 21-Oct-2025           | 4/4 (100%)   |
| Defining Research with Human Subjects - SBE (ID: 491)                                      | 21-Oct-2025           | 5/5 (100%)   |
| History and Ethical Principles - SBE (ID: 490)   | 21-Oct-2025           | 5/5 (100%)   |
| Informed Consent - SBE (ID: 504)   | 21-Oct-2025           | 5/5 (100%)   |
| Assessing Risk - SBE (ID: 503)   | 21-Oct-2025           | 5/5 (100%)   |
| Populations in Research Requiring Additional Considerations and/or Protections (ID: 16680) | 21-Oct-2025           | 4/5 (80%)    |
| University of Wisconsin - Madison (ID: 12133)  | 21-Oct-2025           | No Quiz      |
| Research with Decisionally Impaired Subjects (ID: 16610)                                   | 21-Oct-2025           | 5/5 (100%)   |
| Introduction To Community-Engaged Research (CEnR) (ID: 16994)                              | 21-Oct-2025           | 5/5 (100%)   |

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COMPLETION REPORT - PART 2 OF 2  
COURSEWORK TRANSCRIPT\*\***

\*\* Scores on this Transcript Report (Part 2) reflect the most current quiz completions, including quizzes on optional (supplemental) elements of the course. The Requirements Report (Part 1) lists the reported scores at the time all requirements for the course were met.

- **Name:** Tatiana Predko (ID: 15004943)
- **Institution Affiliation:** University of Wisconsin - Madison (ID: 1160)
- **Institution Email:** tpredko@wisc.edu
  
- **Curriculum Group:** Basic/Refresher Course - Human Subjects Research
- **Course Learner Group:** UW Human Subjects Protections Course
- **Stage:** Stage 1 - Level 1
  
- **Record ID:** 73104560
- **Current Score\*\*:** 97

| REQUIRED, ELECTIVE, AND SUPPLEMENTAL MODULES   | MOST RECENT | SCORE      |
|--|-------------|------------|
| History and Ethical Principles - SBE (ID: 490)   | 21-Oct-2025 | 5/5 (100%) |
| Defining Research with Human Subjects - SBE (ID: 491)                                      | 21-Oct-2025 | 5/5 (100%) |
| Investigator Responsibilities (ID: 16391)  | 21-Oct-2025 | 4/4 (100%) |
| UW-Madison Human Subjects Research Infrastructure (ID: 16392)                              | 21-Oct-2025 | No Quiz    |
| Assessing Risk - SBE (ID: 503)   | 21-Oct-2025 | 5/5 (100%) |
| Informed Consent - SBE (ID: 504)   | 21-Oct-2025 | 5/5 (100%) |
| Populations in Research Requiring Additional Considerations and/or Protections (ID: 16680) | 21-Oct-2025 | 4/5 (80%)  |
| Introduction To Community-Engaged Research (CEnR) (ID: 16994)                              | 21-Oct-2025 | 5/5 (100%) |
| Research with Decisionally Impaired Subjects (ID: 16610)                                   | 21-Oct-2025 | 5/5 (100%) |
| University of Wisconsin - Madison (ID: 12133)  | 21-Oct-2025 | No Quiz    |

**For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program subscribing institution identified above or have been a paid Independent Learner.**

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**Conclusions/action items:**

**Include in the notebook.**

Tatiana Predko - Feb 21, 2024, 6:05 PM CST



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**trainingproof.pdf (45.7 kB)**

Tatiana Predko - Mar 20, 2024, 10:08 PM CDT

**Title:** Biosafety and Chemical Training

**Date:** 02/07/2024

**Content by:** Tatiana Predko

**Present:** Tatiana Predko

**Goals:** Complete Biosafety and Chemical Training

**Content:**



This certifies that Tatiana Predko has completed training for the following course(s):

