BME Design-Fall 2019 - Camille Duan
Complete Notebook

PDF Version generated by

James Tang

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Dec 11, 2019 @03:24 PM CST

Table of Contents

Team contact Information

revisions print · Kavya Vasan · Dec 03, 2019 @08:51 PM CST

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Project description

revisions print • Kavya Vasan • Dec 11, 2019 @01:39 PM CST

Course Number: BME 400

Project Name: Ring cutting and removal in the emergency department

Short Name: Ring cutter

Project description/problem statement:

Current methods used to remove rings made of hard metals, such as Tungsten Carbide, from injured digits when edemas prevent them from being removed, are dangerous to both patients and physicians in emergency rooms. The existing device for tungsten carbide ring removal, the Ring Cracker, is manual and has safety concerns due to sharp flying metal pieces when the ring is broken. The aim is to make the ring removal method safer, to protect both the physicians and the patients.

Tungsten carbide is known for its hardness, durability, and limited susceptibility to scratches, which makes them a popular choice for jewelry and especially for wedding rings. Current ring cutting device and techniques for Tungsten carbide can lead to strong patient discomfort, thus we need to design a better ring cutting system for both cutting hard metal rings more efficiently and to protect patients and staff from discomforts.

About the client:

Dr. Christopher Green is a pediatric pulmonologist in Madison, Wisconsin and is affiliated with University of Wisconsin Hospitals. He received his medical degree from University of Rochester School of Medicine and Dentistry and has been in practice for more than 20 years.

2019/9/20 Client Meeting

revisions print • Camille Duan • Oct 08, 2019 @01:52 PM CDT

Title: First Client Meeting

Date: 9.20.2019

Content by: James Tang, Camille Duan

Present: All team members and client Dr. Green

Goals: Ask questions about the client's expectation for the design and get to see current methods that the hospital is using for ring removal.

Content:

- Our client Dr. Christopher Green brought us to the University of Wisconsin Children and Family Hospital emergency room to show us the current devices being used over at the hospital.
- Dr. Josh Glazer, an emergency physician at UW Children and Family Hospital, guided us to a meeting room to show the devices
- The first device, attached below is a ring cutter that is typically used for gold and silver rings. The bottom of the cutter will be inserted underneath the ring on a swollen finger. The blade will be either rotated manually operated or using a battery powered rotating tool. The advantage is that it works nearly 100% for all rings made of gold or silver. The disadvantage is that it will break the ring, and for some people the ring can be very sentimental.
- The second device, also attached below, is a ring cracker device. This device works for tungsten carbide rings. Tungsten carbide metals have a scale of hardness of 9, compared to gold and silver which only have a scale of hardness of 2.5-3. How this device works is that the finger with the tungsten carbide ring will be inserted through the hole. The screw on the side will push the ring against the ring cracker. Since tungsten carbide has such a high stiffness, the ring will not deform as the force is applied, thus the finger will not get hurt. The emergency physician usually hear for the sound of crack. Sometimes, in order to remove the ring from stuck finger, multiple cracks will be required.
- The third method Dr. Glazer demonstrated is a string wrapping method. He uses a dental floss string as an intact method of ring removal. The string will first go through the finger, and then wrapped clockwise around the finger to reduce edema. He will then unwrapping the string counterclockwise, so that the ring will rotate around the finger with the string. The advantage of this method would be the ring will be kept intact. The disadvantage of this method would be that it does not work for an injured digit with open wound or a very swollen finger.

Conclusions/action items:

Dr. Christopher green gave us his input on the current devices and the direction of this semester's design that he would like to go. Although coming up with creative ideas would be nice for designing a new ring cutting or ring removal device, Dr. Green is okay with us refining the current existing methods and devices. He would like to add a protection system for the ring cracker device so that physicians and patient would be protected against potential flying metal pieces when cracking tungsten carbide rings. Dr. Glazer would also want an automated string wrapping device, so that it could save time and fix the current difficulties of inserting a string underneath a swollen finger.

revisions print ▪ James Tang ▪ Sep 26, 2019 @10:00 PM CDT

Basic_Manually_Ring_Cutter_by_a_Blade.jpg(303.1 KB) - download

revisions print ▪ James Tang ▪ Sep 26, 2019 @10:02 PM CDT

Ring_Cracker_.jpg(375.7 KB) - download

revisions print • James Tang • Sep 26, 2019 @10:03 PM CDT

Wrapping_Method.jpg(409.7 KB) - download

revisions print • James Tang • Sep 26, 2019 @10:05 PM CDT

Ring_Cracker_Operation.mov(5 MB) - download

revisions print • James Tang • Sep 26, 2019 @10:07 PM CDT

Wrapping_Method_Operation.mov(2 MB) - download

2019/09/24 Client Meeting Notes

revisions print • Kavya Vasan • Oct 08, 2019 @10:38 PM CDT

Title: Client Meeting 1

Date: 25th September 2019

Content by: Kavya Vasan

Present: James Tang, Maggie Zhou, Camille Duan, Dr. Green, Dr. Glazer

Goals: To be informed about the problems with the current ring removal devices and what the client wants fixed

Content:

- Dr. Green came across the string method of ring removal in a journal. He saw that tungsten carbide and titanium rings are hard to cut off.
- Questions for client:
  - Challenges with current method?
  - Improvements?
  - size and material requirements?
  - cost?
  - patient demographic?
- Swelling from injury is common when needing rings removed in the ER. Swelling on the knuckle is most common.
- Nerve damage and then necrosis could occur leading to the loss of a finger if not treated promptly.
- Problem with the ring cutter for gold and silver rings (softer metals): the blades used to cut the rings wear out easily and need to be replaced pretty often.
- Patients don't want to ruin the rings. If there's an option to keep the ring intact, they tend to choose that.
- Tip to check if a ring is made of tungsten carbide: if there are scratches, it's not made of tungsten carbide.
- Dislikes with the current tungsten carbide ring cracker: patients are uncomfortable, finger can get fractured. Want to minimize manipulation of the finger.
- One design suggestion: a device that automatically spools the floss on a finger for string ring removal method.
- Safety aspect: Don't want broken ring pieces to fly all over the place. Dangerous for patient and surgeon.
- Automation - issues with friction and heating, diamond blade for some devices. Would it be better to sue the crush technique?
- A smaller device would be better.
- Maybe make an improvement with the disk shaped blades.
- Want a lower removal time as twisting of a knob for the ring cracker takes a long time. Automation of this process would reduce the procedure time.

Conclusions/action items: Make a design matrix with some of the design ideas discussed at the meeting. Research possible protection methods to contain the shards.

2019/10/16 Client Meeting 2

revisions print • Camille Duan • Oct 19, 2019 @10:24 PM CDT

Title: Client Meeting 2

Date: 2019.10.16

Content by: Camille Duan

Present: Team

Goals: To update our progress for the past month with our Client and discuss about purchasing details

Content:

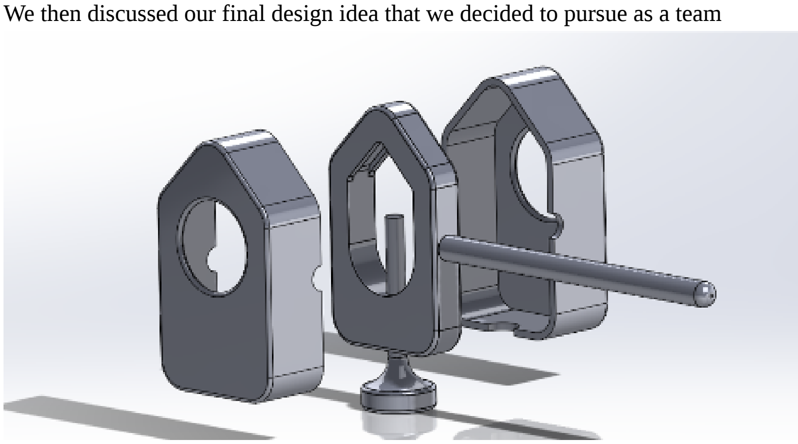
- We first discussed ways to reimburse with clients since we are in the process of purchasing our own tungsten carbide ring cracker
    - Two ways that we can get reimbursed:
        - Ask our client to purchase stuff for us through the UW account, which can take longer time
        - Maggie (As BPAG) purchases stuff for the team and gets reimbursed at the end of the semester
    - Budget for the semester is around $500, even if the spending is a little over $500, such as $525 it is fine with our client Dr. Green
- We then discussed our final design idea that we decided to pursue as a team
- 

Figure 1. Automated ring cracker protection design

- Possible ideas discussed for design details:
    - 3D printing the cover using elastic material
        - rubber can absorb energy due to high elasticity, thus, it should be a good material choice
    - Adding play-doh on the inside for flying metal pieces to stick
        - Disadvantage: play-doh drying up after 3 days
        - Sterilization concern: one time use of play-doh
        - germs could be spreading from patient to patient using play-doh
    - Adding sponge on the inside with holes of similar size as possible flying metal pieces
        - advantage: cheap material
        - disadvantage: risk of using glue for the material to be falling apart; risk of child swollen
    - Adding magnets to each side of the protection system so that the case can stick together
        - risk of magnets falling off
- Safety is always the biggest concern at the hospital and the biggest consideration
    - this is also reflected in our design matrix as safety is listed to be the highest score

Conclusions/action items:

- Fix dimensions on the final design Solidworks graph
- Print prototype and bring it to our next client meeting
- Schedule client meetings (could be at ECB or over at the hospital)
- contact client if we run into any purchasing problems or have any other concerns

2019/11/13 Client Meeting 3

revisions print · Camille Duan · Nov 15, 2019 @12:56 PM CST

Title: Client Meeting 3

Date: 2019.11.13

Content by: Camille

Present: Team but Maggie (due to exam)

Goals: To show our client the prototype and gather feedback

Content:

- Showed client our first prototype made from PLA

- Showed client our second prototype made from Elastic material

Conclusions/action items:

2019/09/13 Advisor Meeting 1

revisions print · Camille Duan · Oct 08, 2019 @03:34 PM CDT

Title: Advisor meeting 1

Date: 2019.9.13

Content by: Camille Duan

Present: Team

Goals: To talk about the project and requirements of BME design for this semester

Content:

- Talk about our new design project about tungsten carbide ring cutter with Dr. Puccinelli
- Discuss the first progress report that was submitted on Thursday (Add more content for the timeline for the next progress report); she wants the progress report to be more precise.
- Divide project goals into more specific things with detail, just list out what we were doing instead of the title team/ client meeting
- Grading rubric: Notebook 25% of the final grade , Participation is 15%, Presentation 10% for preliminary presentation and 15% for final poster presentation, Reports are worth 25% of the final grade, prototype will be worth 5% of the grade.

Conclusions/action items:

During our first advisor meeting, our team discussed research that we've done for the past week on the current existing device

2019/9/20 Advisor Meeting 2

revisions print · Camille Duan · Oct 08, 2019 @08:15 PM CDT

Title: Advisor meeting 2

Date: 2019/9/20

Content by: Camille Duan

Present: Team

Goals: To discuss about the client meeting last weekend and project design specification

Content:

- We met up for only 10 minutes after Outreach seminar today to discuss our progress last week
- We discussed possible design ideas for design matrix
- Updated project design specification to add inputs from our client

Conclusions/action items:

Further research are needed to come up new design ideas for ring removal, especially rings that are made of tungsten carbide. The task for the following week would be create a design matrix with at least 3 different design ideas.

2019/9/27 Advisor Meeting 3

revisions print • Camille Duan • Oct 08, 2019 @08:40 PM CDT

Title: Advisor Meeting 3

Date: 2019.9.27

Content by: Camille Duan

Present: Team

Goals: Discuss design matrix and progress this week

Content:

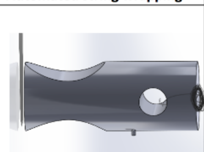
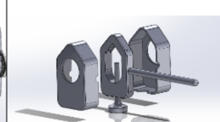
	Automated string wrapping		Ring cracker protection		Finger Shrinking Lubricant	
						
Chemical Stability & Safety (25)	4/5	20	5/5	25	4/5	20
Patient Comfort (20)	3/5	12	3/5	12	5/5	20
Effectiveness (15)	3/5	9	5/5	15	2/5	6
Ease of Fabrication (15)	3/5	9	3/5	9	2/5	6
Patient Ease of Mind (10)	4/5	8	3/5	6	5/5	10
Ease of Operation (10)	5/5	10	4/5	8	5/5	10
Cost (5)	4/5	4	3/5	3	4/5	**4**
Total (100)	**72**		**78**		**76**	

Figure 1. Design Matrix for ring removal design

- The first design, an automated string wrapping design will be a refinement from the current string wrapping method using a dental floss. How it works is that the edema part of the finger will be wrapped around to reduce edema, thus, rings can easily fall of as string unwraps.
- The second design, an automated ring cracker design, is also an refinement from current existing device. Besides its function of cracking the tungsten carbide ring, it can also protect flying metal pieces.
- The third design will require a unique chemical formula that combines lubricant with cold sensation cream that will have the ability to shrink swollen finger.

Conclusions/action items:

Things that need to be done this week, work on presentation slides for next week's preliminary presentation.

Couple of edits needed according to our advisor:

- Background slide: need to list statistics or facts learned--some of this looks like a list of topics you should research, not your findings. Also, add relevant pics. Also, add a descriptive title. Titles should concisely describe the content of each slide. Also very wordy
- Need to add client info
- PDS: way too much text and not quantitative enough. Try to add specific constraints. For example, how much stress can be applied to skin? How long can a finger be wrapped tightly before damaging vessels/nerves? Think along those lines. Some items may be difficult to quantify--I understand that. But do your best.
- Add Design 1, Design 2, Design 3 to your design slide titles. (obviously keep the descriptive names) Put them in the same order as they are in the design matrix.
- Future work is incomplete, plus no timeline--be sure to add that
- Look over the requirements and the evaluation form to make sure you have everything we are grading you on.

2019/10/11 Advisor Meeting 4

revisions print

▪ Camille Duan ▪ Oct 20, 2019 @01:17 PM CDT

Title: Advisor Meeting 4

Date: 10.11.2019

Content by: Camille Duan

Present: Team

Goals: To talk about preliminary presentation and discuss future plannings

Content:

- Received grade back from preliminary presentation
  - grade from Tracy Puccinelli: 74/ 77
  - grade from Drills Suarez-Gonzalez: 74/82
- Gathered feedback from preliminary presentation
  - Need dimensions and labels for Drawing
  - Some of the figures used were not credited
  - Clarification of chemical stability and safety need to be addressed
  - Still need to conduct research on how frequent the issue related to cutting rings in hospitals are (tried to do research but could not find any available data)
- Discussed future plans on final design
- Will discuss preliminary report next week

Conclusions/action items:

- Need to start working on fabrication
- potential material in mind: Play-doh, sponge, magnets
- Contact clients about purchasing
- Fix dimensions on Solidworks drawing

2019/10/18 Advisor Meeting 5

revisions print

▪ Camille Duan ▪ Oct 20, 2019 @01:18 PM CDT

Title: Advisor Meeting 5

Date: 2019.10.8

Content by: Camille Duan

Present: Team

Goals: Short catch up about current progress and followed by individual meetings

Content:

- Discussed about client meeting on Wednesday, which went well
- Will start purchasing next week
- Will have a rough prototype by Wednesday next week (the latest)
- Received feedback about Labarchives notebook

Conclusions/action items:

- Add more entries about design process under team activities
- start printing or fabricating
- start purchase necessary materials

2019/11/15 Advisor Meeting 6

revisions print • Kavya Vasan • Nov 30, 2019 @05:07 PM CST

Title: Advisor Meeting 7

Date: November 15, 2019

Content by: Kavya Vasan

Present: Team

Goals: To show our advisor the 3 different prototypes and current problems regarding the prototype

Content:

- Things regarding prototype:
    - Need to include energy calculation
    - Need to research on thermoplastic elastomer material properties
    - Need to come up with a more detailed testing protocol
    - Need to break ring without the protection device and take video to capture the fracture velocity
    - Test the velocity of the ring shards flying
    - Use a slingshot and release the tungsten carbide rings at different materials - PLA, elastic polymer.
    - Range of velocities, cracker 3 rings.
    - Need more space between the ring cracker and the shield to avoid the pieces hitting the patient.
    - Flexible silicone covering.

- Testing set up:
    - Meter stick set up and calculate the speed
    - Use carrots to mimic human finger
    - If testing needs to use a human subject: IRB approval required, CITI training

- Client new potential project idea:
    - Creating a pulmonary airflow model
    - Could change projects for next semester if the project gets done in one semester

- Analysis of testing:
    - Mathematical model and equations needed
    - Need to calculate the actual absorbed energy amount
    - Range of velocity
    - Minimum 10 samples required
    - Possible t-test for change in velocity

- New ideas:
    - Use valves from cheerio holders to cover up the ring
    - make on side deeper and add more space Report grade: border impact—medical cost, incidents that are happening

- Preliminary report grade:
    - Need to introduce figures before using then
    - Testing protocol minimal
    - Future work minimal
    - The fabrication process of using hinges was hard to understand

Conclusions/action items:

A couple of things that need to be done over the weekend:

1. To fix the dimensions of the current prototype so that one side can fit perfectly with the ring cracker and also the magnets can fit in it

2. Need to create a detailed testing protocol for next week

3. Research on the fracture speed of tungsten carbide rings and PLA and elastic resin material properties

2019/11/22 Advisor Meeting 7

revisions print • Kavya Vasan • Dec 03, 2019 @08:41 PM CST

Title: Advisor Meeting 7

Date: November 22, 2019

Content by: Kavya Vasan

Present: Team

Goals: To report updates on fabrication and testing to Dr. Puccinelli

Content:

- Testing is 3/4 done. We need to test the 4 rings breaking in the protection shield.
- For the final report, we need to use information from Dr. Glazer regarding how many cases he's seen. This needs to be cited as a reference for an interview in IEEE format.
- The team needs to get a list of potential projects to choose a new project for the next semester as there isn't anything left to do for this current project.
- Incorporate Preliminary report notes and notebook entry feedback.
    - Grammar needs to be fixed, need testing to be added and have more than 20 sources.
- Meet before poster presentation on Tuesday at 9am to get feedback on what is needed in the poster.

Conclusions/action items: Do testing calculations and complete the poster for the final presentation. Start working on the final report and update the PDS to reflect protection shield requirements and not new ring cutter design requirements.

2019/12/3 Advisor Meeting 8

revisions print · Kavya Vasan · Dec 03, 2019 @08:43 PM CST

Title: Advisor Meeting 8

Date: 2019/12/3

Content by: Camille

Present: Team

Goals: To discuss outreach activity guide and final poster presentation draft

Content:

- We first started with changing a new project for next semester.
  - New projects: She will email us about the currently available projects
  - Does the client submit a new project for next semester?
- Outreach Activity guide
  - Found a lung model activity on techengineering.com
  - Simple and only requires a water bottle, straws, balloons for demonstration
- Final Presentation Poster
  - Abstract
    - Should include testing results and future work
    - Should be added at the end after the other sections
    - Be concise
  - Problem Statment
    - Change the focus of the project to protection instead of designing a ring cracker for tungsten carbide
  - Design Criteria
    - Be specific
    - Change from preliminary report design criteria to the scope of the project
    - be as quantitative as possible
  - Mechanical Property
    - Change the first sentence (more design specification focused)
    - Change into material Property—add all research about material properties. Make it background.
    - Change the wordiness, be more concise
    - Separate each material into one column, a table for elastic and a table for PLA
    - Do bullet points
  - Testing Result
    - Delete the first sentence
  - Discussion/Conclusion
    - Need to draw from statistical result and literature research
    - Need to back up with formulas for more conclusion part
    - Condense sources of error to one sentence
  - Final Design
    - Include Solidworks Design with Dimensions and Labels
    - Make sure everyone understands the testing result
- Look at the grading criteria and rubrics

Conclusions/action items:

Based on the comments that our advisor gave us for the final poster presentation, we need to go back and edit our poster. We also need to finish the outreach activity guide by the end of Sunday this week and start working on our final report.

2019/09/12 Initial Brainstorming

revisions print • Camille Duan • Oct 20, 2019 @02:15 PM CDT

Title: Initial brainstorming with team

Date: 2019.09.12

Content by: Camille Duan

Present: Team

Goals: To come up ideas that could possible work for removing tungsten carbide rings from finger

Content:

Initial thoughts:

- Use metal blades that are harder than tungsten carbide to cut through the ring
    - **Titanium**
    - **Chromium**
    - **Steel Alloy**
    - **Diamond**
- Use chemicals that can dissolve the rings on the finger
    - Warning: need to protect the finger from melting
- Use chemicals to shrink finger so that ring can be detached

Conclusions/action items:

Based on the initial thoughts and ideas, we need to do further research on each of the idea to figure out which would be reasonable to pursue and could turn into a more complete design idea. We will meet next week after more research is done before client meeting to discuss.

2019/09/15 Continued Brainstorming

revisions print • James Tang • Oct 20, 2019 @05:28 PM CDT

Title: 2019/09/15 Continued Brainstorming

Date: 9.15.2019

Content by: James Tang

Present: The team

Goals: Brainstorming alternative ways to solve the problem without breaking the rings.

Content:

The team had a discussion together considering the possibility of not breaking the rings while successfully removing the rings out of the fingers. New design ideas are needed that different from the current ones such as ring crackers or using a blade.

Some goals to achieve:

- Avoid hurting the patient during the ring removal process
- Less pain as possible for the patients
- Avoid breaking patients' beloved & expensive rings
- Easy to operate by the physicians
- The design should not further damage patients' injured fingers

Ideas:

- Can we make some super lubricants that can dramatically decrease the friction between the ring and the patient's finger?
- Can we make the lubricant to shrink the patient fingers?

Figure 1: Finger lubricant. https://images.ctfassets.net/juauvlea4rbf/2LMSQeIpxKwAUQ42mQoiWq/c36b48e44e9016eb23c0f31ee2c01893/How_to_pick_a_lubricant_contenful_2x-100.jpg?w=960&q=50

Conclusions/action items:

Super lubricant idea can help achieve the goals. Keep research on the chemical properties of commonly used lubes and how to improve them. Also, keep researching on how to be able to shrink swallowed fingers.

2019/09/19 Team Research discussion

revisions print • Camille Duan • Oct 20, 2019 @02:24 PM CDT

Title: Team research post first brainstorming session

Date: 2019.09.20

Content by: Camille Duan

Present: Team

Goals: To follow up with the initial brainstorming and to discuss more reasonable ideas

Content:

- **Blade ideas**
  - **Titanium** has a tensile strength of 63,000 PSI. Its tensile-strength-to-density ratio is higher than any natural metal, even tungsten, but it scores lower on the Mohs scale of hardness. It is also extraordinarily resistant to corrosion.
  - **Chromium,** on the Mohs scale for hardness, is the hardest metal around. It scores 9.0, but it's extremely brittle. So unless it's combined with other metals, it isn't very useful if you need yield and tensile strength.
  - The strongest known metal in the universe is **Steel alloy**. Because steel alloy is so versatile, it can be crafted to meet nearly any requirement. Still, however it is crafted, the combination of steel with other strong metals makes it the strongest known metal in the universe.
  - Use **Diamond** blades
    - There are existing devices on the market that uses diamond blades to cut through titanium rings (which should also work for tungsten carbide rings)
    - Citation: W. J. B., "Zephyr Diamond Ring Saw," *DelphiGlass*, 28-Sep-2019. [Online]. Available: https://www.delphiglass.com/glass-tools/ring-saws/zephyr-diamond-ring-saw?source=froogle&gclid=EAIaIQobChMI_42-gryr5QIVDtbACh3GwwiHEAQYBSABEgJ2zfD_BwE. [Accessed: 20-Sept-2019].

