BME Design-Spring 2022 - TARA BOROUMAND
Complete Notebook

PDF Version generated by

MATTHEW FANG (mjfang@wisc.edu)

on

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Table of Contents

Team contact Information

DRAESON MARCOUX (dmarcoux@wisc.edu) - Mar 02, 2022, 3:56 PM CST

Last Name	First Name	Role	E-mail	Phone	Office Room/Building
Puccinelli	Tracy	Advisor	tjpuccinelli@bme.wisc.edu		
Tipple	Donald	Client	donaldtipple@nakomadental.com		
Boroumand	Tara	Leader	tboroumand@wisc.edu	630-441-3407	
Fang	Matt	Communicator	mjfang@wisc.edu	847-915-9860	
Fang	Matt	BSAC			
Marcoux	Draeson	BWIG	dmarcoux@wisc.edu	715-828-9765	
Silber	Trevor	BPAG	tjsilber@wisc.edu	262-744-1426	

Project description

DRAESON MARCOUX (dmarcoux@wisc.edu) - Mar 02, 2022, 3:58 PM CST

Course Number: BME 402

Project Name: Approximating Surface Matrix Band for Dentist to use for Patients

Short Name: Dental Matrix Band

Project description/problem statement:

Matrix bands are a commonly used dental tool which assist dentists by creating an outside contour of a decayed tooth. They provide support, shape and contour for replacement filling material while protecting surrounding tissues. During typical filling procedures for cavities on interproximal surfaces, or two adjacent teeth, dentists must fill each tooth separately. This is a tedious procedure as each matrix band must be prepared for each tooth, which includes shaping, placement and securing with dental wedges and rings. These must be done one after another because two matrix bands cannot fit in the interproximal space as together they are too wide and would create gaps in the restoration. A new dental matrix band design is desired to alleviate the need to repeatedly place bands. The device should employ a dual-band system with a thickness less than or equivalent to current matrix bands throughout such that the fit is secure and the band molds to the appropriate convex/concave contour of each tooth. The finalized product should also maintain the tensile strength, malleability, and space efficiency of current matrix bands. The material used to fabricate the matrix band must not cause any irritation, must be biocompatible, and must be non-reactive to filling materials.

About the client:

Dr. Donald Tipple is a dentist and the sole owner of Nakoma Dental in Madison, WI. He has over 30 years of experience as a dental practitioner, specializing in preventative care and restorative solutions.

Client Meeting 2/1/2022

DRAESON MARCOUX (dmarcoux@wisc.edu) - Mar 02, 2022, 11:50 AM CST

Title: Client Meeting 1

Date: 2/1/2022

Content by: Matthew Fang

Present: All

Goals: Determine client expectations for this semester

Content:

- Wall welded together
  - Only enough room for wedge
- Wedge compresses gum away from "forcefield"
- Possibly a bit flimsy
- Force between teeth so you can get "floss snapping"
- Bonding agents
  - Primers
  - Cyanoacrylate (spelling?)
- Ask questions for national dental association
- Only touches at a small amount (size 12 font o)
- Convex wings if possible
  - Could remove tab? (pull through instead of up)

Conclusions/action items:

Take feedback from design and last semester's rough prototypes and make modification.

Client Meeting 3/29/2022

MATTHEW FANG (mjfang@wisc.edu) - Mar 29, 2022, 6:06 PM CDT

Title: Client Meeting

Date: 3/29/2022

Content by: Matthew Fang

Present: everyone

Goals: Get Dr. Tipple's opinion on our prototype and changes that should be made to material, design, adhesive, etc.

Content:

- Now uses sectional
- Feet of clamp is pointed towards itself
  - Silicone and wall in between
- Connect at the bottom also
  - May not be able to use wedge
  - Need clamp to act as a wedge in this situation
- Too stiff
- Amount of wings can be shorter
  - Half of that
- Maybe no adhesive
  - Not sure if it helps the way we thought with the contact point
  - Client is confused about that
- Liked variety of size
- Need to look at contact point

Conclusions/action items:

2022/1/28 - Advisor Meeting 1

DRAESON MARCOUX (dmarcoux@wisc.edu) - Mar 02, 2022, 11:17 AM CST

Title: Advisor Meeting 1

Date: January 28, 2021

Content by: Team

Present: Team and Advisor, Dr. Puccinelli

Goals: Reestablish where the team left off last semester, lay the plan for the first few weeks, and touch on the big goals for the semester.

Content:

- Left off with very rough prototype fabricated from our desired material
- Would like to fabricate a higher quality model, but still must decide on a method of fabrication
    - Laser cutter (Electrical Engineering resource)
    - waterjet
    - Still looking at 3rd Party manufacturing
- Speak with former advisor for assistance
- Still must figure out how to bond the folded parts of the design
- Will be submitting an article to a journal for final report

Conclusions/action items:

Contact companies and electrical engineering contact regarding manufacturing as soon as possible. The first step is to get a higher quality model in hand so qualitative testing will be possible later in the semester. Should we have issues with early models, we can revise and re-fabricate. Research on how to bond the metal can be done concurrently.

2022/2/04 - Advisor Meeting 2

DRAESON MARCOUX (dmarcoux@wisc.edu) - Mar 02, 2022, 11:23 AM CST

Title: Advisor Meeting 2

Date: February 4, 2022

Content by: Team

Present: Team and Advisor, Dr. Puccinelli

Goals: Update Dr. Puccinelli on progress toward fabrication and the meeting we had with our client

Content:

1. Difficulties with Fabrication
    1. Speak with professor Williams about potential ideas. Be specific with questions to him
    2. Purchase an epoxy (not medical grade) to play around with bonding the metals together
    3. We need to find a fabricator for the design, using our metal (dead-soft steel), that can fabricate on the scale of our design. Look 3rd party as electrical engineering laser cutter is unable to cut such thin metal.
    4. Could still look at producing a die (punch) in the MakerSpace
2. Journal Article Submission
    1. Look for an impact factor below 6 to ensure it wont be nearly impossible to get article accepted
    2. Should be relevant to our project (dental field probably)
    3. Follow the Journal's author guidlines
3. Client Meeting
    1. Need to bond about 70 percent of the height
    2. He wanted a concave/convex overall shape, but we believe a molding process is required so that is not a main focus right now
    3. We should still have a decent budget (a few hundred dollars) but if fabrication from a 3rd party is quoted to be fairly expensive we may want to speak with him again

Conclusions/action items:

Continue to figure out the best method of fabrication and submit a quote to a company that might be able to fabricate at our specifications. Look for a journal that we plan to submit our final design article to that publishes similar content.

2022/02/18 - Advisor Meeting 3

DRAESON MARCOUX (dmarcoux@wisc.edu) - Mar 02, 2022, 11:40 AM CST

Title: Advisor Meeting 3

Date: February 18, 2022

Content by: Team

Present: Team & Dr. Puccinelli

Goals: Receive feedback from preliminary report last week, update Dr. Puccinelli on our newly, laser cut, prototype, and discuss work moving forward.

Content:

- Continue pursuing fabricating iterations of the model with Sector67
    - Make multiple DLX files to be approved before use on the laser cutter
    - Get in to training so we can produce our prototypes by ourselves in Sector67
- Look into using a microscope to analyze the jaggedness of the edges of the model
- Include more on competing design and more details on our design in the final presentation
    - add blurb on Dr. Tipple as well
- Be concise on the IDR, a paragraph or 2 should be enough for most sections
    - Incorporate "dental" in the title for WARF
    - could also do dental matrix band - ... whatever we'd like...

Conclusions/action items:

Continue to modify and improve the CAD file so multiple variants can be laser cut and some of our team can get trained on how to use the laser cutter at Sector67 to expedite the fabrication process. Keep in mind feedback from preliminary presentation when creating the final presentation later in the semester. Complete IDR to be submitted to WARF.

2022/02/24 - Advisor Meeting 4

DRAESON MARCOUX (dmarcoux@wisc.edu) - Mar 02, 2022, 11:48 AM CST

Title: Advisor Meeting 4

Date: February 24, 2022

Content by: Team

Present: Team & Dr. Puccinelli

Goals: Ask any questions we have about the preliminary deliverables and fabrication using the epoxy we've ordered

Content:

- Use scale where high numbers are positive (strongly agree) and low numbers are areas we need to improve on (strongly disagree). Statistical analysis can then be done on this
- Introduction, materials and methods, and a clear, detailed description of the testing should be included in the preliminary deliverables. Everything else will be an outline and future work
- Detail and justify the use and viability of metals based on materials properties and how they would function in practice
- Look at the style of writing within the journal and attempt to adhere to that as closely as possible!!
- Appendix should be last semesters final report without parts that are already incorporated in the main body of the journal article (concise summary)
- When using the epoxy: try to get a 1:1 ratio, paper clip the design, and place remaining epoxy in a ziplock. Leave it for a couple days to ensure it is set.

Conclusions/action items:

Finish the preliminary deliverables/rough draft of our article. Meet with the team as soon as possible to get hands on with the laser cut prototype and assess the viability of the epoxy as a method of bonding.

2022/03/04 - Advisor Meeting 5

TREVOR SILBER - May 08, 2022, 12:29 PM CDT

Title: Advisor Meeting 5

Date: March 4, 2022

Content by: Team

Present: Team & Advisor, Dr. Puccinelli

Goals: To update our advisor on how the rough draft of our article went, ask questions we have, and discuss what our plans are regarding design, manufacturing and testing moving forward.

Content:

- Matt and Tara were at Sector67 laser cutting multiple models from the approved DXF file. The initial cuts were too large so they're working on scaling them down.
- Get video of Dr. Tipple actually handling the prototype and testing it on his mouth model
- Look for a journal with guidelines that better fit the scope of this project
- Email Dr. Tipple about meeting to handle and give feedback on what we have thus far

Conclusions/action items:

Reach out to Dr. Tipple in order to set up a meeting time to drop off prototype, but first the team needs to finish making the prototype by getting together and using the recently bought adhesive to stick both sides of the band together. Also the team should continue to do journal research to see which journal will be used for the final journal.

2022/03/11 - Advisor Meeting 6

TREVOR SILBER - May 08, 2022, 12:34 PM CDT

Title: Advisor Meeting 6

Date: March 11, 2022

Content by: Team

Present: Team & Advisor, Dr. Puccinelli

Goals: To update Dr. Puccinelli on our epoxy preliminary experimentation and discuss our plans regarding materials and fabrication moving forward. Also to receive feedback on our preliminary deliverables.

Content:

- Feedback for preliminary notebook and report
    - Make sure we get at least 1 entry per person and for the team every week
    - Email Dr. Puccinelli the outline and requirements for our new specific article and a copy of our report in google doc and allow editing permissions (email to her student email)
    - Make sure we have a materials section and detailed protocol for fabrication in the journal article (depending on requirements) and in the notebook
    - Do not include a summary of the conclusion in the introduction
- Executive summary and desired award will be something we'll have to think about soon after break
- With regard to the material used in most matrix bands, are they magnetic like the 1008/1010 steel that we have?
- Do epoxy testing in a fume hood or outside for future reference
- Look into using short, stiff paint brushes for applying epoxy in a thin layer
- Still can look into experimenting with a small spot weld

Conclusions/action items:

Each team member should continue to work on LabArchives entries and look into which award the team should pursue at the end of the semester. Upon returning from break the team should look into new epoxy methods and perform some initial tests to see how the epoxy holds together after it has fully dried.

2022/03/25 - Advisor Meeting 7

TARA BOROUMAND - May 08, 2022, 3:10 PM CDT

Title: Advisor Meeting 7

Date: March 25, 2022

Content by: Team

Present: Team & Advisor, Dr. Puccinelli

Goals: Update Dr. Puccinelli on work done in past couple weeks

Content:

- Generally nickel allergy requires prolonged contact to cause a reaction so it may still be viable in a material for our application but we're still waiting to get it cleared by Dr. Tipple
- WARF IDR meeting on Microsoft teams will happen in the next couple weeks
    - Make sure that Dr. Tipple is aware of IDR and included in it
    - Also include Grace
    - Be prepared, have notebooks handy
    - They will want to know specifics: market, testing data, fabrication protocol, novelty, etc. Generally why it is distinct and should be patented separately from other bands (design form factor)
- Next week is required Tong lecture (might be in person or virtual) so we will have to reschedule meeting (15 min)
    - 11:30 on Thursday in person right outside Dr. Puccinelli's office (2158 ECB). Bring materials
- Executive summary draft is due April 8th
    - Use subtitles if there is room
    - Design excellence vs Tong award - make a decision soon
    - Mostly about selling it to the judges based on award criteria
- Try to take other matrix bands and attempt to bond those together like we are with our material

Conclusions/action items:

Order material soon so there is sufficient time to perform quantitative and qualitative testing with prototypes.

2022/03/31 - Advisor Meeting 8

TREVOR SILBER - May 08, 2022, 9:56 PM CDT

Title: Advisor Meeting 7

Date: March 31, 2022

Content by: Team

Present: Team & Advisor, Dr. Puccinelli

Goals: Update Dr. Puccinelli on conversation with Dr. Tipple and talk about executive summary

Content:

Updated Dr. P about the conversation we had with Dr. Tipple

Some informal testing was done by Dr. Tipple on a few mouth models

Mr. Dr. P thinks using the larger clamps for MTS testing would help to match the properties of existing matrix bands with our material

Draft of the Executive Summary is due next week Friday

Decide which award: probably would fit for the Tong as we have a prototype

Will need more data from Dr. Tipple, maybe from MTS as well

Show iteration

Tong is in person but will also be posted online for those who can’t make it

Conclusions/action items:

Discuss further about design award. Begin working on the executive summary draft and try to include qualitative data from Dr. Tipple and quantitative data from MTS testing.

2022/04/08 - Advisor Meeting 9

TREVOR SILBER - May 08, 2022, 10:00 PM CDT

Title: Advisor Meeting 8

Date: 4/8/22

Content by: Team

Present: Team & Advisor, Dr. Puccinelli

Goals: Update Dr. Puccinelli on work done from this week

Content:

- Ordered new 316 Stainless Steel material that will arrive on 4/10
- Matt picked up tofflemire bands and wedges from Dr. Tipple
- Presented the new materials we got from Tipple
- Asked questions on the executive summary
    - Length requirements
    - Using sources for talking about specific sections
        - (use author/year)
- Meeting next week at Friday
    - 2 weeks on Wed at 9:00 am
- Add section for marketability on the poster

Conclusions/action items:

Figure out time for finals week meeting. Gather data to include in the executive summary and make sure to emphasize the positives (such as the large market). Begin to do fabrication and testing on new material when it arrives.

2022/04/15 - Advisor Meeting 10

TREVOR SILBER - May 08, 2022, 10:06 PM CDT

Title: Advisor Meeting 8

Date: 4/15/22

Content by: Team

Present: Team & Advisor, Dr. Puccinelli

Goals: Update Dr. Puccinelli on work done from this week

Content:

- Dr. J Puccinelli was able to get 2 good runs with our new material and sent the data to Tara along

with a rough protocol. Data from this testing would be good to include in the executive summary

- Put titles and names and such in a header for the executive summary to save space

— First few sentences could be condensed into one smoother sentence

— A couple sentences here and there that could just be eliminated

— Consolidate 2 paragraphs in which we talk about our design

— Replace sentence about testing with results (“preliminary testing” unless we can get 3 test runs

with each sample)

—- ANOVA test to find any significant difference or not - material we are using is comparable to

existing material

— If material is dissimilar it will skew qualitative testing

- Demo showing plastic deformation of different materials is good

•- Run our qualitative testing protocols and criteria by Dr T Puccinelli before performing tests

— Include how often they use bands, and a scale for scoring with low numbers being unfavorable and high numbers more favorable

— Think about the PDS in determining functional criteria

- Look into loctite adhesives based on material

Conclusions/action items:

Compete and submit executive summary. Continue to perform material testing and pursue qualitative testing as soon as possible. Fabricate more precise prototypes to distribute for qualitative testing. Begin working on poster presentation for review.

2022/04/20 - Advisor Meeting 11

TARA BOROUMAND - May 08, 2022, 11:30 PM CDT

Title: Advisor Meeting 8

Date: 4/20/22

Content by: Team

Present: Team & Advisor, Dr. Puccinelli

Goals: Update Dr. Puccinelli on work done from this week and plans for the final week of the semester.

Content:

- Detail future work in appendices, but should be fairly concise in the poster and journal article

- More detail in explaining each score on the scale from 1-5 where 1 is the worst score and 5 is the best score, will be easier to add up in the end

- Make sure questions are easy to score on our scale, not just open ended

- Respond to warf email about how our design is different/novel/unique

- Talk about prevalence and market in first paragraph, then split what the matrix bands are, and the procedure into respective paragraphs

- Identify themes in qualitative testing and open comments (world clouds, repeated words, similar words, etc)

Conclusions/action items:

Change the current survey to follow consistent language, with statements the dentist can agree or disagree with. For example, a score of 1 would be strongly disagree and 5 would be strongly agree. The statements should all be positive, meaning a score of 5 would be most favorable. Create this survey and send out for qualitative asessment.

2022/02/15- Updates from Fall 2021 Design

TARA BOROUMAND - Mar 02, 2022, 11:06 AM CST

Title: Updates from Fall 2021 Design

Date: 02/15/2022

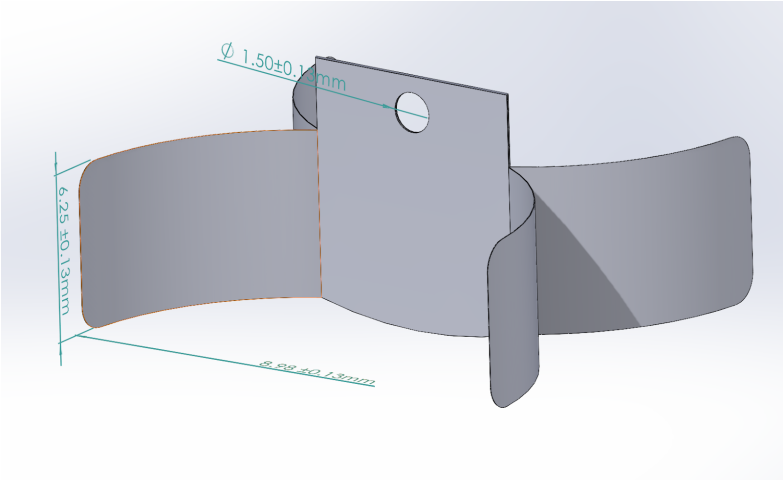
Content by: Team

Present: N/A

Goals: To emphasize changes made to the design since the final report of Fall 2021 semester.

Content:

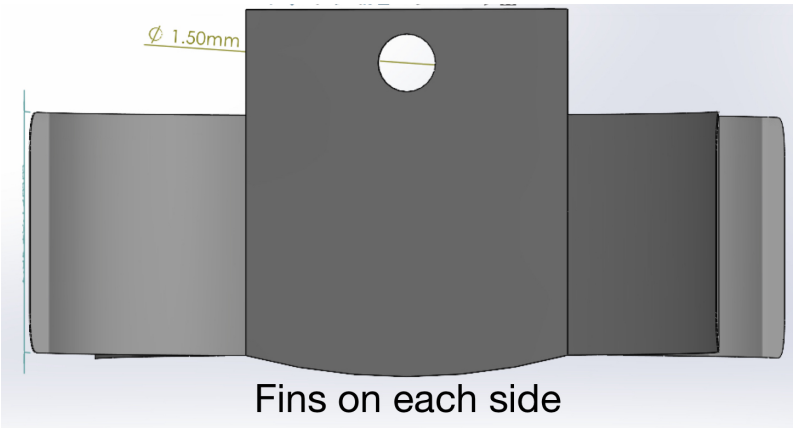
Fall 2021 Final Design:



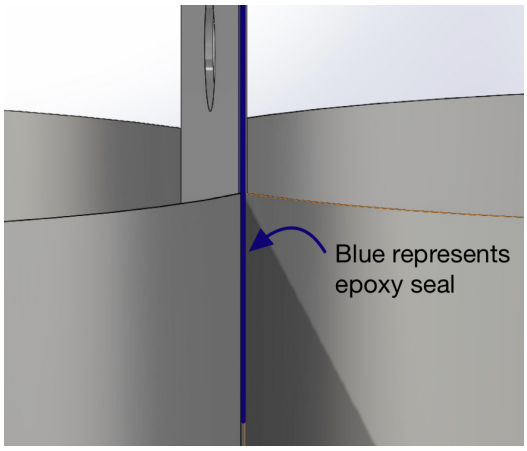
- Please refer to the Fall 2021 notebook that is attached at the end of this one for further details regarding this design and its features

Modifications:

- Addition of "fins"
  - This is the convex bottom that allows for the proper tooth contour throughout the tooth and prevents gingival overhanging. It was requested by the client and is shown below.