**Expand All**

**Collapse All**

| Course                                    | Assignment                                 | Completion | Expiration |
|---|--|------------|------------|
| 2020-21 HIPAA Privacy & Security Training | HIPAA Quiz                                 | 4/15/2021  |            |
| 2019-20 HIPAA Privacy & Security Training | HIPAA Quiz                                 | 2/18/2020  | 2/18/2021  |
| 2018-19 HIPAA Privacy & Security Training | HIPAA 2018-19 Completion Verification Quiz | 11/9/2019  | 11/9/2020  |
| Biosafety Required Training               | Biosafety Required Training Quiz           | 12/2/2019  | 12/2/2024  |
| Chemical Safety: The OSHA Lab Standard    | Final Quiz                                 | 1/24/2024  |            |

Data Last Imported: 01/28/2024 07:31 PM

**Conclusions/action items:**

1. Can utilize skills learned through Biosafety and Chemical Training in order to fabricate biomaterial.

# 10/21/2025 Training Documentation

Tatiana Predko - Oct 21, 2025, 10:36 AM CDT

**Title:** Training Documentation


**Date:** 10/21/2025

**Content by:** Tatiana Predko

**Present:** N/A

**Goals:** Complete the woodworking training to fulfill the training throughout the curriculum requirement.

**Content:**



**TATIANA PREDKO**

ID Number: 908220817  
5

Eligibility: CoE  
Students

- Profile
- Program Registrations
- Bookings
- Memberships
- Orders
- Invoices

| My Memberships                 |                  |                  |               |           |
|--------------------------------|------------------|------------------|---------------|-----------|
| Membership Type                | Start Date       | Expiry Date      | Renew         | Card Info |
| Woodshop Orientation           | Mon, Oct 20 2025 | Permanent        | Not Renewable | N/A       |
| Woodshop Orientation Eligible  | Wed, Aug 20 2025 | Wed, Dec 31 3000 | Not Renewable | N/A       |
| Shop Tools                     | Tue, Aug 20 2024 | Thu, Jan 2 3000  | Not Renewable | N/A       |
| Shop Tools                     | Thu, May 11 2023 | Wed, Jan 1 3000  | Not Renewable | N/A       |
| Machining                      | Sun, Jan 1 2023  | Permanent        | Not Renewable | N/A       |
| Machining - Training Eligible  | Sun, Jan 1 2023  | Tue, Dec 30 3000 | Not Renewable | N/A       |
| Lab Orientation                | Sun, Jan 1 2023  | Tue, Dec 30 3000 | Not Renewable | N/A       |
| Laser Cutter                   | Sun, Jan 1 2023  | Tue, Dec 30 3000 | Not Renewable | N/A       |
| Shop Tools                     | Sun, Jan 1 2023  | Tue, Dec 30 3000 | Not Renewable | N/A       |
| Shop Tools - Training Eligible | Sun, Jan 1 2023  | Tue, Dec 30 3000 | Not Renewable | N/A       |

Fig. 1. Image showing documentation of all previous training, as well as this semester's woodworking training.

**Conclusions/action items:**

**Upload this document to Canvas.**



## 10/18/2025 Woodworking Training

Tatiana Predko - Oct 19, 2025, 12:15 AM CDT

**Title:** Woodworking Training Notes

**Date:** 10/18/2025

**Content by:** Tatiana Predko

**Present:** N/A

**Goals:** Learn how to woodwork to fulfill the training throughout the curriculum requirement.

**Content:**

- Expansion: wood is hygroscopic; takes on moisture from the air, which causes expansion.
- Expansion in humid conditions and shrinking in dry conditions. More noticeable laterally/radially than longitudinally.
- Warping: due to uneven uptake of environmental moisture, or a flaw in the initial drying process.
- Anisotropy: material has different properties when measured in different directions. Wood is stronger along the grain than across it (e.g. chopping vs. splitting a log).
- Rip cut: cutting along the grain (splitting the log). Split propagates itself along the length of the fibers; fibers remain mostly intact.
- Cross cut: cutting across the grain (chopping the log). Each of the wood fibers must be severed.
- Choosing wood material: consider sustainability, hardness (different species have different hardness; better to work with soft wood as a beginner), and surprises (bugs, moisture, nails/staples, etc.- common in pallet wood).

\*softwoods come from evergreen trees (faster growing) and hardwoods come from deciduous trees (slower growing).

- Softwoods: pine and cedar.
- Softer hardwoods: cherry, walnut, oak, ash, and maple.
- Harder hardwoods: hickory, rosewood, purple heart, ebony, and padauk.