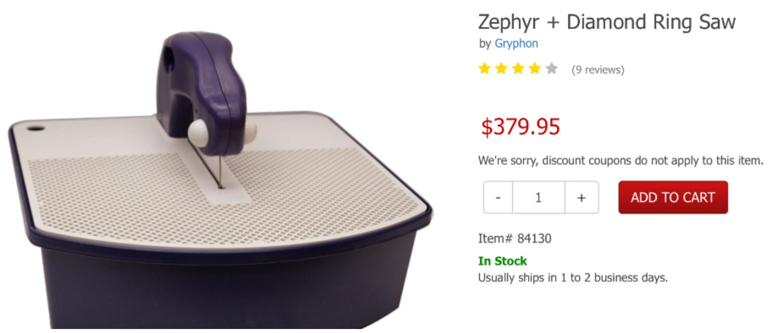


Figure 1. Diamond Ring Saw (W.J.B., 2019)

- **Chemical Ideas:**
  - **Hydrochloric acid**
  - **Nitric Acid**
  - **Aqua regia**, which does dissolve gold. Platinum and a few other metals are particularly resistant to acids, but hot aqua regia dissolves them, although slowly.
- New idea:
  - super oil: extremely silky that rings can be detached from finger more easily

Conclusions/action items:

More research is needed to come up more feasible ideas for preliminary

2019/10/01 Preliminary Super Oil Idea to Shrink Finger

revisions print ▪ James Tang ▪ Oct 20, 2019 @05:49 PM CDT

Title: 2019/10/01 Preliminary Super Oil Idea to Shrink Finger

Date: 10.01.2019

Content by: James Tang

Present: The Team

Goals: Figure out whether it is possible to create a super lubricant that can diminish the friction between the ring and the finger. If so, how?

Content:

The issues:

1. Swallowed finger

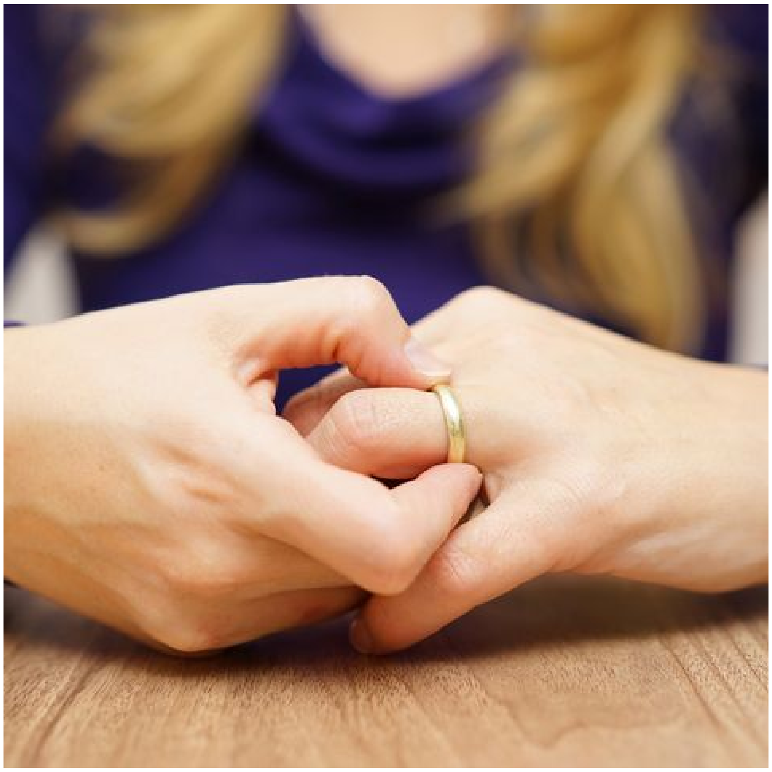


Figure 1. A very swallowed figure, the ring is stuck. https://hips.hearstapps.com/hmg-prod.s3.amazonaws.com/images/woman-is-taking-off-the-wedding-ring-royalty-free-image-467302114-1543873934.jpg?crop=0.668xw:1.00xh;0.163xw,0&resize=480:*

Solution: Thermal Contraction

Iced Shrinking Lubricant:

Figure 2. The general appearance of the iced shrinking lubricant.

- Improvement of current existing skin lubricant by applying thermal contraction mechanism. Changes in temperature change the physical properties of substances which, as a result, lead to the shrinkage of blood vessels in fingers[2] In addition, coldness help reduce the sense of pain. [2] The major functions of this design are its ability to smooth the surface between the patients' fingers and rings, to shrink the finger in size resulting easier removal of the rings, and to reduce the pain of the finger during removing process.

- Patients are able to obtain many benefits from this design. The first benefit would be that the iced finger shrinking lubricant can rescue patients' beloved and expensive rings because it does not damage the ring by any means. In addition, this method does not make the patients as painful as the ones requiring to compress the fingers. What is more, this method benefits the doctors as well by not requiring considerable work or unique skills to perform.
- However, there are a few problems with this method. In some situations, the patients may have blooded injured fingers which are sensitive and fragile. The apply of iced finger shrinking lubricant can lead to infection and future damage of the fingers. If worse, patients may lose their fingers totally because thermal contraction of blood vessels in fingers can result in lack of enough blood flow. In addition to the risks of ending blood flow, thermal contraction also has limits on how much the finger can shrink. As a result, the method may not work effectively enough for situations that patients have extremely swollen fingers.

Reference:

[1] https://www.google.com/url sa=i&source=images&cd=&ved=2ahUKEwjZouqdyPHkAhURvJ4KHSkiCbQQjRx6BAgBEAQ&url=https%3A%2F%2Fimgur.com%2Fgallery%2Fr7aC7dn&psig=AOvVaw2Ie-8R-51ed4Q2nTt8UFh_&ust=1569683254287027

[2] C. Sissons, "What are the causes of swollen hands?," *Medical News Today*. [Online]. Available: https://www.medicalnewstoday.com/articles/325207.php. [Accessed: 14-Sep-2019].

Conclusions/action items:

This design can smooth the surface between the patients' fingers and rings, to shrink the finger in size resulting easier removal of the rings, and to reduce the pain of the finger during removing process. Thermal contraction play as the most important machanism. However, the team did not the idea too much because they consider the lubricant would be hard to create or it would rely on current existing product too much, so we decide not to take this method as our final one.

2019/10/03 Preliminary string wrapping ring removal idea

revisions print • Kavya Vasan • Nov 30, 2019 @05:08 PM CST

Title: Automated string wrapping idea

Date: September 25th 2019

Content by: Kavya Vasan

Present: Team

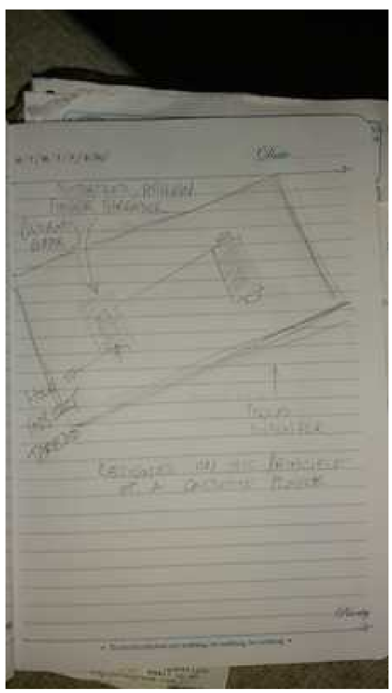
Goals: To come up with potential design ideas for ring removal methods

Content:

- A current technique that is used at home and by some surgeons is the string wrapping method.
- The string wrapping method entails inserting the string through the ring and wrap the string around the finger above the ring.
- To remove the ring, unloop the string using the end that was inserted in the ring. The ring will slowly move up the finger as the string is unlooped.
- Dr. Glazer suggested an automated version of this.
  - This would include a motor to automatically wrap the string around the finger.
  - There would need to be a hole big enough for the swollen finger to be inserted.
  - A button to start/stop.
  - Maybe like a worm gear concept where the string is in the grooves and can come out through a small hole so that it can loop around the finger.

Conclusions/action items: Create a solidworks design for this idea as it seems like a viable idea for the design matrix. Fabrication wise it seems more feasible than the laser idea. The motorized component can be tricky to fabricate but is viable idea and the client likes it.

revisions print • Kavya Vasan • Oct 20, 2019 @09:13 PM CDT



cb277b35-7701-4b3a-aeda-2a9fb0e3253b.JPG(64.3 KB) - download String wrapping design draft

2019/10/08 Preliminary ring cracker idea

revisions print ▪ Maggie Zhou ▪ Oct 20, 2019 @02:46 PM CDT

Title: Preliminary idea for ring cracker

Date: 2019/10/08

Content by: Maggie

Present: All

Goals: Brainstorm preliminary design for ring cracker protection

Content:

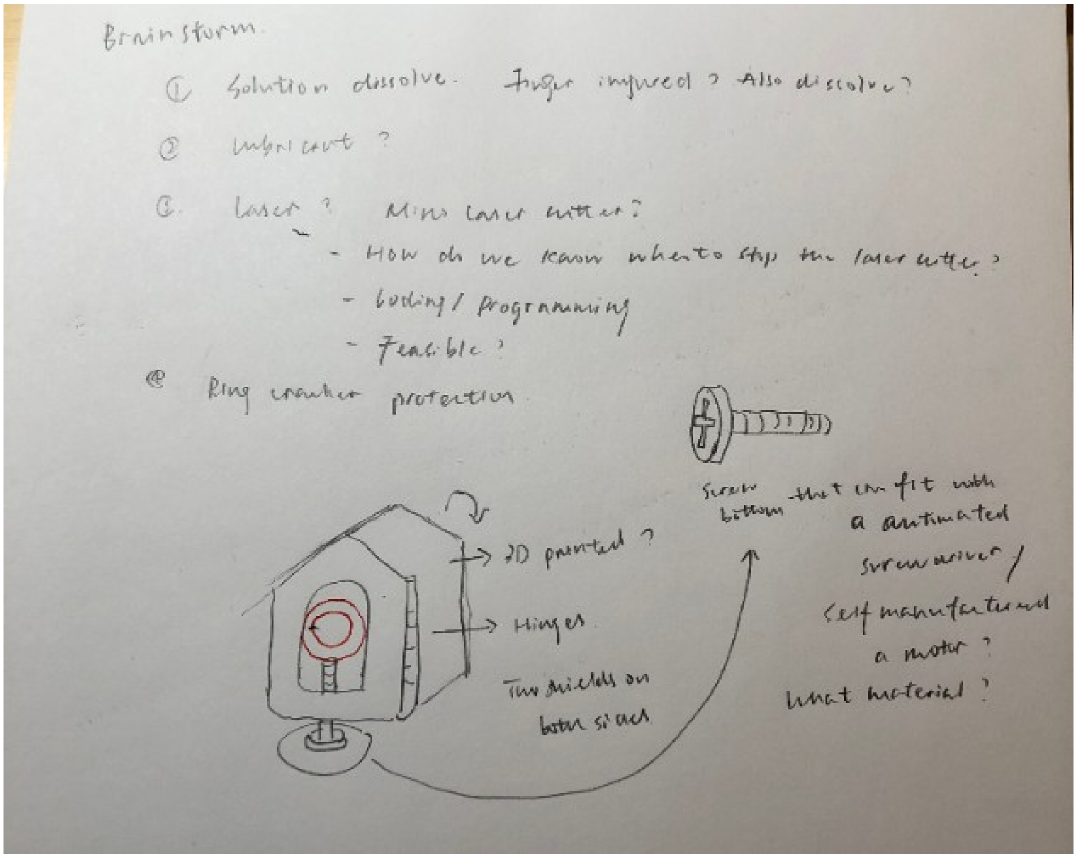


Figure 1. Brainstorm ideas with the preliminary design of ring cracker

Conclusions/action items:

The team went through some other potential ideas and come up with the preliminary design for the ring cracker. It consists of to shields of protection that are attached to the body by hinges and the shields would be potentially 3D printed. For the automation part, we want to change the bottom of the current cracker to the screw shape and fit the automated screw driver. The other thoughts are manufacturing the motor by ourselves, but we are not sure if this is feasible.

2019/10/10 Revised String Wrapping Design

revisions print • Kavya Vasan • Dec 11, 2019 @10:23 AM CST

Title: Revised Automatic String Wrapping Design

Date: October 10, 2019

Content by: Kavya Vasan

Present: Kavya Vasan

Goals: To re-do the automatic string wrapping design from the preliminary presentation

Content:

- The first design was not clear with what it was supposed to do. Without a written explanation, no-one would be able to understand what the design does.
- But a good aspect of the old design was that it had a handle grip for the user.
- The automatic string wrapper design has to be re-done to look like a worm gear,

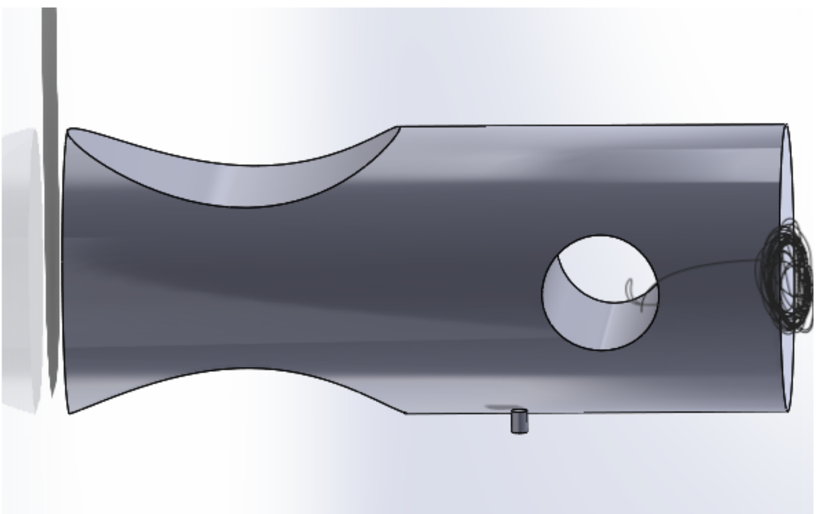


Fig 1. Preliminary presentation solidworks design

- The revised design is much more professional, clear and aesthetically pleasing.
- The design is a worm gear. One end of string from a spool would wrap around a hollow motorized worm gear device, with the finger inserted in one end, and go through a small hole hole at the other end of the device, to be attached to the ring. When main button is clicked, the motorized device will rotate and loop the string around the finger. Once the looping is done, another button is clicked to reverse the movement of the motorized device and unloop the string automatically, moving the ring up the finger.

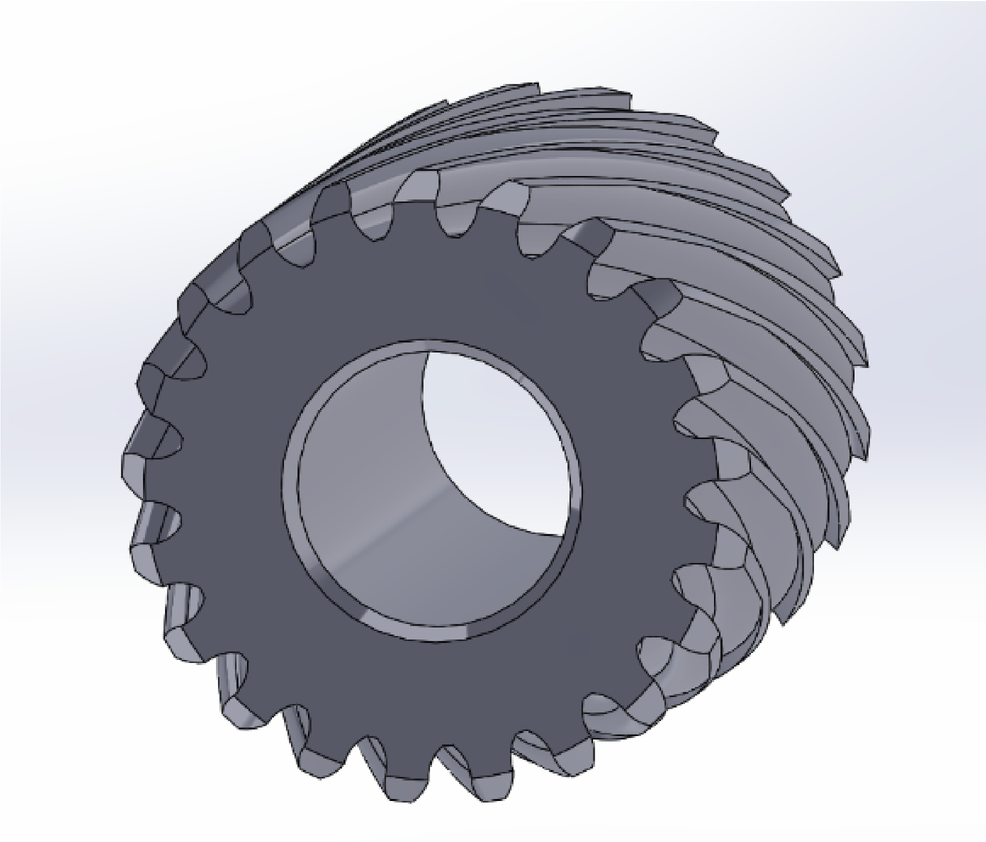


Fig 2. Revised Automatic string wrapping solidworks design

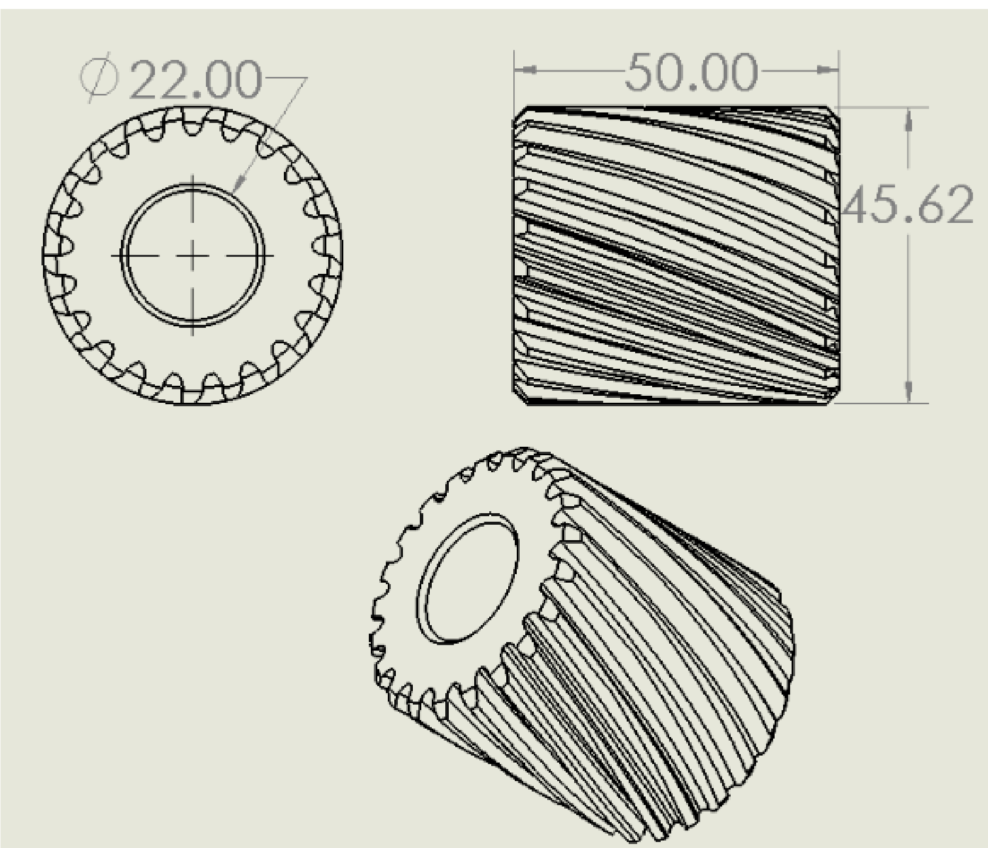


Fig 3. Revised Automatic string wrapping drawing dimensions in mm

Conclusions/action items: Dr. Puccinelli's comments were incorporated and we added dimensions for this design. The solidworks design of the string wrapper, made for the preliminary presentation, was not clear and didn't match the description for this design. The re-done design looks like a worm gear, is better for understand the concept of motorized string wrapping around a finger. The downside of this design is that it won't work for fingers with alot of swelling/injury. Therefore, the team will likely go ahead with developing a protection system for the ring cracker.

2019/10/13 Solidwork update

revisions print · Kavya Vasan · Dec 11, 2019 @12:02 AM CST

Title: Solidwork files for the ring cracker protection design

Date: 2018/10/03

Content by: Maggie

Present: Maggie

Goals: Make the solidworks design for ring cracker design

Content:

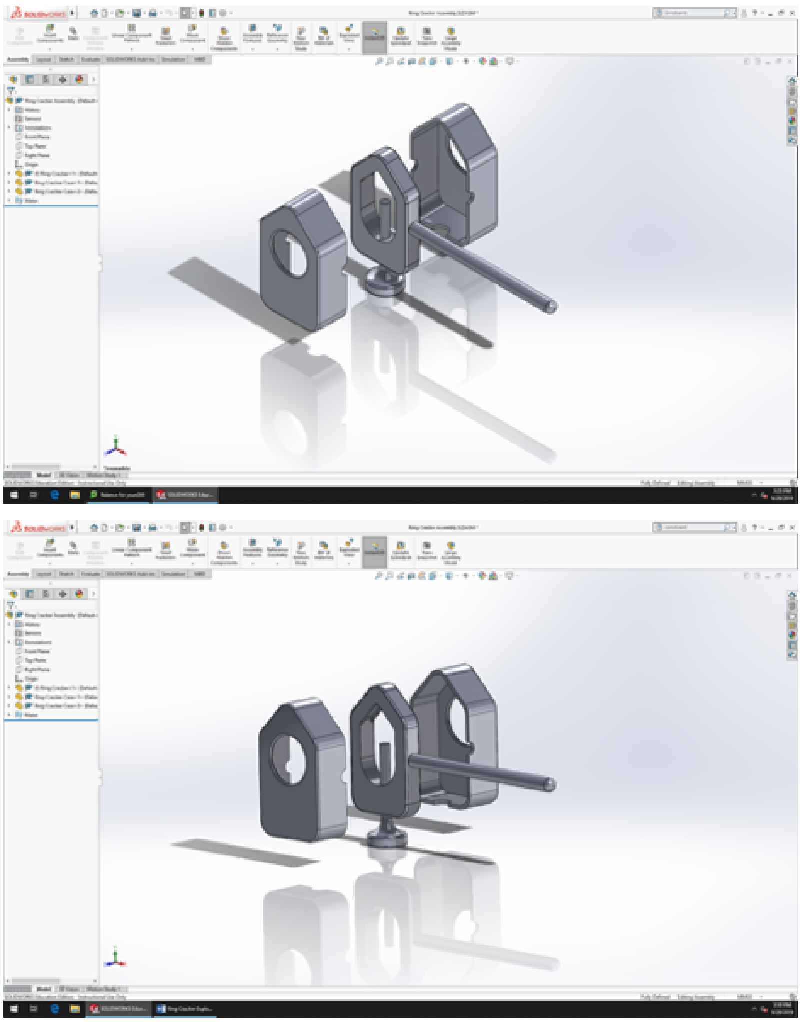


Figure 1. 2 Solidworks design for ring cracker protection device

Conclusions/action items:

This is just the preliminary design of solidworks for the ring cracker protection device. Basiclally it's consisted of two halves of the protection shield potentially going to be manufactured by rubber in the 3D printing lab and hinges on both side for stablization. There will be two holes on both sides of the shields for the finger with edema to put through. The size of the hole needs more consideration and research.