- Bonding of upper 70% of proximal space
  - Permatex 84109 PermaPoxy 4 Minute Multi-Metal Epoxy
  - This bonding will ensure proper tooth contact. Ideally the epoxy should properly seal the two while contributing minimal thickness. Testing is necessary to determine this.
  - A visual of where this bonding would go is shown below



- Variety of sizes - 5mm, 6mm, 7mm

Conclusions/action items:

Test epoxy, and outsource design for manufacturing.

2022/04/07- WARF Meeting

TARA BOROUMAND - Apr 07, 2022, 3:49 PM CDT

Title: WARF Meeting

Date: 4/7/22

Content by: Tara

Present: Trevor

Goals: Discuss meeting for patent

Content:

- This initial meeting is to see if we will be moving forward for a second meeting with a patent attorney
    - Hear back within a day
- Asked about the overall design, company that we would potential market to (Triodent)
- He will spend time looking through patent literature to see if there is anything that looks similar
    - if so, will send and we can identify if it is similar or if there are key differences
- Asked about other teams and what they would do
- A lot of these ideas would need more refinement
- We have 1 year grace period to apply for patent after presentation

Conclusions/action items:

Wait to hear back regarding similar patents

Final Design Flat

MATTHEW FANG (mjfang@wisc.edu) - May 08, 2022, 1:38 PM CDT

Title: Final Flat Design

Date:

Content by:

Present:

Goals:

Content:

Conclusions/action items:

MATTHEW FANG (mjfang@wisc.edu) - May 08, 2022, 1:38 PM CDT

Download

Matrix_Band_Flatv_SmallerWing.SLDDRW (139 kB)

2022/03/01- Preliminary Expense Sheet

TARA BOROUMAND - Mar 02, 2022, 1:56 PM CST

Title: Preliminary Expense Sheet

Date: 3/01/22

Content by: Team

Present: N/A

Goals: Document expenses for project thus far and this semester.

Content:

Fall Semester:

Item	Supplier / Brand	UPC / Item Number	Link	Quantity	Date	Price
Dental Implant Teeth Model Study Teach Standard Model with Removable Teeth	Amazon / Smile1000	UPC: 601263927587	https://www.amazon.com/dp/B071JVJ1LG/ref=cm_sw_r_sms_api_glt_fabc_BZN7G1DC333NTE4CCJVE	1	10/20/21	$28.42
Steel Shim Stock Roll, 1008-1010 Grade, 0.001 in Thickness, +/-0.0001 in Thickness Tolerance	Grainger	Item Number: 3L432	https://www.grainger.com/product/PRECISION-BRAND-Steel-Shim-Stock-Roll-3L432?opr=PDPRRDSP&analytics=dsrrItems_5EY10	1	11/21/21	$35.96
Permatex 84109 PermaPoxy 4 Minute Multi-Metal Epoxy, 0.84 oz	Amazon	UPC: 8622684109	https://www.amazon.com/dp/B000ALDXV2/ref=cm_sw_r_sms_api_glt_i_GVTR56HW6JCMF75DXPMF?_encoding=UTF8&psc=1	1	2/24/2022	$8.11
				Semester 1	Total	$64.38
				Semester 2	Total	$8.11

Spring Semester:

Item	Supplier / Brand	UPC / Item Number	Link	Quantity	Date	Price
Permatex 84109 PermaPoxy 4 Minute Multi-Metal Epoxy	Permatex Store	84109	https://www.amazon.com/dp/B000ALDXV2/ref=cm_sw_r_sms_api_glt_i_6Y8GXPW52WYTC8JJPZDS	1	2/28/22	$7.95

Conclusions/action items:

Update costs to preliminary report.

2022/05/08- Final Expense Sheet

TREVOR SILBER - May 08, 2022, 8:14 PM CDT

Title: Final Expense Sheet

Date: 5/08/22

Content by: Team

Present: N/A

Goals: Document expenses for project thus far and this semester.

Content:

Item	Supplier / Brand	UPC / Item Number	Link	Quantity	Date	Price
Dental Implant Teeth Model Study Teach Standard Model with Removable Teeth	Amazon / Smile1000	UPC: 601263927587	https://www.amazon.com/dp/B071JVJ1LG/ref=cm_sw_r_sms_api_glt_fabc_BZN7G1DC333NTE4CCJVE	1	10/20/21	$28.42
Steel Shim Stock Roll, 1008-1010 Grade, 0.001 in Thickness, +/-0.0001 in Thickness Tolerance	Grainger	Item Number: 3L432	https://www.grainger.com/product/PRECISION-BRAND-Steel-Shim-Stock-Roll-3L432?opr=PDPRRDSP&analytics=dsrrItems_5EY10	1	11/21/21	$35.96
Permatex 84109 PermaPoxy 4 Minute Multi-Metal Epoxy, 0.84 oz	Amazon	UPC: 8622684109	https://www.amazon.com/dp/B000ALDXV2/ref=cm_sw_r_sms_api_glt_i_GVTR56HW6JCMF75DXPMF?_encoding=UTF8&psc=1	1	2/24/2022	$8.11
316 Stainless Steel Shim Stock, 8” x 12” Sheet, 0.001” Thick	McMaster - Carr	Item Number: 2317K51	https://www.mcmaster.com/2317K51/	1	4/9/22	$19.99
				Semester 1	Total	$64.38
				Semester 2	Total	$28.10

Conclusions/action items:

Submit expense report to Dr. Tipple for reimbursement.

2022/03/01- Current Prototype Plans

TARA BOROUMAND - Mar 02, 2022, 11:00 AM CST

Title: Current Prototype Plans

Date: 3/1/22

Content by: Team

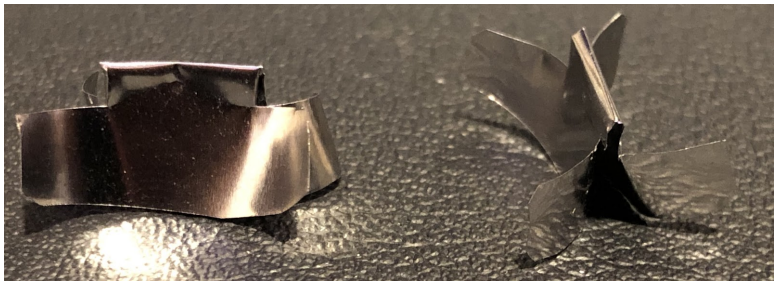
Present: N/A

Goals: To lay out current plans for prototype to summarize in journal

Content:

Team's Fabrication:

- The final prototype was fabricated out of the 2540 mm long by 152.4 mm wide by 0.0254 mm thick shim stock made from 1008-1010 Grade Stainless Steel.



The above is clearly not a functional prototype which is why outsourcing is required for fabrication.

Prototype:

- Prototyping for qualitative testing will be outsourced to Sector67 for dimensional accuracy
- Epoxy: Permatex 84109 PermaPoxy 4 Minute Multi-Metal Epoxy
    - the team still plans on testing this epoxy
        - this will be immediate future work after submission of the preliminary deliverables
- Check the design process folder for updates on the design since the previous Fall 2021 notebook.

Conclusions/action items:

Discuss the qualitative testing that will be done on this design and create an official protocol for such.

Sector 67 Laser Cutting

2022/05/01- Current Prototype Plans

MATTHEW FANG (mjfang@wisc.edu) - May 08, 2022, 9:00 PM CDT

Title: Current Prototype Plans

Date: 5/1/22

Content by: Team

Present: N/A

Goals: To lay out current plans for prototype to summarize in journal

Content:

Team's Fabrication:

- Our final prototype is created using 316 Stainless Steel. This was swapped for the 1008-1010 due to easier bending and better shape memory.

Prototype:

- Prototyping for qualitative testing will be outsourced to Sector67 for dimensional accuracy
    - Approximately 96 bands could be printed on a single 316 stainless steel sheet using the UV laser cutter
    - Files traced with a DXF drawing
- Epoxy: Permatex 84109 PermaPoxy 4 Minute Multi-Metal Epoxy
    - Epoxy is best applied using a micropipette to ensure a controlled very small amount to apply to the surface of the bands. They are then pressed together and left to cure overnight

Conclusions/action items:

Discuss the qualitative testing that will be done on this design and create an official protocol for such.

Qualitative Testing for Dr. Tipple

TREVOR SILBER - Mar 02, 2022, 2:52 PM CST

Title: Qualitative Testing Protocol

Date: 3/1/22

Content by: Trevor Silber

Present: Draeson

Goals: Create a testing protocol

Content:

Materials:

- Different Sized Butterfly Matrix Bands (V1-V6 for each different version)
- Universal Tofflemire Matrix Band (0.002") (UTMB)
- Tofflemire Retainer
- 2 Dental Wedges
- 1 Dental Ring Clamp
- Adult Tooth Model

Procedure:

1. Rate each of the different design iterations and the Universal Tofflemire Matrix Band on a scale from 1-5 for each of the different evaluation criteria. Add up the total scores for each of the different devices and compare their scores. The device with the highest score will be chosen as our final design.

Evaluation Criteria	V1	V2	V3	V4	V5	V6	UTMB	Comments
Ease of Use								
Tooth Contour								
Protective Coverage								
Restoration Contact								
Efficiency								
Compatibility with existing tools & Procedures								
Total Score (out of 30)								

Conclusions/action items:

The table above will be provided to Dr. Tipple for qualitative testing. The testing will consist of running mach trials on a model mouth to test out the efficiency of each device. Dr. Tipple will compare the traditional matrix band to 6 slightly different variation of the butterfly matrix band. The winner of the table will be chosen as the final design for the semester.

MTS Testing Protocol

MATTHEW FANG (mjfang@wisc.edu) - May 08, 2022, 9:43 PM CDT

Title: MTS Testing Protocol

Date: 5/1/2022

Content by: Team

Present: -

Goals: Create goals and protocols for MTS testing

Content:

1. What is the material tested: 316 Steel
2. Type of testing: Tensile testing (Impact/bending test in the future?)
3. Protocol details: Rate of loading - past semester used 5mm/min and found the samples slipped from the grips. Potentially use a slower loading rate to prevent slipping. However, a faster loading rate is more similar to real applications. Stop the test upon fracture.
4. Fixtures Used: Vice clamps?
5. Number of samples/tests: 3 Tofflemire bands and 3 316 steel samples
6. Expected load: about 40-70 N for a 0.0254 (0.001") thick x 5 mm wide sample
7. Exported data type: Force vs Displacement

Key Outcome Measures: Yield stress

- Loaded Bands by wrapping masking tape and around the ends of the band for better grasp in the clamps
- Cross sectional area and gauge length for stress-strain calculations
- Pull until break or until slippage occurs

Conclusions/action items:

Solidworks Testing Protocol

MATTHEW FANG (mjfang@wisc.edu) - May 08, 2022, 10:02 PM CDT

Title: Solidworks Testing Protocol

Date: 5/2/2022

Content by: Team

Present: -

Goals: Determine methods for Solidworks simulink testing

Content:

1. Type of testing: Stress Test Simulation
2. Protocol details: Requires premade 3d model of matrix band. User must fix one end of the band and apply loads normal and lateral in separate tests. Then the user must also vary the material between the 316 stainless steel and the stainless steel between tests.
3. Number of samples/tests: 4 tests are going to be run based on the force applied and the material of the band
4. Expected load: 100N for normal loading and 10kN for tensile loading
5. Exported data type: Simulation report detailing some of the mechanical properties of the part

Key Outcome Measures: Yield stress, von mises stress, displacement

Conclusions/action items:

2022/03/09 - Preliminary Epoxy Testing

DRAESON MARCOUX (dmarcoux@wisc.edu) - Mar 09, 2022, 7:45 PM CST

Title: Preliminary Epoxy Testing

Date: March 9, 2022

Content by: Draeson Marcoux

Present: Draeson Marcoux, Tara Boroumand, Matt Fang

Goals: To test potential procedures for applying the epoxy and determining the viability of this specific bonding material for use in our project

Content:

Protocol/Directions

1. Roughen, clean and dry surfaces to be joined or repaired
2. Turn nozzle end up and pull plunger back slightly (1/8"). Allow air bubbles to rise to top. Snap off and save storage cap.
3. Push plunger evenly to dispense equal amounts of hardener and resin onto a discardable surface. Pull back plunger to stop flow
4. MIX THOROUGHLY (working time of 5 minutes)
5. Apply to surface (epoxy will fixture in 10 min and cure in 24 hours)
6. Replace cap for storage

Notes:

- Weight for maintaining pressure and close contact of bonding area
- All 3 of us did a trail with variable amounts of epoxy: Matt - very little; Tara - little; Draeson - slightly more
    - very little meaning residuals were almost all scraped up, little meaning very thin layer, slightly more is a thin layer with some residual
- Need to figure out how to curve the wings, even slightly, in a consistent manner
    - potentially look at a new material (316L Stainless Steel)
- Epoxy created a thickness of 0.01" from 0.002"
- Need a better method for epoxy application as well
    - Maybe just pressure thinning but need a way to prevent spill over onto unintended areas

Conclusions/action items:

Emailed Dr. Tipple to discuss status.

2022/04/13 - MTS Tensile Testing 2

TARA BOROUMAND - Apr 19, 2022, 7:07 PM CDT

Title: MTS Tensile Testing 2

Date: April 13, 2022

Content by: Draeson & Tara

Present: Dr. John Puccinelli, Draeson, & Tara

Goals: To create an effective protocol for MTS tensile testing and gather viable data

Content:

Conclusions/action items:

2022/04/19 - Secondary Epoxy Testing

DRAESON MARCOUX (dmarcoux@wisc.edu) - Apr 19, 2022, 6:51 PM CDT

Title: Epoxy Testing - Round 2

Date: April 19, 2022

Content by: Draeson, Tara, & Matt

Present: Draeson, Tara, & Matt

Goals: To attempt to create a more

Content:

Conclusions/action items:

2022/04/19- MTS Tensile Testing 3

TARA BOROUMAND - May 08, 2022, 4:55 PM CDT

Title: MTS Tensile Testing 3

Date: 4/19/22

Content by: Tara

Present: Draeson, Matt, Tara and Dr. Puccinelli

Goals: Collect mechanical properties of new material (316) vs currently used

Content:

Tofflemire band material

6.65mm x .0381mm

6.67mm x .0381mm

- 20mm/min:
  - Gauge length: 24.53
    - slippage occured
    - Test run 1
  - Gauge length: 15.28
    - slippage occured
    - Test run 2
  - Gauge length: 13.48
    - slippage
    - Test run 3

3.3mm x .0381mm

- 20mm/min
  - Gauge length: 13.50
    - test run 7
    - slippage

316 Steel

6.96 x .0254 mm

8.00 x .0254 mm

7.08 x .0254mm

- 20 mm/min
  - Gauge length: 29.17
    - Test run 4
    - slippage
  - Gauge length: about 30
    - Test run 5
    - slippage
  - Gauge length: 26.17
    - Test run 6
    - slippage

Conclusions/action items:

Analyze data in matlab

2022/04/21- MTS testing Matlab code for stress-strain curves

TARA BOROUMAND - May 08, 2022, 5:00 PM CDT

Title: MTS testing Matlab code for stress-strain curves

Date: 04/21/22

Content by: Tara

Present: n/a

Goals: Solve for Young's Modulus by coding for stress-strain curves and finding linear region for equation of best fit

Content:

```
close all;
clear all;
data=load("TestRun6.txt"); %import the correct data (different for each run)
disp=data(:,1);
force=data(:,2);
time=data(:,3);
dispMain= disp-disp(1,1); %subract initial values (initial values should be 0 regardless)
%Below is a force vs. frame plot to determine where the linear region is.
%This plot is used to select the frame where linear region begins and ends
figure(1)
plot(force);
xlabel('Frame (point)')
ylabel('Force (N)')
title('Force Measured Using an MTS Machine over Many Frames');
x1= input("Enter the first frame of testing")
x2= input("Enter the last frame of observable data")
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');
stress = (force)/A;
strain = dispMain/Lo;
figure(2)
plot(strain(x1:x2), stress(x1:x2),'b',strain(j1:j2),stress(j1:j2),'g')
xlabel('Strain (mm/mm)')
ylabel('Stress (MPa)')
title('Stress vs. Strain Plot for 316 Stainless Steel Matrix Band (20mm/min)')
%Change title as appropriate for trials
```

Conclusions/action items:

Analysis stress-strain curves for results and analysis

2022/04/27- Dr. Brodek survey

TARA BOROUMAND - May 08, 2022, 7:30 PM CDT

Title: Dr. Brodek survey

Date: 4/27/22

Content by: Dr. Brodek

Present: n/a

Goals: Display Dr. Brodek's evaluation

Content:

316 Stainless Steel Band

Rate each of the following questions on a scale from 1 to 5, with:

1= strongly disagree

2= disagree

3= neutral

4= agree

5= strongly agree

1. Fabrication Integrity - The adhesive held together and stayed in the proper area of the band

Score (1-5)	Additional Comments:
N/A	N/A- Samples left for evaluation were not epoxied (Dr. Hazen preferred non-epoxied samples)

2. Protective Coverage - The matrix band protects the gingival tissue and other parts of the oral cavity from filling materiall

Score (1-5)	Additional Comments:
5	

3. Ease of Placement The band is easy to place and remove from the interproximal space?

Score (1-5)	Additional Comments:
5	

4. Compatibility -The design fits with existing tools and procedures.

Score (1-5)	Additional Comments:
5	

5. Material- The material is easy to bend and placement of the band in the proper shape is achievable.

Score 1-5	Additional Comments:
5	

6. The band sits properly in the mouth when placed. In other words, if a filling was performed the correct tooth contour would be created.

Score (1-5)	Additional Comments:
3	The top bar of the matrix is slightly too wide, which would make the occlusal contour more difficult to create. Additionally, because it pinches together at the top, creating a rounded marginal ridge that easily accepts floss may be more challenging

7. The band aids in restoring the proper tooth contact. If a filling was performed the correct tooth contact would be achieved?

Score (1-5)	Additional Comments:

4	I believe contact would be achieved but I wonder how easy it would be to floss

In comparison to 1008/1010 Steel Band

8. The new 316 stainless steel band is more favorable than the 1008/101 steel band in regard to achieving proper tooth contour and contact.

Score (1-5)	Additional Comments:
5	

In comparison to the Tofflemire Bands

9. The team's design offers similar results to the currently used bands in regard to achieving the proper tooth contour and contact.

Score (1-5)	Additional Comments:
4	I believe this would perform similarly to Tofflemire but may not create as anatomical of a contact as other sectional matrices (kidney beans, etc.)

10. The team's design decreases the filling procedure time. (In additional comments please provide how many minutes are saved from filling cavities using this prototype (for adjacent cavities).

Score (1-5)	Additional Comments:
5	Biggest benefit is this- do not need to place one matrix at a time, which can can be tedious and time consuming

Conclusions/action items:

Utilize this is quantitative data analysis

2022/04/27- Dr. Tipple survey

TARA BOROUMAND - May 08, 2022, 7:36 PM CDT

Title: Dr. Tipple survey

Date: 4/27/22

Content by: Dr. Tipple

Present: n/a

Goals: To display Dr. Tipple's evaluation and comments

Content:

316 Stainless Steel Band

Rate each of the following questions on a scale from 1 to 5, with:

1= strongly disagree

2= disagree

3= neutral

4= agree

5= strongly agree

1. Fabrication Integrity - The adhesive held together and stayed in the proper area of the band

Score (1-5)	Additional Comments:
1	→ Held together
4	→ Stayed in proper area of bond

2. Protective Coverage - The matrix band protects the gingival tissue and other parts of the oral cavity from filling material

Score (1-5)	Additional Comments:
5	With use of auxiliary wedge- yes

3. Ease of Placement The band is easy to place and remove from the interproximal space?

Score (1-5)	Additional Comments:
5	Very easy

4. Compatibility -The design fits with existing tools and procedures.

Score (1-5)	Additional Comments:
5	Yes

5. Material- The material is easy to bend and placement of the band in the proper shape is achievable.

Score 1-5	Additional Comments:
1	Not dead soft enough

6. The band sits properly in the mouth when placed. In other words, if a filling was performed the correct tooth contour would be created.

Score (1-5)	Additional Comments:
2	Ideally needs to be more convex with respect to the filling

7. The band aids in restoring the proper tooth contact. If a filling was performed the correct tooth contact would be achieved?

Score (1-5)	Additional Comments:
2	Similar question to #6 (No?)

In comparison to 1008/1010 Steel Band

8. The new 316 stainless steel band is more favorable than the 1008/101 steel band in regard to achieving proper tooth contour and contact.

Score (1-5)	Additional Comments:
4	Yes, more favorable because it's a little more dead soft, but still could be a little more

In comparison to the Tofflemire Bands

9. The team’s design offers similar results to the currently used bands in regard to achieving the proper tooth contour and contact.