**Bandsaw:**

- Good for: all-purpose straight or curved cuts, cutting down rough lumber, and re-sawing (slicing a thicker board into 2 thinner boards).
- Bad for: precise cuts (use table saw instead), and very large pieces (use panel saw or table saw).
- Careful when workpiece is round, can get pulled down by blade.

**Miter Saw:**

- large circular blade brought down onto the workpiece by pulling down on the handle. Workpiece rests flat on the surface.
- Good for: straight or angled crosscuts (cuts that go against grain of the wood) and repeat cuts.
- Bad for: rip cuts (use table saw), and small pieces.
- Make sure workpiece is snug against the fence/table, watch out for small offcuts that could get trapped.

**Table Saw:**

- Blade rises out of the table.
- Good for: precise, repeatable, straight cuts.
- Bad for: freehand cuts, small pieces, rough/twisted/warped stock.
- Watch out for kickback (don't stand directly behind the blade, do feed the material straight into the blade, and don't have an over-constrained setup where the offcuts can't separate from the blade properly).

**Jointer:**

- Prepared rough wood for use on the other machines in the shop.
- Good for: flattening one side of stock at a time.

#### Planer:

- Takes thickness off of stock.
- Good for: making stock flat and parallel to the opposite side and taking thickness off flat stock.
- Bad for: stock that doesn't already have one flat side, and short or thin pieces.
- Don't overload the cutters with a too-aggressive depth or speed of cut.

#### Router Table:

- Good for: edge contour and cutting along a template.
- Bad for: small pieces.
- Watch out for: high cutter RPM (10,000+), exposed spinning cutter, poorly-held workpiece, and moving the router along the cut in the wrong direction (climb cutting).

#### Drum Sander:

- No blade or cutter; abrasive process.
- Good for: sanding down flat stock or workpieces, esp. things that cannot go on the planer (e.g. thin stock).
- Bad for: removing a lot of thickness (use multiple passes of planer for this).

#### Wood Lathe:

- Allows fabrication of radially symmetrical pieces (e.g. bowls or chair legs).
- Requires separate training.

#### **Conclusions/action items:**

- Attend the woodworking orientation on October 20th at 6 PM.



## 03/12/2026: Autoclave Training

---

Tatiana Predko - Mar 12, 2026, 7:05 PM CDT

**Title:** Training Throughout the Curriculum: Autoclave

**Date:** 03/12/2026

**Content by:** Tatiana Predko

**Present:** N/A

**Goals:** Complete the autoclave training Canvas course to satisfy the training throughout the curriculum requirement.

**Content:**

- Contaminated: soiled, stained or infected by contact or association with a biological substance.
- Sterilization: preventative treatment method which destroys living microorganisms.
- Disinfection: cleaning an article or some or all of the pathogenic organisms which may cause infection.
- Autoclaves kill microbes using steam heat under pressure.
- Hazards: heat, physical (electricity near water), and biological hazard.
- Pathogenic material cannot go to a landfill; must be decontaminated prior to disposal: cultures, pathogens, tissues, bodily fluids, recombinant organisms, bedding/waste from animals housed under containment, and PPE.
- Scalpels, forceps, flasks, tubes, beakers, and plates should also be autoclaved to be reused.
- Can be autoclaved: durable metal or glass laboratory supplies, such as: surgical tools, beakers, flasks, and bottles of media. Some plastics can be autoclaved if labelled autoclavable.
- If plastic melts in the autoclave, can clog drain, emit toxic fumes, and smell bad.
- Cannot autoclave: corrosives, solvents or volatiles, flammables, and radioactive materials.
- Specially-handled medical and biological waste: contaminated animal carcasses or body parts; prepare materials for pickup by bagging, freezing, then calling for pickup. Sharps should be placed in sharps container; don't need to autoclave prior to MERI bin.

Gravity or "fast exhaust" cycle: used for dry goods, glassware, etc. Charges the chamber with steam and holds it at a set pressure and temperature for a set period of time. At the end of the cycle, a valve opens and the chamber rapidly returns to atmospheric pressure. Drying time may also be added to the cycle.