2019/10/20 Design Matrix

revisions print • Camille Duan • Dec 11, 2019 @10:25 AM CST

Title: Design Matrix

Date: October 20, 2019

Content by: Kavya Vasan

Present: Team

Goals: To create a design matrix for 3 design ideas for ring removal and rate them based on criteria chosen

Content:

- We chose used 7 criteria to compare our 3 preliminary designs. They are sorted from the most weighted to least weighted in terms of priority. The most heavily weighted criteria is safety because currently, the ring removal methods aren't very safe for tungsten carbide and that is a priority of the client.
- Chemical Stability and Safety: Automated ring cracker protection scored the highest since it's the only device that has a complete protection system. The cover over the ring cracker will protect both the patient and the physician from flying metal pieces.
- Patient Comfort: The Iced lubricant received the highest score because the patient will not experience any discomfort and helps swelling.
- Effectiveness: The ring cracker protection design highest score because of its near 100% success rate of ring removal. Unlike the string wrapping and lubricant methods, the ring cracker is effective even when fingers have severe injuries or open wounds.
- Ease of fabrication: Both the automated string wrapping and automated ring cracker protection got the highest score. Both use 3D printing for fabrication. However, for the iced finger lubricant, a new chemical formula, is hard to fabricate.
- Patient Ease of Mind: The iced finger shrinking lubricant method received the highest score. Patients are more likely to accept putting a lubricant on their swollen fingers than using an automated machine.
- Ease of Operation: Automated string wrapping design and iced finger shrinking lubricant methods got highest score. Both designs are refined from current intact methods to remove rings, and do not require any force to be applied on the rings.
- Cost: The automated string wrapping got the highest score. Only involves 3D printing and drilling the insertion hole to add a motor. It does not require expensive titanium that will be used for the ring cracker design. The device can also be used for years.

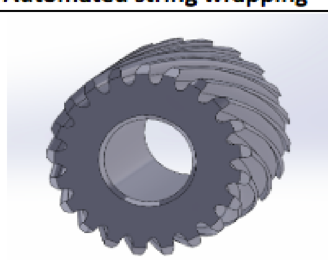
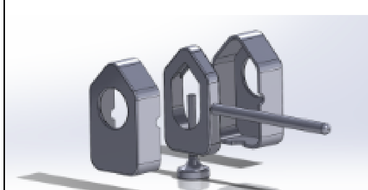
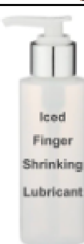
	Automated string wrapping		Ring cracker protection		Finger Shrinking Lubricant	
						
Chemical Stability & Safety (25)	4/5	20	5/5	25	4/5	20
Patient Comfort (20)	3/5	12	4/5	12	5/5	20
Effectiveness (15)	3/5	9	5/5	15	2/5	6
Ease of Fabrication (15)	3/5	9	3/5	9	2/5	6
Patient Ease of Mind (10)	4/5	8	3/5	6	5/5	10
Ease of Operation (10)	5/5	10	4/5	8	5/5	10
Cost (5)	4/5	4	3/5	3	3/5	**3**
Total (100)	**72**		**78**		**75**	

Table 1. Design matrix comparing the 3 preliminary designs

Conclusions/action items: The automated ring cracker design scored the highest among the 7 criteria. It scored the highest in safety, effectiveness and ease of fabrication. After consulting with the client, the team decided to just focus on increasing safety in the design, since there is a ring cracker that exists for Tungsten carbide. Therefore, we are going to create the protection shields from the Automated ring cracker design. We will not modify the ring cracker by automating the knob.

2019/10/23 Preliminary setting of the dimensions of the prototype and 3D printing

revisions print • Camille Duan • Dec 11, 2019 @10:25 AM CST

Title: Dimension fixed and 3D printing the prototype

Date: 2019/10/23

Content by: Maggie

Present: All but Kavya (due to classes)

Goals: Set up the estimated dimensions in the Solidworks and 3D print it

Content:

The team met and each gave an estimated dimension for the Solidworks of protecting shields since we could not find the information of the actual size of the ring cracker online and we haven't received our ring cracker in hand. Then we send the file to Makerspace and 3D print it with PLA material because it has a cheaper price and we don't have the actual dimensions, so everything is just estimation. Camille picked it up on Thursday.

Conclusions/action items:

We are waiting to see how accurate the 3D printer could give us the prototype and after we receive our ring cracker next week. We'll use the measuring devices in the shop to measure the accurate dimensions of the ring cracker and gives our Solidworks a better dimension estimation.

2019/11/07 Prototype fixation and assembly

revisions print • Maggie Zhou • Nov 07, 2019 @07:29 PM CST

Title: Dimension fixation and prototype assembly

Date: 11/07/2019

Content by: Maggie

Present: All

Goals: Fix the dimensions for the prototype and brainstorm for show and tell

Content:

Things needed to be fixed:

- increase the size of magnets

- Open 5 mm on the side of the

- Increase the height for 1 cm

- Increase bottom hole for 2 mm

Conclusions/action items:

Maggie will fix the dimension over the weekend and we will reprint it with PLA next time. We will print the prototype until Dr. Green set up the Makerspace account since elastic material is more expensive.

Title: Dimension fixation

Date: 11/17/2019

Content by: Maggie

Present:

Goals: Fix the dimensions for the prototype

Content:

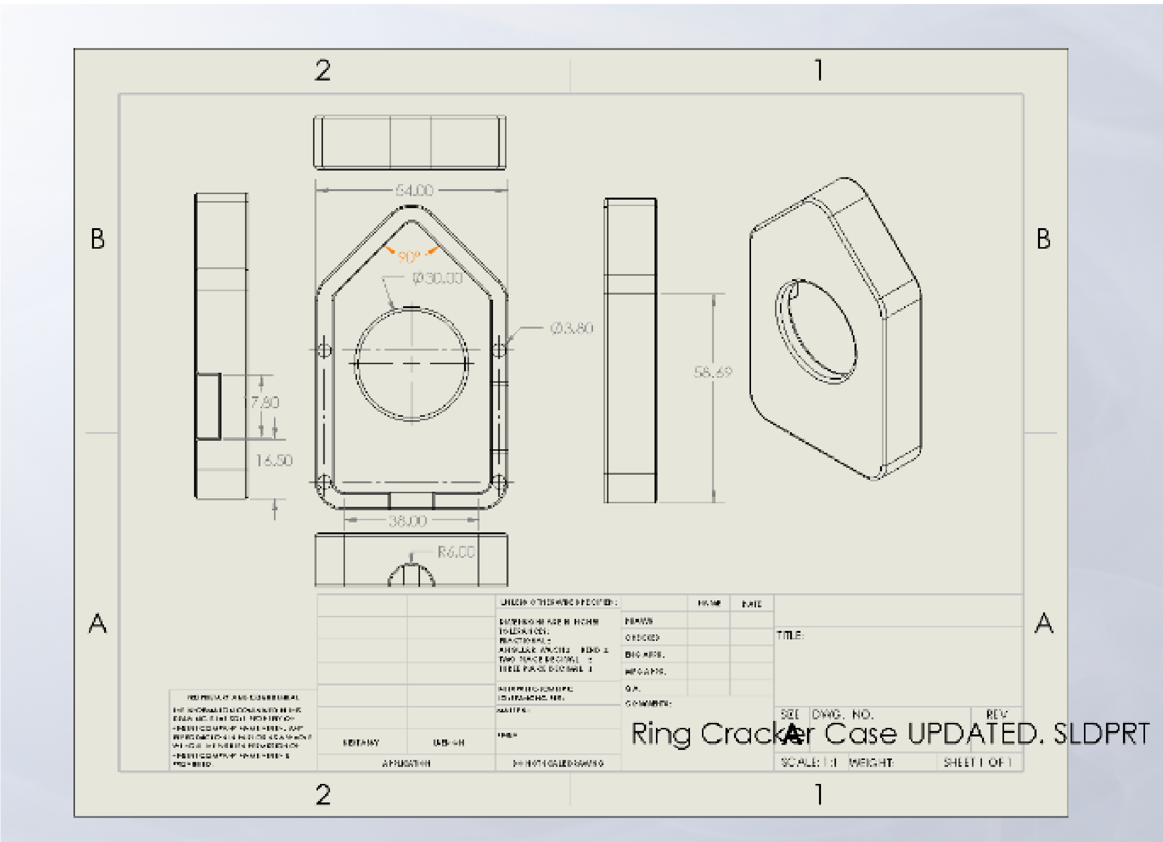


Figure 1. Updated dimension for one shield of the ring cracker

Conclusions/action items:

I fixed the dimension for one side of the shield since the team decided that for the patients' convenience, it's better for our device to have only one shield of protection. The next step is to 3D print the final, hopefully last prototype next Monday and the team will meet for testing procedures.

2019/11/24 Final Design

revisions print · Kavya Vasan · Dec 11, 2019 @12:23 PM CST

Title: Final Design Idea

Date: 2019/11/24

Content by: Camille and Kavya

Present: Team

Goals: To use Solidworks to fix dimension problems and come up with a final design idea

Content:

The final design consists of two sides of a protection shield for tungsten carbide ring crackers.

One side has a thickness of 11 mm and the other side of the shield has a thickness of 7mm.

For each side of the shield, it has a rectangular cut with 10 mm height for the tungsten carbide handle to go through.

On the bottom of each shield, it has a circular cut with 27mm in diameter as the screw insertion points.

4 holes were added on either side for magnets so that the shield can stick together.

This design allows proper insertion of the finger with rings on it while protects patients and physicians from the potential danger of flying metal pieces. The shield has the ability to catch all possible broken ring pieces.

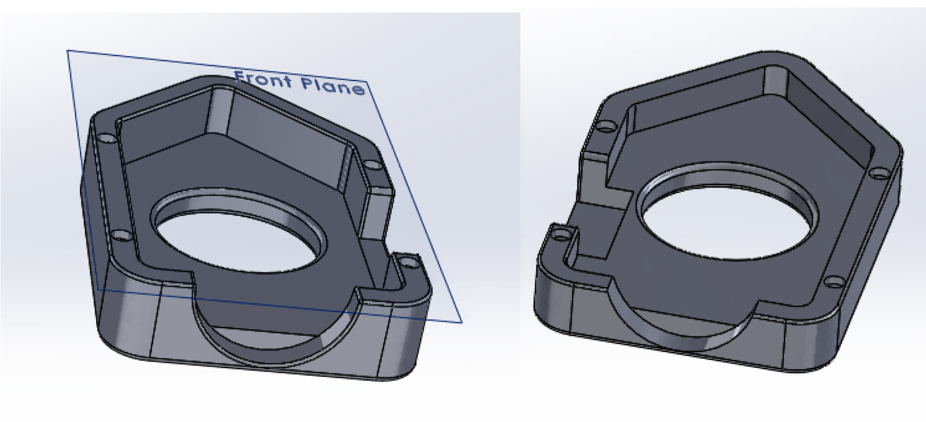


Figure 1. Solidworks Final Design

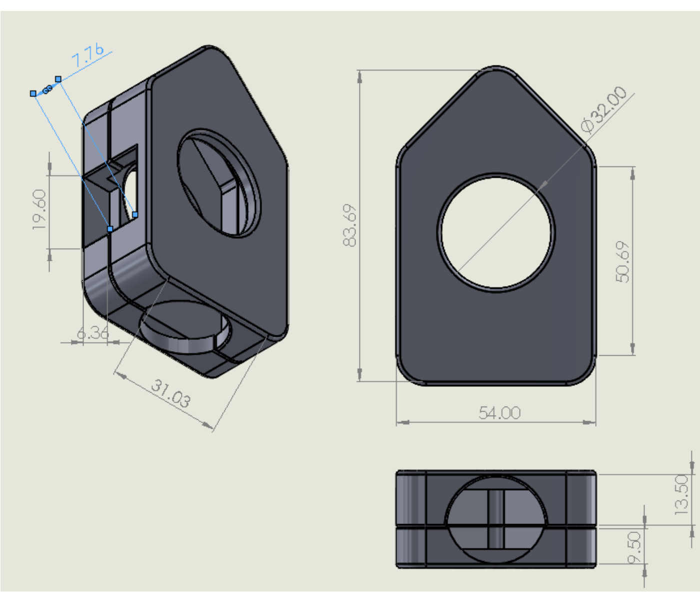


Figure 2. Solidworks Final Design with dimensions

Conclusions/action items:

Now that the design has been done, we need to start printing the final prototype. We plan on printing this in both elastic resin material and PLA material. Elastic resin has the potential of failing and is more costly, thus, printing in PLA first would be a safer choice.

2019/10/19 Initial Purchasing table

revisions print ▪ Maggie Zhou ▪ Oct 19, 2019 @02:29 PM C

Title: Initial purchasing table

Date: 2019/10/19

Content by: Maggie

Present: /

Goals: Set up a preliminary purchasing list before the actual placement of orders

Content:

List of material		Link		Manufacturer	Memo
Ring cracker	109.95$	https://www.ishor.com/ring-cutter		Shor inernation	Discount from the hospital?
Magnets	10.99$	https://www.magcraft.com/magcraft-nsn0566?feed=Froogle&gcli		Magcraft	0.125 in diameter and 0.0625 in thick, 100 count
Titanium ring	17$	https://www.kohls.com/product/prd-1994331/titanium-textured-b		Kohl's	How many?
Sponge	2$?			Fresh	

Table 1. List of material

Conclusions/action items:

This is a preliminary list of materials that our team potentially will order for this project. However, since the BPAG meeting is this Friday so we have to make sure all the websites we are purchasing from are eligible and we also have to double check with our client to see if he's paying with UW funds. Orders will be placed by the end of next week.

2019/11/14 Elastic Resin Material

revisions print · Kavya Vasan · Dec 05, 2019 @06:37 PM CST

Title: Elastic Resin properties

Date: November 14, 2019

Content by: Kavya Vasan

Present: Kavya Vasan

Goals: To research the properties of elastic resin for the prototype

Content:

- It is durable, tear-resistant, and resilient. It is also translucent.
- High elongation - 160%, soft flexible, high energy return/spring back
- Tear strength: 19.1 kN/m
- It is designed to bounce back and return to original shape.
- Ultimate Tensile strength: 3.23 MPa
- 160% elongation at failure.
- Cost: $199/L
- It requires more support than other resins.
- modulus of elasticity: 2.7 GPa
- Minimum wall thickness required: 1mm.

"Elastic Resin," *Formlabs*, 01-Jul-2019. [Online]. Available: https://formlabs-media.formlabs.com/datasheets/Elastic_Resin_Technical.pdf. [Accessed: 14-Nov-2019].

"Using Elastic Resin," *Formlabs*, 20-May-2019. [Online]. Available: https://support.formlabs.com/s/article/Using-Elastic-Resin?language=en_US. [Accessed: 14-Nov-2019].

Conclusions/action items: Elastic resin can bend, stretch and compress under repeated cycles without tearing. It is the best option for a final prototype due to its ability to bounce back and maintain its shape. The disadvantage is that it is more expensive than the PLA and TPE and doesn't support thin walls. This is the best rubber option at TEAM lab for 3-D printing so we will use this material. For testing, need to perform calculations on how the prototype made of elastic resin absorbs energy.

2019/11/18 Prototype Material Property Research

revisions print • James Tang • Dec 11, 2019 @11:52 AM CST

Title: Prototype Material Property Research

Date: 2019.11.18

Content by: James Tang

Present:

Goals: Explore the material properties of potential candidates of the prototype and decide which is the most appropriate one to choose from.

Content:

Overview of materials properties for Polylactic Acid (PLA) Biopolymer:

Mechanical Properties	Metric	English	Comments
Hardness, Shore A	67 - 85	67 - 85	Average value: 76.3 Grade Count:3
Hardness, Shore D	59 - 77	59 - 77	Average value: 65.8 Grade Count:5
Tensile Strength, Ultimate	14.0 - 114 MPa	2030 - 16500 psi	Average value: 46.8 MPa Grade Count:92
Film Tensile Strength at Yield, MD	19.0 - 54.0 MPa	2760 - 7830 psi	Average value: 30.5 MPa Grade Count:13
Film Tensile Strength at Yield, TD	14.0 - 48.0 MPa	2030 - 6960 psi	Average value: 26.5 MPa Grade Count:13
Tensile Strength, Yield	2.00 - 103 MPa	290 - 14900 psi	Average value: 37.5 MPa Grade Count:28
Film Elongation at Break, MD	160 - 600 %	160 - 600 %	Average value: 326 % Grade Count:16
Film Elongation at Break, TD	100 - 640 %	100 - 640 %	Average value: 402 % Grade Count:16
Elongation at Break	0.50 - 700 %	0.50 - 700 %	Average value: 62.9 % Grade Count:114
Elongation at Yield	2.0 - 400 %	2.0 - 400 %	Average value: 68.2 % Grade Count:20
Modulus of Elasticity	0.0850 - 13.8 GPa	12.3 - 2000 ksi	Average value: 2.80 GPa Grade Count:86
Tenacity	0.177 - 0.441 N/tex	2.00 - 5.00 g/denier	Average value: 0.296 N/tex Grade Count:9
Flexural Yield Strength	6.00 - 145 MPa	870 - 21000 psi	Average value: 77.4 MPa Grade Count:71
Flexural Modulus	0.215 - 13.8 GPa	31.2 - 2000 ksi	Average value: 3.86 GPa Grade Count:72
Secant Modulus, MD	3.30 - 3.44 GPa	479 - 499 ksi	Average value: 3.35 GPa Grade Count:3
Secant Modulus, TD	3.78 - 3.90 GPa	549 - 566 ksi	Average value: 3.85 GPa Grade Count:3
Izod Impact, Notched	0.128 - 8.54 J/cm	0.240 - 16.0 ft-lb/in	Average value: 1.39 J/cm Grade Count:47
Izod Impact, Unnotched	2.67 - 5340 J/cm	5.00 - 10000 ft-lb/in	Average value: 6.19 J/cm Grade Count:35
Charpy Impact Unnotched	0.500 J/cm^2 - NB	2.38 ft-lb/in^2 - NB	Average value: 2.39 J/cm^2 Grade Count:33
Charpy Impact, Notched	0.100 - 1000 J/cm^2	0.476 - 4760 ft-lb/in^2	Average value: 0.768 J/cm^2 Grade Count:42
Tear Strength	65.0 - 90.0 kN/m	371 - 514 pli	Average value: 76.7 kN/m Grade Count:3
Elmendorf Tear Strength, MD	0.0441 - 0.862 g/micron	1.12 - 21.9 g/mil	Average value: 0.426 g/micron Grade Count:16
Elmendorf Tear Strength, TD	0.0361 - 1.28 g/micron	0.918 - 32.6 g/mil	Average value: 0.510 g/micron Grade Count:16
Dart Drop Total Energy	240 - 420 J/cm	0.450 - 0.787 ft-lb/mil	Average value: 347 J/cm Grade Count:3
Film Tensile Strength at Break, MD	19.0 - 110 MPa	2760 - 16000 psi	Average value: 43.7 MPa Grade Count:13
Film Tensile Strength at Break, TD	13.0 - 145 MPa	1890 - 21000 psi	Average value: 50.5 MPa Grade Count:13

Figure 1: a table of materials properties for Polylactic Acid (PLA) Biopolymer.

Reference: http://www.matweb.com/search/DataSheet.aspx?MatGUID=ab96a4c0655c4018a8785ac4031b9278&ckck=1

Mechanical properties*

	Injection molding		3D printing	
	Typical value	**Test method**	**Typical value**	**Test method**
Tensile modulus	-	-	2,346.5 MPa	ISO 527 (1 mm/min)
Tensile stress at yield	-	-	49.5 MPa	ISO 527 (50 mm/min)
Tensile stress at break	-	-	45.6 MPa	ISO 527 (50 mm/min)
Elongation at yield	-	-	3.3%	ISO 527 (50 mm/min)
Elongation at break	-	-	5.2%	ISO 527 (50 mm/min)
Flexural strength	-	-	103 MPa	ISO 178
Flexural modulus	-	-	3,150 MPa	ISO 178
Izod impact strength, notched (at 23 °C)	-	-	5.1 kJ/m^2	ISO 180
Charpy impact strength (at 23 °C)	-	-	-	
Hardness	-	-	83 (Shore D)	Durometer

Figure 2: Ultimaker PLA Data Sheet.

Reference: https://ultimaker.com/download/74599/UM180821%20TDS%20PLA%20RB%20V10.pdf

Elastic Resin:

Material Properties Data

	METRIC[1]		IMPERIAL[1]		METHOD
	Green	Post-Cured[2]	Green	Post-Cured[2]	
Ultimate tensile strength [3]	1.61 MPa	3.23 MPa	234 psi	468 psi	ASTM D 412-06 (A)
Stress at 50% elongation	.92 MPa	.94 MPa	133 psi	136 psi	ASTM D 412-06 (A)
Stress at 100% elongation	1.54 MPa	1.59 MPa	223 psi	231 psi	ASTM D 412-06 (A)
Elongation at Failure [3]	100%	160%	100%	160%	ASTM D 412-06 (A)
Compression set at 23C for 22 hrs	2%	2%	2%	2%	ASTM D 395-03 (B)
Compression set at 70C for 22 hrs	3%	9%	3%	9%	ASTM D 395-03 (B)
Tear strength [4]	8.9 kN/m	19.1 kN/m	51 lbf/in	109 lbf/in	ASTM D 624-00
Shore hardness	40A	50A	40A	50A	ASTM 2240

[1] Material properties can vary with part geometry, print orientation, print settings and temperature.

[2] Data was obtained from parts printed using Form 2, 100 µm, Elastic settings, washed in Form Wash for 20 minutes and postcured with Form Cure at 60C for 20 minutes.

[3] Tensile testing was performed after 3+ hours at 23 °C, using a Die C dumbbell and 20 in/min cross head speed.

[4] Tear testing was performed after 3+ hours at 23 °C, using a Die C tear specimen and a 20 in/min cross head speed

Figure 3: Elastin Resin material properties data.

Summaries:

Young's moduli ranged from 2.19 to 7.15 GPa

Bulk moduli from 12.79 to 22.43 GPa

Shear moduli from 0.74 to 2.47 GPa

Poisson's ratio ranged from 0.45 for the stiffer to 0.47 for the more compliant composites

Statistically significant differences (ANOVA and Bonferroni at $p = 0.05$) were found depending on filler volume-fraction.

Elastic moduli varied significantly and a positive correlation existed between elastic moduli and filler volume-fraction ($r2$: 0.905–0.992 and 0.940–1.000 for Young's and bulk moduli, respectively).