Score (1-5)	Additional Comments:
2	Doubtful although I haven’t yet tried it for a patient

10. The team’s design decreases the filling procedure time. (In additional comments please provide how many minutes are saved from filling cavities using this prototype (for adjacent cavities).

Score (1-5)	Additional Comments:
4	1. Won’t need the removing a single band and placing an opposing surface 2. 8 minutes of time saved perhaps

Conclusions/action items:

Use the above data in qualitative testing analysis.

2022/04/27- Dr. Friend survey

TARA BOROUMAND - May 08, 2022, 7:38 PM CDT

Title: Dr. Friend survey

Date: 4/27/22

Content by: Dr. Friend

Present: n/a

Goals: To display Dr. Friend's evaluation

Content:

316 Stainless Steel Band

Rate each of the following questions on a scale from 1 to 5, with:

1= strongly disagree

2= disagree

3= neutral

4= agree

5= strongly agree

1. Fabrication Integrity - The adhesive held together and stayed in the proper area of the band

Score (1-5)	Additional Comments:
4	Unnecessary. Packing of composite will keep area together

2. Protective Coverage - The matrix band protects the gingival tissue and other parts of the oral cavity from filling materiall

Score (1-5)	Additional Comments:
5	□

3. Ease of Placement The band is easy to place and remove from the interproximal space?

Score (1-5)	Additional Comments:
2	Band is too wide and tall for placement of palodent ring system.

4. Compatibility -The design fits with existing tools and procedures.

Score (1-5)	Additional Comments:
2	Not with current height and width. Wedge gucci

5. Material- The material is easy to bend and placement of the band in the proper shape is achievable.

Score 1-5	Additional Comments:
5	□

6. The band sits properly in the mouth when placed. In other words, if a filling was performed the correct tooth contour would be created.

Score (1-5)	Additional Comments:
5	

7. The band aids in restoring the proper tooth contact. If a filling was performed the correct tooth contact would be achieved?

Score (1-5)	Additional Comments:

3	Too wide of contact. Possible open contact

In comparison to 1008/1010 Steel Band

8. The new 316 stainless steel band is more favorable than the 1008/101 steel band in regard to achieving proper tooth contour and contact.

Score (1-5)	Additional Comments:
1	Better without epoxy. Use cheaper materia, unable to tel difference

In comparison to the Tofflemire Bands

9. The team's design offers similar results to the currently used bands in regard to achieving the proper tooth contour and contact.

Score (1-5)	Additional Comments:
3	Without filling won't for sure know, but current design won't allow for ring placement

10. The team's design decreases the filling procedure time. (In additional comments please provide how many minutes are saved from filling cavities using this prototype (for adjacent cavities).

Score (1-5)	Additional Comments:
3	Would guess that it does, but again without testing and current design. Won't for sure know.

Notes:

- Too big → maybe even make half the size

- Get rid of hole at the top→ would not aid in placement or removal. Placement and removal would likely be done with the wings of the band. Even if shorter wings are used it is still a better placement method than the hole
- Most likely would be able to use the current ring that is being used on the market today. Would be able to use wedges as well. But to use the ring the middle section needs to become shorter and skinnier
- Material seems a bit stiff but the material overall should be fine if the other changes are made
- The epoxied section is too wide→ again, make the middle part skinnier and shorter so it is compatible with the current ring system
- When the dentist tries pressing the band down into place it crinkles. This would likely be fixed if the dimensions of the middle section were decreased
    - Middle overall is too tall and too wide
- The prototypes that are epoxied further down do not allow wedge placement
    - Again, epoxy not even needed
        - The purpose of the epoxy was to ensure the material on the interproximal part is touching each other, however, if the dentist is able to perform the filling with the normal procedure that is being used today, packing the material down should made the metal contact
- Not as relevant but talked about pricing: would need to bring it down to about 50 cents a band for it to be profitable which would be extremely difficult to do

Conclusions/action items:

Use this in qualitative testing analysis

2022/04/27- Dr. Hazen survey

TARA BOROUMAND - May 08, 2022, 7:39 PM CDT

Title: Dr. Hazen survey

Date: 4/27/22

Content by: Dr. Hazen

Present: n/a

Goals: To display Dr. Hazen's evaluation and comments.

Content:

316 Stainless Steel Band

Rate each of the following questions on a scale from 1 to 5, with:

1= strongly disagree

2= disagree

3= neutral

4= agree

5= strongly agree

1. Fabrication Integrity - The adhesive held together and stayed in the proper area of the band

Score (1-5)	Additional Comments:
N/A	N/A- Samples left for evaluation were not epoxied (Dr. Hazen preferred non-epoxied samples)

2. Protective Coverage - The matrix band protects the gingival tissue and other parts of the oral cavity from filling materiall

Score (1-5)	Additional Comments:
5	

3. Ease of Placement The band is easy to place and remove from the interproximal space?

Score (1-5)	Additional Comments:
4	

4. Compatibility -The design fits with existing tools and procedures.

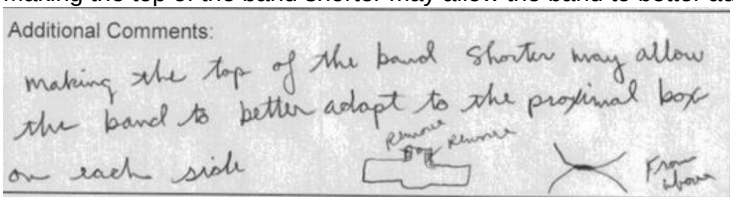
Score (1-5)	Additional Comments:
4	See #6

5. Material- The material is easy to bend and placement of the band in the proper shape is achievable.

Score 1-5	Additional Comments:
5	

6. The band sits properly in the mouth when placed. In other words, if a filling was performed the correct tooth contour would be created.

Score (1-5)	Additional Comments:
4	Making the top of the band shorter may allow the band to better adapt to the proximal box on each side



7. The band aids in restoring the proper tooth contact. If a filling was performed the correct tooth contact would be achieved?

Score (1-5)	Additional Comments:
5	Better if adjusted as in #6 question

In comparison to 1008/1010 Steel Band

8. The new 316 stainless steel band is more favorable than the 1008/101 steel band in regard to achieving proper tooth contour and contact.

Score (1-5)	Additional Comments:
5	

In comparison to the Tofflemire Bands

9. The team's design offers similar results to the currently used bands in regard to achieving the proper tooth contour and contact.

Score (1-5)	Additional Comments:
4	

10. The team's design decreases the filling procedure time. (In additional comments please provide how many minutes are saved from filling cavities using this prototype (for adjacent cavities).

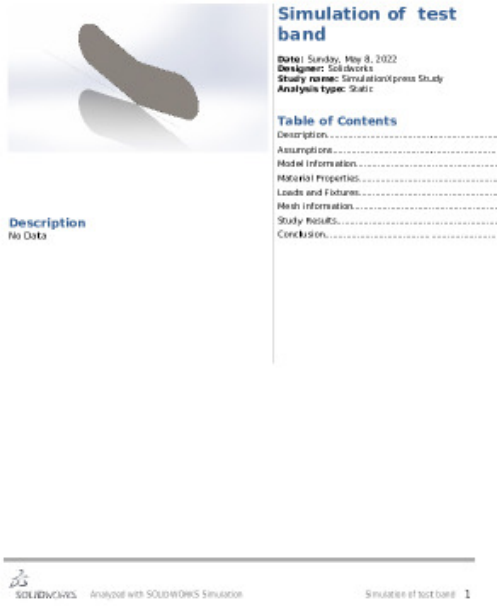
Score (1-5)	Additional Comments:
5	10-15 min easy depending on provider

Conclusions/action items:

Use this in qualitative testing analysis.

Solidworks Simulink Testing-Tensile 316

MATTHEW FANG (mjfang@wisc.edu) - May 08, 2022, 11:29 PM CDT

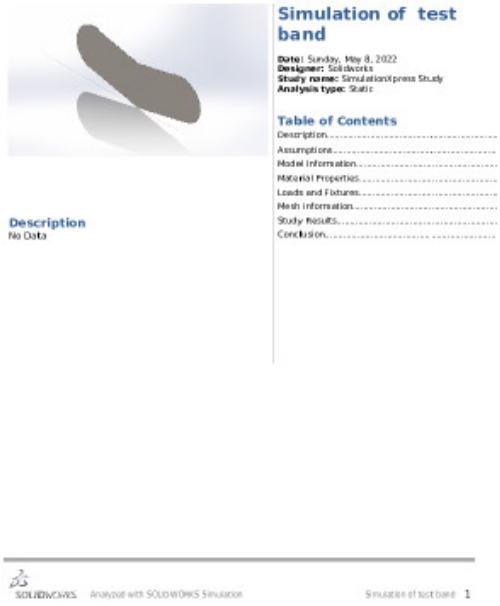


Download

Test_Band_Perp_using_Stainless_Steel.docx (1.07 MB)

Solidworks Simulink Testing-Normal 316

MATTHEW FANG (mjfang@wisc.edu) - May 08, 2022, 11:30 PM CDT


Simulation of test band

Date: Sunday, May 8, 2022
Designer: Solidworks
Study name: SimulationXpress Study
Analysis type: Static

Table of Contents
Description
Assumptions
Model Information
Material Properties
Loads and Fixtures
Mesh Information
Study Results
Conclusion

Description
No Data

SOLIDWORKS Analyzed with SOLIDWORKS Simulation Simulation of test band 1

Download

Test_Band_Normal_using_316.docx (1.17 MB)

2022/03/01- SolidWorks Results and Discussion

TARA BOROUMAND - Mar 02, 2022, 10:44 AM CST

Title: Solidworks Results and Discussion

Date: 3/2/22

Content by: Team

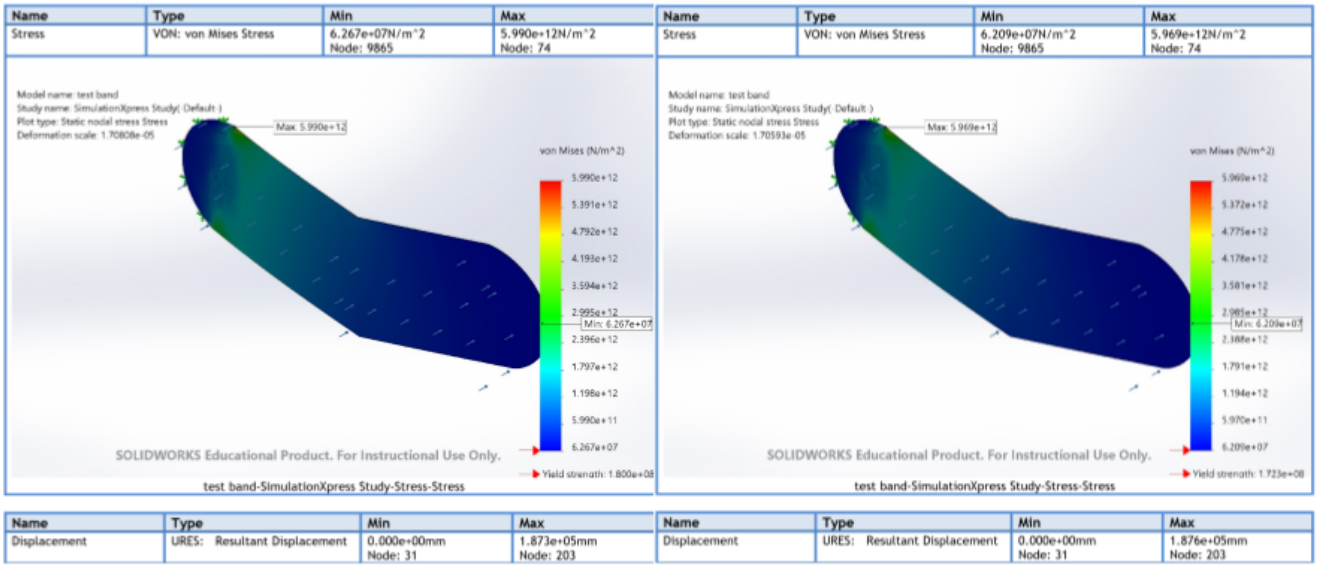
Present: N/A

Goals: To display Solidworks results and how it will apply to Journal

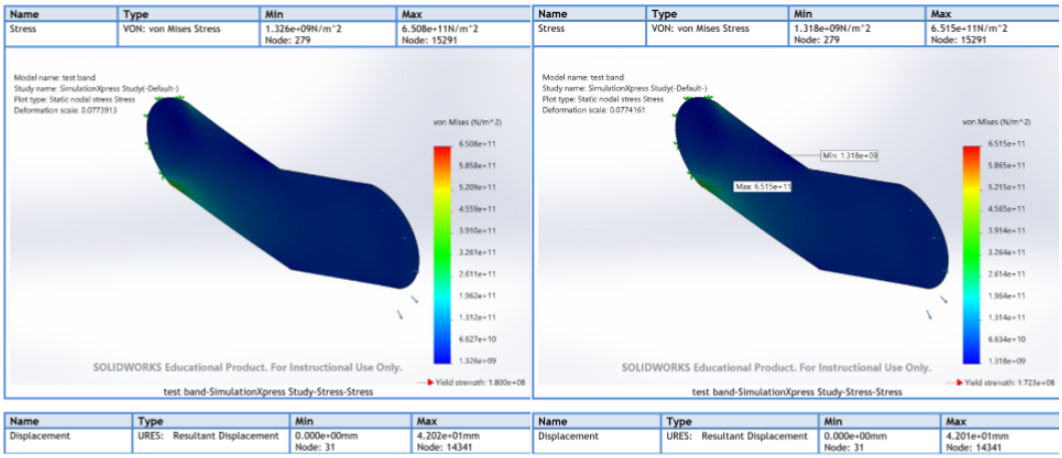
Content:

Below are details from last semester's work:

Protocol details: 4 Tests were performed where loads were applied normal and laterally to band modeled in solidworks in order to get resultant stress and strain calculations for multiple directions of force. In the normal test, at 200N load was applied as the force required to move the band wouldn't need to be super high. Conversely, the load applied laterally was 20kN as the force required to pull the band apart is much higher than the force required to bend the band. The tests varies in the force directions and the material type



Solidworks Simulink stress simulations with load applied normal to the band. Output yields the distribution of Von Mises stresses. 1008-1010 alloy on the left and stainless steel on the right.



Solidworks Simulink stress simulations with load applied normal to the band. Output yields the distribution of Von Mises stresses. 1008-1010 alloy on the left and stainless steel on the right.

Format: Yield Stress, Max Displacement, Max Von Mises Stress

Normal Force:

1008= 180.0 MPa, 1.876 m, 5990 GPa

Stainless Steel = 172.2 MPa, 1.873 m, 5969 GPa

Lateral Force:

1008 = 180.0 MPa, 4.202 mm , 650.8 GPa

Stainless Steel = 172.2 MPa, 4.201 mm , 651.5 GPa

Application for Journal:

The team has decided that while MTS machine is not applicable to the Journal. The testing was very flawed and likely would not hold up in a Journal. However, the team will be keeping Solidworks results and briefly discussing its success in displaying similar mechanical properties between the 1008-1010 steel alloy and the stainless steel. By declaring similar mechanical properties the team will focus on emphasizing qualitative testing results.

Conclusions/action items:

Focus on discussing the results of this in a concise manner for the Journal.

2022/05/01- MTS tensile testing results: stress-strain curves

TARA BOROUMAND - May 08, 2022, 4:16 PM CDT

Title: MTS tensile testing results

Date: 5/1/22

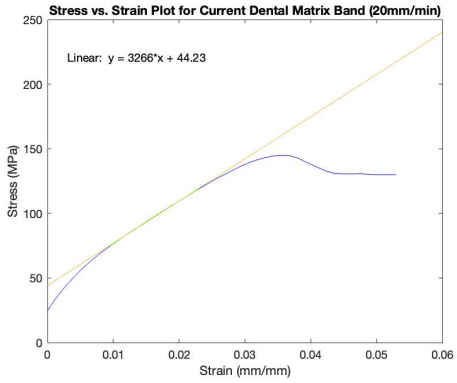
Content by: Tara

Present: Matt and Draeson (for experimentation)

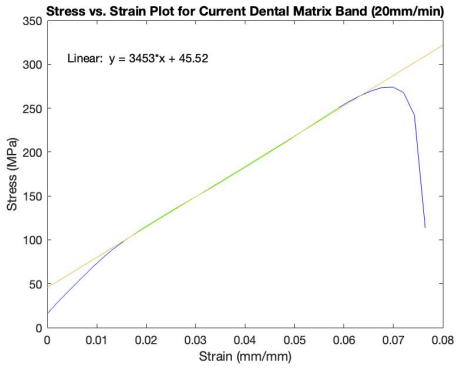
Goals: To identify linear regions of the stress-strain curves for data analysis and find the Young's Modulus with a line of best fit in this region

Content:

Test 1: Tofflemire
First frame of data: 1
Last frame of data: 40
First frame of elastic region: 8
Last frame of elastic region: 18
Gauge Length: 24.53mm
Cross-sectional area: 0.1334mm^2

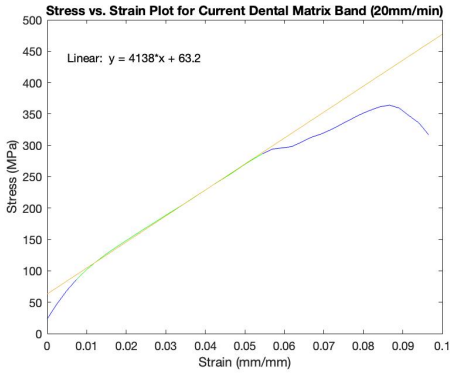


Test 2: Tofflemire
First frame of data: 1
Last frame of data: 36
First frame of elastic region: 8
Last frame of elastic region: 28
Gauge Length: 15.28mm
Cross-sectional area: 0.1334mm^2

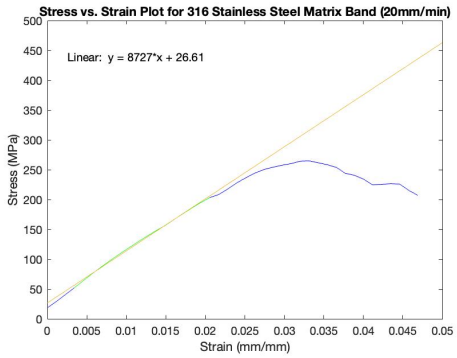


Test 3: Tofflemire
First frame of data: 1
Last frame of data: 40
First frame of elastic region: 4
Last frame of elastic region: 23

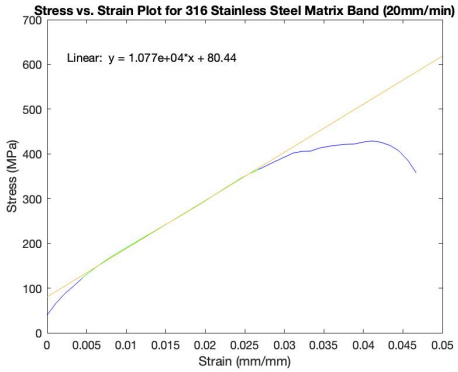
Gauge Length: 13.48mm
Cross-sectional area: 0.1334mm^2



Test 4: 316 Stainless Steel
First frame of data: 1
Last frame of data: 42
First frame of elastic region: 4
Last frame of elastic region: 19
Gauge Length: 29.17
Cross-sectional area: 0.1798mm^2

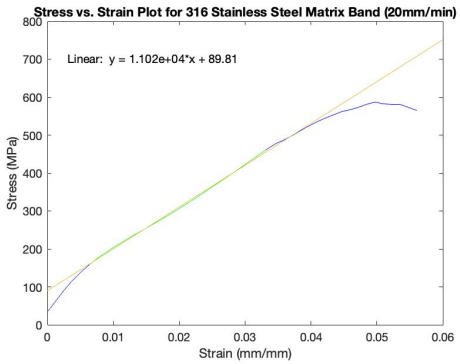


Test 5: 316 Stainless Steel
First frame of data: 1
Last frame of data: 43
First frame of elastic region: 5
Last frame of elastic region: 25
Gauge Length: 30.00
Cross-sectional area: 0.1798mm^2



Test 6: 316 Stainless Steel
First frame of data: 1
Last frame of data: 45

First frame of elastic region: 6
Last frame of elastic region: 27
Gauge Length: 26.17
Cross-sectional area: 0.1798mm^2



Conclusions/action items:

Perform statistical analysis on this data.

2022/05/01- ANOVA Analysis

TARA BOROUMAND - May 08, 2022, 4:38 PM CDT

Title: ANOVA Analysis

Date: 5/1/22

Content by: Tara

Present: n/a

Goals: To test whether there is a significant difference between the 316 stainless steel and tofflemire matrix band stainless steel

Content:

RESULTS FROM FALL SEMESTER

Table 1: One-Way ANOVA Test between 1008/1010 stainless steel and Tofflemire matrix band stainless steel Young's Modulus yielding p-value of 0.0796. Values below are given in MPa.