Liquid or "slow exhaust": used for liquids, biohazard waste; prevents sterilized liquids from boiling. Steam is exhausted slowly at the end of the cycle, allowing the liquids (which will be super-heated) to cool.

To maximize decontamination:

- Bags should be no more than 2/3 full, partially-open bags during autoclaving, add 300 mL water to the load, at least 250-255 F temperature, minimum 60 minutes, use of vacuum cycle may be recommended by the manual.
- Steam production, penetration, and contact with load contents are essential.

After autoclaving:

- wear heat resistant gloves
- be sure steam pressure is down before opening the door
- open the door slowly, keeping head, face, and hands away from opening
- wait at least 30 seconds before reaching in or looking
- for non-liquid loads, let cool 15 minutes before touching without heat protection

- for liquid loads, let stand 1 hour before touching without heat protection
- to reduce odor and vapor emissions, autoclaved materials may be placed inside a fume hood while cooling

## Biosafety 106: Autoclave Use: Safety and Efficacy - Verification Quiz

Due No due date      Points 15      Questions 15  
 Time Limit None      Allowed Attempts Unlimited

### Instructions

Completion of this verification quiz will create a training record for your completion of this course.

There is no score requirement to pass this quiz.

[After you submit the quiz and view your score, click here to finish the course.](#)

Take the Quiz Again

### Attempt History

|        | Attempt   | Time       | Score        |
|--------|-----------|------------|--------------|
| LATEST | Attempt 1 | 26 minutes | 15 out of 15 |

Score for this attempt: **15** out of 15

Submitted Mar 12 at 7:03pm

This attempt took 26 minutes.

#### Conclusions/action items:

- Take the quiz at the end of the course.
- Submit quiz score to LabArchives.

 **Tong Lecture Notes**

Tatiana Predko - Apr 29, 2026, 9:03 PM CDT

**Title: Tong Lecture Notes****Date:** 04/29/2026**Content by:** Tatiana Predko**Present:** N/A**Goals:** Listen to Dr. Justin Williams speak about his career experience.**Content:**

- Professor Williams has experience in neuroengineering. Wanted to take damaged tissues and repair them to restore function.
- He grew up in a rural town that had a population of 91. His dad didn't want him to be a farmer due to the physical labor. Him and his brother were both in the biomedical engineering field.
- Got a mechanical engineering degree from South Dakota; worked at Daktronics. Worked on LED scoreboards because wanted to create something new.
- His friend from his track team passed away from a brain injury, so he went to Arizona to get a master's degree in biomedical engineering.
- Got a PhD.
- Started a company but failed.
- Started a company to sell research product.
- Worked at NeuroNexus.
- Bounced between companies for a while.
- NeuroOne lesson: sometimes less is more. To treat epilepsy, to avoid using drugs, use surgery to implement device into brain and monitor brain activity; this is very invasive and leaves marks on the brain. Additionally, it's a one size fits all design. He wanted to improve this process by using thin film electrodes due to their flexibility and small size; took away more material making it more flexible to conform to brain surface.
- One of his design ideas was stolen by Gray's Anatomy. Small design that unfolds in the brain uses small incision.
- Brainsync lesson: market and timing is everything. Did this experiment where they implemented electrodes into the motor cortex, made the patient move a digital block to the desired side by only using his mind. Tried the same with electrodes only on the surface. Used it for stroke rehabilitation instead. If you think about moving, could move a virtual arm that stimulates muscles and moves your arm for you. This is useful for paralyzed people.
- NeuraWorx lesson: sometimes it's personal. His dad was diagnosed with a rare neurodegenerative brain disorder. It is due to the buildup of toxic compounds in the brain. Newly discovered the Glymphatic system which eliminates toxic compounds from the brain; this process occurs while you sleep when arteries expand and contract which causes movement of fluid, clearing out toxic waste. There are many diseases associated with Glymphatic dysfunction (e.g., Alzheimers, Parkinson's, etc.). Wanted to come up with a method to activate this system. One method was vagus nerve stimulation. Can use a mouth g

**Conclusions/action items:**

- **Sometimes less is more.**
- **Market and timing is everything.**
- **Sometime's it's personal.**