Solvent Compatibility

Percent weight gain over 24 hours for a printed and post-cured 1 x 1 x 1 cm cube immersed in respective solvent:

Mechanical Properties	24 hr size gain (%)	24 hr weight gain (%)	Mechanical Properties	24 hr size gain (%)	24 hr weight gain (%)
Acetic Acid, 5 %	<1	2.8	Hydrogen Peroxide (3 %)	<1	2.2
Acetone	19.3	37.3	Isooctane	<1	3.5
Isopropyl Alcohol	13.3	25.6	Mineral Oil, light	<1	<1
Bleach, ~5 % NaOCl	<1	2	Mineral Oil, heavy	<1	<1
Butyl Acetate	18.2	39.6	Salt Water (3.5 % NaCl)	<1	1.7
Diesel	1.2	4.2	Sodium hydroxide (0.025 %, pH = 10)	<1	2
Diethyl glycol monomethyl ether	12	28.6	Water	<1	2.3
Hydrolic Oil	<1	2.1	Xylene	20.4	46.6
Skydrol 5	9.9	21.7	Strong Acid (HCl Conc)	14.2	39.4

Figure 4: Elastic Resin solvent compatibility.

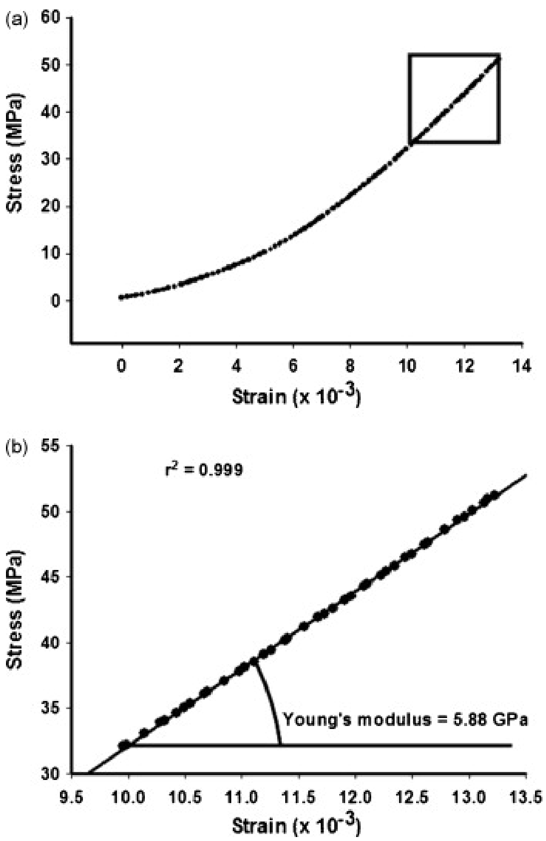


Figure 5: Young's and bulk moduli were obtained from the slope of the stress/strain curve at the higher loads for the unconstrained and constrained specimens respectively, using graphics software.

Thermoplastic Elastomers (TPE)

Properties

- Dense rubber

- Slip resistance
- Excellent weather resistance
- Shock absorption
- Outstanding ozone resistance
- Flexibility
- Soft texture
- Benefit of being co-extruded
- UL and NSF approval with certain TPE grades

Advantages

- Simplified processing - no mixing or vulcanization involved
- Lower part costs through lower density and thinner wall sections
- TPEs are colorable
- Recyclable scraps and parts
- Long-lasting

Reference:

https://www.sciencedirect.com/science/article/pii/S010956410700262X?via%3Dihub

https://formlabs.com/blog/elastic-resin-soft-resilient-3d-printing/

Conclusions/action items:

Elastic resin is a softer and more resilient 3D printing material, however, it is expensive. PLA is stronger and stiffer, and it has a lower price.

revisions print • James Tang • Dec 11, 2019 @11:52 AM CST


MATERIAL DATA SHEET

Elastic

Elastic Resin for Soft Flexible Parts $199 / L

Our softest Engineering Resin, this 50A Shore durometer material is suitable for prototyping parts normally produced with silicone. Choose Elastic Resin for parts that will bend, stretch, compress, and hold up to repeated cycles without tearing.

Wearables and consumer goods prototyping Medical models and devices

Compliant features for robotics Special effects props and models

FLELCL01 formlabs

Prepared

Rev

Elastic_Resin_Technical.pdf(161.6 KB) - download

revisions print ▪ James Tang ▪ Dec 11, 2019 @11:52 AM CST

Technical data sheet PLA

Ultimaker

Chemical composition	See PLA safety data sheet, section 3
Description	Ultimaker PLA filament provides a no-hassle 3D printing experience thanks to its reliability and good surface quality. Our PLA is made from organic and renewable sources. It's safe, easy to print with, and it serves a wide range of applications for both novice and advanced users
Key features	Good tensile strength and surface quality, easy to work with at high print speeds, user-friendly for both home and office environments, PLA allows the creation of high-resolution parts. There is a wide range of color options available
Applications	Household tools, toys, educational projects, show objects, prototyping, architectural models, as well as lost casting methods to create metal parts
Non-suitable for	Food contact and in vivo applications. Long term outdoor usage or applications where the printed part is exposed to temperatures higher than 50 °C

Filament specifications

	Value	Method
Diameter	2.85 ± 0.10 mm	-
Max roundness deviation	0.10 mm	-
Net filament weight	350 g / 750 g	-
Filament length	~ 44 m / ~ 95 m	-

Color information

Color	Color code
PLA Green	RAL 6018
PLA Black	RAL 9005
PLA Silver Metallic	RAL 9006
PLA White	RAL 9010
PLA Transparent	N/A
PLA Orange	RAL 2008
PLA Blue	RAL 5002
PLA Magenta	RAL 4010
PLA Red	RAL 3020
PLA Yellow	RAL 1003
PLA Pearl White	RAL 1013

Ultimaker_PLA_Data_Sheet.pdf(85.7 KB) - download

2019/12/11 Final Expense Sheet

revisions print

▪ Maggie Zhou ▪ Dec 11, 2019 @11:46 AM CST

Title: Final Expense Sheet

Date: 2019/12/11

Content by: Maggie

Present:

Goals: Update the final expense sheet

Content:

Item	Description		Manufacturer	Part Number	Date	QTY	Cost Each (with tax)	Total	Link
Rubber sheet	Used to wrap around the hole on the shield to increase patient's comfortability		ACE		10/23	1	6.47$	6.47$	https://www.acehardware.com/departments/plumbing/faucet-and-faucet-repair/faucet-and-valve-packing/4218095?x429=true&utm_source=google&utm_medium=cpc&gclid=Cj0KCQjwrrXtBRCKARIsAMbU6bE4l5IiKF-v1sgHg4yUXFx78YYsZM0JS1--PBkoth8NOV4uWcNIiPsaAjSXEALw_wcB&gclsrc=aw.ds
Tungsten carbide ring	Used for testing purpose		MetalMaster		10/23	5	22.99$	114.95$	https://metalmastersco.com/products/wcrx11278?utm_campaign=gs-2018-12-03&utm_source=google&utm_medium=smart_campaign&gclid=Cj0KCQjwrrXtBRCKARIsAMbU6bELbvD4_HFKrKNCc661ML-66cFVl5D2o3ajTDTthDzV2cqY6EeTBUEaAiDbEALw_wcB
Magnets	Used to attached to two shields over the ring cracker		MAGCRAFT		10/23	1	10.99$	10.99$	https://www.magcraft.com/magcraft-nsn0566?feed=Froogle&gclid=Cj0KCQjw3JXtBRC8ARIsAEBHg4lfOFf9SgE5VSHdyjd4k3xWIyhJsxBqXLZkL1Pcr8baJDzDkak95u0aApJZEALw_wcB
Ring cracker	For manufacturing the prototype		Shor International		10/23	1	109.95$	109.95$	https://www.ishor.com/ring-cutter
3D printing protecting shield version 1	Fabricating the prototype		Makerspace		10/22	1	4.47$	4.47$	
3D printing shield version 2 (half)	Farbricating the protytpe		Makerspace		10/31	1	15.00$	15.00$	
3D print	Fabrication		Makerspace		11/21	1	$1.85	$1.85	
3D print	Fabrication		Makerspace		11/25	1	$1.77	$1.77	
3D print	Fabrication		Makerspace		11/26	1	$2.77	$2.77	
Superglue	Fabrication		Makerspace		12/3	1	$1.15	$1.15	
Total:								269.37$	

Figure 1. Updated expense sheet

Conclusions/action items:

For this semester's project our budget is 500$. The final cost we spent during this semester is 269.37$ which is well beyond the budget limit.

2019/10/31 Elastic prototype

revisions print ▪ Camille Duan ▪ Dec 11, 2019 @11:24 AM CST

Title: Elastic prototype model fabrication

Date: 2019.10.31

Content by: Camille

Present: Camille

Goals: To fabricate an elastic model for the project using a 3D printer

Content:

- Fabrication of the first prototype in Elastic resin

Figure 1. Elastic prototype with a support system

The cost of printing one side of the protective shield was $14, which is a lot more expensive than printing in PLA that only costs $3 for the entire print.

Conclusions/action items:

We need to fix the dimensions of the prototype and start reprint soon.

2019/11/19 Prototype 3D Printing

revisions print ▪ Camille Duan ▪ Nov 27, 2019 @11:46 AM CST

Title:

Date: 2019.11.19

Content by: Camille

Present: Camille

Goals: To print a new prototype with a fixed dimension for design

Content:

Figure 1. The new prototype of ring cracker protection system using black PLA

The Solidwork design was fixed by Maggie from the last prototype

Camille went to the Makerspace to print the model using Cura software

The printing process took 4 hours and 25 minutes in total and the cost was around $3 dollars

Conclusions/action items:

This is the prototype after two rounds of dimension fixation. We need to change the cut location of the handle, specifically, we need to move the cut insertion point upwards about 1 cm. In addition, we need to increase the circle size at the bottom of the protective case so that the screw can be inserted further down the ring to increase strength.

2019/12/2 Final Prototype print

revisions print ▪ Camille Duan ▪ Dec 11, 2019 @11:33 AM CST

Title: Final Prototype printing procedure

Date: 2019/12/2

Content by: Camille Duan

Present: Camille

Goals: To print the final prototype in PLA and Elastic

Content:

- Software Cura was used for 3D printing PLA material:
    - Solidworks of the prototype is done
    - Save the file into an STL file type
    - Upload file into Cura
    - Start slicing process
    - Fill out the google doc file for printing and material amount used

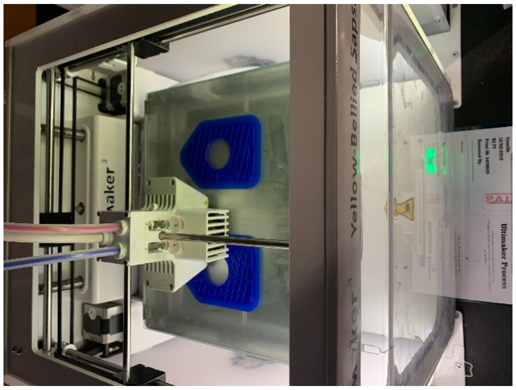


Figure 1. 3D printing process for PLA final prototype

- Software Preform was used for 3D printing PLA material:
    - Solidworks of the prototype is done
    - Save the file into an STL file type
    - Upload file into Preform
    - Start slicing process and autogenerate support system at 45 degree angle
    - Fill out the google doc file for printing and material amount used

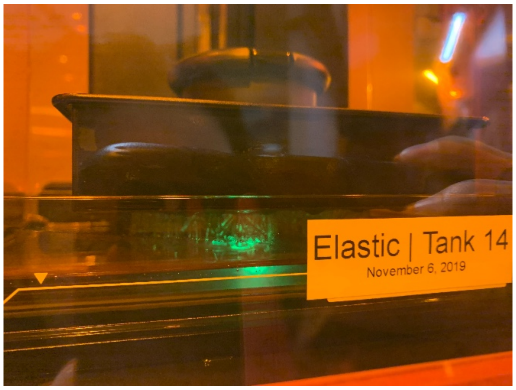


Figure 2. 3D printing process for Elastic material

Conclusions/action items:

The 3D printing for PLA material was successfully completed after 9 hours of printing, however, Elastic print failed due to machine failure at Makerspace. They will start reprint for us the next day.

2019/12/3 Final Prototype Assembly PLA

revisions print ▪ Camille Duan ▪ Dec 11, 2019 @12:28 PM CST

Title: Final Prototype Assembly

Date: 2019.12.3

Content by: Camille

Present: Team

Goals: To assemble the 3D printed PLA prototype

Content:

- Remove support system from 3D printed PLA prototype
- Use super glue to stick magnets inside each hole
- Cut rubber sheet into a valve shape
- Cut a hole at the finger insertion points for less insertion pressure on the injured finger
- Glue the rubber valve on the prototype

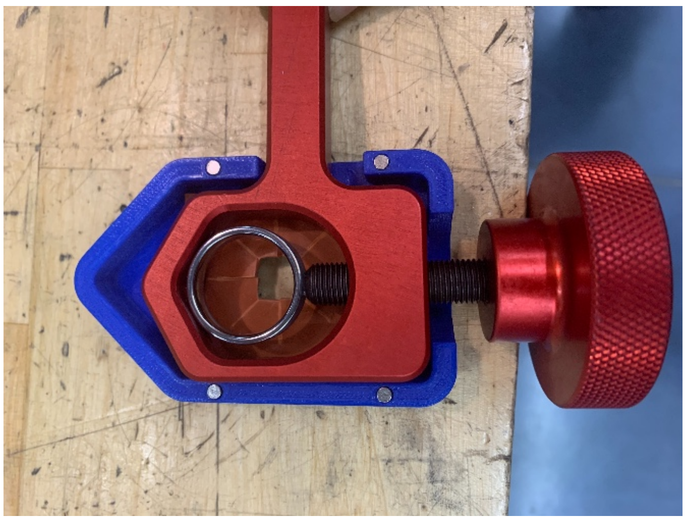


Figure 1. Final Prototype Assembly

Conclusions/action items:

The final prototype for PLA material is done and works. Now we only need to use this for final design testing and find if it works.

2019/12/5 Final Prototype Elastic Resin

revisions print · James Tang · Dec 11, 2019 @11:38 AM CST

Title: Final Prototype printing procedure

Date: 2019.12.05

Content by: James Tang

Present: James & Camille

Goals: To manually fix the elastic resin prototype since the 3D printing fails again.

Content:

We fail the 3D printing 3rd time for the elastic resin prototype and the Makerspace people inform us they won't keep printing anymore since they have wasted a lot of material.

As a result, we have to manually fix the old prototype by hands.

The main work done:

- Add small magnets into the prototype so the two pieces can attach to each other.
- Glue the magnets so they do not fall apart
- Cut the holes to fit the magnets
- Attached rubber sheet to the shields

Figure 1: a flat view of the finished prototype.

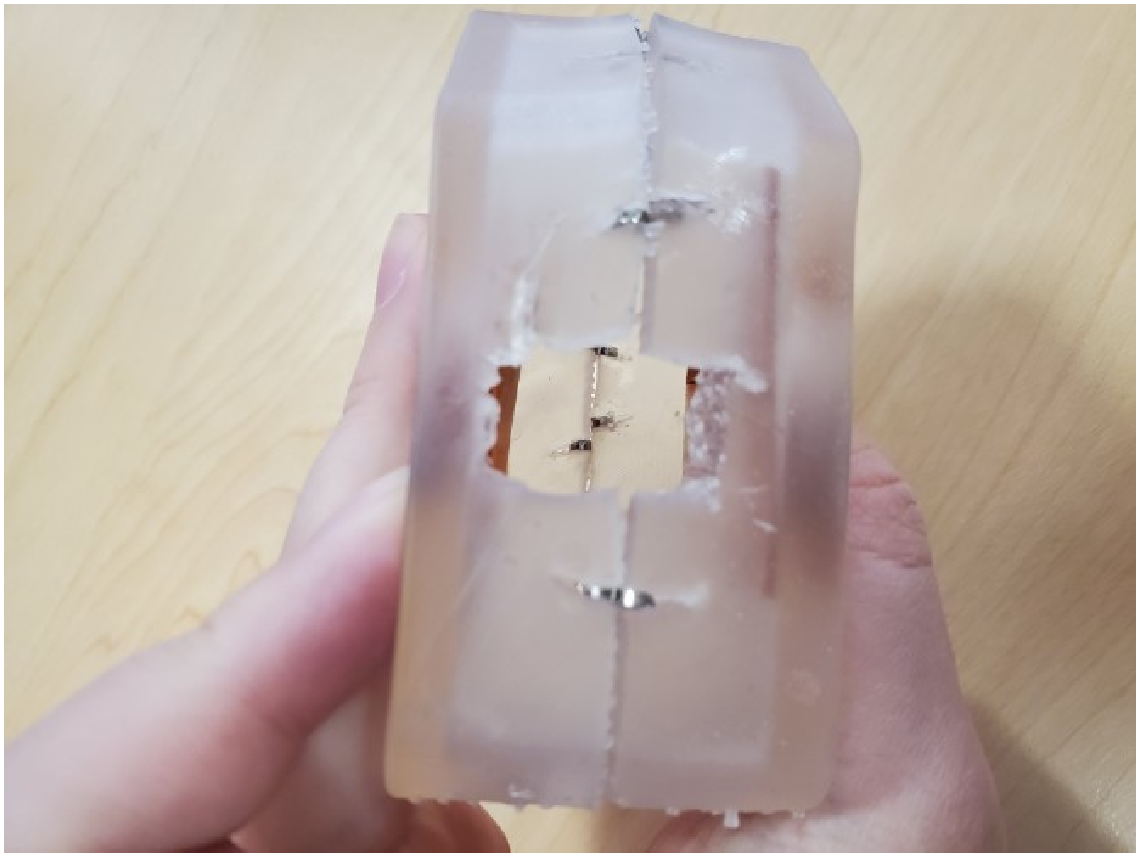


Figure 2: a side view of the finished prototype.

Conclusions/action items:

This manually fixed prototype does not look perfect but it works okay.

2019/10/20 Protocol for testing

revisions print • Kavya Vasan • Dec 11, 2019 @01:14 AM CST

Title: Testing protocol

Date: 2019.10.20

Content by: Camille

Present: Camille

Goals: To come up with a rough draft for testing final design

Content:

1. Once prototype is successfully 3D printed with the correct dimensions to fit into the ring cracker, we will start testing procedure below
2. 5 Standard size 7 tungsten carbide rings will be used to test
3. Each ring will be cracked multiple times until the ring start to deform
4. Metal pieces will be collected every time after ring is cracked
5. Protection case integrity will be examined thoroughly every time
6. After 5 times of repeated testing, results will be analyzed
7. More testings might be needed depend on success rate of not breaking the protection case and protecting patients and clients

Conclusions/action items:

Edits might be needed depending on real time of use

2019/11/17 Updated testing protocol

revisions print · Camille Duan · Nov 17, 2019 @05:04 PM CST

Title: Updated testing protocol

Date: 2019.11.17

Content by: Camille

Present: Camille

Goals: To come up with a more detailed testing protocol

Content:

Ring Cracker Protection System Testing Protocol

1. Material Selection Testing

Objective:

To perform testing on PLA and Elastic resin to evaluate the strength and energy absorbance capability between the two different materials. The material with higher stiffness and energy absorption ability will be selected for part B testing.

Material:

One 3D printed PLA protection case

One 3D printed Elastic protection case

One slingshot

One tape measure

One slow capture camera

One timer

One aluminum washer

Methods:

1. Each case will be placed on a table with a steel tape measure set up
2. The original placement of the case will be marked
3. A slingshot will be placed 50 cm away from the end of the case
4. The rubber band of the slingshot will be stretched 15 cm
5. The bounce distance of the aluminum washer and time will be recorded
6. The test will be repeated 10 times to find the average distance and time
7. The rubber band will then be stretched 20,25 cm
8. Repeat step 5-6

Analysis/ Selection Criteria

The amount of force load of impact on each case can be calculated with the mass of the aluminum times gravitational acceleration, ignoring the air friction.

F= mg

Energy absorbed during impact is determined from measurements of dynamic load and striking head velocity during the time of impact.

E= V∫Fdt

Kinetic energy can also be calculated using:

KE= 12mv2

Evaluation:

2. Tungsten Carbide Ring Testing

Objective:

To perform a test on the selected ring cracker protection system using 4 tungsten carbide rings to evaluate the feasibility of the system

Material:

4 tungsten carbide rings of size 5,7,9 and 13

Carrots to mimic human finger

Ring cracker

Method:

1. Each ring will be placed on a carrot and inserted through the ring cracker
2. The amount of pressure placed on each ring will be equivalent to the number of rotation of the screw
3. The test will end at the sound of a crack

Evaluation Criteria:

The amount of pressure with each ring size

Whether the protection system was able to catch the flying metal pieces (if any)

The fracture velocity of tungsten carbide rings

Conclusions/action items:

Start fabrication on Monday next week with the new fixed dimension prototype and start testing by the end of Friday next week

2019/11/18 Updated testing protocol

revisions print • Maggie Zhou • Dec 02, 2019 @10:53 PM CST

Title: Update the testing protocol

Date: 2019/11/18

Content by: Maggie

Present:

Goals: Finish the testing protocol

Content:

The following content are added to the previous entry of testing protocol

1. Broken tungsten carbide ring speed velocity testing

Objective:

To perform testing on tungsten carbide ring when it got cracked. Measure the time and distance the broken pieces flying out. The procedure will be recorded and played as a slow motion for analysis.

Material:

One tungsten carbide ring

One ring cracker without protection shield

One camera

One timer

One tape measure

One piece of baby carrot (mimic human finger)

Methods:

1. One tungsten carbide ring will be put over a baby carrot
2. The ring with carrot will be placed into the ring cracker without protecting shield
3. The ring will be cracked and the cracking process will be recorded

Analysis/ Selection Criteria

To measure the velocity of the broken pieces when the ring is a cracker, a certain frame period will be picked during the slow motioned video and the distance will be measured based on the tape measure on the wall. Velocity will be the distance traveled during that frame period.

$V = d / t$

Conclusions/action items:

With the addition of this part we will be able to find the velocity of the broken pieces when the tungsten carbide is cracker to prove that his project exists for a reason. The velocity might be high enough to hurt the patients or physicians when the ring cracking procedure happen.

2019/11/18 Prototype Energy Calculations

revisions print · James Tang · Dec 11, 2019 @11:50 AM CST

Title: Prototype Energy Testing Research

Date: 2019.11.18

Content by: James Tang

Present: James Tang

Goals:

Determine how well each material performs base on how much energy being absorbed by the materials.

Content:

Determine elastic or inelastic collision:

- A collision is an event where momentum or kinetic energy is transferred from one object to another
- Momentum (p) is the product of mass and velocity (p = mv)
- Kinetic energy is the energy of motion; it is defined as K = (1/2) m v^2
- calculate the total kinetic energy of the system both before and after the collision.
- kinetic energy before the collision is equal to the kinetic energy after the collision (kinetic energy is conserved), this is an elastic collision.
- In an elastic collision, both momentum and kinetic energy are conserved. Almost no energy is lost to sound, heat, or deformation.

Gravitational Potential Energy

$$PE_g = ham$$

Loss of Energy

$$\Delta PE_g = \left| PE_g' - PE_g \right|$$

% of Energy Lost

$$\% \ Lost = \frac{\Delta PE_g}{PE_g} \bullet 100$$

Figure 1: formula need for energy lost.