Groups	N	Mean	Standard Deviation	Standard Error	F-Statistic	P-Value
Tofflemire Band Steel	2	162800	17536	12400	**11.08**	**0.0796**
316 Steel	2	672700	215950	152700		

RESULTS FROM SPRING SEMESTER

Table 2: One-Way ANOVA Test between 316 stainless steel and Tofflemire band stainless steel Young's Modulus yielding p-value of .0011. Values below are given in MPa

Groups	N	Mean	Standard Deviation	Standard Error	F-Statistic	P-Value
Tofflemire Band Steel	3	1884	206	119	**69.25**	**0.0011**
316 Steel	3	9817	1638	946		

Conclusions/action items:

Explain the significance of these tests and explain why the the Young's Modulus values are off in Figure 2 (likely due to slow continuous slippage through the linear region of the stress-strain curve).

2022/05/01- Qualitative Testing Results

TARA BOROUMAND - May 08, 2022, 4:47 PM CDT

Title: Qualitative Testing Results

Date: 4/27-5/2/22

Content by: Tara

Present: n/a

Goals: Assess functionality of our design with qualitative data results

Content:

Category	Dentist 1	Dentist 2	Dentist 3	Dentist 4	Average
Protective Coverage	5	5	5	5	5
Ease of Placement	5	4	5	2	4
Compatibility	5	4	5	2	4
Material	5	5	1	5	4
Proper Placement	3	4	2	5	3.5
Proper Contact	4	5	2	3	3.5
Comparison- 1008/1010	5	5	4	1	3.75
Comparison- Tofflemire	4	4	2	3	3.25
Procedure Time	5	5	4	3	4.25
					3.92

Table 1: Results from survey taken by dentists with a 1 being the least favorable and 5 being the most favorable score in each category.

Conclusions/action items:

Discuss the significance of these results and future work based on these comments. Specifically, discuss how proper placement and proper contact can be improved.

2022/02/26 Files for Sector 67

MATTHEW FANG (mjfang@wisc.edu) - Mar 02, 2022, 12:10 PM CST

Title: DXF Files for printing round 2

Date: 2/26/2022

Content by:

Present:

Goals: Files we sent to sector 67 for second round of printing

Content:

Linked in attachment

Conclusions/action items:

MATTHEW FANG (mjfang@wisc.edu) - Mar 02, 2022, 12:11 PM CST

Download

Matrix_Band_Flatv2.DXF (104 kB)

MATTHEW FANG (mjfang@wisc.edu) - Mar 02, 2022, 12:11 PM CST

Download

Matrix_Band_Flatv2_Bigger_Convex.DXF (96.4 kB)

MATTHEW FANG (mjfang@wisc.edu) - Mar 02, 2022, 12:11 PM CST

Download

Matrix_Band_Flatv2_Large_Tab.DXF (104 kB)

MATTHEW FANG (mjfang@wisc.edu) - Mar 02, 2022, 12:11 PM CST

Download

Matrix_Band_Flatv_LargeWing.DXF (95.2 kB)

MATTHEW FANG (mjfang@wisc.edu) - Mar 02, 2022, 12:11 PM CST

Download

Matrix_Band_Flatv_SmallWing.DXF (94.1 kB)

2022/02/26 Initial Sector 67 Test

MATTHEW FANG (mjfang@wisc.edu) - Mar 02, 2022, 2:33 PM CST

Title: DXF Files for printing round 1

Date: 2/14/2022

Content by:

Present:

Goals: Files we sent to sector 67 for first round of printing

Content:

Linked in attachment

Conclusions/action items:

MATTHEW FANG (mjfang@wisc.edu) - Mar 02, 2022, 2:36 PM CST

Download

Matrix_Band_Flat.DXF (53.1 kB)

2022/02/10- Cavity Brief Overview

TARA BOROUMAND - Mar 02, 2022, 11:25 AM CST

Title: Cavity Brief Overview

Date: 02/20/22

Content by: Tara

Present: N/A

Goals: To discuss key points from the biology and physiology research done in Fall 2021. This discussion will highlight important concepts that should go in the selected Journal and corresponding reports.

Content:

- Dentists can use sectional or circumferential matrix bands.
  - Circumferential bands are to be tightened with a Tofflemire
  - A sectional matrix band can be placed with tweezer
- The team decided to pursue a sectional matrix band for a variety of reasons.
  - One study found: "Use of the sectional matrix system in two-surface Class II cavities resulted in statistically significantly tighter proximal contacts than the use of the circumferential matrix system" [1]
- The wedge has two purposes:
  - "to get a separation between teeth which compensates the matrix thickness for obtaining a strong interproximal contact, and to adapt the matrix intimately to the contour of the tooth all around the cavity floor." [2]

Figure 1: This is the Tofflemire which is used for tightening circumferential bands

Figure 2: This is a sectional matrix band being used with a ring (meant to push teeth further apart)

Figure 3: Circumferential matrix band being used with Tofflemire.

Conclusions/action items:

This summary and overview will be reported in the introduction of the Journal. Keywords should also be defined that will go in the Journal.

[1] D. Richards, “Sectional or circumferential matrix systems for direct composite restorations?,” *National Elf Service*, 30-Sep-2011. [Online]. Available: https://www.nationalelfservice.net/publication-types/randomised-controlled-trial/sectional-or-circumferential-matrix-systems-for-direct-composite-restorations/. [Accessed: 20-Oct-2021].

[2] https://clinicadentalvictoralonso.com/Publicaciones/Sectional%20matrix%20-%20Step-by-step%20directions%20for%20their%20clinical%20use.pdf

2022/03/01- Keywords

TARA BOROUMAND - Mar 02, 2022, 11:33 AM CST

Title: Keywords

Date: 03/01/22

Content by: Tara

Present: N/A

Goals: Select Keywords for Journal report.

Content:

JADA articles seem to have a section where they refer to keywords at the beginning. The following are possibilities for keywords to include at the beginning of report.

- Dental Matrix Band
- Interproximal Cavity
- Class ll Restoration
- Dead Soft Metal
- Tooth contact
- Interproximal Space
- Gingival overhanging

The first four key words seem to be the most applicable. They should be defined throughout the paper in the introduction.

Conclusions/action items:

There are some clarifications that need to be made on what to place in the journal/how detailed. For now, the first 4 keywords will be placed in but discussion with advisor should be done for clarifications on the amount of detail or summary to go into the Journal report.

2022/02/10- Attaching Metals at Interproximal Space

TARA BOROUMAND - Feb 10, 2022, 1:09 PM CST

Title: Attaching Metals at Interproximal Space

Date: 2/10/22

Content by: Tara

Present: N/A

Goals: To research alternatives to welding

Content:

- Intermittent Welding
  - A fewer number of big passes results in less distortion than a greater number of small passes with small electrodes [1]
- Epoxy Adhesives
  - composite carbon/epoxy resin techniques for restorative dentistry [2]
    - since they are used in dentistry it likely means they are approved to be used in mouth
  - Would a composite carbon expoxy work for sealing two metals? [3]
    - "**Master Bond EP31** is a two component room temperature curing epoxy for high performance structural bonding applications featuring lap shear strengths exceeding 4600 psi and peel strength exceeding 40 pli"
      - excellent resistance to many chemicals
      - excellent adhesion to a wide variety of substrates including many metals and composites
    - Toughened high strength epoxy --> **Supreme 10HT**
      - "This outstanding epoxy offers tensile shear strengths in excess of 3,600 psi and T-peel strengths up to 30 pli."
      - Viscosity will not thicken over time
    - Other epoxy options:
      - EP21TDCHT
      - FLM36
- Potential other options:
  - Soldering, brazing [4]

Conclusions/action items:

Meet with team to discuss these options and pick a plan this week

[1] “Avoiding weld distorti - ccctc.k12.oh.us.” [Online]. Available: https://www.ccctc.k12.oh.us/Downloads/Article%20tips-avoiding-weld-distorti.pdf. [Accessed: 10-Feb-2022].

[2] V. G. M. G. V. B. B. D; “Epoxy/carbon composite resins in Dentistry: Mechanical properties related to fiber reinforcements,” *The Journal of prosthetic dentistry*. [Online]. Available: https://pubmed.ncbi.nlm.nih.gov/7965896/. [Accessed: 10-Feb-2022].

[3] “Composite to metal adhesives bonding,” Composite to Metal Adhesives Bonding | MasterBond.com. [Online]. Available: https://www.masterbond.com/applications/composite-metal-adhesives-bonding. [Accessed: 10-Feb-2022].

[4] “How to bond metal to metal without welding: 5 smart alternatives,” CromWeld.com, 25-May-2021. [Online]. Available: https://www.cromweld.com/how-to-bond-metal-to-metal-without-welding/. [Accessed: 10-Feb-2022].

2022/02/10- Third Party Manufacturers

TARA BOROUMAND - May 08, 2022, 5:07 PM CDT

Title: Third Party Manufacturers

Date: 2/10/22

Content by: Tara Boroumand

Present: n/a

Goals: To research potential manufacturers

Content:

- US manufacturers will create smaller batches and make it easier to monitor process [1]
- Options
    - Midwest prototyping
    - BFHammer Mfg
    - Swift Manufacturing and Engineering
        - "Working with us from the early concept stages gives us great insight when you get to production."

Conclusions/action items:

Likely reach out to Sector67 and use above options as alternative.

[1] “How to find a manufacturing facility,” *Business News Daily*. [Online]. Available: https://www.businessnewsdaily.com/8820-how-to-find-factory.html. [Accessed: 10-Feb-2022].

2022/03/29- 316L Stainless Steel Search

TARA BOROUMAND - May 08, 2022, 7:28 PM CDT

Title: 316L Stainless Steel Search

Date: 3/29/22

Content by: Tara

Present: n/a

Goals: Differentiate between 316 and 316L stainless steel and determine which is a better suited replacement for the 1008/1010 steel.

Content:

This study has already been done on using 316L stainless steel in dental applications. The Young's Modulus of this metal is around 193 GPa which is higher than that of bone (5-30 GPa) which can be problematic when this material is being used for implants due to stress shielding (although this is not how we will be applying the material). However, what is significant here is that 316L is used as a dental implant which is a much more invasive application of the material than using it as a dental matrix band. Thus, the minimal nickel content is not of concern. [1]

316L vs 316

The "L" means that the carbon content of the alloy is below 0.03% which makes the 316L stainless steel sheet preferable for welding over standard 316 stainless steel [2].

Conclusions/action items:

The 316L stainless steel is more ideal, however, the team is having trouble finding .001inch 316L and needs to continue searching. 316 will be ordered if we cannot find since we do not have the budget or time or do a custom order.

[1] B. H. B. Kuffner, P. Capellato, L. M. S. Ribeiro, D. Sachs, and G. Silva, “Production and characterization of a 316L stainless steel/β-TCP biocomposite using the functionally graded materials (fgms) technique for dental and Orthopedic Applications,” *MDPI*, 29-Nov-2021. [Online]. Available: https://www.mdpi.com/2075-4701/11/12/1923. [Accessed: 08-May-2022].

[2] “316L stainless steel plate,” 316L Stainless Steel Plate | Stainless Supply. [Online]. Available: https://www.stainlesssupply.com/order-metal-online/docs/g1c1066s55ss0p0/316L-Stainless-Steel-Plate.htm. [Accessed: 08-May-2022].

2022/04/07- Global Dental Fillings Market Size

TARA BOROUMAND - May 08, 2022, 5:32 PM CDT

Title: Global Dental Fillings Market Size

Date: 4/7/22

Content by: Tara

Present: n/a

Goals: Research market of fillings

Content:

"The global dental fillings market size was estimated at USD 5.57 billion in 2019 and is expected to reach USD 5.97 billion in 2020."

The global dental fillings market size was valued at USD 5.2 billion in 2018 and is expected to grow at a compound annual growth rate (CAGR) of 7.2% from 2019 to 2026. Increasing the prevalence of dental caries is the major driving factor. Also, the high prevalence of other dental conditions, such as tooth decay and cavity due to unhealthy eating habits along with increasing patient awareness and growing geriatric population are expected to fuel the market.

Dental caries and periodontal diseases are also prevalent in approximately 15% to 20% adult population (between 35 to 44 age group). Such high prevalence is anticipated to drive the demand.

Conclusions/action items:

Discuss this data in the executive summary.

"Dental fillings market size, share: Industry Report, 2019-2026," *Dental Fillings Market Size, Share | Industry Report, 2019-2026*. [Online]. Available: https://www.grandviewresearch.com/industry-analysis/dental-fillings-market#:~:text=The%20global%20dental%20fillings%20market%20size%20was%20estimated%20at%20USD,USD%205.97%20billion%20in%202020. [Accessed: 08-May-2022].

2022/02/20- Design Changes

TARA BOROUMAND - Mar 02, 2022, 11:14 AM CST

Title: Design Changes

Date: 2/20/22

Content by: Tara

Present: N/A

Goals: Document changes discussed in my specific part of preliminary presentation and discuss importance

Content:

- Addition of Fins
- Bonding of upper 70% of proximal space
    - Permatex 84109 PermaPoxy 4 Minute Multi-Metal Epoxy
- Variety of sizes - 5mm, 6mm, 7mm

These changes are discussed in more detail in the team notebook's "Design Process" folder.

Epoxy research was done with various considerations. The epoxy should sufficiently seal the top 70% but it should also contribute to minimal thickness. The team's concern is that if the epoxy is very thick, it will not allow for the proper tooth contact in the interproximal space which would greatly impact the overall functionality of the design. Brief mechanical testing should be done with the epoxy to ensure it functions correctly.

The addition of fins will allow for the proper tooth contact throughout the tooth's surface while also preventing gingival overhanging. This was directly requested by the client.

Normally, there are. two standard sizes in dentistry (adult and pedio). However, the team is unsure whether our design would need a third size due to its dual matrix feature. This will be assessed after qualitative testing results.

Conclusions/action items:

Create a protocol for testing the epoxy and looking forward, qualitative testing of the entire design.

2022/03/02- Convexity + Epoxy

TARA BOROUMAND - Mar 02, 2022, 12:19 PM CST

Title: Convexity + Epoxy

Date: 03/02/2022

Content by: Tara

Present: N/A

Goals: To source the need for convex bottom and discuss the post fabrication changes (epoxy)

Content:

Below is part of my writing in paper:

After the fabrication of the prototype by Sector 67, the interpoximal space of the matrix band should be sealed together along the top 70% of its contact, leaving sufficient room for wedge placement during the process. The sealing of the interproximal space will ensure the proper tooth contact: the thickness of the two bands on both sides of the dual matrix band put together. Various methods of sealing were considered, and in order to prevent deformation of the material, an epoxy seal should be used. The specific epoxy sealant to be used is the Permatex 84109 PermaPoxy 4 Minute Multi-Metal Epoxy. Successful sealing of the top 70% of the interproximal space should not contribute significant additional thickness to the interproximal space, otherwise, the proper tooth contact would not be maintained.
Additionally, the convexity of the bottom contour of the band is essential in its design to both allow for the proper tooth contour along its entire surface and prevent gingival overhanging. Gingival overhanging is the extension of the restorative material beyond the intended confinement during preparation [1].

Discussion/concerns on this section:

- Something else to maybe add is to ensure smooth curvature throughout the edges for patient safety and comfort. But also, after writing this section I noticed we do not define the degree of convexity which would be beneficial to do for the final report.
- I was unsure whether to include the full epoxy name or not
- These are the two main design changes from Fall 2021. Should design changes be addressed separate from the previous final design? Or all discussed at once?

Conclusions/action items:

Paste into journal and discuss significance

[1] M. A. Brunsvold and J. J. Lane, “The prevalence of overhanging dental restorations and their relationship to periodontal disease,” Journal of clinical periodontology. [Online]. Available: https://pubmed.ncbi.nlm.nih.gov/2406294/. [Accessed: 02-Mar-2022].

2022/03/01- Journal Outline

TARA BOROUMAND - Mar 02, 2022, 11:44 AM CST

Title: Journal Outline

Date: 03/01/22

Content by: Tara

Present: N/A

Goals: To determine abstract/outline for journal

Content:

Abstract/Outline

Background
The main objective of this report is to outline the process used to design, manufacture and test a modified dental matrix band that allows the simultaneous filling of an interproximal cavity.
Methods
Solidwork Simulink testing was performed on the chosen 1008-1010 steel alloy material to ensure parallel mechanical properties with the current standard in dentistry (dead soft stainless steel). Prototype fabrication was outsourced to Sector67 to ensure dimensional accuracy. Functional testing will be performed on this prototype to qualitatively assess its ability to perform interproximal restorations with the proper tooth contact and contour.
Results
Solidworks Simulink testing concluded yield strengths were found to be 180.0 MPa and 172.2 MPa for the 1008-1010 steel alloy with maximum displacements at 1.876m. These results closely resemble the mechanical properties of currently used dead soft stainless steel. This suggests the tested alloy either is dead soft or accurately behaves as such. Qualitative testing has not been performed yet, but desirable results would entail an ease of use for the dentist and correct tooth contact and contour post-procedure.
Clinical Implications
This new design offers dentists an alternative to preparing the matrix band and wedge twice for the separate filling of two adjacent teeth during an interproximal filling. Simultaneous interproximal cavity filling will decrease procedural time while maintaining the appropriate tooth contact. With 175 million individuals receiving at least one filling every year, this design will assist in helping millions of individuals with untreated cavities.

Remaining Questions/Concerns

- Is the outline of the journal what serves as the abstract? Currently, the abstract is what lays out the outline. This was followed by the following research article in JADA journal: https://jada.ada.org/article/S0002-8177(14)63080-4/fulltext
- Should there be a conclusion section in this abstract/outline? If so, how does this conclusion differ from the one at the end of the introduction? Do we need a conclusion in both sections?
- Do we provide further details in the Journal such as discussing the protocol and fabrication around the epoxy addition to the design?

Conclusions/action items:

Discuss the above concerns of the outline with advisor and revise if necessary.

2022/03/02- Introduction Conclusion vs Paper Conclusion

TARA BOROUMAND - Mar 02, 2022, 2:13 PM CST

Title: Introduction Conclusion vs Paper Conclusion

Date: 03/02/22

Content by: Tara

Present: N/A

Goals: To differentiate between concluding paragraphs that correspond to just the introduction and entire paper

Content:

On the Whitesides typing a paper document, it showed that there should be a summary/conclusion section in the introduction. The team was unsure on what may go into this section. Additionally, the team was unsure about the length of the conclusion of the entire paper.

Below is what I typed for each section for the preliminary paper:

Summary/Conclusion (at the end of the introduction)

During a typical interproximal filling procedure, a dentist is unable to place current matrix bands adjacent to one another due the thickness of two bands exceeding that of the proper tooth contact. Thus, the dentist must perform one filling at a time. An alternative approach by using a modified dual dental matrix band is discussed in this report. This new design would allow for the simultaneous filing of two adjacent teeth, and with desirable testing results, should prove to provide the correct tooth contour and contact after the procedure is completed.

Conclusion (of final paper)

The viability of the proposed matrix band is dependent on its performance in functionality testing since mechanical testing has yielded successful results. Upon retrieval and qualitative assessment of the prototype, the team will determine whether its effectiveness matches that of the existing Tofflemire Matrix Band while minimizing procedure time. Specifically, the prototype should display ease of use, while yielding the proper tooth contact and contour post-procedure.

Concerns/Questions for Advisor

- These summaries seem a bit redundant. Is the summary at the end of the introduction standard? What differentiates these two summaries
- If a summary is also needed at the end of the abstract/outline, how would it differ to the two shown above
- Should quantitative testing numbers go into these sections?

Modified Introduction Conclusion

To create the correct contour, shape and contact while restoring a decayed tooth, dentists most commonly use matrix bands. During a typical interproximal filling procedure, a dentist is unable to place current matrix bands adjacent to one another due the thickness of two bands exceeding that of the proper tooth contact. Thus, the dentist must perform one filling at a time. The Tofflemire™ matrix band is a circumferential matrix band that serves in filling one tooth at a time during an interproximal procedure and is the current gold standard in dentistry. An alternative approach by using a modified dual dental matrix band is discussed in this report. This new design would allow for the simultaneous filing of two adjacent teeth, and with desirable testing results, should prove to provide the correct tooth contour and contact after the procedure is completed.

Conclusions/action items:

Paste corresponding parts into preliminary journal report and meet with advisor with concerns.

2022/05/01- Quantitative Data Analysis

TARA BOROUMAND - May 08, 2022, 5:56 PM CDT

Title: Quantitative Data Analysis

Date: 5/1/22

Content by: Tara

Present: n/a

Goals: Analyze quantitative data that is documented in the results and analysis folder of the team notebook.