## 01/30/2026 - Background on Dental Caries

---

ANYA HADIM - Apr 29, 2026, 8:00 PM CDT

**Title: Background on Dental Caries and Interproximal Cavities****Date:** 1/30/2026**Content by:** Anya Hadim**Present:** N/A**Goals:** conduct background research on dental caries and what causes interproximal cavities.**Content:**

Dental caries is one of the most prevalent chronic diseases worldwide, affecting individuals across all age groups and significantly impacting oral health and quality of life. According to the World Health Organization, untreated dental caries in permanent teeth is among the most common health conditions globally. Caries formation occurs through a multifactorial process involving bacterial metabolism of fermentable carbohydrates, leading to acid production that demineralizes enamel and dentin over time.

Interproximal cavities, which develop on the contact surfaces between adjacent teeth, present unique clinical challenges compared to occlusal or smooth surface lesions. These lesions are more difficult to detect early due to their location and often require radiographic imaging for diagnosis. As the lesion progresses, structural integrity between adjacent teeth is compromised, making restoration more complex. In Class II restorations, achieving proper proximal contact and contour is critical to prevent food impaction, maintain periodontal health, and restore natural tooth function.

Traditional restorative approaches for interproximal caries rely on matrix systems to recreate the natural tooth anatomy during composite placement. However, conventional matrix bands are typically designed to restore one surface at a time, which can increase procedure time and introduce variability in contact formation. In cases where adjacent teeth both present with interproximal lesions, clinicians must repeat the process sequentially, leading to inefficiencies in workflow. These limitations highlight the need for improved matrix systems, such as dual-surface or modified designs, that can enable simultaneous restoration while maintaining proper contact geometry and clinical performance.

[1] World Health Organization, "Oral health," 2023. [Online]. Available: <https://www.who.int/news-room/fact-sheets/detail/oral-health>

[2] National Institute of Dental and Craniofacial Research, "Dental caries (tooth decay) in adults," 2022. [Online]. Available: <https://www.nidcr.nih.gov/research/data-statistics/dental-caries>

[3] S. Selwitz, A. Ismail, and N. Pitts, "Dental caries," *The Lancet*, vol. 369, no. 9555, pp. 51–59, 2007.

[4] J. O. Summitt, J. W. Robbins, and R. S. Schwartz, *Fundamentals of Operative Dentistry: A Contemporary Approach*, 4th ed. Chicago, IL, USA: Quintessence Publishing, 2013.

[5] F. J. Burke and W. Cheung, "Current concepts in the management of dental caries and restorative treatment," *Dental Update*, vol. 40, no. 3, pp. 199–210, 2013.

**Conclusions/action items:**

Dental caries can form easily in an interproximal way from food lodging between the teeth and bacterial spread from one tooth to the other. These are very common and so our product has a large demand in the dental healthcare field.



## 2/10/2026 - Materials Research

---

ANYA HADIM - Apr 29, 2026, 7:53 PM CDT

**Title: Materials Research****Date:** 2/10/2026**Content by:** Anya**Present:** Anya**Goals:** Conduct research on other materials feasible for the project**Content:**

Titanium:

- superior corrosion resistance because of high oxidation
- bioinert, tissues heal in close opposition to this implant and do not build large fibrous capsules (will not cause oral irritation)
- reduces stress shielding in orthopedic applications
- light weight and high strength, low modulus, very biocompatible
- used commonly for dental implants
- beta type Ti alloys have better cold forming capabilities which decreases the processing cost

Titanium Alloy (Nitinol)

- possesses shape memory properties due to two different temperature dependent crystal structures
- Martensite crystalline structure (low temp phase): soft and ductile
- Austenite (high temp phase): hard and stiff
- temperature of the transition is dependent on variations in the alloy composition and in different phases the material has different properties
- we could get a nitinol that changes phase once it feels the body temperature inside of the mouth

too crazy of an idea?

Brass (Dr. Williams recommendation):

- not typically used for clinical applications
- can be used as proof of concept more so since he knows that it will work well with the laser cutter

**Conclusions/action items:**

Use this materials research to determine material of best fit for our project.