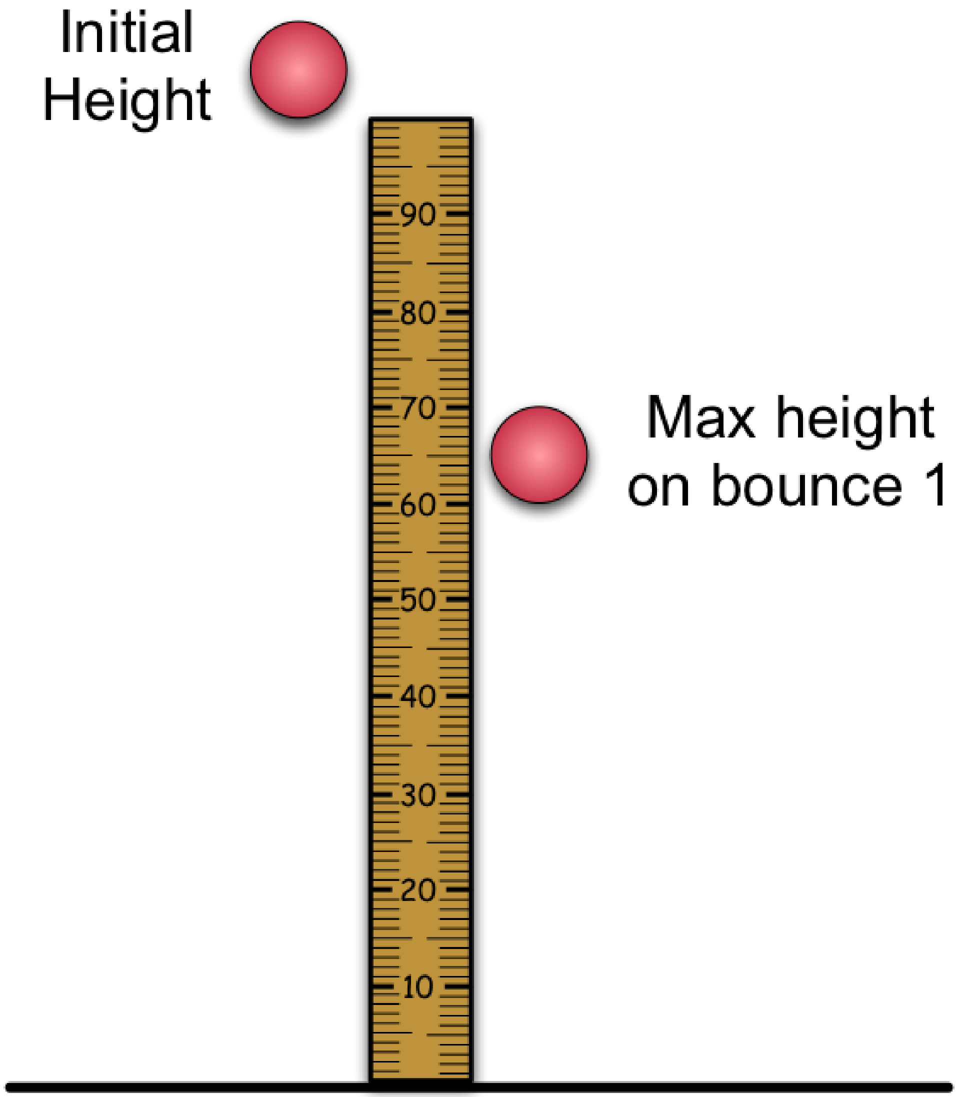


Figure 2: Initial height energy minus final height energy should be the total energy lost.

Reference: http://ffden-2.phys.uaf.edu/211_fall2002.web.dir/ben_townsend/TypesofCollisions.htm

https://sites.google.com/site/delseaphysics1/Home/other-topics/energy/energy-loss-on-bounce

Conclusions/action items: Use this formula to compare the energies absorbed from different materials during drop testing.

2019/11/21 Preliminary testing for broken piece velocity and comparison between two materials

▪ Kavya Vasan ▪ Dec 11, 2019 @01:15 AM CST

Title: Testing for the velocity of broken piece and compare the two materials

Date: 2019/11/21

Content by: Maggie

Present: All

Goals: Finish the first two parts of the testing protocol

Content:

The team met and set up the testing place with black background and measure tape stick to the wall. Mini carrots are used in lieu of a finger, to ensure our safety. The first procedure was performed to test the cracking speed of the broken pieces from the tungsten carbide ring. The second procedure was conducted to compare the energy absorbed by PLA and Elastic resin to prove that elastic resin absorb more energy of the broken piece from the tungsten carbide ring. For details please see the protocol file.

Figure 1. The carrot is used to mimic the finger with the ring cracker and tungsten carbide ring in.

Conclusions/action items:

We only completed the first two procedures of the protocol since our prototype still have some minor issue so it doesn't really fit to the ring cracker. We will finish the testing results analysis and perform the third testing part to prove that there are fewer broken pieces from tungsten carbide ring after the protecting shields are on.

2019/11/18 Fracture Testing Calculations

revisions print · James Tang · Dec 11, 2019 @10:59 AM CST

Title: Prototype Energy Calculations

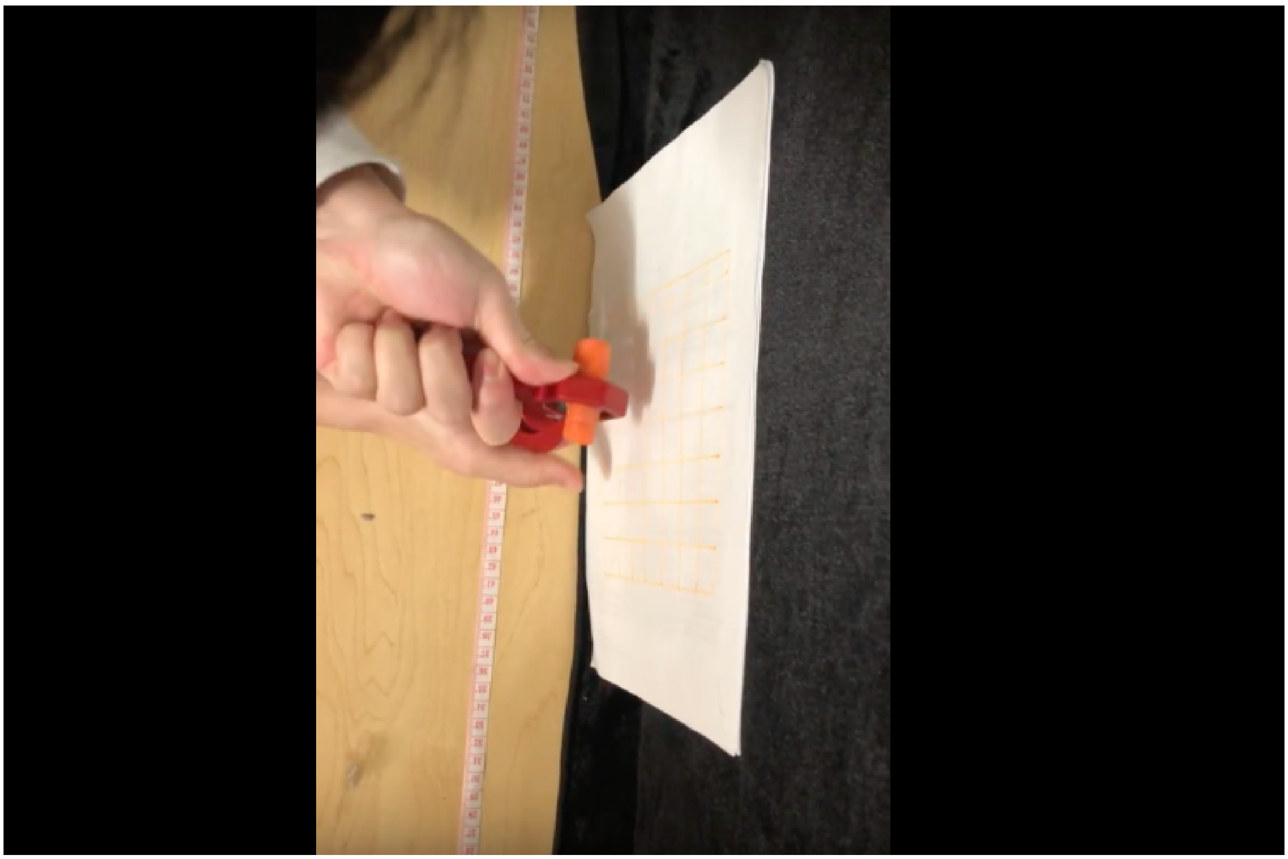
Date: 2019.11.18

Content by: James Tang

Present: James Tang

Goals: Determine the velocity at which a Tungsten Carbide ring flies when broken

Content:



- Fracture Testing:
- Data from testing: 27 cm
- Time duration: 0.5 second
- Displacement: $0.5*t*a^2 = 0.27$
- $a=1.04\ m/s^2$
- $v= a*t = 1.04*0.5 = 0.52\ m/s$

Conclusions/action items:

The flying speed of the broken tungsten carbide ring was not as high as we expected, such low speed won't bring big dangers to humans other than places like eyes or mouth.

revisions print · James Tang · Dec 11, 2019 @10:56 AM CST

IMG_3135.MOV(8 MB) - download The film of initial testing

2019/11/21 Energy Testing Data

revisions print ▪ Kavya Vasan ▪ Dec 11, 2019 @11:34 AM CST

Title: Energy Testing Data and Calculations

Date: November 21, 2019

Content by: Kavya Vasan

Present: Team

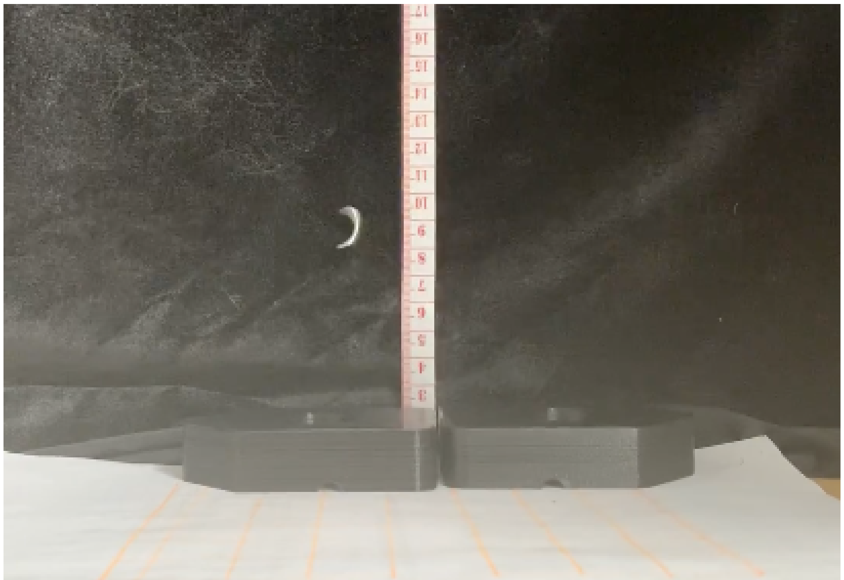
Goals: To calculate the energy absorption from collisions on PLA and Elastic Resin at different heights

Content:

- PE = m*g*h (3), where m is mass, g is gravitational acceleration, h is height
- Energy absorption rate = (initial PE - final PE) / (Initial PE)
- 1. ((25 - 2.8) / 25)*100 = 88.8% for 25 cm PLA
- 2. ((25-0.06) /25)*100 = 99.76% fo 25 cm Elastic Resin
- 3. ((50 - 8.9) / 50)*100 = 82.2% for 50 cm PLA
- 4. ((50 - 2.1) / 50)*100 = 95.8% for 50 cm Elastic Resin
- The average energy absorption rate at height 25 cm for the PLA is 88.8% and for elastic resin is 99.76%.
- Average energy absorption rate at height 50 cm for the PLA is 82.2% and for elastic resin is 95.8%.

	25 (PLA) cm	25(Elastic) cm	50 (PLA) cm	50(Elastic) cm	25 PLA (PE) J	25 Elastic (PE) J	50 PLA (PE) J	50 Elastic (PE) J
Trial 1	4	0	6.5	2.5	0.00012	0	0.000195	0.000075
Trial 2	1.5	0.3	10	0.5	0.000045	0.000009	0.0003	0.000015
Trial 3	2	0	8	4.5	0.00006	0	0.00024	0.000135
Trial 4	4	0	9.5	3	0.00012	0	0.000285	0.00009
Trial 5	2.5	0	10.5	0	0.000075	0	0.000315	0
Average	2.8	0.06	8.9	2.1	0.000084	0.0000018	0.000267	0.000063
TotalAverage	3.465							

Table 1. Energy testing data collected for PLA and Elastic resin when tungsten carbide ring piece is dropped from 25 cm and 50 cm for each material 5 trials



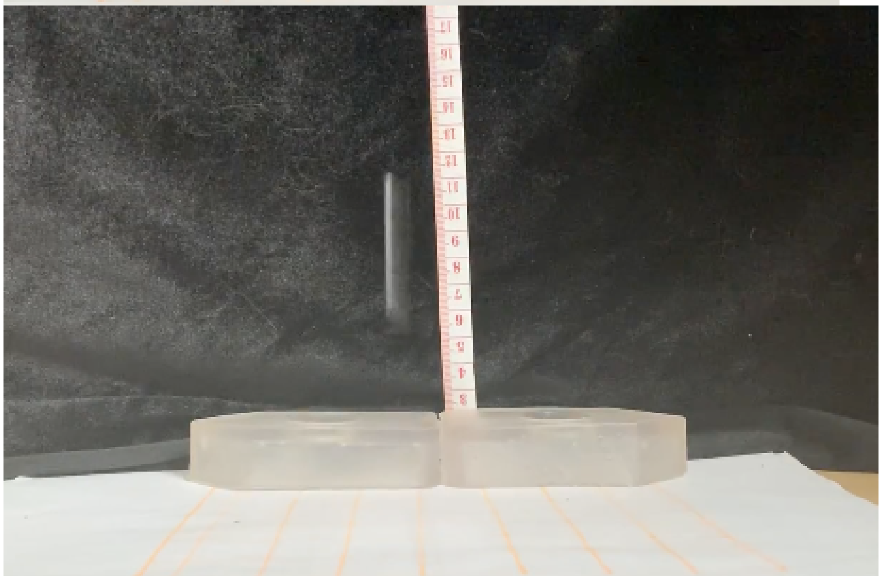


Fig 1. Testing setup for Tungsten carbide dropped on PLA Fig 2. Testing setup for Tungsten carbide dropped on Elastic Resin

Conclusions/action items: The Elastic resin absorbed 11-13% more energy than PLA, when Tungsten carbide is dropped from 25 cm and 50 cm. The Tungsten carbide bounced up twice as much as Elastic Resin when dropped from 25 cm. The Tungsten carbide bounced up 4 times as much as Elastic Resin when dropped from 50 cm. Therefore, a higher initial height also increased the bounce back distance as seen from the elastic resin and PLA height data. The elastic resin bounced back almost twice as much at 50 cm compared to 25cm.

2019/12/4 Protection Shield Testing

revisions print • Camille Duan • Dec 11, 2019 @12:29 PM CST

Title: Protection shield testing for containment of broken ring pieces

Date: Dec 4, 2019

Content by: Kavya Vasan, Camille

Present: Team

Goals: To test whether the prototype is effective in preventing flying ring shards.

Content:

- The team inserted the magnets into the final PLA protection shield prototype.
- The final prototype was supposed to be printed in Elastic Resin also, but the print failed, so final shield testing was done on the final PLA prototype and the old elastic resin prototype.
- A rubber sheet was cut using scissors, to cover the holes on both faces of the shields. The rubber sheet was cut into squares, and small cuts were made in a circular pattern, to allow the finger to enter through the rubber sheet.
- The rubber sheets were taped onto the protection shields using scotch tape.
- Results of the testing:
  - 100% success rate for the PLA prototype. No tungsten carbide ring pieces flew out of the protective shield.
  - 100% success rate for the old Elastic Resin prototype: No tungsten carbide pieces flew out of the protective shield.

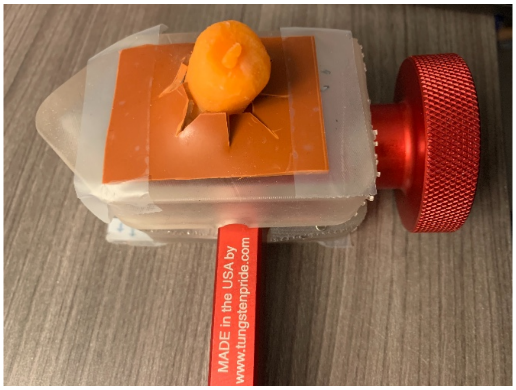


Figure 1. Testing photo

Conclusions/action items: The team's final prototype was a success and fulfilled the client's specifications. Even though the elastic resin 3D print failed, both testing scenarios were successful. The team is to present our findings at the poster presentation on Dec 6th and we need to compile all of our results in the final report. The statistical analysis needs to be recorded in the notebook. After talking to Dr. Puccinelli, we decided that we are done with this project this semester, and will not continue it.

2019/12/3 Statistical testing analysis

revisions print • Camille Duan • Dec 11, 2019 @11:38 AM CST

Title: Statistical Analysis of Energy Testing data

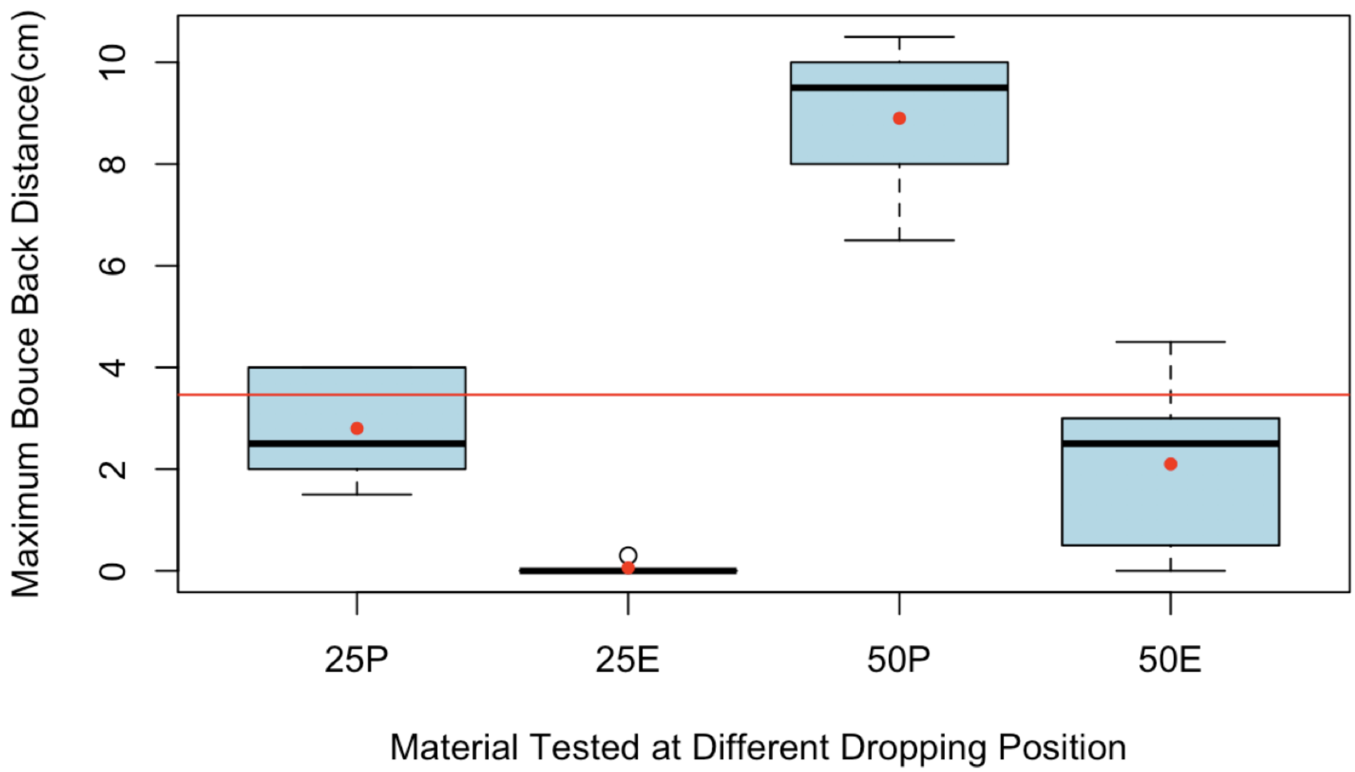
Date: December 3, 2019

Content by: Camille Duan

Present: Camille

Goals: To analyze energy data using ANOVA analysis using R studio

Content:



`{r}

library(ggplot2)

PLA25<-c(4,1.5,2,4,2.5)

Elastic25<-c(0,0.3,0,0,0)

PLA50<-c(6.5,10,8,9.5,10.5)

Elastic50<-c(2.5,0.5,4.5,3,0)

plot<-boxplot(PLA25,Elastic25,PLA50,Elastic50,xlab="Material Tested at Different Dropping Position ",ylab="Bouce Back Distance(cm)",names = c("25P","25E","50P","50E"),col="pink")+geom_boxplot()+stat_summary(fun.y=mean, geom="Point")

abline(h=3.465,col="red")

points(1, mean(PLA25),pch=20, col="red")

points(2,mean(Elastic25),pch=20,col="red")

points(3,mean(PLA50),pch=20,col="red")

points(4,mean(Elastic50),pch=20,col="red")

`

`{r}

hypothesis in one-way ANOVA test

H0: The means between groups are identical

Ha: The mean of at least one group is different

Combined_Trials<-data.frame(cbind(PLA25,Elastic25,PLA50,Elastic50))

summary(Combined_Trials)

Stacked_Trials<-stack(Combined_Trials)

Anova_result<-aov(values ~ ind, data = Stacked_Trials)

summary(Anova_result)

`

```
     PLA25       Elastic25        PLA50         Elastic50
 Min.   :1.5   Min.   :0.00   Min.   : 6.5   Min.   :0.0
 1st Qu.:2.0   1st Qu.:0.00   1st Qu.: 8.0   1st Qu.:0.5
 Median :2.5   Median :0.00   Median : 9.5   Median :2.5
 Mean   :2.8   Mean   :0.06   Mean   : 8.9   Mean   :2.1
 3rd Qu.:4.0   3rd Qu.:0.00   3rd Qu.:10.0   3rd Qu.:3.0
 Max.   :4.0   Max.   :0.30   Max.   :10.5   Max.   :4.5
            Df Sum Sq Mean Sq F value   Pr(>F)
ind          3 217.19   72.40   38.91 1.41e-07 ***
Residuals   16  29.77    1.86
---
```

Figure 2. One way ANOVA result summary table

Conclusions/action items:

The x-axis represents each of the groups tested. The numbers of each column represent the dropping height for testing, and P stands for PLA material and E stands for Elastic material. Finally, a one-way ANOVA test was performed to test the null hypothesis that the individual means were identical. A p-value of < 0.001 was found, meaning there are enough evidence and statistical significance to reject the null hypothesis. Overall, Elastic material shows a higher energy absorption due to smaller bounce back distance.

2019/11/8- Show and Tell

revisions print • Kavya Vasan • Nov 10, 2019 @02:09 PM CST

Title: Show and Tell

Date: November 8, 2019

Content by: Kavya Vasan

Present: Kavya and Maggie

Goals: To gain feedback on our prototype from other groups

Content:

- Group 1: No feedback. Satisfied.
- Group 2: magnets inside to attract flying pieces.
- Group 3: If there is enough space for magnets, that could work. Would it interfere? Stability of the finger has been a common question.
- Group 4: We can maybe use a carrot for testing the ring cracker.
- Group 5: Keep one side thick and the other side thin to allow the base of the finger to be reached.
- Group 6: did not give feedback.