Content:

Key points

- Elastic modulus for tofflemire matrix band: 200 - 215 GPa [1]
- The first round of tensile MTS testing yielded an average Young's Modulus for the tofflemire matrix band stainless steel and 1008/1010 stainless steel to be 162.8GPa and 672.7GPa, respectively.
    - There was not a significant difference between the Young's Modulus values of the 1008/1010 stainless steel and the tofflemire matrix band stainless steel, with a p-value of 0.0796 (at a .05 significance level).
- Further MTS testing that evaluated the new 316 stainless steel material found the average Young's Modulus of the 316 stainless steel and tofflemire matrix band stainless steel was 9.8 GPa and 1.9 GPa, respectively.
    - There was a significant difference between the Young's Modulus values of the 316 stainless steel and the Tofflemire matrix band stainless steel yielding a p-value of 0.0011.
- Theory as to why the second round of testing had significantly lower young modulus values than both first round of testing and literature values:
    - The most probable reason for the significantly lower Young's Modulus value is the different fixtures that were utilized during the second round of testing. It is likely that the material was slowly and consistently slipping out of the fixtures throughout the linear region. Slow and consistent slippage would have not been visible compared to the sudden slippage that had been occurring in the first round of testing after the linear region of the stress-strain curve, and thus, this was not actively being watched out for. This would have directly impacted the Young's Modulus values obtained, yielding lower values than expected which is what was observed. Thus, due to the slippage limitation, these values cannot be compared to those of literature. However, since both materials followed identical testing protocols, including their cut out/shape, the insertion of the material in the machine, the fixtures used, the rate of deformation, the Young Modulus values were compared to one another.

Conclusions/action items:

Discuss the above points in the journal final report. Discuss limitations to this as well.

[1] "ASTM A109 Grade no. 5 dead-soft," Matmatch. [Online]. Available: https://matmatch.com/materials/minfm65939-astm-a109-grade-no-5-dead-soft. [Accessed: 20-Oct-2021].

2022/05/06- Quanitative Testing Discussion/Limitations

TARA BOROUMAND - May 08, 2022, 6:03 PM CDT

Title: Quantitative Testing Discussion/Limitations

Date: 5/6/22

Content by: Tara

Present: n/a

Goals: Discuss limitations and clinical significance of these results

Content:

Part of my typed portion in the journal paper:

There are limitations to this comparison since it cannot be certain that the slippage was occurring at the exact rate and amount between the two materials, yet, numerous trials were conducted on each material and with all other conditions maintained, the Young's Modulus values were analyzed. Although statistical analysis on the second round of MTS testing revealed a significant difference in Young's Modulus between the Tofflemire matrix band stainless steel and the 316 stainless steel, it was moreso relevant that the 316 stainless steel was able to withstand forces in a similar range (GPa range) compared to the Tofflemire matrix band. The Young's Modulus of the 316 stainless steel was much greater, and thus, would require a significantly greater force to be displaced in the mouth when compared to the Tofflemire matrix band stainless steel.

In regard to the clinical relevance of these results, stresses in the GPa range never occur in the mouth during filling procedures. It is essential to know the selected material could theoretically tolerate stresses this high, to ensure it is capable of withstanding even the greatest stresses that a typical Tofflemire matrix band would experience during a filling. Both the old material (1008/1010 stainless steel) and the new material (316 stainless steel) would be suitable substitutes for matrix band material in regard to their mechanical properties since overall, they both behaved very similarly to the Tofflemire dental matrix bands and were able to withstand greater stresses.

Key Points

- The second round of MTS testing has limited results because there is no way to quantify the amount of slippage that occurred through the linear region and moreso, there is no way to compare this slippage quantification across both materials
- The first round and second round of MTS testing cannot be directly compared due to the use of different fixtures and limitations discussed above
- Clinical relevance is not as great with quantitative data for reasons discussed above
- Overall: the material behaves similarly to that of stainless steel in regard to mts tensile testing, however, qualitative assessment by dentists is more important

Conclusions/action items:

Discuss this is the paper and discuss importance of qualitative results over quantitative due to stresses in GPa range never being reached in the mouth.

2022/05/08- Qualitative Testing Discussion

TARA BOROUMAND - May 08, 2022, 7:27 PM CDT

Title: Qualitative Testing Discussion

Date: 5/8/22

Content by: Tara

Present: n/a

Goals: Discuss how/why qualitative testing is more applicable in determining the success of our design.

Content:

Key points (average scores from table of results from team activities folder listed below)

- Protective coverage: 5
  - This meant that dentists found our design to sufficiently protect the gingival tissue from filling material. This was likely due to the convexity of our design
- Ease of placement: 4
  - This was a relatively good ranking. We were told the hole in our butterfly matrix band was not necessary because placement would be done by just holding onto the wings
- Compatibility: 4
  - This butterfly matrix band is fully compatible with the wedges dentist use today to perform filling. It would also be fully compatible with the current ring system if the dimensions of the middle section were scaled down. Currently, the dimensions are too big for ring placement
- Material: 4
  - Could be more dead soft. This would be fixed by getting 316L stainless steel instead of 316
- Proper placement: 3.5
  - Most dentists found it okay. Client (Dr. Tipple) requests more convexity
- Proper contact: 3.5
  - The current dimensions of the inner section of the band are too thick. The actual tooth contact is not that thick. Thus, the middle section needs to be scaled down to have the correct tooth contact
- Comparison to 1008/1010: 3.25
  - Still not dead soft enough, although it has improved from this old material
- Comparison to Tofflemire: 3.25
  - Improvements mentioned above should help this ranking as well
- Procedure time: 4.25
  - All dentists suspect this would decrease procedure time with varying answers from 8-15 minutes.

Conclusions/action items:

Discuss these points in the journal. Discuss how to fix each of these in the future work (ex- decrease middle section dimensions, more dead soft, etc).

2022/05/08- Qualitative Testing Conclusions, Future Work

TARA BOROUMAND - May 09, 2022, 1:45 AM CDT

Title: Qualitative Testing Conclusions, Future Work

Date: 5/8/22

Content by: Tara

Present: n/a

Goals: Tie in results and analysis to conclusions and future work in regard to qualitative testing results.

Content:

This is a draft of a part of my written section from the qualitative discussion in the journal

The qualitative feedback received from dentists was promising in displaying the functionality and clinical relevance of the butterfly matrix band. After distributing samples to four dentists for evaluation, all dentists agreed they preferred the prototypes without epoxy in the interproximal space. This is due to the dentist's ability to pack down filling material with their ball burnisher tool in order to ensure proper restorative contact distance between the two sides of the matrix band. Thus, no epoxy would be needed in this application and prototypes with epoxy were not evaluated. In protective coverage, an average score of 5 was received which was the most favorable score, as discussed in the methods section. This meant the device was sufficient in protecting the gingival tissue from filling material, largely due to the convexity along the bottom of the matrix band. Ease of placement, compatibility and the favorability of the 316 stainless steel material averaged a score of 4 in each of their respective categories. The compatibility criteria was concerned with whether the design worked alongside current filling tools such as wedges and the ring system. The design's shortcoming here was that the dimensions of the middle section were slightly too large and thus, simultaneous usage of the matrix band with the ring system was difficult. Decreasing the width of the middle section would allow for easier placement of the ring. Proper placement and proper contact each averaged a score of 3.5. This was again mainly due to the dimensions of the middle section of the band. Since this section was too wide, the correct tooth contact would not be achieved because the actual tooth contact covers less of a surface area than the contact allowed by the butterfly matrix band. By decreasing the contact point in the interproximal space that the current butterfly matrix band is creating, the proper placement and contact should be achieved. When the 316 stainless steel was compared to the previous material, the 1008/1010 stainless steel, it received an average score of 3.75. Although it was an improvement upon the previous material, it was not dead-soft enough. This could be addressed by replacing the 316 stainless steel with 316L stainless steel which has a lower carbon content and is thus, more dead-soft [1]. Additionally, 316L stainless steel is already largely used in dentistry, specifically in orthodontics and implants, so it would be an appropriate substitute [2]. When compared to the Tofflemire matrix band system, the butterfly matrix band received an average score of 3.25. This was greatly due to limitations of the butterfly matrix band discussed above, most notably the inaccurate dimensions of the middle section that is placed in the interproximal space. Lastly, the butterfly matrix band received a very favorable score of 4.25 for procedure time. All dentists found that this matrix band would decrease procedure time, with answers ranging from 8-15 minutes in saved time, which was overall the main motivation behind the design.

Takeaways

- Overall rating of 3.92 considered successful
- Low rankings are relatively easy changes that can be performed:
    - switch from 316 to 316L as it is more dead soft
    - Decrease dimensions of the middle section of the band (where it was originally epoxied)
        - this will improve the tooth contact as it would currently be too large with the current butterfly matrix band
        - will make it compatible with the ring system

Conclusions/action items:

1. B. H. B. Kuffner, P. Capellato, L. M. S. Ribeiro, D. Sachs, and G. Silva, "Production and Characterization of a 316L Stainless Steel/β-TCP Biocomposite Using The Functionally Graded Materials (FGMS) Technique For Dental and Orthopedic Applications," *MDPI*, 29-Nov-2021. [Online]. Available: https://www.mdpi.com/2075-4701/11

/12/1923. [Accessed: 08-May-2022].

2. "316L Stainless Steel Plate," 316: Stainless Steel Plate | Stainless Supply. [Online]. Available: https://www.stainlesssupply.com/orde

r-metal-online/docs/g1c1066s55ss0p0/316L-Stainless-Steel-Plate.htm. [Accessed: 08-May-2022].

2022/03/29 - Review of Dental Anatomy and Sizing

DRAESON MARCOUX (dmarcoux@wisc.edu) - May 09, 2022, 1:06 AM CDT

nTitle: Dental Anatomy and Sizing

Date: March 29, 2022

Content by: Draeson Marcoux

Present:

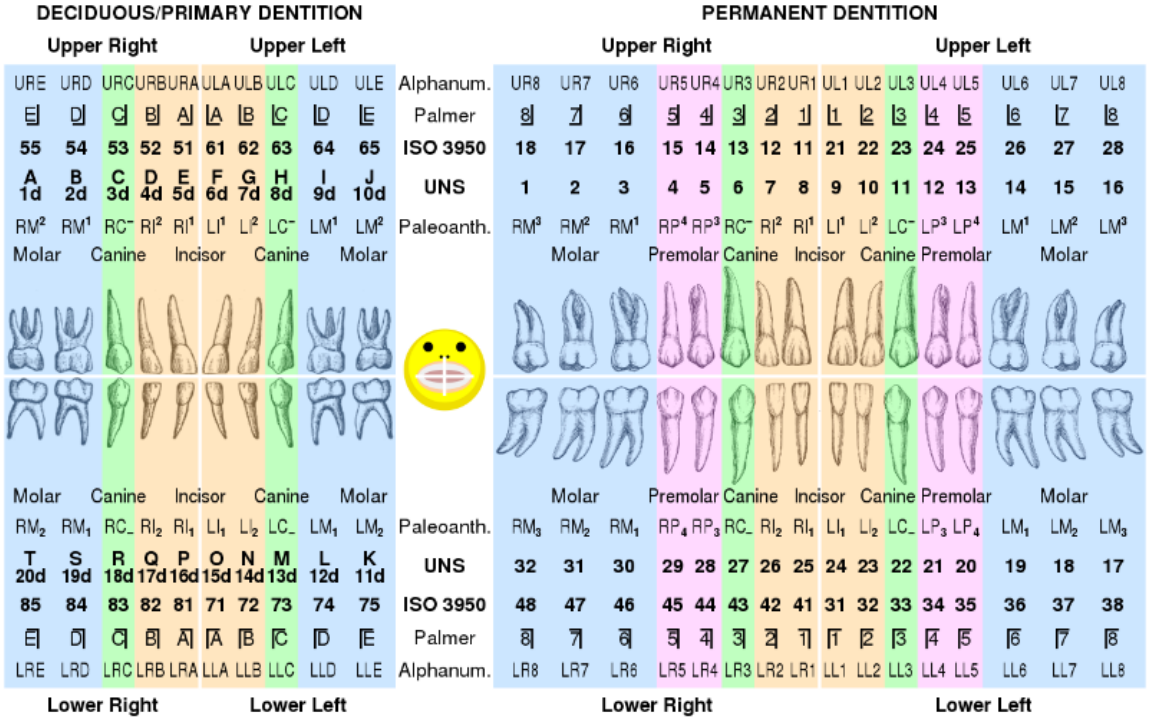
Goals: To re-evaluate the tooth and gum sizing data we used last semester for sizing out matrix band.

Content:

Dental Anatomy - https://en.wikipedia.org/wiki/Dental_anatomy

- 20 primary teeth and 32 permanent teeth (including 4 third molars or "wisdom teeth")
- Maxilla = upper jaw; mandible = lower jaw
- Enamel, Dentin, Cementum and Periodontium are essential for a "healthy oral environment" and are all developed during the fetal stage
- Identification
    - Teeth are named by their sets, arch, class, type and side
        - Sets = primary/baby/deciduous or permanent/adult teeth
        - Arch = Maxillary (teeth of the upper jaw) or Mandibular (teeth of the lower jaw)
        - Classes = incisors, canines, premolars, and molars
            - premolars are only permanent, not is primary set
            - Incisors => central and lateral
                - Anterior 8 teeth, 4 in maxilla and 4 in mandible
                - Functions for shearing during chewing, no cusps, but incisal ridge
                - On average, 16mm long (tall), with 6mm of crown and 10mm of root
            - Canines
                - Functions for tearing food, with a single cusp
            - Premolars => first and second
                - Mixed functions depending on specific tooth
            - Molars => first, second, and third
                - Functions to grind food during chewing
- Numbering Systems (See Figure 1)
    - FDI World Dental Federation notation
        - Used worldwide
        - Uses a 2-digit numbering system where the first number represents a tooth's quadrant and the second, the number of teeth from the midline of the face
    - Universal numbering system (dental)
        - Widely used in the United States
        - Uses a unique number (1-32) or letter (A-T) for permanent and primary teeth, respectively
    - Palmer notation method
        - Preferred method used by dental students and practitioners in the United Kingdom
        - Uses quadrant and number (1-8) or lettering (A-E) to indicate specific tooth for permanent and primary teeth, respectively
- Anatomic Landmarks
    - "Anatomic crown" = area above the "neck" (cementoenamel junction) of the tooth
    - "Clinical crown" = any part of the tooth visible in the mouth
        - Most of the crown in made of dentine with a pulp chamber within
    - "Anatomic root" = area below the "neck" (cementoenamel junction) of the tooth
    - "Clinical root" = any part of the tooth not visible in the mouth
        - Dentin composes most of the root, which contain pulp canals
        - Canines and premolars (except the maxillary first) generally have on root, while maxillary first premolars and mandibular molars have 2. Maxillary molars usually have 3.
    - Tooth us supported in bone by attachment known as the periodontium which connects with the root
    - "Buccal" = surfaces nearest the cheeks or lips
    - "Labial" = buccal but when on anterior teeth near the lips
    - "Lingual" = surfaces nearest the tongue
    - "Palatal" = lingual but when on maxillary teeth beside the "hard palate"
    - "Occlusal" = surfaces that aid in chewing on posterior teeth
    - "incisal" = surfaces that aid in chewing on anterior teeth
    - "Cervical" = surfaces nearest the junction of the crown and root
    - "Apical" = surfaces closest to the apex of the root
        - "Periapical" = tissues surrounding the apex of the root
    - "Mesial" = surfaces closer to the median line of the face
    - "Distal" = surfaces farther away from the median line of the face
    - "Cusp" = elevation on an occlusal surface of posterior and canine teeth
        - Canines have 1 cusp
        - Maxillary premolars and mandibular first premolars have 2 cusps
        - Mandibular second premolars have 3 cusps, one buccal and 3 lingual
        - Maxillary molars have 2 buccal and 2 lingual cusps
    - "Cingulum" = convexity on the lingual surface of anterior teeth, resembling a V-shaped ridge or girdle
    - "Ridges" = linear, flat elevations on teeth, named according to their location

- "Embrasures" = triangularly shaped spaces located between the proximal surfaces of adjacent teeth
  - borders are formed by the interdental papilla of the gingiva, the adjacent teeth, and the contact point where the teeth meet
  - 4 embrasures for every contact area: facial/labial/buccal, lingual/palatal, occlusal/incisal, cervical/interproximal (filled by interdental papilla from gingiva) spaces
    - Absence of adequate gingival tissue shows a black angle (instead of pink)



<u>Maxillary</u> Anterior Teeth Dimensions and Relative Width Proportion in a Saudi Subpopulation - https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8046947/#:~:text=The%20recorded%20mean%20lengths%20for,%2C%20women%20%3D%208.69%20mm).

- Mean Central Incisor
  - Width: 8.74mm (Men = 8.89mm; Women = 8.60mm)
  - Length: 9.84MM (Men = 10.04mm; Women = 9.64mm)
- Mean Lateral Incisor
  - Width: 6.64mm (Men = 6.79mm; Women = 6.49mm)
  - Length: 8.09mm (Men = 8.30mm; Women = 7.89mm)
- Mean Canine
  - Width: 7.82mm (Men = 8.01mm; Women = 7.63mm)
  - Length: 9.08mm (Men = 9.48mm; Women = 8.69mm)

Maxillary and <u>Mandibular</u> Mesiodistal Tooth Sizes Among Different Malocclusions in a Sample of the Turkish Population - https://academic.oup.com/ejo/article/33/5/592/519916

- 3 classes with 100 Individuals each, between the ages of 13-18
- Mesiodistal sizes = from lingual to buccal ends
- Classes are based on "Angle's classification" of malocclusion groups
- Distances are given in millimeters

Male			Female		
Class I	ClassII	Class III.	Class I	ClassII	Class III

	Mandible				Mandible		
Central	5.64 ± 0.40	5.73 ± 0.33	5.58 ± 0.31	ns	5.60 ± 0.37a	5.63 ± 0.46a	5.40 ± 0.4b
Lateral	6.19 ± 0.47	6.26 ± 0.32	6.08 ± 0.35	ns	6.09 ± 0.38	6.13 ± 0.32	5.97 ± 0.42
Canine	7.02 ± 0.58a	7.26 ± 0.42b	6.92 ± 0.37a	**	6.65 ± 0.38a	6.85 ± 0.38b	6.55 ± 0.41a
First premolar	7.18 ± 0.42	7.36 ± 0.46	7.14 ± 0.45	ns	7.13 ± 0.46a	7.18 ± 0.43a	6.91 ± 0.54b
Second premolar	7.29 ± 0.48	7.56 ± 0.73	7.38 ± 0.39	ns	7.12 ± 0.49	7.19 ± 0.47	7.03 ± 0.51
First molar	11.45 ± 0.63	11.51 ± 0.54	11.57 ± 0.65	ns	10.89 ± 0.62	11.07 ± 0.56	10.82 ± 0.69
Second molar	10.69 ± 0.61	10.66 ± 0.80	10.98 ± 0.61	ns	10.13 ± 0.55	10.35 ± 0.65	10.2 ± 0.61

Conclusions/action items:

Base the dimensions and different matrix band sizes on sizing data of relevant teeth. Use dental naming and numbering systems to address specific areas of the oral cavity and teeth.