## 3/10/2026 - Background on Dental Fillings

ANYA HADIM - Apr 29, 2026, 8:02 PM CDT

**Title:** Background on Dental Fillings

**Date:** 4/29/2026

**Content by:** Anya

**Present:** Anya

**Goals:** conduct background research on dental fillings to understand how they proceed

**Content:**

Dental fillings are used to restore teeth after removal of decayed tissue caused by caries

Primary goals:

Restore structural integrity of the tooth

Re-establish function (chewing, load-bearing)

Prevent further bacterial infiltration via proper sealing

Evolution of materials:

Amalgam (historically dominant): strong, durable, but poor aesthetics

Composite resins (current standard):

Tooth-colored → improved aesthetics

Adhesively bond to enamel and dentin

Allow more conservative cavity preparation

Composite filling process:

Caries removal → cavity preparation

Etching, priming, bonding agent application

Incremental placement of composite resin

Polymerization using blue light (visible light curing)

Final shaping and polishing

Key advantages of composite materials:

Adhesion reduces need for mechanical retention

Better stress distribution across tooth structure

Improved marginal seal compared to older methods

Clinical challenges (especially relevant to your project):

Technique-sensitive procedure (moisture control, layering, curing)

Polymerization shrinkage → can lead to gaps or stress at margins

Achieving proper anatomical contour is operator-dependent

Class II (interproximal) restorations:

Require reconstruction of contact between adjacent teeth

Critical for:

Preventing food impaction

Maintaining periodontal health

Preserving natural tooth alignment

Role of matrix systems:

Provide temporary wall for shaping composite material

Used with wedges and clamps to:

Seal gingival margin

Create proper contact and contour

Limitation: typically restore one surface at a time

Relevance to project:

Restoring adjacent interproximal cavities requires repeated steps

Leads to increased procedure time and inefficiency

Variability in contact strength and geometry

→ Justifies need for improved matrix designs (e.g., dual-surface systems)

[1] American Dental Association, "Dental fillings," 2023. [Online]. Available: <https://www.ada.org/resources/ada-library/oral-health-topics/dental-fillings>

[2] National Institute of Dental and Craniofacial Research, "Restorative dental materials," 2022. [Online]. Available: <https://www.nidcr.nih.gov>

[3] J. O. Summitt, J. W. Robbins, and R. S. Schwartz, *Fundamentals of Operative Dentistry: A Contemporary Approach*, 4th ed. Chicago, IL, USA: Quintessence Publishing, 2013.

[4] R. Sakaguchi and J. Powers, *Craig's Restorative Dental Materials*, 14th ed. St. Louis, MO, USA: Elsevier, 2019.

**Conclusions/action items:**

Use this knowledge to form a prototype that won't affect standard filling procedures.



## 2/14/2026 - Competing Designs

ANYA HADIM - Apr 29, 2026, 8:04 PM CDT

### Title: Competing Designs

Date: 2/16/2026

Content by: Anya

Present: Anya

Goals: Research competing designs to understand what is currently in the market

### Content:

Modern Class II restorations commonly use sectional matrix systems instead of traditional circumferential bands

Designed to improve proximal contact formation and anatomical contour

Especially important for composite restorations (vs amalgam)

Example system: Halo Sectional Matrix System

Consists of:

Pre-contoured sectional matrix band

Separation ring (applies force to teeth)

Wedge (seals gingival margin and stabilizes band)

Key design features of sectional matrices:

Pre-contoured bands → mimic natural tooth curvature

Separation rings → slightly separate teeth to compensate for matrix thickness

Improved contact tightness compared to flat matrix systems

Advantages over traditional matrix systems:

More accurate proximal contact formation

Better anatomical contour and emergence profile

Reduced finishing and post-processing time

Increased clinical predictability

Other competing sectional systems (similar concept):

Palodent Plus Sectional Matrix System

V3 Sectional Matrix System

Composi-Tight 3D Fusion Matrix System

Common limitations across existing systems:

Designed for single-tooth (single-surface) restoration

When two adjacent teeth require fillings:

Matrix must be placed, filled, removed → then repeated

Increases total procedure time

Adds complexity to workflow

Technique limitations:

Requires precise placement of band, wedge, and ring

Improper positioning → open contacts or overhangs

Ring stability can be affected in tight or irregular anatomies

Clinical challenges still present:

Achieving consistent contact strength across cases

Maintaining band stability during composite placement

Difficulty in simultaneous multi-tooth restorations

Relevance to project:

Current systems optimize quality of single restorations, not efficiency

No widely adopted system enables simultaneous dual interproximal restorations

Opportunity:

Reduce procedure time

Improve workflow efficiency

Maintain or improve contact accuracy

[1] Ultradent Products Inc., "Halo Sectional Matrix System," 2023. [Online]. Available: <https://www.ultradent.com>

[2] Dentsply Sirona, "Palodent Plus Sectional Matrix System," 2023. [Online]. Available: <https://www.dentsplysirona.com>

[3] Triodent, "V3 Sectional Matrix System," 2023. [Online]. Available: <https://www.triodent.com>

[4] Garrison Dental Solutions, "Composi-Tight 3D Fusion Matrix System," 2023. [Online]. Available: <https://www.garrisdental.com>

[5] D. Loomans and N. Opdam, "A guide to matrix systems for direct Class II restorations," *Dental Materials*, vol. 34, no. 1, pp. 12–22, 2018.

**Conclusions/action items:**

Our product needs to mimic exactly what already exists and works but it must also fulfill its role to fill both caries at the same time.



## Laser cutting warping solutions

---

ANYA HADIM - Mar 02, 2026, 9:18 PM CST

**Title:** Laser cutting materials ideas

**Date:** 3/2/2026

**Content by:** Anya

**Present:** Anya

**Goals:** brainstorm design ideas to fix the heating and warping issues with the stainless steel while laser cutting

**Content:**

sandwich stainless steel metal:

-we can reinforce the steel and sandwich it between thing MDF/HDF, or masking film, leaving a cut window for the laser path. We could also tape it to a flat sacrificial backing plate. The goal here is to maximize surface contact, improve heat conduction, and reduce distortion

use a heat sink plate:

-we could put the foil on thick aluminum plate or a copper plate (best thermal conductivity). These would hopefully pull heat away and result in less of a thermal gradient reducing the warping on the stainless steel.

**Conclusions/action items:**

Bring these ideas up to Dr. Williams during our meeting and see what he thinks. Schedule a design consultation meeting with Jesse at the design lab.



## Tong lecture notes

---

ANYA HADIM - Mar 06, 2026, 2:42 PM CST

**Title:** Tong Lecture

**Date:** 3/6/2026

**Content by:** Anya Hadim

**Present:** Anya Hadim

**Goals:** learn about imagination and implantation from lecturer Justin Williams

**Content:**

Dr. William's shared his extremely impressive goals in the field of neuroimaging and neuroscience. It was very inspiring to learn about the numerous advancements he contributed to in the field as well as how it is evolving.

**Conclusions/action items:**

Use Dr Williams work and advice to inspire my future career.



## 2014/11/03-Entry guidelines

---

John Puccinelli - Sep 05, 2016, 1:18 PM CDT

Use this as a guide for every entry

- Every text entry of your notebook should have the **bold titles** below.
- Every page/entry should be **named starting with the date** of the entry's first creation/activity, subsequent material from future dates can be added later.

You can create a copy of the blank template by first opening the desired folder, clicking on "New", selecting "Copy Existing Page...", and then select "2014/11/03-Template")

**Title:** Descriptive title (i.e. Client Meeting)

**Date:** 9/5/2016

**Content by:** The one person who wrote the content

**Present:** Names of those present if more than just you (not necessary for individual work)

**Goals:** Establish clear goals for all text entries (meetings, individual work, etc.).

**Content:**

Contains clear and organized notes (also includes any references used)

**Conclusions/action items:**

Recap only the most significant findings and/or action items resulting from the entry.



# 2014/11/03-Template

---

John Puccinelli - Nov 03, 2014, 3:20 PM CST

**Title:**

**Date:**

**Content by:**

**Present:**

**Goals:**

**Content:**

**Conclusions/action items:**



BME Design-Fall 2025 - Roshan Patel  
Complete Notebook

PDF Version generated by  
Roshan Patel  
on  
Jan 23, 2026 09:11:12 PM CST

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