Conclusions/action items: Fix the dimensions on solidworks and start testing. Also, think about the stability aspect of the finger, since that was a common question that came up.

2019/9/20 What is Edema

revisions print · Camille Duan · Oct 08, 2019 @09:30 PM CDT

Title: Edema

Date: 2019/09/20

Content by: Camille Duan

Present: Camille Duan

Goals: To learn about edema

Content:

<Edema - Symptoms and causes. (2017, October 26). Retrieved from https://www.mayoclinic.org/diseases-conditions/edema/symptoms-causes/syc-20366493>

Definition of edema: edema is the swelling caused by excess fluid trapped in the body tissue. Edema can happen in various parts of the body such as hands, arms, feet, ankles and legs.

Symptoms of edema:

- Swelling or puffiness of the tissue directly under your skin, especially in your legs or arms
- Stretched or shiny skin
- Skin that retains a dimple (pits), after being pressed for several seconds
- Increased abdominal size

Figure 1. Comparison of normal feet verses edema feet

Mild cases of edema may result from:

- Sitting or staying in one position for too long
- Eating too much salty food
- Having premenstrual signs and symptoms
- Being pregnant

Edema can also be a side effect of some medications, including:

- High blood pressure medications
- Nonsteroidal anti-inflammatory drugs
- Steroid drugs
- Estrogens
- Certain diabetes medications called thiazolidinediones

Conclusions/action items:

In this research study, I learned about what is edema and some of the mild reasons that can cause edema to happen, which will help our design when considering removing ring under finger edema situations.

2019/09/25 Common causes of edema

revisions print • Camille Duan • Oct 08, 2019 @09:38 PM CDT

Title: Case report of Partially embedded ring upon a finger

Date: 2019/9/25

Content by: Camille

Present: Camille

Goals: To learn about finger edema when a ring is stuck

Content:

< Kumar, A., Edwards, H., Lidder, S., & Mestha, P. (2013). Dangers of neglect: partially embedded ring upon a finger. *Case Reports*, *2013*(may09 1), bcr2013009501-bcr2013009501. doi:10.1136/bcr-2013-009501>

Upper limb injury or infection can cause swelling or dependent oedema in fingers and this may be further complicated by the presence of a ring. Patients often present to accident and emergency (A&E) whereby these rings can be removed; however, this may be difficult with a late presentation.

Digital swelling is a common presentation in clinical practice. Patients presenting with swollen fingers to the emergency department will often have rings on their finger, which can be removed using a variety of simple non-operative techniques or by cutting the ring off and thus avoiding any long-term consequences. Very rarely, when there is a delay in presentation of these patients, serious consequences may proceed, including finger ischaemia, infection, tendon attrition or ultimately the need for surgical amputation. We present an unusual case of patient with psychiatric illness who presented late with a ring that had embedded upon the volar aspect of the index finger. The difficulties faced by the emergency care practitioners in such circumstances, the consequences of rings acting as a tourniquet and strategies for removal of rings on swollen fingers are highlighted.

Swelling of the fingers may be secondary to dependence, infection, trauma or fluid retention secondary to other medical conditions. Digital swelling can be exacerbated with the presence of a ring acting as a tourniquet. This will cause disruption to the lymphatic drainage exacerbating digital oedema. Progression of the swelling will then cause disruption to the venous drainage leading to venous congestion. Eventually arterial compromise will ensue.

Conclusions/action items:

With a ring becoming imbedded into the volar aspect of the finger as in this case, the sequelae can include infection, contracture, flexor tendon rupture and finger ischaemia which may require amputation. Simple methods such as lubrication with axial traction should first be attempted. If this fails, elevation of the limb, followed by exsanguination of the digit, and the application of a tourniquet around the upper extremity, can decrease swelling. Axial traction with lubrication can then be attempted again. The use of thread can be used as an adjunct in removing the ring. Wrapped tightly around the digit to decrease the swelling, the ring is gently rotated with traction while holding the proximal end of the thread (under the ring). Failure of the conservative methods mentioned above requires cutting the ring, either with a ring cutter or orthopedic wire cutter. If all non-operative methods fail, then surgical removal of the ring may be necessary.

2019/9/12 Two techniques for tungsten carbide ring

revisions print • Camille Duan • Sep 13, 2019 @11:07 AM CDT

Title: Comparison of two techniques for tungsten carbide ring removal

Date: 2019.9.12

Content by: Camille Duan

Present: Camille Duan

Goals: To research the existing methods for removing tungsten carbide ring

Content:

Due to the mechanical properties of tungsten, it usually can not be directly cut. The " umbilical tape technique" or "string technique" could potentially be an effective alternative way to remove them. This method of ring removal is performed by passing a strip of cloth tape or string underneath the ring from distal to proximal and then tightly wrapping the tape around the digit, digital to the entrapped ring. The purpose of this wrapping is to compress the edema in the finger, effectively rendering it less edematous. The proximal piece of tape is then used to unwrap the tape. Each time the tape is unwound it pushes the ring distally. The ring will eventually be pushed beyond the proximal interphalangeal joint onto the thinner, distal finger from which it can be easily removed.

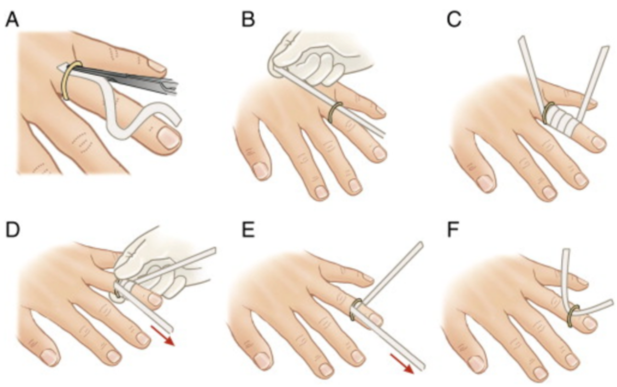


Figure 1. The umbilical tape technique

Another common method for removing the ring would be to fracture the ring using medium-sized locking pliers. The jaws of the locking pliers were adjusted so that, when closed, they would grip the ring snuggly without being overly tight. They were then opened and the tightening screw was turned one-quarter of a turn to the ring to slightly increase the grip pressure on the ring. The pliers were then reapplied to the ring. This process was repeated until the ring was fractured.

Figure 2. A locking plier is used to remove a ring

Conclusions/action items:

There was no difference in the primary objective as both techniques were 100% effective in ring removal with no attempt taking more than 5 minutes. However, the tests were done on a medical simulation mannequin, so that the discomfortness can not be measured.

2019/09/18 Mooney Ring Cutting System

revisions print • Camille Duan • Oct 08, 2019 @09:57 PM CDT

Title: Mooney Ring Cutting System

Date: 2019.09.18

Content by: Camille

Present: Camille

Goals: Competing device for cutting tungsten carbide rings

Content:

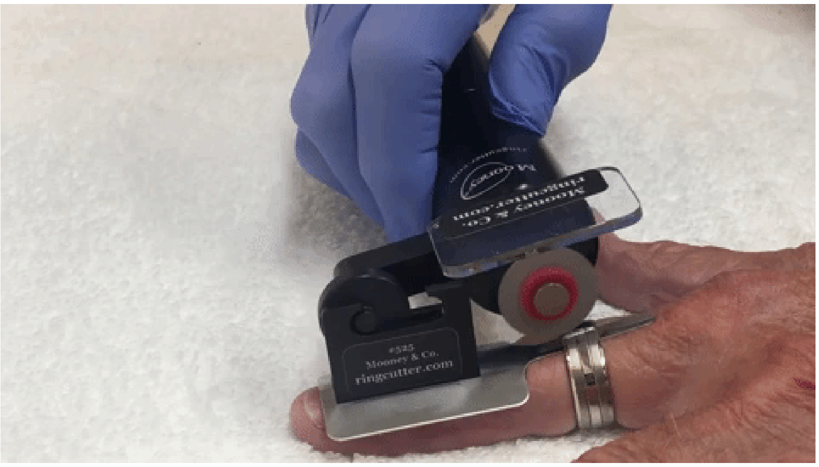


Figure 1. Mooney & Co ring cutting system

Manufactured in Ashland, Oregon the Mooney Ring Cutting System™ is used by hospital emergency departments and critical care units worldwide. Introduced in 1993, the system is specifically designed to remove rings or bands which have led to strangulation of the digit, or other limb created by traumatic injury.

Figure 2. Ring cutting system

- Alloys such as titanium, chromium cobalt and tungsten carbide present unique challenges: rings made of these super-hard alloys tend to be thick and wide and the relatively long duration of the cutting process requires the handpiece to produce constant, optimal rotational speed and torque, free from the degradation of performance that accompanies battery energy drain.
- In 2006 Mooney & Co. introduced its AC powered version of the original battery powered ring cutting system specifically to overcome these challenges. The model #622's handpiece receives power via a compact wall adapter which ensures that optimum performance is maintained no matter what the duration of the cutting process.
- It comes with two different types of blades, the red packaging is diamond blade, which can cut through hard metals such as titanium and tungsten carbide, and blue colored blade is for soft metals such as gold and silver.

- The cost of this ring cutting system is approximately $660.

Conclusions/action items:

This device act as a competing device for cutting through metals such as titanium and tungsten carbide. It also has a long stick that protects finger being cut during the procedure.

2019/09/20 Titanium ring cutter

revisions print • Camille Duan • Oct 08, 2019 @10:11 PM CDT

Title: Titanium ring cutting device

Date: 2019.9.20

Content by: Camille

Present: Camille

Goals: To research other competing design for cutting tungsten carbide rings

Content:

Figure 1. Power ring cutting device

A diamond disc saw is the secret to cutting hard metals.

The diamond disc works differently from steel saws. It grinds the metal away instead of cutting it.

Continued application of water is strongly recommended while cutting to keep the disc cool and to greatly extend the life of the disk.

The blade guard slips under the ring and completely protects the finger while cutting.

Conclusions/action items:

Since tungsten carbide have such a high stiffness and hardness, the only existing and commonly used metal that is harder than tungsten carbide would be diamond. From the two competing devices that I have found, both of them use diamond blade as a cutting blade.

2019/10/6 3D Printing technology dynamics analysis

revisions print • Camille Duan • Oct 08, 2019 @08:53 PM CDT

Title: 3D Printing technology dynamics analysis

Date: 10/6/2019

Content by: Camille

Present: Camille

Goals: To research 3D printing as fabrication method

Content:

<Garechana, G., Río-Belver, R., Bildosola, I., & Cilleruelo-Carrasco, E. (2019). A method for the detection and characterization of technology fronts: Analysis of the dynamics of technological change in 3D printing technology. *PLoS ONE*, *14*(01), 1–27. https://doi-org.ezproxy.library.wisc.edu/10.1371/journal.pone.0210441>

3D printing technology is experiencing an explosion in the number of patents filed since 2013, according to the data retrieved using the query described in the "data download" section. The number of simple patent families filed that year more than quadrupled the number of patents filed in 2012, and the average growth rate in the number of patents filed each year from 2013 to 2016 stands at a remarkable 75%.

The disruption that 3D printing technology is expected to bring is bound to transform business models from the dependence of economies of scale and the massive outsourcing of production facilities to a less wasteful, logistically far more efficient approach, based on mass customization and the re-location of manufacturing centers near the main markets where sales actually take place, thus giving a new boost to the principles of Just in Time production of goods. In addition to this, the manufacturing of complex geometries would be cost-efficient almost regardless of the manufacturing batch size, and materials wasted would be negligible when compared to traditional subtractive manufacturing methods. A special socio-economical challenge posed by the arrival of this technology will be the destabilizing effect of the deep transformation—or sheer reduction—that traditional manufacturing labor force will have to endure under this new paradigm.

Photopolymers are a particular type of liquid polymers that polymerize (we could say solidify or harden, for 3D printing purposes) when exposed to visible or ultraviolet (UV) wavelengths. The most frequent commercial materials used in this technology are acrylates, epoxies and vinyl ethers, and well-known applications of photopolymerization include the plastic coating of paper or cardboard and tooth fillings using dental composite. The first patent of a 3D printing machine based on VAT photopolymerization, titled "Apparatus for production of three-dimensional objects by stereolithography" was filed in 1984 by Charles Hull, hence the popularity of the name "stereolithography" to refer to this technology. The typical design of a 3D printing machine based on this technology is formed by a platform that controls the Z axis and a light source that can be directed to solidify the polymer in the desired points on a layer-by-layer basis. The platform will move downwards as the printing progresses, and once the product is finished the remaining polymer liquid in the vat is evacuated.

Conclusions/action items:

The development of 3D printing technology was fast and massive according to this article, especially since after 2013 when this technology was first publicly exposed to all. Since then, a lot of various materials are used to test 3D printers and it has also been tested to print different parts. More research needs to be done at this point to see its real applications rather than the market that it has at the moment.

2019/10/6 Advantage of 3D printing

revisions print ▪ Camille Duan ▪ Oct 08, 2019 @08:55 PM CDT

Title: Advantage of 3D printing

Date: 2019.10.6

Content by: Camille Duan

Present: Camille

Goals: To research the benefits of using 3D printing technology

Content:

<Chen, Y.-Y., Lin, K.-H., Huang, H.-K., Chang, H., Lee, S.-C., & Huang, T.-W. (2018). The beneficial application of preoperative 3D printing for surgical stabilization of rib fractures. *PLoS ONE*, *13*(10), 1–9. https://doi-org.ezproxy.library.wisc.edu/10.1371/journal.pone.0204652>

Three-dimensional (3D) printing is a spectacular manufacturing technology with rapid prototyping, which enables the creation of 3D structures from computer-aided design data sets via an additive layering process. Until this report, there have been no definite conclusions in the literature about the clinical application of 3D printing in patients with rib fractures. Rib fractures are noted in 10% of all trauma patients and in about 30% of patients with significant chest trauma.Surgical stabilization of rib fractures (SSRF) has traditionally required a big incision wound for adequate exposure; however, the degree of chest wall instability is determined by palpation, and the planned approach for surgery is fine-tuned on the basis of direct visualization of the rib fracture location during surgery. Recently, Schots et al.mentioned that video-assisted thoracoscopic surgery (VATS) is effective and safe and can be of additional value by providing the possibility to adjust the planned incision for SSRF and to decrease the area of muscle destruction. However, the preoperative preparation of VATS is time-consuming, and single-lung ventilation and a prolonged operation time are expected. Moreover, at least one additional assistant is required to control the thoracoscopy process. In this study, they utilized 3D reconstruction from computed tomographic images to simulate the patient’s rib cage to determine the length and curve of the titanium plates before surgery to decrease the length of the incisions, identify the precise location of the fracture sites, and easily measure the rib thickness using a caliper to determine the proper screw length.

Conclusions/action items:

Utilizing 3D printing to create a personalized design model to assist in rib fixation surgery has showed that 3D printing for SSRF significantly reduced the operation time and aided in preoperatively determining the surgical plans, such as the location and length of the incision. Therefore, the preoperative 3D printing approach has the following three advantages for SSRF: (1) Ease of locating the rib fracture site and predicting the incision length, (2) Shortened operation time, (3) Useful for explaining the steps of SSRF to patients and families.

2019/10/8 3D printable rubber

• Camille Duan • Oct 08, 2019 @09:13 PM CDT

Title: 3D printable rubber

Date: 2019/10/8

Content by: Camille

Present: Camille

Goals: To research on 3D printable rubbers

Content:

<Lukic, M., Clarke, J., Tuck, C., Whittow, W., & Wells, G.. (2016, May 10). Printability of elastomer latex for additive manufacturing or 3D printing (Version 1). figshare. Retrieved from https://hdl.handle.net/2134/21163>

There are currently two main types of thermoset elastomeric materials compatible with additive manufacturing technology: one is liquid silicone rubber and the other is a set of UV curable materials, including polyurethane and acrylic based polymers. The liquid silicone elastomers can be processed using an extrusion process, sometimes referred to as direct writing. The material is deposited from a micro-dispensing device or syringe. The high viscosity of the material is largely relied upon to maintain the shape of the product, while most of the cross linking reaction can be carried out as a separate process after forming. This technique has been used to make a product with a controlled porosity and indicates it may have a niche application for silicone elastomer materials7. However, this form of direct extrusion is not suitable for the vast majority of elastomers which can be classed as soft solids and have much too high a viscosity to be extruded in this way. There are two ways in which UV curable polymers can be additively manufactured. The first is stereolithography, in which the object is built up in a batch of liquid polymer which is selectively cured, as the object is lowered step-wise into the bath as each layer is cured. In the second method the liquid polymer is printed by an inkjet process and is cured after deposition by a UV light attached to the print head8-11. This combination of UV curable polymer and inkjet printing technology is potentially very powerful, allowing a range of materials to be printed at the same time to a high level of precision. However, although rubber-like materials with a range of hardness are commercially available, their mechanical properties fall well below those of most conventional rubber compounds.

Conclusions/action items:

additive manufacturing of elastomers is currently extremely limited from a material point of view because only three classes of rubbery materials (TPE, liquid rubbers, photo-curable polymers) are compatible with the technology. The types of elastomer with the required performance for most automotive, aerospace, construction and engineering applications cannot be used in additive manufacturing processes at the moment.

2019/11/20 Testing Protocol Research

revisions print ▪ Camille Duan ▪ Dec 05, 2019 @12:01 AM CST

Title: Testing Protocol Research Notes

Date: 2019/11/20

Content by: Camille

Present: Camille

Goals: To create a testing protocol for prototype

Content:

Reference: <Importance of test protocol for medical device testing projects. (2018, September 11). Retrieved from https://www.element.com/nucleus/2018/09/11/15/21/test-protocol-for-medical-devices>

How to start a protocol:

1. Scope
   - Lays the groundwork for the device and why it is being evaluated
2. Objective
   - what is the goal and why
   - Example: To characterize the antero-posterior,medio-lateral, and rotational constraint behavior of a unicondylar knee replacement system
3. Specifications/Standards
   - List any relevant standards and comment on any expected deviations. The FDA guidance documents can also be references as they may outline the required testing
4. Materials and Worst-Case Analysis
   - List all components that are needed for testing, quantities, and any other relevant information. Maintaining traceability to ensure a clear expectation of what is to be tested is also important
5. Equipment
6. Methods
   - The Method or Procedure sections outline the actual testing steps. They often align with the applicable FDA guidance documents and ASTM or ISO testing specifications. If you are not sure how to get started with this section, the Procedures section in the standards is often the best place to go.
7. Data Interpretation, Acceptance Criteria and Results
   - Defining the data you are looking for and what you are comparing against needs to be documented. Determining acceptance criteria based on previous or predicate testing upfront helps everyone involved evaluate the data that is being generated, and quickly make adjustments if needed. It also drives the procedure section to make sure there is an “apples to apples” comparison to predicates. If there are no predicates available for your device, clear definition of acceptance criteria is paramount.
   - This section should also include the reporting requirements from your company’s internal reporting procedures. Similar to the methods section, the ASTM or ISO test standards outline the common deliverables for the testing. However, if you also require raw data, specific photographs or inspections, these should be clearly outlined in this section. Statistical analysis information should also be outlined here for data evaluation
8. References
9. Signatures

Conclusions/action items:

Based on the criteria guideline for creating a protocol, I need to design a testing protocol for our final design and also for material property testing.

2019/09/25 Water Power Cutting Tool

revisions print • Camille Duan • Oct 08, 2019 @10:23 PM CDT

Title: Automated String Cutting Tool Design

Date: 2019/09/25

Content by: Camille Duan

Present: Camille

Goals: To come up with an design idea for cutting tungsten carbide rings

Content:

Figure 1. Water gun for high pressure cutting

Similar to using laser as a cutting device, high pressure water gun can also be used as a cutting device.

Based off the mechanical properties of tungsten carbide, water will emits up to 1000 Mpa, which exceeds the maximum strain of tungsten carbide. Thus, the ring can be broken into two pieces. An stainless steel glass cover will be added tip of the water gun, so that finger will be protected throughout the cutting process.

Conclusions/action items:

The advantage of this design is that the ring will be removed at a timely manner. However, the disadvantage of this device is that rings will not be kept intact. Rngs can be very sentimental to some population. The ability of tungsten carbide to not deform easily is actually one reason why so many people choose tungsten carbide material as wedding bands.

2019/11/11 One side open protection

revisions print ▪ Camille Duan ▪ Nov 15, 2019 @12:59 PM CST

Title: New design idea of one side shield protection system

Date: 2019.11.11

Content by: Camille

Present: Camille

Goals: To fix current issues with the old prototype by coming up with a new design idea

Content:

Conclusions/action items:

2018/03/08 Green pass

revisions print • Camille Duan • Dec 10, 2018 @01:34 AM CST

Title: Green pass

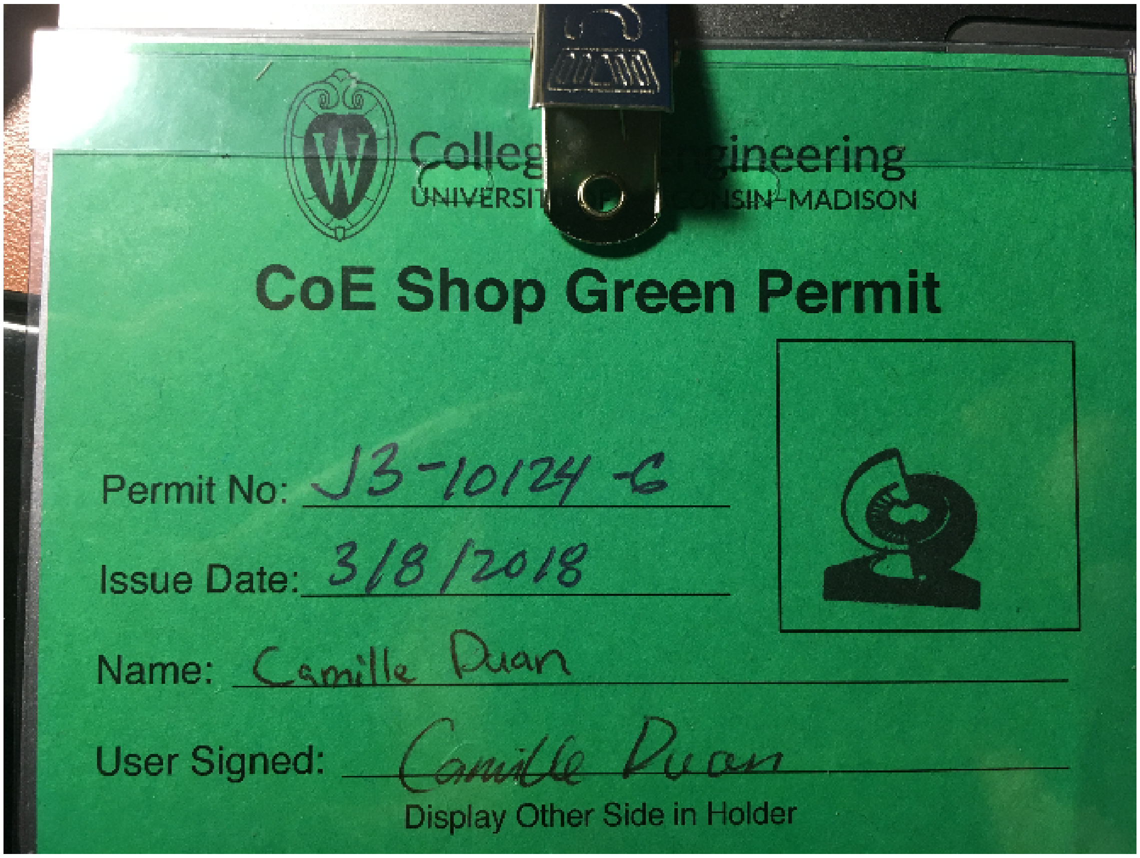
Date: 2018.03.08

Content by: Camille Duan

Present: Camille

Goals: To complete my green pass

Content:



Conclusions/action items:

I complete my training for green pass by making an alpha part. I was on the lathe and mill in total of 7 hours. I learned a lot in the process and mastered how to correctly use mill and lathe. Since I have my green pass now, I will be able to help my team member to fabricate our final design project. We might need help since our design is hard to fabricate and might require other use of machines that we do not have access to yet. We might also change the fabrication plan to make it easier so that we are able to do it by ourselves.