2022/02/11 - Matrix Band Sizing

DRAESON MARCOUX (dmarcoux@wisc.edu) - Mar 02, 2022, 2:45 PM CST

Title: Sizing of Existing Matrix Bands

Date: Feb. 11, 2022

Content by: Draeson Marcoux

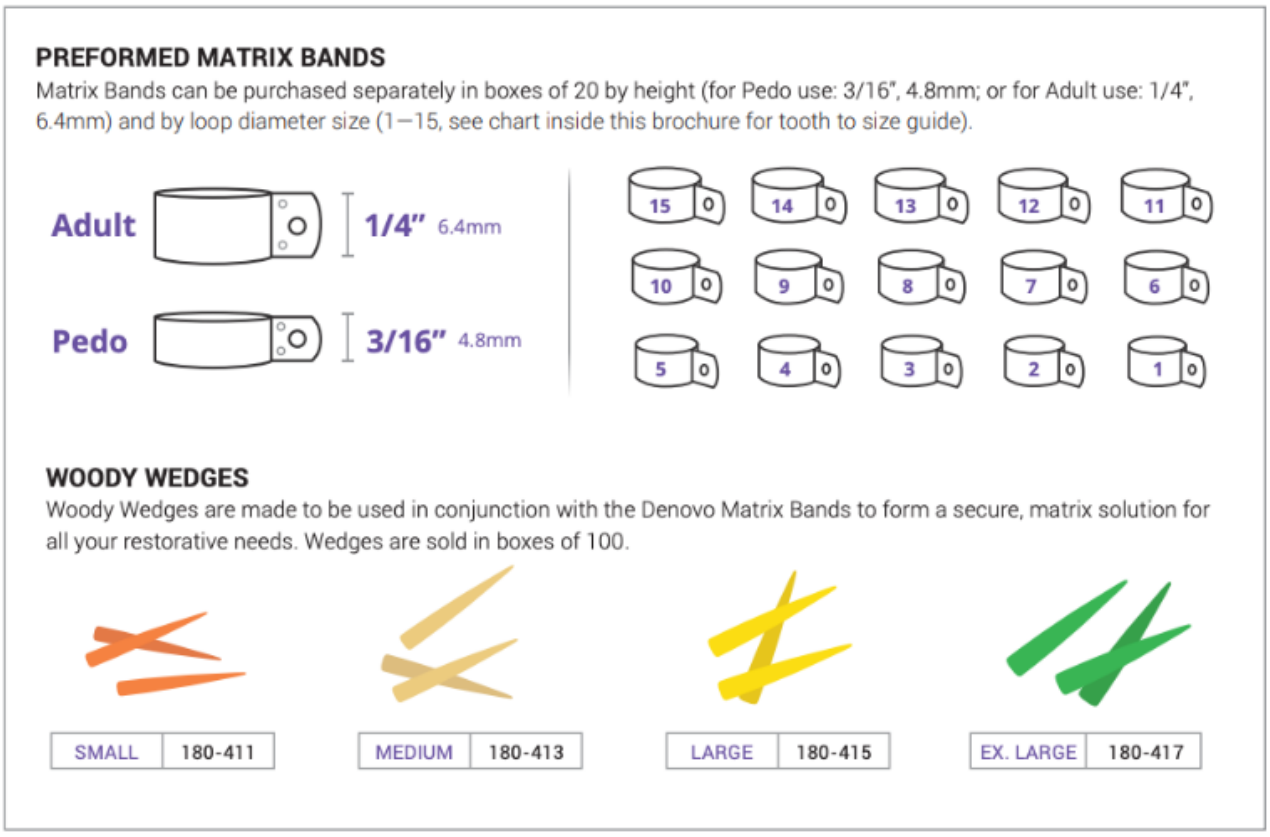
Present: N/A

Goals: To look at size ranges for existing dental matrix bands and base our dimensions on those along with our tooth anatomy research

Content:

Denovo Dental Matrix Systems - https://denovodental.com/app/uploads/2015/11/Matrix-Band-Instructions1.pdf

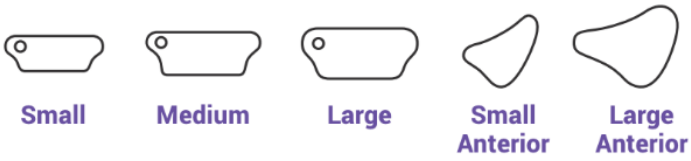
- Preformed matrix band (circumferential) offers Adult and Pediatric types with heights of 6.4mm (1/4") and 4.8mm (3/16") respectively
  - Each type has sizes 1-15 with varying diameters (actual diameters not listed)
- Strip-T Matrix System (sectional) offers small, medium, large, small anterior, and large anterior sizings and forms
- Both offer small, medium, large and extra large woody wedges that are compatible with both bands



STRIP-T MATRIX KIT

The Strip-T Matrix is a highly effective and economical matrix system that can be used for a variety of applications, including posterior and anterior restorations. The introductory kit comes with 250 matrices (50 of each size) and 400 wooden wedges (100 of each size). An excellent companion to the Retainerless Matrix System.

PART #	177-301



Small Medium Large Small Anterior Large Anterior

Tofflemire® Matrix Band - https://www.waterpik.com/oral-health/pro/dental-supplies/matrix/band-tofflemire/

- Circumferential matrix bands available in 2 thicknesses: 0.002" and 0.0015"
- Offer Adult, modified Adult, and Pediatric sizing
  - modified Adult "wide" is available in both thicknesses while "narrow" is only available in 0.0015"
- Different counts of matrix bands are available to purchase in packs which can be seen in the right column

Available Sizes

No. 1 Adult Universal - .002 in (.05 mm)	34577-0 36 Bands
No. 1 Adult Universal - .002 in (.05 mm)	062001-000 144 Bands
No.1 Adult Universal - .0015 in (.0375 mm)	34578-9 36 Bands
No. 1 Adult Universal - .0015 in (.0375 mm)	062002-000 144 Bands
No. 1 Adult Universal - .0015 in (.0375 mm)	061032-000 1000 Bands
No. 2 Adult MOD Wide - .002 in (.05 mm)	34579-7 36 Bands
No. 2 Adult MOD Wide - .0015 in (.0375 mm)	34580-0 36 Bands
No. 3 Adult MOD Narrow - .0015 (.0375 mm)	34582-6 36 Bands
No. 13 Pedo Universal - .002 in (.05 mm)	34584-2 36 Bands
No. 13 Pedo Universal - .0015 in (.0375 mm)	34585-0 36 Bands
No. 13 Pedo Universal - .0015 in (.0375 mm)	062010-000 144 Bands

Conclusions/action items:

Continue to gather data on various sizes available in the market. Modify our design to offer multiple sizing options that can cover the range of marketable needs once we have on solid prototype of proper dimensions.

2022/04/16 - Walser Matrices

DRAESON MARCOUX (dmarcoux@wisc.edu) - May 09, 2022, 2:22 AM CDT

Title: Walser Sectional Matrix System

Date: April 16, 2022

Content by: Draeson Marcoux

Present:

Goals: To Identify characteristics of a matrix band that can also be used to fill interproximal type cavities

Content:

Walser Website - https://www.walser-dental.com/en/walser-matrices/clips-matrix-system/

- Clip O-shape sectional matrix band utilizes a built-in spring loaded clamp system that is opened with tweezers/forceps
- Provides a sectional matrix band-like contour around both sides of **one** tooth
- Newly developed X-shaped matrix band similar to butterfly design but with built-in spring loaded clamp system

Conclusions/action items:

Consider this matrix band and its patents in relation to the novelty of our design. Potentially modify design to avoid patent infringement.

2022/02/03 - Potential 3rd Party Manufacturers

DRAESON MARCOUX (dmarcoux@wisc.edu) - Mar 02, 2022, 1:47 PM CST

Title: 3rd Party Prototyping Companies

Date: February 3, 2022

Content by: Draeson Marcoux

Present: N/A

Goals: To find a company that could fabricate our design on the proper scale and with the desired material.

Content:

Midwest Prototyping - https://midwestproto.com/

- Works mainly with plastics and cannot fabricate such small, precise dimensions
- Laser Sintering - Powdered thermoplastics are precisely fused by a high-power laser.
- Multi - Jet Fusion - Additive manufacturing process that uses a powdered thermoplastic, liquid agent and infrared energy to fuse
- Stereolithography - UV-sensitive liquid resins are instantly cured after UV laser activation.
- Digital Light Processing - UV sensitive liquid resin cured by a digital light projector. Supports removed after processing
- Fused Filament Fabrication - Thermoplastic filament is melted through a heated nozzle and selectively extruded
- Material Jetting/Polyjet - UV sensitive gel deposited by a print head and cured with UV lamp. Rigid and rubber-like materials
- Case Urethane
- 3D Scanning - lasers capture shape of physical objects to create a CAD file
- Additional Capabilities that require sheet metal or CNC machined components available through Protek - https://www.prototek.com/
    - Sheet Metal:
        - Manufacturing Design Assistance
          Laser Cutting - Punching
          Material Graining
          Drilling - Countersinking - Tapping
          Forming - Bending
          Hardware Insertion
          Mechanical Assembly
          TIG, MIG, Spot Welding & Weld Grinding
          Welded Assemblies & Frames
- Called and they said they likely would not be able to work with us as they do most fabrication in plastics

Protolabs - https://www.protolabs.com/resources/guides-and-trend-reports/metal-fabrication-a-guide-to-manufacturing-metal-parts/

Big Blue Saw - https://www.bigbluesaw.com/home?gclid=CjwKCAiAyPyQBhB6EiwAFUuakrZMOSvd-JR-vddHND9EeigffjbE--TEhIp1cqJgbvmLEfA05aB2mBoCGTIQAvD_BwE

- Found this source from the previous team's work where they stated they had come to an agreement to produce a prototype of similar proportions and material
- Located in Atlanta, Georgia
- Orders as low as 1 part, delivered straight to us
- Use Waterjet to manufacture parts
- Called and confirmed that a part could likely be manufactured, we simply need to submit a compatible CAD file to receive a quote

Conclusions/action items:

Trevor was able to make contact with Sector67, a education and manufacturing company, that was able to laser cut a prototype for us within a day. We've also contacted them about being trained on their laser cutter so we will be able to print multiple iterations when we'd like to make modifications. For now, we will continue with Sector67 as our main manufacturer.

2022/02/03 - Metal on Metal Bonding

DRAESON MARCOUX (dmarcoux@wisc.edu) - Mar 02, 2022, 1:54 PM CST

Title: Metal on Metal Bonding

Date: February 3, 2022

Content by: Draeson Marcoux

Present: N/A

Goals: To find a method of bonding the 2 "halves" of our folded design together

Content:

"The development of resing-bonding for amalgam restorations" - https://www.nature.com/articles/4800102.pdf?origin=ppub#:~:text=Some%20of%20the%20main%20adhesives,phoric%20acid%20for%2015%20seconds.

- "Resin cements as amalgam bonding agents"
    - Superbond and Panavia were 2 resins used that were found to be very effective in bonding amalgam to the enamel surfaces of tooth restorations.
    - Bond strengths of up to 17.7 MPA for Superbond * though this may have been in relation to its bond between amalgam and enamel
- Current adhesives used to bond amalgam
    - "intended for use with some resin composites. Some of them also have metal bonding capabilities and may be used alone or with additional components for amalgam bonding"
    - All-Bond 2 (Bisco) - enamel and dentine are acid etched with this adhesive
    - Amalgambond Plus with HPA (high performance additive) powder (Parkell) - dentine is acid etched and primed. "Self-curing methacrylate resin is applied to impregnate the primed dentine". Contains adhesive monomer called 4-META
    - Optibond 2 (Kerr)
    - Panavia EX - Powder and liquid system
    - Panavia 21 (Kuraray) - Paste-paste system * Best

"METAL GLUE: ALL YOU NEED TO KNOW" - https://www.loctiteproducts.com/en/know-how/fix-stuff/metal-glue.html

- TYPES OF METAL GLUE
    - epoxy adhesives - often used in carpentry or woodworking, or for specialized jewelry. Can be: flexible or rigid, transparent or opaque, fast or slow setting. High resistance to hear and chemicals
    - polyurethanes - Most commonly used with metal. Water-resistant, UV-resistant and set quickly without brittleness. Works on metals across a wide range of temperatures
    - super glues - high-performance industrial, best for metal as well as fabrics, wood and plastics. Loctite Super Glue Liquid is recommended for bonding of metals

Conclusions/action items:

Pursue epoxy initially to bond the sections of the folded design as it is described as the best material for bonding metal to metal. Should we have issues with thickness, bonding time, bonding strength, or anything else, we will reevaluate and likely attempt to use another bonding agent like super glue.

2022/02/18 - Potential Mechanical Testing

DRAESON MARCOUX (dmarcoux@wisc.edu) - Apr 26, 2022, 5:34 PM CDT

Title: Mechanical Testing Protocols

Date: February 18, 2022

Content by: Draeson Marcoux

Present: N/A

Goals: Gather ideas about potentially relevant forms of mechanical testing

Content:

Shear Testing of the Epoxy - "A Guide to Shear Testing" - https://www.azom.com/article.aspx?ArticleID=18907

- Lap Shear testing is commonly done on adhesives
- Sunlight and heat can influence adhesive strength so they must be kept in mind during the testing procedure
- ASTM D1002 – Standard Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading
    - This is the standard test method that we would use for our design
- Overlap area influences the maximum shear load that can be applied and should be accounted for in the testing protocol
- Overlap width of the joint influences strength as well while overlap length is not as influential
- A depiction of the different joint/lap types can be seen below

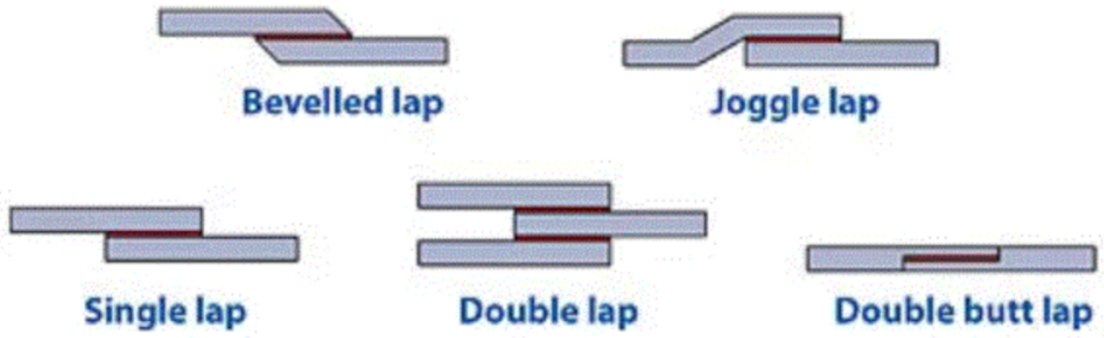


Image Credit: Admet, Inc. - Materials Testing Equipment

Conclusions/action items:

We've determined that, for the time being, our focus will be on the qualitative testing and fabricating a quality prototype as they are more relevant and important to our design process.

2022/03/07 - Metals Research

DRAESON MARCOUX (dmarcoux@wisc.edu) - May 09, 2022, 1:45 AM CDT

Title: Metals Research

Date: March 7, 2022

Content by: Draeson Marcoux

Present:

Goals: Find a material that has similar properties to the Tofflemire band. Improve on plastic deformation when compared to 1008/1010 steel.

Content:

What are matrix bands? - https://forwardonclimate.org/trending/what-are-matrix-bands/

- Made out of surgical grade stainless steel
- Manufactured generally using a stamp out which provides "consistently smooth (burr-free) edges that keep you patient comfortable and reduce the risk of gingival trauma"

1008 vs 1010 Steel Comparison - https://capitalsteel.net/blog/1008-vs-1010-steel-comparison

CHEMICAL PROPERTIES

The chemical properties of 1008 and 1010 steel are the following.

	1008	1010
Carbon, C	0.10% Max	0.08-0.13%
Manganese, Mn	0.30-0.50%	0.30-0.60%
Sulfur, S	0.050%	0.050%
Phosphorus, P	0.040%	0.040%

MECHANICAL PROPERTIES

The following are the mechanical properties for both cold drawn and hot rolled 1008 and 1010 steel.

Cold Drawn

	1008	1010
Tensile Strength	49,000 psi	53,000 psi
Yield Strength	41,500 psi	44,000 psi
Elongation (2")	20%	20%
Reduction in Area	45%	40%
Brinell Hardness	95	105

Hot Rolled

	1008	1010
Tensile Strength	44,000 psi	47,000 psi
Yield Strength	24,500 psi	26,000 psi
Elongation (2")	30%	28%
Reduction in Area	55%	50%
Brinell Hardness	86	95

The average machinability rating percentage based on SAE1212 as 100% for 1008 cold drawn and 1010 cold drawn:

Type 316 and 316L Stainless Steels - https://www.thoughtco.com/type-316-and-316l-stainless-steel-2340262

- 316 - contains more carbon and more susceptible to weld decay than 316L (L stands for low carbon) but is more durable in acidic environments
- "Annealing (a treatment to reduce hardness and increase ductility, or the ability to accept plastic deformation) 316 and 316L stainless steels require heat treatment of between 1,900 and 2,100 degrees Fahrenheit (1,038 to 1,149 degrees Celsius) before rapidly quenching."
- Approximate modulus of elasticity of both 316 and 316L: 193x10^3 MPA in tension

Element	Type 316 (%)	Type 316L (%)
Carbon	0.08 max.	0.03 max.
Manganese	2.00 max.	2.00 max.
Phosphorus	0.045 max.	0.045 max.
Sulfur	0.03 max.	0.03 max.
Silicon	0.75 max.	0.75 max.
Chromium	16.00-18.00	16.00-18.00
Nickel	10.00-14.00	10.00-14.00
Molybdenum	2.00-3.00	2.00-3.00
Nitrogen	0.10 max.	0.10 max.

Conclusions/action items:

316L stainless steel would likely be the most effective metal for our application of a matrix band. The inclusion of nickel, while some are allergic, is likely low enough to precent a reaction, and provides increased plasticity. It also has a lower carbon content than both 1008/1010 steel and 316 stainless steel, making it more dead-soft.

2022/03/11 - Potential Journals

DRAESON MARCOUX (dmarcoux@wisc.edu) - May 09, 2022, 1:55 AM CDT

Title: Potential Journals

Date: March 11, 2022

Content by: Draeson Marcoux

Present:

Goals: To find suitable journals to submit out final research paper to

Content:

Journal of Medical Devices - https://asmedigitalcollection.asme.org/medicaldevices

- Impact Factor: 0.582
- Design innovation paper format
- Guide for Journal authors
  - https://www.asme.org/wwwasmeorg/media/resourcefiles/shop/journals/asme_guide_for_journal_authors_final.pdf
- Information for authors - https://www.asme.org/publications-submissions/journals/information-for-authors

Journal of The American Dental Association (JADA) - https://jada.ada.org/

- Impact factor: 3.634
- Information for authors - https://jada.ada.org/content/authorinfo

Conclusions/action items:

Initially we chose to submit to the Journal of The American Dental Association, but because they do not accept article types in the format that best fits our project, we transitioned to the Journal of Medical Devices. This journal accepts Design Innovation papers which is better suited for our project and has a lower impact score making it a better option.

2022/04/07 - Marketability Research

DRAESON MARCOUX (dmarcoux@wisc.edu) - May 09, 2022, 2:15 AM CDT

Title: Marketability Research

Date: April 7, 2022

Content by: Draeson Marcoux

Present:

Goals: To determine, in what capacity, our product might be able to serve in commercial markets

Content:

Interproximal caries and premature tooth loss in primary dentition as risk factors for loss of space in the posterior sector - https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6426507/

- Small sample (17 kids with an average age of about 6)
- All had cavities and 88% had interproximal cavities

Presence of Interproximal Carious Lesions in Primary Molars - https://pubmed.ncbi.nlm.nih.gov/33662247/

- In a population of young high-risk children where almost 1300 molars were analyzed, about 70% - 90% of the children had interproximal cavities

Treatment of Interproximal Cavities on Primary Molar Teeth With Silver Diamine Fluoride - https://clinicaltrials.gov/ct2/show/NCT03770286

- "Vast majority of caries observed in children 5-10 are on interproximal surfaces"

Dental Caries (Tooth Decay) in Children Age 2 to 11 - https://www.nidcr.nih.gov/research/data-statistics/dental-caries/children

Prevalence of caries in primary teeth (dft) among youths 2–11 years of age, by selected characteristics: United States, National Health and Nutrition Examination Survey, 1999–2004

Characteristic	Percent with caries in primary teeth
Age	
2 to 5 years	27.90
6 to 11 years	51.17
Sex	
Male	44.43
Female	39.80
Race and Ethnicity	
White, non-Hispanic	38.56
Black, non-Hispanic	43.34
Mexican American	55.40
Poverty Status (Income compared to Federal Poverty Level)	
Less than 100%	54.33
100% to 199%	48.75
Greater than 200%	32.30
Overall	**42.17**

Prevalence of tooth decay in permanent teeth (DFT) among youths 6–11 years of age, by selected characteristics: United States, National Health and Nutrition Examination Survey, 1999–2004

Characteristic	Percent with decay in permanent teeth
Age	
6 to 8 years	10.16
9 to 11 years	31.36
Sex	
Male	19.36
Female	22.87
Race and Ethnicity	
White, non-Hispanic	18.59
Black, non-Hispanic	19.03
Mexican American	30.76
Poverty Status (Income compared to Federal Poverty Level)	
Less than 100%	28.28
100% to 199%	24.09
Greater than 200%	16.31
Overall	**21.06**

Conclusions/action items:

Target marketing towards children who have a higher prevalence of interproximal cavities when there is at least one cavity. Continue research to find more about financial aspects of matrix bands. Feedback from dentist recommended keeping sale price at or below 50 cents per matrix band. Other similar matrix bands I've seen online range from $1 - $2 per.