2018/3/20 Animal Contact/ Biosafety Training

revisions print • Camille Duan • Feb 26, 2019 @09:08 PM CST

Title: Animal Contact/ Biosafety Training

Date: 2018/3/20

Content by: Camille Duan

Present: Camille Duan

Goals: To compete training for research

Content:

University of Wisconsin-Madison

This certifies that CAMILLE DUAN has completed training for the following course(s):

Curriculum	Group Name	Completion Date	Expiration Date
Animal Contact Personnel Quiz	Safety for Personnel with Animal Contact	3/20/2018	
Biosafety 107 Centrifuge Safety Quiz	Biosafety 107: Centrifuge Safety	3/20/2018	
Biosafety Required Training Quiz	Biosafety Required Training	3/10/2018	
Bloodborne Pathogens Safety in Research	Biosafety 102: Bloodborne Pathogens for Laboratory and Research	3/20/2018	

Data Effective: Wed Mar 21 9:01:59 2018
Report Generated: Wed Mar 21 16:43:47 2018

Conclusions/action items:

I have competed all those quiz above for oncology research with possibly using mice to locate abnormal or tumor tissue.

2019/2/20 CITI training

revisions print • Camille Duan • Feb 26, 2019 @09:05 PM CST

Title: CITI training

Date: 2/20/2019

Content by: Camille Duan

Present: Camille

Goals: To complete CITI training

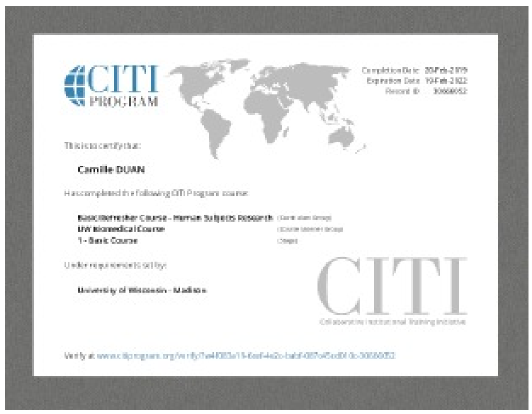
Content:

Attached is the CITI certificate that I completed for biomedical research with human subjects.

Conclusions/action items:

Camille Duan has a Human Subjects Research certification for conducting biomedical research with human subjects.

revisions print • Camille Duan • Feb 26, 2019 @09:02 PM CST



citiCompletionReport7930587.pdf(409.7 KB) - download

2019/09/15 Research for why is Titanium so hard to cut

revisions print • Maggie Zhou • Sep 15, 2019 @01:09 PM CDT

Title: Research for why is Titanium so hard to cut

Date: 2019/09/15

Content by: Maggie

Present: /

Goals: Find out the reason why Titanium is different from other metal

Content:

Reference: "Is It Really That Hard to Machine Titanium?," *Manufacturing Lounge*, 09-Aug-2018. [Online]. Available: http://www.manufacturinglounge.com/is-it-really-that-hard-to-machine-titanium/. [Accessed: 15-Sep-2019].

Based on the information I found on this website, I learned that the key point of cutting Titanium is not how hard it is but the the heat dissipation, so heat gathers at the point of cutting. This can cause work hardening as you're cutting or even deformation and chipping of your cutter. Another hard part about picking tooling for cutting Titanium is the fact that Ti can be both gummy and hard. Typically with gummy materials you look to using cutters with fewer flutes. Conversely, when cutting hard materials (like stainless), having multiple fluted end mills is ideal so you can engage the cutter properly at desired feed rates.

Some potential method of solving the heat dissipation problem is using a lot of coolant at the point of cutting, but this method could not be that useful when we are trying to cut Titanium in an ER where time is very limited and if not enough coolant is used the cutting tool will be chipped.

Conclusions/action items:

Titanium is hard not only for its hardness but also for its finicky material property. It's bad heat conductivity causes poor heat dissipation which increases the tool wear. The general idea I have based on the previous research could be using diamond, which is something harder than Titanium to cut it, which is the current most common way to do it. Or we could try to use some acid to dissolve it, but we first have to figure out how to protect the finger without getting dissolved as well. The third idea could be try to use laser to cut the metal, which could potential be used for both Titanium and Tungsten. More research needed to be done for all of these ideas.

2019/11/04 Tungsten carbide ring material property for testing

revisions print • Maggie Zhou • Dec 03, 2019 @03:11 PM CST

Title: Tungsten carbide ring material property

Date: 2019/11/04

Content by: Maggie

Present:

Goals: Figure out the material property for tungsten carbide to prepare for testing

Content:

1. Strength - Tungsten carbide has very high strength for a material so hard and rigid. Compressive strength is higher than virtually all melted and cast or forged metals and alloys.

2. Rigidity - Tungsten carbide compositions range from two to three times as rigid as steel and four to six times as rigid as cast iron and brass. Young's Modulus is up to 94,800,000 psi.

3. High resistance to deformation and deflection is very valuable in those many applications where a combination of minimum deflection and good ultimate strength merits first consideration. These include spindles for precision grinding and rolls for strip or sheet metal.

4. Impact Resistant - For such a hard material with very high rigidity, the impact resistance is high. It is in the range of hardened tool steels of lower hardness and compressive strength.

5. Electrical Conductivity - Tungsten carbide is in the same range as tool steel and carbon steel.

Reference: http://www.carbideprocessors.com/pages/carbide-parts/tungsten-carbide-properties.html

Conclusions/action items:

Based on the research I conducted for tungsten carbide, it's necessary for the team to wear protection system when testing the ring breaking procedure for the metal shards velocity. In addition, since the conductivity of tungsten is really low so it will not interfere with the magnets on the protecting shields.

2019/09/07 Competing designs for titanium/tungsten carbide ring cutter

revisions print • Maggie Zhou • Sep 07, 2019 @08:25 PM CDT

Title: Competing designs for titanium/tungsten carbide ring cutter

Date: 9/7/2019

Content by: Maggie

Present: /

Goals: Research on some existing device that's for medical use of cutting titanium/tungsten carbide ring

Content:

Reference: “Can Titanium or Tungsten Carbide ring be cut off?,” *Titanium Ring Cut Off | Tungsten Rings Emergency Removal*. [Online]. Available: https://www.titaniumstyle.com/titanium-tungsten-ring-cut-off.htm. [Accessed: 08-Sep-2019].

Figure 1. Power Ring Cutting Kit for Titanium

The above figure demonstrates the current cutting kit for titanium. It has a diamond coated disk blade that ill cut through the strongest, aircraft grade titanium rings in less than 5 minutes without heat or discomfort. The lower jaw of the cutter slides between the ring and finger. The circular saw is turned by the cordless power driver (included) to cut through the ring. Since titanium is so hard, it may be easier to make two cuts (one on each side of the ring) than try to spread it. The kit also includes an extra steel blade and manual turning key for cutting softer metal rings such as platinum, gold and silver. The price is 189.99$.

Figure 2. The process of using a cutter to cut the tungsten carbide ring

Tungsten carbide and ceramic rings are removed by cracking them into pieces with standard vice grip locking pliers. The same technique is used for removing natural stone bands like onyx or jade.

Place vice grip locking pliers over the band and adjust the jaws to clamp lightly. Release and adjust tightening screw one-forth turn and clamp again. Repeat this process until a crack is heard. The ring will brake in to two or more pieces.

Conclusions/action items:

Based on this article, I found that currently the device that used to cut the titanium ring and tungsten ring are not the same. The titanium cutting device utilize a little bit simpler process when cutting the ring, and the tungsten device needs a few more attempts when tried to cut the ring. So my team should try to design a product that could cut both the titanium and the tungsten ring in a try. In addition, the price of this device is not really cheap, around 200 dollars, so we should also try to see if we could lower this price for our design.

2019/10/17 Material property and potential infection

revisions print ▪ Maggie Zhou ▪ Oct 17, 2019 @08:36 PM CDT

Title: Research for material used for protecting shield and associated infection risks

Date: 2019/10/17

Content by: Maggie

Present: /

Goals: Find out the property for the material we want to use for the protecting shield

Content:

"TPE Filament - Explained and Compared," *All3DP*. [Online]. Available: https://all3dp.com/2/tpe-filament-explained-and-compared/. [Accessed: 18-Oct-2019].

TPE, or thermoplastic elastomer, is a category of rubberlike plastics that are helpful for anything that needs impact or vibration resistance, non-slip characteristics, or just plain old flexibility. Used in dampeners, non-slip feet, phone cases, and the like, TPE deforms and compresses easily to counter loads, making it incredibly durable. Although sometimes tricky to print with, the results are often well worth the struggle.

TPE filaments are known to be hygroscopic, which means that they absorb moisture from the air. This can degrade the material, so any filament not in use should be stored in a low humidity environment. An airtight container or bag with desiccant packs should do the job.

Conclusions/action items:

Based on our team's 3D printing experience from last semester, we think that thermoplastic elastomer would be a good option for our protecting shields since it's really flexible and they are vibration and impact resistant. Based on the article above, there might be a storage factor that needed to be considered during the device is stored in the hospital because there's a possibility that the thermoplastic elastomer will degrade overtime. This point needed to be discussed with team furthermore. No information related to potential infection happens with thermoplastic elastomer has been found.

2019/11/20 Material Comparison Research

revisions print ▪ Maggie Zhou ▪ Dec 11, 2019 @11:58 AM CST

Title: Material Research for Elastic Resin

Date: 2019/11/20

Content by: Maggie

Present:

Goals: Find out the material property and characteristic for Elastic Resin

Content:

References:

https://formlabs.com/blog/elastic-resin-soft-resilient-3d-printing/

Elastic Resin is suitable for directly printing soft flexible prototypes and models that once needed to be produced with moldmaking.Producing quality elastic materials was once only possible for expensive industrial equipment, but with affordable, industrial-quality 3D printers like the Form 2 and new advancements like Resin Tank LT, it's possible to produce elastic parts on the desktop in a matter of hours.

Figure 1. Elastic Resin Example

Elastic Resin is designed to “bounce back” and return to its original shape quickly. Durometer is the hardness of a material. Elastic Resin has a lower durometer than other Formlabs resins, making it suitable for prototyping parts normally produced with silicone.

ELASTIC RESIN

FLELCL01

	METRIC[1]		IMPERIAL[1]		METHOD
	Green	Post-Cured[2]	Green	Post-Cured[2]	
Mechanical Properties					
Ultimate Tensile Strength [3]	1.61 MPa	3.23 MPa	234 psi	468 psi	ASTM D 412-06 (A)
Stress at 50% Elongation	.92 MPa	.94 MPa	133 psi	136 psi	ASTM D 412-06 (A)
Stress at 100% Elongation	1.54 MPa	1.59 MPa	223 psi	231 psi	ASTM D 412-06 (A)
Elongation at Break [3]	100%	160%	100%	160%	ASTM D 412-06 (A)
Compression set at 23 °C for 22 hrs	2%	2%	2%	2%	ASTM D 395-03 (B)
Compression set at 70 °C for 22 hrs	3%	9%	3%	9%	ASTM D 395-03 (B)
Tear strength [4]	8.9 kN/m	19.1 kN/m	51 lbf/in	109 lbf/in	ASTM D 624-00
Shore hardness	40A	50A	40A	50A	ASTM 2240

[1] Material properties can vary with part geometry, print orientation, print settings and temperature.

[2] Data was obtained from parts printed using Form 2, 100 µm, Elastic settings, washed in Form Wash for 20 minutes and postcured with Form Cure at 60 °C for 20 minutes.

[3] Tensile testing was performed after 3+ hours at 23 °C, using a Die C dumbbell and 20 in/min cross head speed.

[4] Tear testing was performed after 3+ hours at 23 °C, using a Die C tear specimen and a 20 in/min cross head speed.

Figure 2. Elastic Resin material property

Conclusions/action items:

In general elastic resin will be a more suitable material for the purpose of energy absorbance and it is designed not to bounce back broken material when hit. But more research is needed for PLA as well to see the material property and potential usage.

2019/11/20 Material Property Research for PLA

revisions print • Maggie Zhou • Dec 11, 2019 @12:04 PM CST

Title: Material Property Research for PLA

Date: 2019/11/20

Content by: Maggie

Present:

Goals: Find out the material property for PLA

Content:

Reference: http://www.matweb.com/search/DataSheet.aspx?MatGUID=ab96a4c0655c4018a8785ac4031b9278&ckck=1

PLA has a glass transition temperature 60–65 °C, a melting temperature 173–178 °C and a tensile modulus 2.7–16 GPa. Heat-resistant PLA can withstand temperatures of 110 °C. ... The flexural modulus of PLA is higher than polystyrene and PLA has good heat sealability.

Mechanical Properties	Metric
Hardness, Shore A	67 - 85
Hardness, Shore D	59 - 77
Tensile Strength, Ultimate	14.0 - 114 MPa
Film Tensile Strength at Yield, MD	19.0 - 54.0 MPa
Film Tensile Strength at Yield, TD	14.0 - 48.0 MPa
Tensile Strength, Yield	2.00 - 103 MPa
Film Elongation at Break, MD	160 - 600 %
Film Elongation at Break, TD	100 - 640 %
Elongation at Break	0.50 - 700 %
Elongation at Yield	2.0 - 400 %
Modulus of Elasticity	0.0850 - 13.8 GPa
Tenacity	0.177 - 0.441 N/tex
Flexural Yield Strength	6.00 - 145 MPa
Flexural Modulus	0.215 - 13.8 GPa
Secant Modulus, MD	3.30 - 3.44 GPa
Secant Modulus, TD	3.78 - 3.90 GPa
Izod Impact, Notched	0.128 - 8.54 J/cm
Izod Impact, Unnotched	2.67 - 5340 J/cm
Charpy Impact Unnotched	0.500 J/cm² - NB
Charpy Impact, Notched	0.100 - 1000 J/cm²
Tear Strength	65.0 - 90.0 kN/m
Elmendorf Tear Strength, MD	0.0441 - 0.862 g/micron
Elmendorf Tear Strength, TD	0.0361 - 1.28 g/micron
Dart Drop Total Energy	240 - 420 J/cm
Film Tensile Strength at Break, MD	19.0 - 110 MPa
Film Tensile Strength at Break, TD	13.0 - 145 MPa

Figure 1. Mechanical Property of PLA

Conclusions/action items:

Based on the information I found, PLA will not be a suitable choice if we want a material that could absorb more energy since it as high stiffness and strength so when the broken metal pieces fit the shields they will bounce back and could potentially hurt the patients. The team is going to perform a material comparison test based on the two material to acquire data support fo the difference of two materials. The material that could absorb more energy will the material we use for the final design.

2019/09/16 Laser cutting tool for Titanium

revisions print • Maggie Zhou • Sep 16, 2019 @08:30 PM CDT

Title: Research for laser cutting tool for titanium

Date: 2019/09/16

Content by: Maggie

Present: /

Goals: Find out some relevant information that might help to form some ideas of laser cutting tool

Content:

Reference: “Laser Cutting Titanium,” *Convergent*. [Online]. Available: https://www.convergent-photonics.com/laser-cutting-titanium/. [Accessed: 17-Sep-2019].

“NEJE DK-8-KZ 1000mW High Speed Mini USB Laser Engraver Sales Online black,” *TOMTOP*. [Online]. Available: https://www.tomtop.com/p-e1436.html?utm_source=shareasale&sscid=91k3_d2tn5#flow_review. [Accessed: 17-Sep-2019].

Although metal cutting operations traditionally employ mechanical or manual processes, laser cutting can be a viable, effective, and cost-efficient option for metal fabrication. Laser equipment is distinct from other cutting machines in both design and application. For example, laser cutters do not make direct contact with material, rely on high-energy power sources, have tighter cutting tolerances, and are generally automated to maximize precision.

A laser device fires a concentrated stream of photons in a precise area of the workpiece in order to trim excess material and shape the workpiece into a specific design, for cutting titanium, aluminum and other metal-based materials.

Types of Lasers

Laser technology has several unique attributes that affect the quality of its cuts. The degree to which light curves around surfaces is known as diffraction, and most lasers have low diffraction rates to enable higher levels of light intensity over longer distances. In addition, features such as monochromaticity determine the laser beam’s wavelength frequency, while coherence measures the continuous state of the electromagnetic beam.

Laser Cutting Capabilities

Laser cutting involves removing material to shape a workpiece in a process that generally reduces the amount of post-fabrication finishing work. For example, when cutting thermally treated material, laser heat can cause hardening at the outer edges of the cut. Hardening can be useful for many applications because it increases product durability, but it also limits the amount of machining that can be done, making post-cut threading or deburring difficult.

Most laser cutting systems are automated under CNC parameters. These computer controls enable high levels of precision and increased cutting speed. Some CNC programs offer “flying optics” capabilities that allow a laser to shape material while the cutting head is in motion. The moveable laser can perform fast cutting operations while maintaining accuracy, and is highly effective on thin sheet metal. CNC programming can also regulate power output, enabling the laser to shift settings depending on the contours and thickness of the material being cut.

Laser Cutting Titanium

Thick titanium materials, such as plates or reinforced sheets, are typically cut with CO_2 lasers because they have higher power capacity than other laser models. In general, the thicker the steel sheet, the more power required to cut it, and the optimum cutting rate is largely determined by the ratio of thickness to the strength of the laser’s beam. Unlike many mechanical cutting processes, laser cutting can produce hole sizes significantly smaller than the thickness of titanium, sometimes as low as a fifth of the workpiece’s size.

Laser Cutting Aluminum and Titanium

Using gases in conjunction with cutting operations is fairly common. Nitrogen and oxygen assisted laser cutting machines can shape aluminum and titanium at relatively high capacities and with quality edge finishes. However, higher electricity consumption and the cost of peripheral equipment, such as gas or air filters, can increase expenses for these systems.

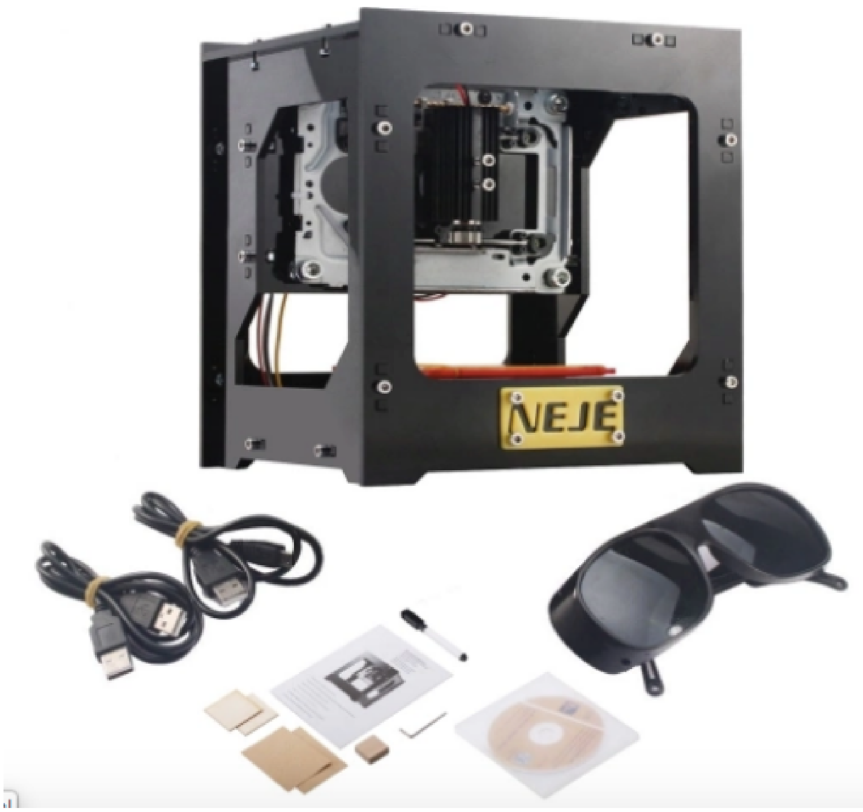


Figure 1. Mini Laser engraving machine with the cost of 63$.

The above machine is found as a mini laser engraving machine that doesn't need to connect to a computer and the cost is affordable. My team could try to incoperate some parts of this device into our design because of its size and affodability. In addition, the laser engraving power should be strong enough to cut the titanium ring as well.

Conclusions/action items:

The above article showed me a few important points. First, for laser cutting device, it's mostly automated. So our team might have of the problem of coding or looking for cooperation with existing codes that could be utilized by us. Second, the laser cutter has the ability of cutting titanium with high precision and short amount of time so with modification, it could be potentially used to cut rings. However, I also researched for some laser cutter, which all ranges between at least thousands of dollars. So this might not be that practical for out project. Also the direct contact of skin and laser is definitely a damage to the patient, so more consideration needed to be done for this laser cutting plan.

2019/09/26 Automated Ring cracker

revisions print • Maggie Zhou • Sep 29, 2019 @04:28 PM CDT

Title

revisions print • Maggie Zhou • Sep 26, 2019 @05:04 PM CDT

Title: Automated Ring Cracker prototype brainstorm

Date: 2019/09/26

Content by: Maggie

Present: /

Goals: Form the prototype of automated ring cracker

Content:

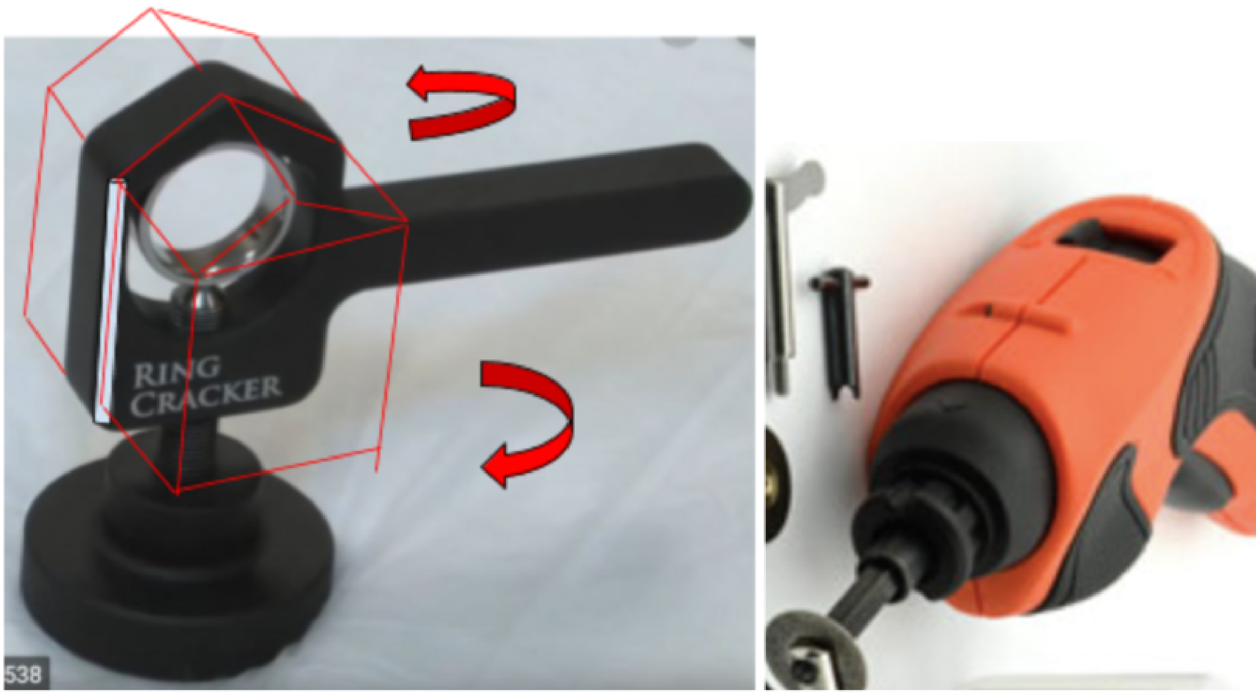


Figure 1. The basic idea of the automated ring cracker

This design is based on the existing device that is used to cut the titanium or tungsten ring. This device is very efficient in cutting the ring, usually done it in a few seconds. However, the surgeons were complaining that the ER physicians and the patients both have to wear safety glasses becasue when the ring is cracked, there might be soem piece of the ring flying around. Also sometimes it takes some effort to twist the ring cracker manually. So I thought we could combine the automted twisting gun from the sompleting design and we'll add a protection cover over this device potentilly using stalinite, but the specific material needs more research.