2022/02/24 - Design Iterations

DRAESON MARCOUX (dmarcoux@wisc.edu) - May 09, 2022, 2:15 AM CDT

Title: Design Iterations

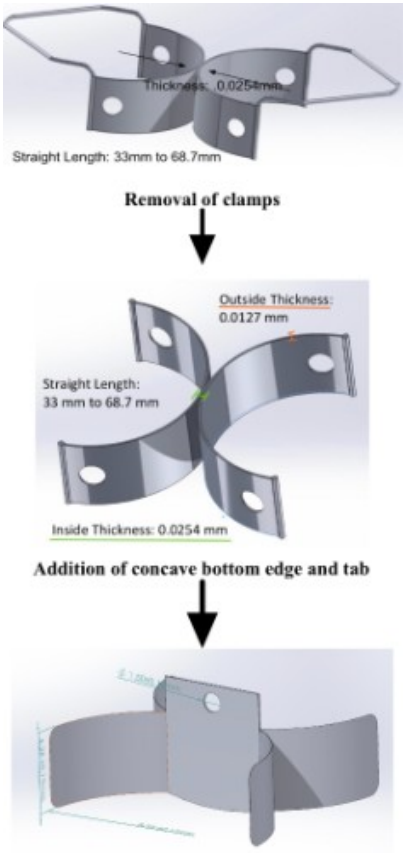
Date: Feb. 24, 2022

Content by: Draeson Marcoux

Present: N/A

Goals: To lay out each step of the design process, modifications that were made, and justification for those modifications

Content:



Epoxy Thickness

MATTHEW FANG (mjfang@wisc.edu) - Feb 16, 2022, 9:26 PM CST

Title: Epoxy Research

Date: 2/15/2022

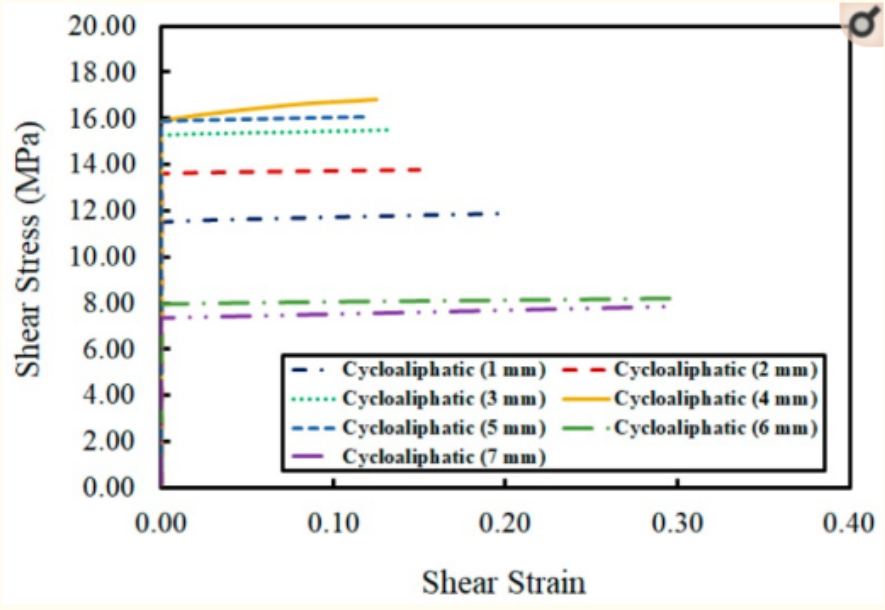
Content by: Matthew Fang

Present:

Goals: Determine the effects that Epoxy may have on our design

Content:

- Shear stress development still allows for a lot of strength



Open in a separate window

Figure 7

Relationship between shear strain and shear stress for Adhesive 2.

- Shear Strength doesnt increase past 4mm
  - Try for super thin layer

Conclusions/action items:

Yeon, Jaeheum et al. “Effects of Epoxy Adhesive Layer Thickness on Bond Strength of Joints in Concrete Structures.” *Materials (Basel, Switzerland)* vol. 12,15 2396. 27 Jul. 2019, doi:10.3390/ma12152396

Types of Epoxy

MATTHEW FANG (mjfang@wisc.edu) - Feb 16, 2022, 9:41 PM CST

Title: Epoxy Type

Date: 2/162020

Content by: Matthew Fang

Present:

Goals: Look into finding an epoxy for our prototype

Content:

- The operating conditions of epoxy compounds may have a large impact on their strength, as well as the strength of adhesive joints made with the use of various epoxy compounds
    - Under conditions of high humidity, epoxy compounds may change their strength reversibly or irreversibly, which was presented and confirmed in many works
- exposure to moisture results in plasticization and decreases in the performance characteristics of epoxy adhesives
- The epoxy adhesive containing this type of epoxy resin is used for “cold” bonding of glass, metals, thermosetting polymers, ceramics, leather, and rubber.
    - It is most often used with low molecular weight (liquid) epoxy resins or in various compounds based on them

Conclusions/action items:

Rudawska, Anna. “Mechanical Properties of Epoxy Compounds Based on Bisphenol a Aged in Aqueous Environments.” *Polymers* vol. 13,6 952. 19 Mar. 2021, doi:10.3390/polym13060952

Dental Journals to Submit

MATTHEW FANG (mjfang@wisc.edu) - Mar 02, 2022, 11:12 AM CST

Title: Dental Journal

Date: 2/14/2022

Content by: Matthew Fang

Present:

Goals: Determine which journal we should

Content:

- Journal of the American Dental Association (1939)
- Journal of dental research
- The Dental register
- Dental materials journal
- Journal of dentistry

Conclusions/action items:

Packaging

MATTHEW FANG (mjfang@wisc.edu) - May 08, 2022, 1:26 PM CDT

Title: Packaging Research

Date: 4/8/2022

Content by: Matthew Fang

Present:

Goals: Determine good ways to package out butterfly design

Content:

- Low-risk (Class I) devices are subject to “general controls,” which include adherence to predefined Good Manufacturing Practices (GMP), such as adequate manufacturing, packaging and storage
  - PMDA hosts a publicly searchable database of adverse event and recall data as well as a database for package inserts.
- Hard casing for bands prevents crinkling of edges, protects design structure
  - Higher Volume

Kramer DB, Tan YT, Sato C, Kesselheim AS. Ensuring medical device effectiveness and safety: a cross--national comparison of approaches to regulation. *Food Drug Law J*. 2014;69(1):1-i.

Conclusions/action items:

Cad Flat Model

MATTHEW FANG (mjfang@wisc.edu) - Mar 02, 2022, 10:39 AM CST

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Matrix_Band_Flat.SLDPRT (106 kB)

MATTHEW FANG (mjfang@wisc.edu) - Mar 02, 2022, 10:39 AM CST

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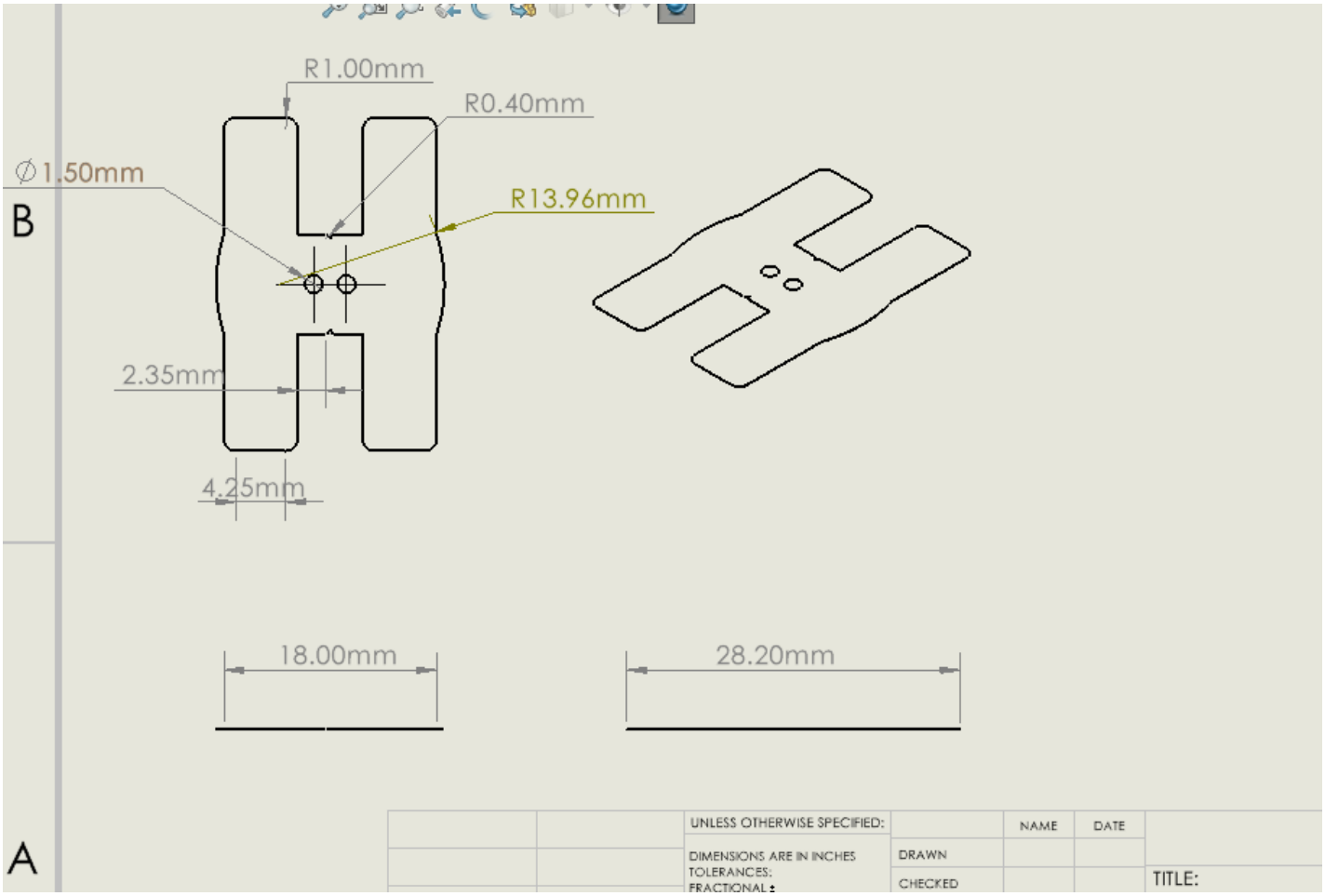
Matrix_Band_Flat.SLDDRW (128 kB)

MATTHEW FANG (mjfang@wisc.edu) - Mar 02, 2022, 10:50 AM CST



Cad Flat Model v2

MATTHEW FANG (mjfang@wisc.edu) - Mar 02, 2022, 10:51 AM CST

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Matrix_Band_Flatv2.SLDDRW (125 kB)

MATTHEW FANG (mjfang@wisc.edu) - Mar 02, 2022, 10:51 AM CST

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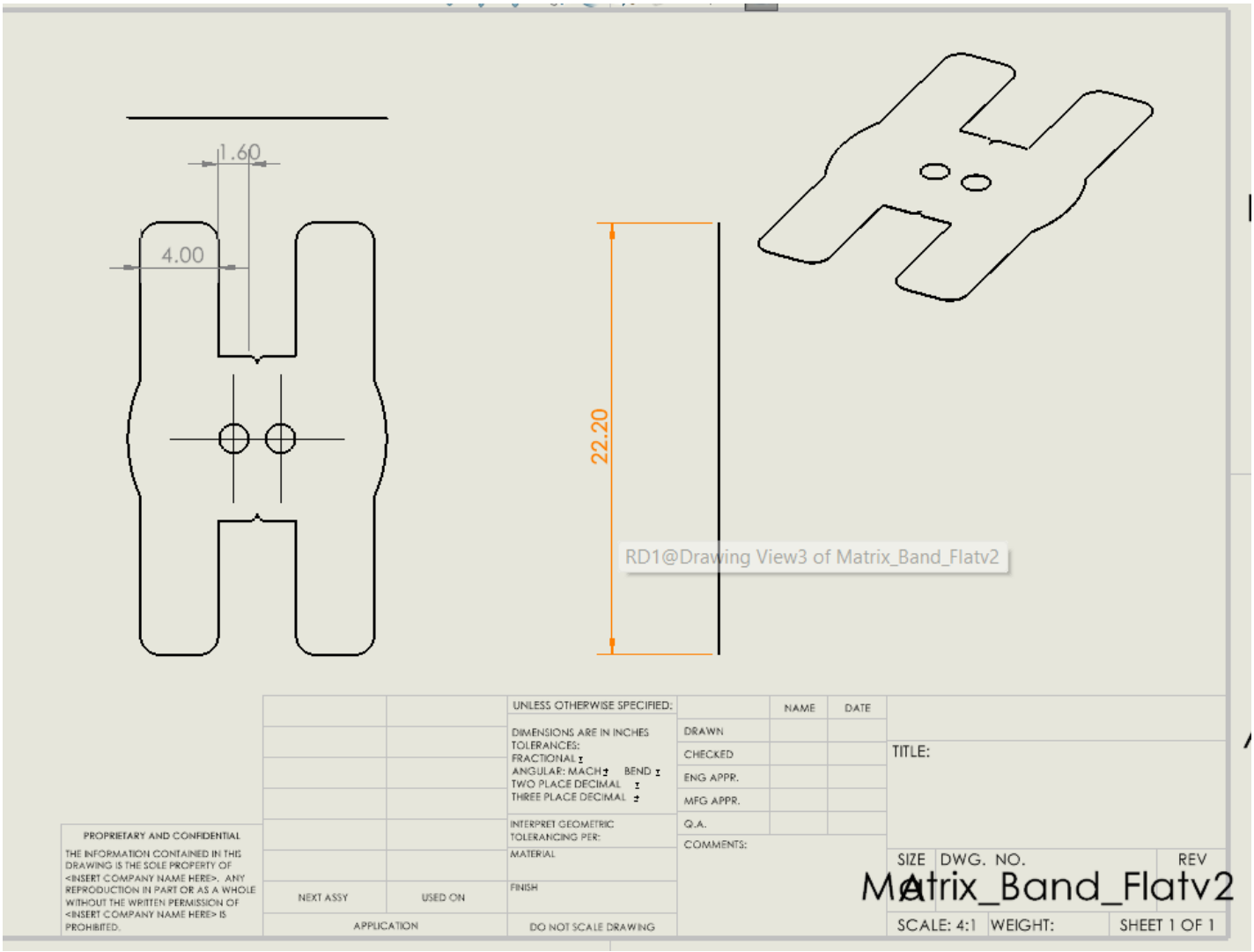
Matrix_Band_Flatv2.SLDPRT (110 kB)

MATTHEW FANG (mjfang@wisc.edu) - Mar 02, 2022, 10:52 AM CST



Cad Flat Model v3

MATTHEW FANG (mjfang@wisc.edu) - Mar 02, 2022, 10:52 AM CST

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Matrix_Band_Flatv2_Bigger_Convex.SLDDRW (123 kB)

MATTHEW FANG (mjfang@wisc.edu) - Mar 02, 2022, 10:52 AM CST

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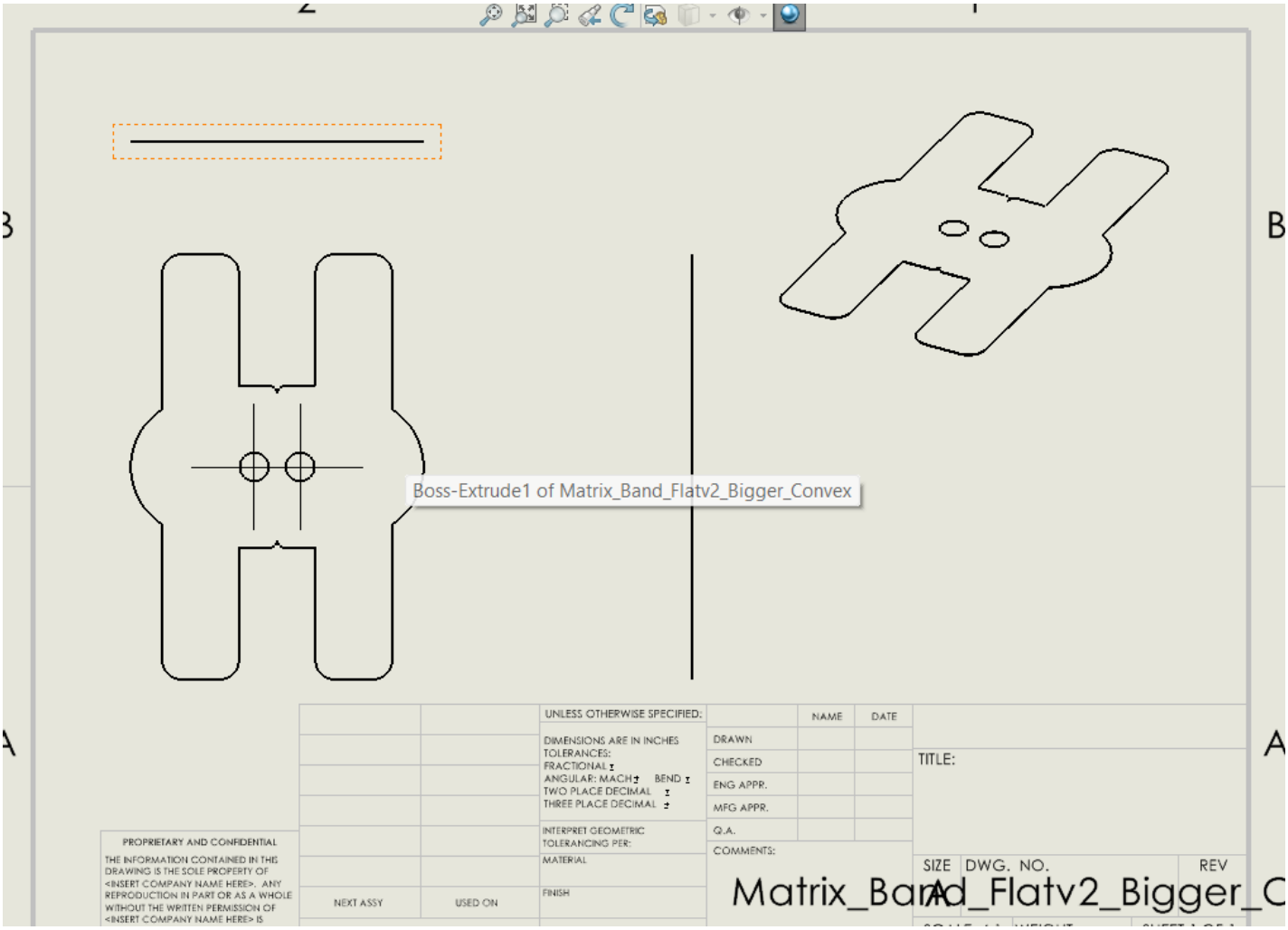
Matrix_Band_Flatv2_Bigger_Convex.SLDPRT (111 kB)

MATTHEW FANG (mjfang@wisc.edu) - Mar 02, 2022, 10:54 AM CST



Cad Flat Model v4

MATTHEW FANG (mjfang@wisc.edu) - Mar 02, 2022, 10:54 AM CST

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Matrix_Band_Flatv2_Large_Tab.SLDDRW (126 kB)

MATTHEW FANG (mjfang@wisc.edu) - Mar 02, 2022, 10:54 AM CST

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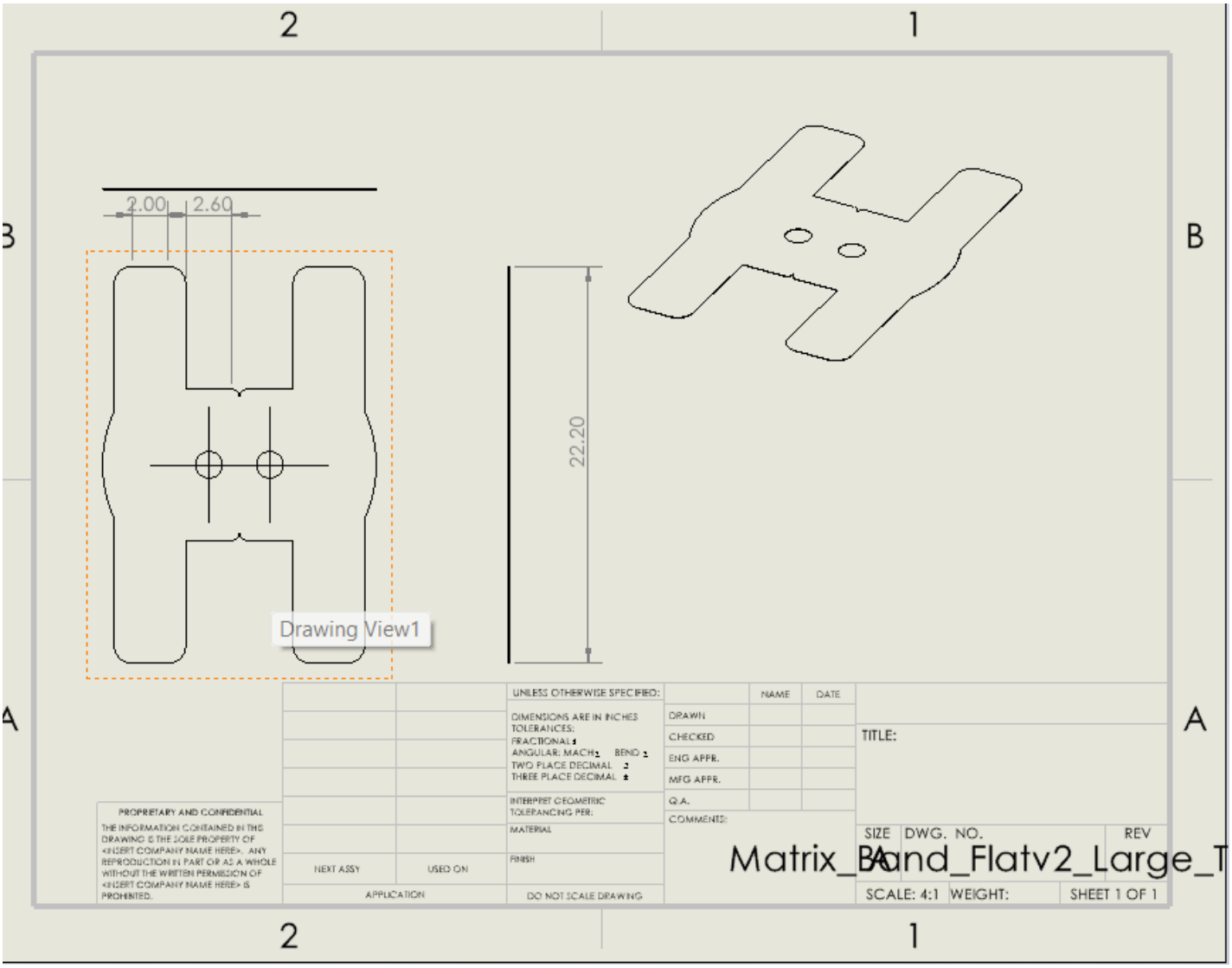
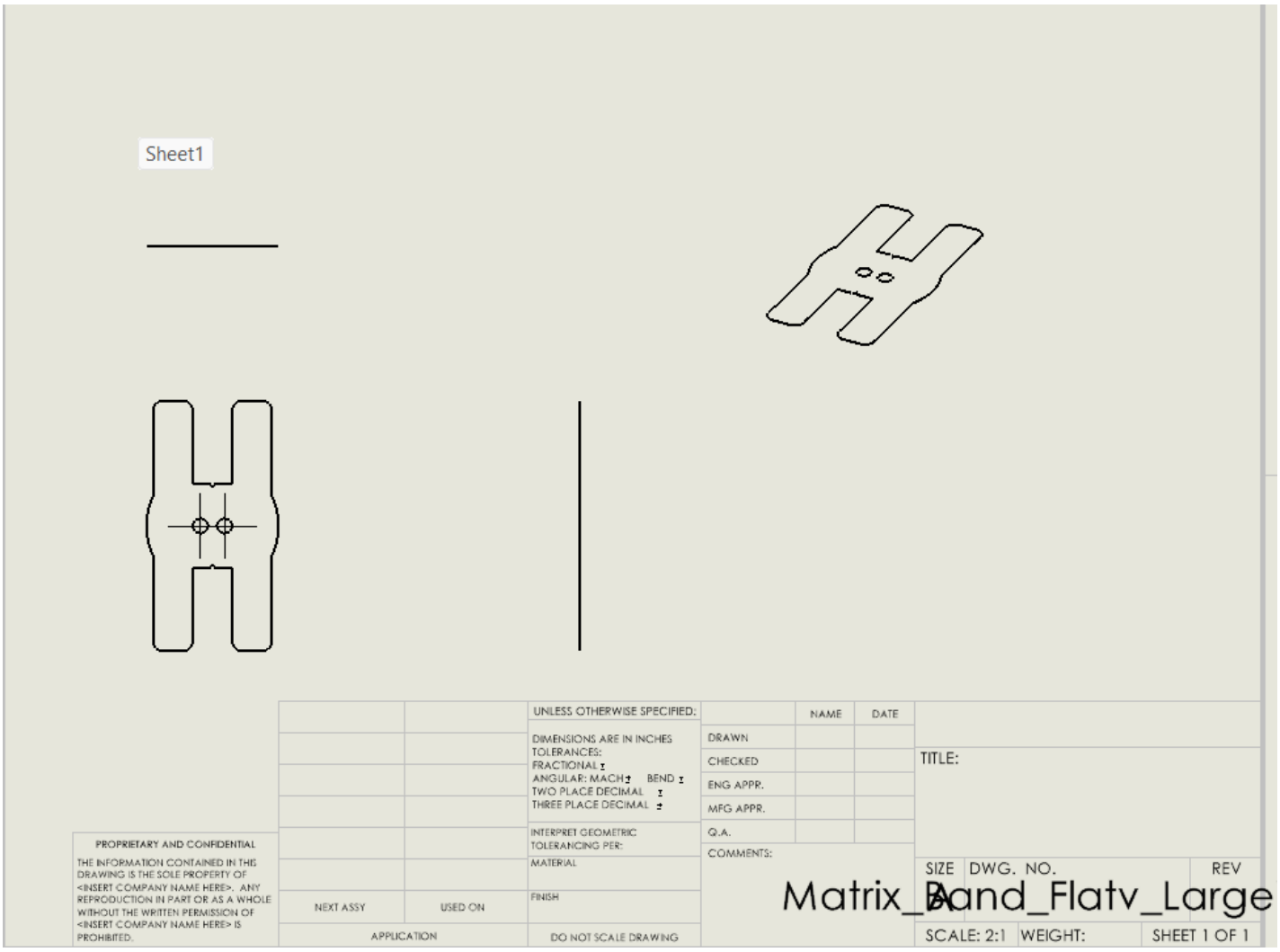
Matrix_Band_Flatv2_Large_Tab.SLDPRT (115 kB)

MATTHEW FANG (mjfang@wisc.edu) - Mar 02, 2022, 10:55 AM CST



Cad Flat Model v5

MATTHEW FANG (mjfang@wisc.edu) - Mar 02, 2022, 11:00 AM CST



Cad Flat Model v6

MATTHEW FANG (mjfang@wisc.edu) - Mar 02, 2022, 11:00 AM CST

Download

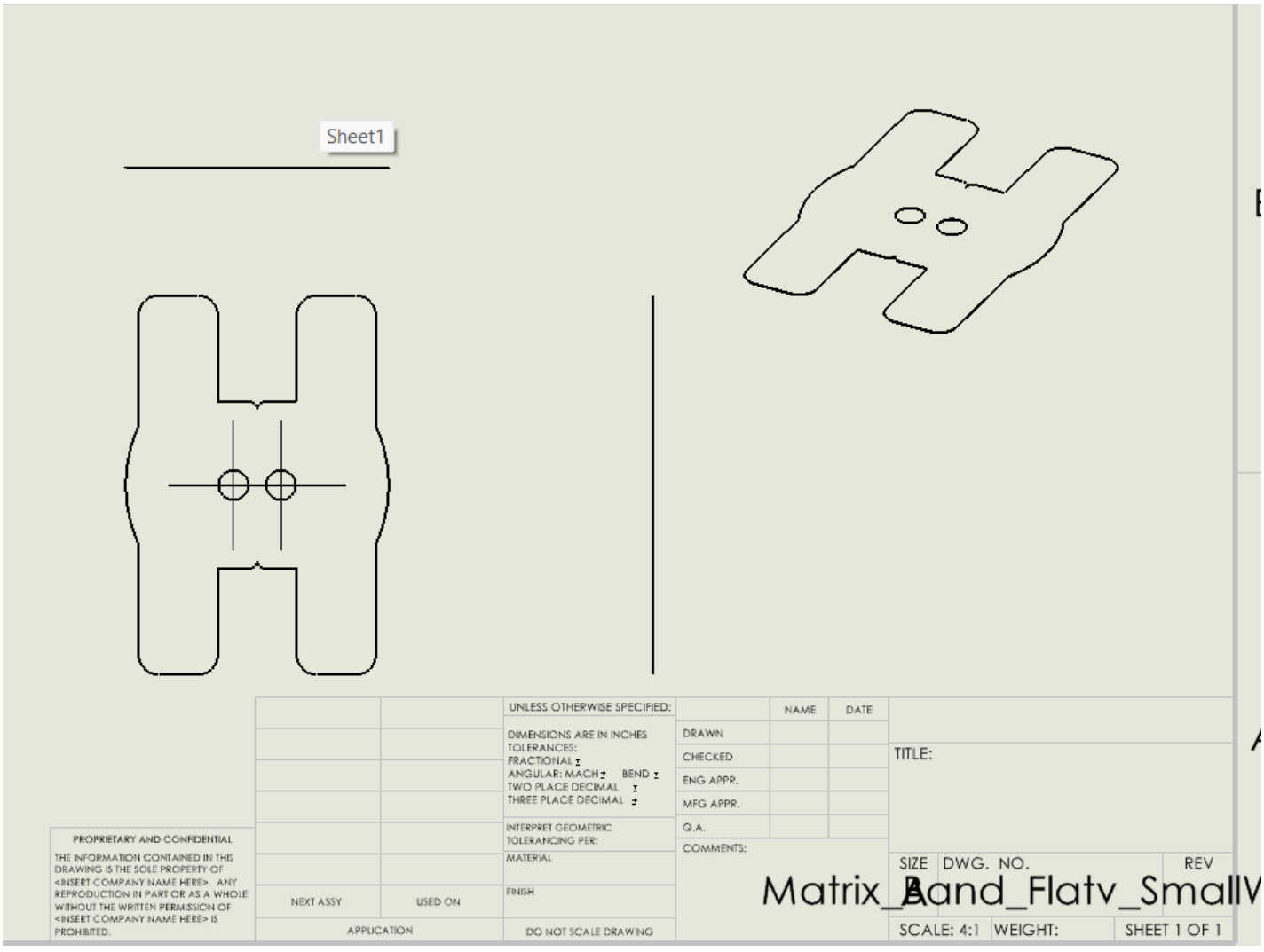
Matrix_Band_Flatv_SmallWing.SLDDRW (122 kB)

MATTHEW FANG (mjfang@wisc.edu) - Mar 02, 2022, 11:00 AM CST

Download

Matrix_Band_Flatv_SmallWing.SLDPRT (141 kB)

MATTHEW FANG (mjfang@wisc.edu) - Mar 02, 2022, 11:02 AM CST



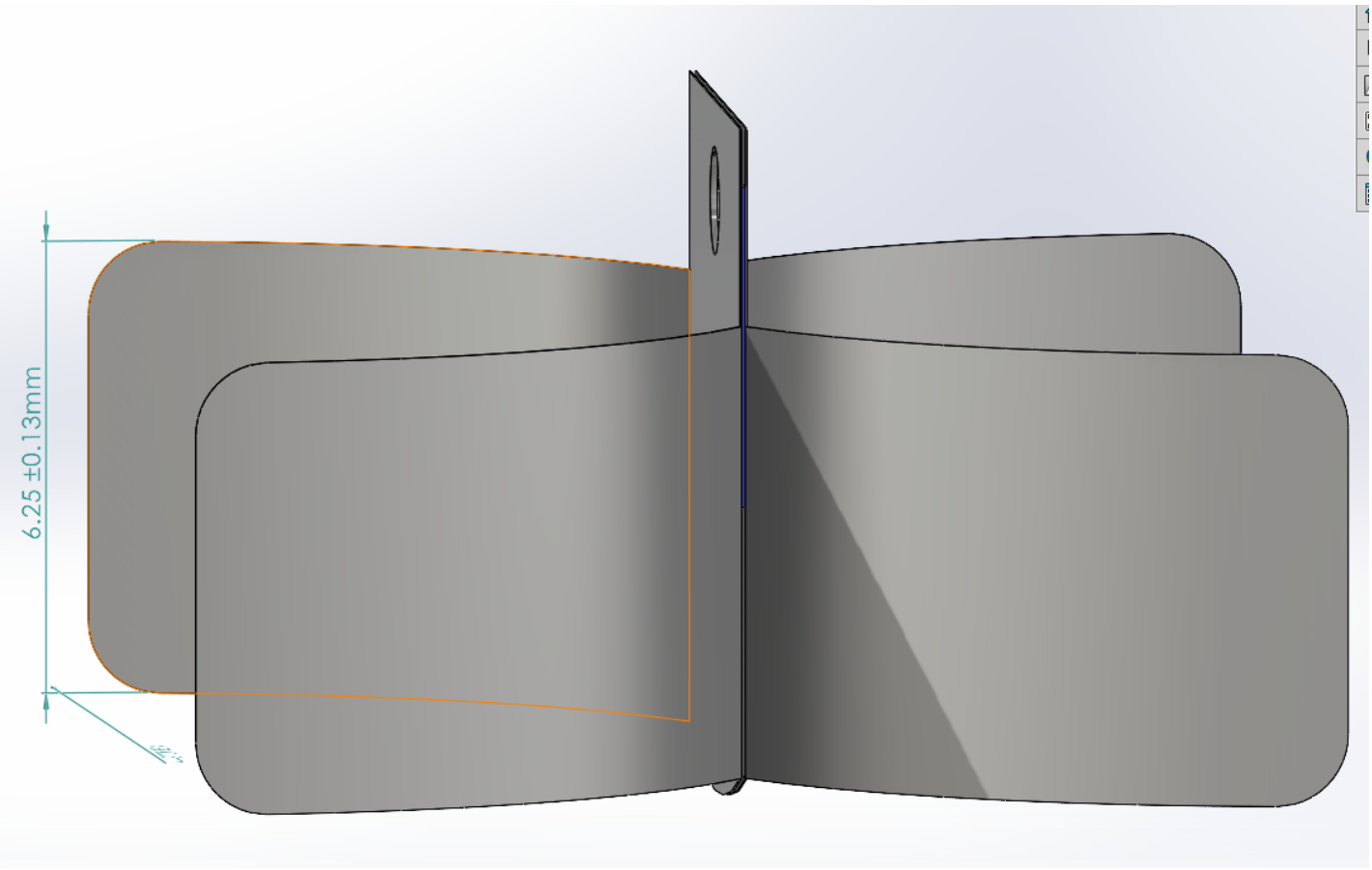
New Prelim Design

MATTHEW FANG (mjfang@wisc.edu) - Mar 02, 2022, 10:47 AM CST

Download

New_Prelim_Design.SLDPRT (200 kB)

MATTHEW FANG (mjfang@wisc.edu) - Mar 02, 2022, 10:47 AM CST



Self-Sealing Sterilization Pouch

TREVOR SILBER - Mar 02, 2022, 2:53 PM CST

Title: Self-Sealing Sterilization Pouch

Date: 2/8/22

Content by: Trevor

Present: N/A

Goals: Gain knowledge on how other matrix bands are packaged

Content:

After doing some research on different dentistry websites, I found that there are a lot of devices sold in sterilization pouches. Upon further investigation, I found that a box of 200 pouches for only $8.99 on Amazon.

‹ Back to results

Roll over image to zoom in

200 2.25 x 2.75 Inch Self Sealing Sterilization Autoclave Pouch Bags with Indicators, 1 Box of 200

Visit the PlastCare USA Store

4.5 out of 5 stars 233 ratings

Amazon's Choice for "sterlization pouch steam"

Price: $8.99 prime & FREE Returns

- BULK SELF-STERILIZATION BAGS: PlastCare USA provides boxes of 200 pouches. These sterilizing bags keep teeth cleaning instruments and other dental tools sterilized until their next use. Keep your dental office or lab clean and sterile with these pouches.
- KEEP TOOLS CLEAN: After instruments have been cleaned, they must be placed in sterile bags or pouches to ensure that they remain sterile until their next use. This is true for nail technicians, dentists, and other medical professionals. Knowing you're getting clean and sterile instruments is a very calming thought when sitting in the dentist chair.
- EFFECTIVE INFECTION CONTROL: These self-sterilization pouches help ensure the safety of staff members and dental patients alike.
- MAINTAIN ORGANIZATION: Not only do these pouches help with sterilization but they also improve organization. These pouches act as organizers as they keep dental tool kits together so all the instruments are in the same place.
- HOW TO USE: Fold perforation back and crease with the protective strip still in place. While wearing gloves, load the clean instruments into the pouch. Do not overfill bag. We recommend filling ¾ full. Make sure instruments don't pierce package. Expel excess air. Remove strip from adhesive, and fold at perforated line and adhere to both the plastic and the paper to form a tight seal.

Specifications for this item

Brand Name	PlastCare USA
Model Number	RIT-2337-200
Number of Items	1
Part Number	RIT-2337-200
UNSPSC Code	42281904

See more product details

Conclusions/action items:

The team will need to decide on final packaging for the matrix band. These pouches offer a safe way to deliver a sterilized product to the customer. It may be smart to order these soon to see how the matrix bands fit into the package. Depending on the size of the pouch, the band might not be able to be glued together. However, Amazon offers multiple different sizes of these pouches and we may be able to find one that could hold the folded and epoxied final device.

Dentistry Kit

TREVOR SILBER - Mar 02, 2022, 3:00 PM CST

Title: Dentistry Kit

Date: 2/8/22

Content by: Trevor Silber

Present: N/A

Goals: Gain knowledge on how other matrix bands are packaged

Content:

Online, I found that some matrix bands are currently being sold in kits. These kits contain bands of multiple different thicknesses, lengths, and heights. These kits can be more beneficial to dentists as having different sizes of the device can make them more versatile. An example is shown below:

Conclusions/action items:

Due to the large variety in tooth size, not only within one's own mouth but also between individuals, it may be beneficial to make different sizes of our device. The variations in size would allow the final device to be used on kids and full grown adults. A kit like this would be more practical for a dentist doing lots of cavity fillings on lots of different people. The team will need to decide if this is something worth pursuing or not as it may make fabrication much more complicated. It would also increase the cost of manufacturing to include a kit of this size.

Dr. Tipple Interproximal Fillings

TREVOR SILBER - May 05, 2022, 6:57 PM CDT

Title: Amount of Interproximal Filling Dr. Tipple Does Per Day

Date: 4/27/22

Content by: Trevor Silber

Present: N/A

Goals: Learn how many interproximal fillings Dr. Tipple performs per day for poster presentation

Content:

After getting in contact with Dr. Tipple I learned the following information.

Most fillings these days are interproximal fillings and they typically cost the patient/insurance anywhere from $200 - $500. Dr. Tipple performs anywhere from 5 to 8 interproximal fillings per day.

Conclusions/action items:

The information Dr. Tipple provided will be useful in the marketing portion of our presentation and may be applicable to the final paper.

Sector67 Prototype

TREVOR SILBER - Mar 02, 2022, 1:00 PM CST

Title: Sector67 Prototype

Date: 2/13/22

Content by: Trevor

Present: N/A

Goals: Obtain functional prototype from Sector67 and see if Laser cutting is a viable method for producing our prototype

Content:

Below are two images of the folded and unfolded prototype from Sector67.

Conclusions/action items:

After getting my hands on the prototype, I can tell that the laser cutter did a very good job at cutting the metal. No sharp edges or sharp corners. We will be able to use the contact to develop future iterations of our device.

Permatex

TREVOR SILBER - Feb 24, 2022, 2:26 PM CST

Title: Permatex Steel Weld

Date: 2/24/2022

Content by: Trevor Silber

Present: n/a

Goals: Place receipt in notebook for documentation

Content:

Order Details

Ordered on February 24, 2022 | Order# 114-1021749-0381800

Shipping Address
Trevor Silber
42 CRAIG AVE
MADISON, WI 53705-1336
United States

Payment Method
VISA **** **44

Order Summary

Item(s) Subtotal:	$8.11
Shipping & Handling:	$0.00
Total before tax:	$8.11
Estimated tax to be collected:	$0.45
Grand Total:	**$8.56**

Arriving tomorrow by 10pm

Track package

Permatex 84109 PermaPoxy 4 Minute Multi-Metal Epoxy, 0.84 oz.
Sold by: Amazon.com Services LLC
$8.11
Condition: New

Buy it again

Cancel items >

Conclusions/action items:

This receipt will be given to our client at the end of the semester for reimbursement.

316 Stainless Steel

TREVOR SILBER - Apr 14, 2022, 10:57 AM CDT

Title: 316 Stainless Steel

Date: 4/14/2022

Content by: Trevor Silber

Present: n/a

Goals: Place receipt in notebook for documentation

Content:

Conclusions/action items:

This receipt will be given to our client at the end of the semester for reimbursement.

We did NOT want to order from McMaster-Carr, however, the only other source of 316 shim stock at 0.001” thickness would not have shipped for 18-21 days from the date of purchase and it would have gotten here far too late.

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 2021- notebook

TARA BOROUMAND - May 08, 2022, 3:24 PM CDT

BME Design-Fall 2021 - TARA BOROUMAND
Complete Notebook

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GRACE JOHNSON

on

Dec 16, 2021 @ 02:21 PM CST

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