Conclusions/action items:

This idea is based on a current design and it doesn't have a lot of innovation; it does solve all of the physician's problem and is efficient in removing the ring. My team will evaluate all of the potential designs and see if this one would work.

2019/10/03 Solidwork update for the ring cracker protection design

revisions print • Maggie Zhou • Oct 05, 2019 @06:28 PM CDT

Title: Solidwork files for the ring cracker protection design

Date: 2018/10/03

Content by: Maggie

Present:

Goals: Make the solidwork for ring cracker design

Content:

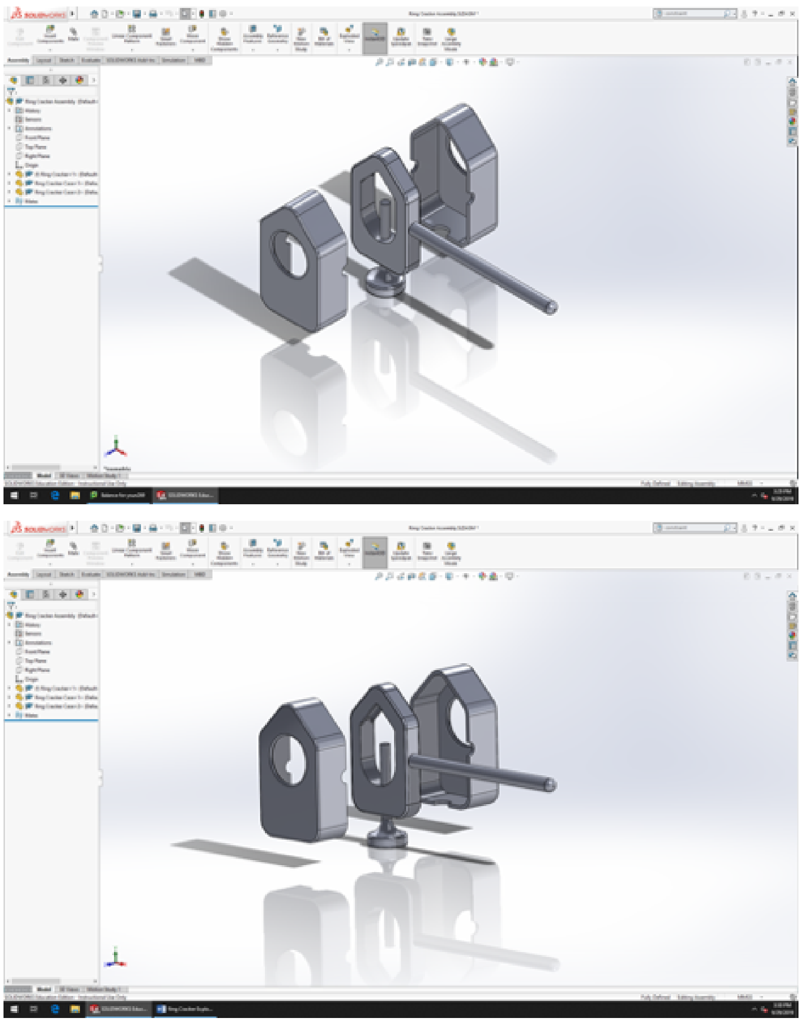


Figure 1. 2 Solidworks for ring cracker protectio device

Conclusions/action items:

This is just the preliminary design of solidwork for the ring cracker protection device. Basiclally it's consisted of two halves of the protection shield potentially going to be manufactured by rubber in the 3D printing lab and hinges on both side for stablization. There will be two holes on both sides of the shileds for the finger with edema to put through. The size of the hole needs more consideration and research.

revisions print ▪ Maggie Zhou ▪ Oct 05, 2019 @06:28 PM CDT

Ring_Cracker_Assembly.SLDASM(171.7 KB) - download

2019/10/17 Green pass

revisions print ▪ Maggie Zhou ▪ Oct 17, 2019 @08:38 PM CDT

Title: Completion of green pass

Date: 2018/03/09

Content by: Maggie Zhou

Present:

Goals: Acquire the green pass for BME 201

Content:

Figure 1. Green pass

Conclusions/action items:

I completed the quiz associated with the green pass and made the beta parts twice to pass the green pass exam. This pass is for BME 201 class and it's valid for a variety of machine available in the team lab, such as the mills and lathe. It's not used for our project since our project is majorly made up of bioinsturmentaion, which is a bunch of writing of codes.

2019/10/18 BPAG Meeting

revisions print

▪ Maggie Zhou ▪ Oct 18, 2019 @12:41 PM CDT

Title: BPAG Meeting

Date: 2019/10/18

Content by: Maggie

Present: /

Goals: Find out what websites are possible for online purchasing

Content:

- We pay, and then get reimburse

- Keep track of all the purchases

- All original detailed receipts in the notebook, progress report and final report

- It's recommended that the client pays

- UW funds or personal funds?
    - UW Funds， 90 days rule, hard copy

Conclusions/action items:

Need to double check with the client if he's using the UW funds and if he's willing to purchase the items for our team. If not we will just purchase by ourselves and get reimbursed at the end of semester.

2019/09/16 Client meeting preparation and notes

revisions print ▪ Maggie Zhou ▪ Sep 16, 2019 @08:35 PM CDT

Title: Questions for the client meeting

Date: 2019/09/16

Content by: Maggie

Present: /

Goals: List some questions for the client meeting

Content:

1. Do you want us to focus on the Titanium or tungsten or both?

2. What's the problem with the current design?

3. Do you have any thoughts regarding this cutting problem that you want to to incorperate to our design?

Conclusions/action items:

Our client meeting is on this upcoming Friday, so we could clarify with him about his project design expectation. Then we are also going to meet Dr. Glazer, who's from the ED and could see the ring cutters they use.

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revisions print ▪ Maggie Zhou ▪ Sep 24, 2019 @06:30 PM CDT

Title: Client Meeting Notes

Date: 2019/09/20 (Organized on 09/24)

Content by: Maggie

Present: Team

Goals: Communicate with our client to learn more about this project

Content:

Client Meeting Notes

- Different degree of finger injury, permanent injury?
- Manually quickly burned off of each blade, not cut at all, also needs multiple cuts, hurts the patient
  - Ruined the ring, discomfort is ok if we could save the ring
- Automated on, 15 sec, not tungsten, sometimes titanium works
- Check if it’s tungsten by magnifying glasses, safety glasses, www.TungstenPride.com
- Minimize manipulation, uncomfortable, jewelry damaged.
- Protection option for both patients and the physicians.
- Patient would rather be a little discomfort, but keep their ring.
- Keep the ring intact!!!
- Affect all ages, genders, not too many babies.
- The smaller the better
- Cost below 500 $, cut we need to keep him updated.

Conclusions/action items:

Based on our visit to the hospital, I personally think that the current device does not have very serious problem, instead the potential problems are protecting system and automating system. However, our client does mention that it would be really nice that if we could design something that could remove the ring without damaging it. This could be our focus for the first semester, and if nothing really works, we could focus on improving the current designs.

2019/10/24 Set up preliminary fabrication protocol

revisions print • Maggie Zhou • Oct 24, 2019 @06:42 PM CDT

Title: Preliminary fabrication protocol

Date: 2019/10/23

Content by: Maggie

Present:

Goals: Set up a general procedure for fabricating the protecting shields

Content:

- First we are going to modified the dimensions of our current Solidworks based on the actual ring cracker after we receive it next week

- Then we will send the file to Makerspace and 3D print it.

- We will glue the magnets into the holes on the cracker

- We will try it on on the ring cracker to see if the shields fit

- Further modification will be made based on potential problems happened during fitting process

- If the preliminary prototype fits the device and everything else is perfect we will print it with elastomer material

- The final prototype will be tested on tungsten carbide rings.

Conclusions/action items:

These steps are subjected to change based on the potential problem that might happen during the actual manufacturing process or testing process. Further steps might needed to be added on to this list.

Background Research

revisions print • James Tang • Sep 15, 2019 @

Title: What is a Ring Cutter?

Date: 2019.9.12

Content by: James Tang

Present: James Tang

Goals: Learn about ring cutters on what they do. Search for different types of ring cutters.

Content:

What does a ring cutter do?

A ring cutter is a mechanical device used for the safe and painless removal of metal rings or bands which have led to strangulation of fingers or other limbs. A ring cutter almost ex makes use of an abrasive or toothed cutting disc to cut through the band.

Some commonly used tool to cut rings.

What is a ring cracker?

Figure 1. A picture of ring cracker that is used to slowly tightened against the ring made of very hard materials like tungsten carbides until enough pressure is applied to safely crack the material sharp, hardened point.

What is a ring spreader?

Figure 2. Once the initial cut of a constricting band has been made, the ring still may not be easily removed from the limb or finger. A ring spreader is designed to painlessly spreac bands for removal without the need for an additional cut.

Reference:

1. http://www.ringcutter.com/SIB/images/Spreader%20Post%20Card%20Side%201%20Photo.jpg

2. https://www.ishor.com/media/catalog/product/cache/1/image/650x/040ec09b1e35df139433887a97daa66f/c/a/capture_2_2.jpg

3. https://www.atlasprosales.com/Ring_Cutter_s/88.htm

Conclusions/action items:

Ring cutter is used to cut rings for those people who cannot pull their ring out of their finger or arm obviously, but there are many ways to achieve the goals.

Properties of Titanium and Tungsten Carbide

revisions print ▪ James Tang ▪ Oct 09, 2019 @12:31 AM CDT

Title: Properties of Titanium and Tungsten Carbide

Date: 9.15.2019

Content by: James Tang

Present: James Tang

Goals: Learn important properties of Titanium and Tungsten Carbide

Content:

Tungsten Carbide [5]:

- Tungsten carbide is a material with very high strength, unusual hardness, and rigidity.
- Its compressive strength is higher than virtually all melted, cast or forged metals and alloys.
- Tungsten carbide is two to three times as rigid as steel and four to six times as rigid as cast iron and brass. In addition, it's Young's Modulus is up to 94,800,000 psi.
- Additionally, its high resistance to deformation and deflection is very valuable in instances where a combination of minimum deflection and good ultimate strength is desired, such as rings, spindles for precision grinding, and rolls for strip or sheet metal.
- Tungsten-base carbides perform well up to about 1000°F in oxidizing atmospheres and up to 1500°F in non-oxidizing atmospheres.[8] Tungsten carbide can retain toughness and impact strength in the cryogenic temperature ranges around -453°F.

Material:	Tungsten Carbide - An Overview
Composition:	WC

Property	Minimum Value (S.I.)	Maximum Value (S.I.)	Units (S.I.)	Minimum Value (Imp.)	Maximum Value (Imp.)	Units (Imp.)
Atomic Volume (average)	0.0062	0.0064	m^3/kmol	378.347	390.552	in^3/kmol
Density	15.25	15.88	Mg/m^3	952.027	991.357	lb/ft^3
Energy Content	150	200	MJ/kg	16250.8	21667.7	kcal/lb
Bulk Modulus	350	400	GPa	50.7632	58.0151	10^6 psi
Compressive Strength	3347	6833	MPa	485.441	991.043	ksi
Ductility	0.005	0.0074		0.005	0.0074	NULL
Elastic Limit	335	530	MPa	48.5876	76.87	ksi
Endurance Limit	285	420	MPa	41.3357	60.9158	ksi
Fracture Toughness	2	3.8	$MPa.m^{1/2}$	1.82009	3.45818	$ksi.in^{1/2}$
Hardness	17000	36000	MPa	2465.64	5221.36	ksi
Loss Coefficient	5e-005	0.0001		5e-005	0.0001	NULL
Modulus of Rupture	482	820	MPa	69.9082	118.931	ksi
Poisson's Ratio	0.2	0.22		0.2	0.22	NULL

Property	Minimum Value (S.I.)	Maximum Value (S.I.)	Units (S.I.)	Minimum Value (Imp.)	Maximum Value (Imp.)	Units (Imp.)
Shear Modulus	243	283	GPa	35.2442	41.0457	10^6 psi
Tensile Strength	370	530	MPa	53.664	76.87	ksi
Young's Modulus	600	686	GPa	87.0226	99.4958	10^6 psi
Glass Temperature			K			°F
Latent Heat of Fusion	330	560	kJ/kg	141.874	240.755	BTU/lb
Maximum Service Temperature	1000	1050	K	1340.33	1430.33	°F
Melting Point	3000	3193	K	4940.33	5287.73	°F
Minimum Service Temperature	0		K	-459.67		°F
Specific Heat	184	292	J/kg.K	0.14239	0.225967	BTU/lb.F
Thermal Conductivity	28	88	W/m.K	52.4169	164.739	BTU.ft/h.ft^2.F
Thermal Expansion	4.5	7.1	10^{-6}/K	8.1	12.78	10^{-6}/°F
Breakdown Potential			MV/m			V/mil
Dielectric Constant						NULL
Resistivity	41.7	100	10^{-8} ohm.m	41.7	100	10^{-8} ohm.m

Environmental Properties	Resistance Factors 1=Poor 5=Excellent
Flammability	5
Fresh Water	5
Organic Solvents	5
Oxidation at 500C	5
Sea Water	5
Strong Acid	4
Strong Alkalis	5
UV	5
Wear	5
Weak Acid	5
Weak Alkalis	5

Titanium

- Atomic Symbol: Ti
- Atomic Number: 22
- Element Category: Transition Metal
- Density: 4.506/cm3
- Melting Point: 3034°F (1668°C)
- Boiling Point: 5949°F (3287°C)
- Moh's Hardness: 6
- adhesion coefficient: 5.3

Important facts:

- High strength, lightweight, and exceptional corrosion resistance.

- High resistance to corrosion by both water and chemical media. It does this by forming a thin layer of titanium dioxide (TiO_2) on its surface that is extremely difficult for these materials to penetrate

Reference:

[1] https://ourpastimes.com/how-to-make-a-ring-from-a-hex-nut-12319034.html

[2] https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19660006202.pdf

[3] https://www.thebalance.com/metal-profile-titanium-2340158

[4] https://www.engineeringtoolbox.com/friction-coefficients-d_778.html

[5]“Carbide Processors, Woodworking Tools,” Tungsten Carbide Properties. [Online]. Available: http://www.carbideprocessors.com/pages/carbide-parts/tungsten-carbide-properties.html. [Accessed: 10-Sep-2019].

Conclusions/action items:

Titanium and Tungsten Carbide share similar properties. Both have very high strength, unusual hardness, and rigidity. Also, they have high resistance to deformation and deflection is very valuable in instances where a combination of minimum deflection and good ultimate strength is desired, such as rings, spindles for precision grinding, and rolls for strip or sheet metal.

Methods Making Finger Super Smooth and Shrink

revisions print ▪ James Tang ▪ Oct 09, 2019 @12:00 AM CDT

Title: Methods Making Finger Super Smooth and Shrink

Date: 9.25.2019

Content by: James Tang

Present: James Tang

Goals: Explore ways to satisfy the goals of brainstorming about how to shrink fingers.

Content:

Method one: Change Diet[1]

Key function: avoid edema and keep fast water flow in the body

- Avoid high sodium contained food that causes edema.
- Eating water-rich food such as fruits and vegetables to keep rapid water flow in body.

Method two: Thermal Contraction[2]

Figure 1. Holding ice in hands to shrink fingers.

- Changes in temperature change the physical properties of substances which, as a result, lead to the shrinkage of blood vessels in fingers
- Reduces the flow of blood to the skin

Conclusions/action items:

[1] E. Narins, "Tight Ring? Foods That Slim Swollen Fingers," *Women's Health*, 11-Jun-2019. [Online]. Available: https://www.womenshealthmag.com/food/a19924475/tight-ring-foods-that-slim-swollen-fingers/. [Accessed: 25-Sep-2019].

[2] C. Sissons, "What are the causes of swollen hands?," *Medical News Today*. [Online]. Available: https://www.medicalnewstoday.com/articles/325207.php. [Accessed: 14-Sep-2019].

2019/11/18 Prototype Material Property Research

revisions print • James Tang • Dec 11, 2019 @11:48 AM CST

Title: Prototype Material Property Research

Date: 2019.11.18

Content by: James Tang

Present:

Goals: Explore the material properties of potential candidates of the prototype and decide which is the most appropriate one to choose from.

Content:

Overview of materials properties for Polylactic Acid (PLA) Biopolymer:

Mechanical Properties	Metric	English	Comments
Hardness, Shore A	67 - 85	67 - 85	Average value: 76.3 Grade Count:3
Hardness, Shore D	59 - 77	59 - 77	Average value: 65.8 Grade Count:5
Tensile Strength, Ultimate	14.0 - 114 MPa	2030 - 16500 psi	Average value: 46.8 MPa Grade Count:92
Film Tensile Strength at Yield, MD	19.0 - 54.0 MPa	2760 - 7830 psi	Average value: 30.5 MPa Grade Count:13
Film Tensile Strength at Yield, TD	14.0 - 48.0 MPa	2030 - 6960 psi	Average value: 26.5 MPa Grade Count:13
Tensile Strength, Yield	2.00 - 103 MPa	290 - 14900 psi	Average value: 37.5 MPa Grade Count:28
Film Elongation at Break, MD	160 - 600 %	160 - 600 %	Average value: 326 % Grade Count:16
Film Elongation at Break, TD	100 - 640 %	100 - 640 %	Average value: 402 % Grade Count:16
Elongation at Break	0.50 - 700 %	0.50 - 700 %	Average value: 62.9 % Grade Count:114
Elongation at Yield	2.0 - 400 %	2.0 - 400 %	Average value: 68.2 % Grade Count:20
Modulus of Elasticity	0.0850 - 13.8 GPa	12.3 - 2000 ksi	Average value: 2.80 GPa Grade Count:86
Tenacity	0.177 - 0.441 N/tex	2.00 - 5.00 g/denier	Average value: 0.296 N/tex Grade Count:9
Flexural Yield Strength	6.00 - 145 MPa	870 - 21000 psi	Average value: 77.4 MPa Grade Count:71
Flexural Modulus	0.215 - 13.8 GPa	31.2 - 2000 ksi	Average value: 3.86 GPa Grade Count:72
Secant Modulus, MD	3.30 - 3.44 GPa	479 - 499 ksi	Average value: 3.35 GPa Grade Count:3
Secant Modulus, TD	3.78 - 3.90 GPa	549 - 566 ksi	Average value: 3.85 GPa Grade Count:3
Izod Impact, Notched	0.128 - 8.54 J/cm	0.240 - 16.0 ft-lb/in	Average value: 1.39 J/cm Grade Count:47
Izod Impact, Unnotched	2.67 - 5340 J/cm	5.00 - 10000 ft-lb/in	Average value: 6.19 J/cm Grade Count:35
Charpy Impact Unnotched	0.500 J/cm² - NB	2.38 ft-lb/in² - NB	Average value: 2.39 J/cm² Grade Count:33
Charpy Impact, Notched	0.100 - 1000 J/cm²	0.476 - 4760 ft-lb/in²	Average value: 0.768 J/cm² Grade Count:42
Tear Strength	65.0 - 90.0 kN/m	371 - 514 pli	Average value: 76.7 kN/m Grade Count:3
Elmendorf Tear Strength, MD	0.0441 - 0.862 g/micron	1.12 - 21.9 g/mil	Average value: 0.426 g/micron Grade Count:16
Elmendorf Tear Strength, TD	0.0361 - 1.28 g/micron	0.918 - 32.6 g/mil	Average value: 0.510 g/micron Grade Count:16
Dart Drop Total Energy	240 - 420 J/cm	0.450 - 0.787 ft-lb/mil	Average value: 347 J/cm Grade Count:3
Film Tensile Strength at Break, MD	19.0 - 110 MPa	2760 - 16000 psi	Average value: 43.7 MPa Grade Count:13
Film Tensile Strength at Break, TD	13.0 - 145 MPa	1890 - 21000 psi	Average value: 50.5 MPa Grade Count:13

Figure 1: a table of materials properties for Polylactic Acid (PLA) Biopolymer.

Reference: http://www.matweb.com/search/DataSheet.aspx?MatGUID=ab96a4c0655c4018a8785ac4031b9278&ckck=1

Mechanical properties*

	Injection molding		3D printing	
	Typical value	**Test method**	**Typical value**	**Test method**
Tensile modulus	-	-	2,346.5 MPa	ISO 527 (1 mm/min)
Tensile stress at yield	-	-	49.5 MPa	ISO 527 (50 mm/min)
Tensile stress at break	-	-	45.6 MPa	ISO 527 (50 mm/min)
Elongation at yield	-	-	3.3%	ISO 527 (50 mm/min)
Elongation at break	-	-	5.2%	ISO 527 (50 mm/min)
Flexural strength	-	-	103 MPa	ISO 178
Flexural modulus	-	-	3,150 MPa	ISO 178
Izod impact strength, notched (at 23 °C)	-	-	5.1 kJ/m²	ISO 180
Charpy impact strength (at 23 °C)	-	-	-	
Hardness	-	-	83 (Shore D)	Durometer

Figure 2: Ultimaker PLA Data Sheet.

Reference: https://ultimaker.com/download/74599/UM180821%20TDS%20PLA%20RB%20V10.pdf

Elastic Resin:

Material Properties Data

	METRIC[1]		IMPERIAL[1]		METHOD
	Green	Post-Cured[2]	Green	Post-Cured[2]	
Ultimate tensile strength [3]	1.61 MPa	3.23 MPa	234 psi	468 psi	ASTM D 412-06 (A)
Stress at 50% elongation	.92 MPa	.94 MPa	133 psi	136 psi	ASTM D 412-06 (A)
Stress at 100% elongation	1.54 MPa	1.59 MPa	223 psi	231 psi	ASTM D 412-06 (A)
Elongation at Failure [3]	100%	160%	100%	160%	ASTM D 412-06 (A)
Compression set at 23C for 22 hrs	2%	2%	2%	2%	ASTM D 395-03 (B)
Compression set at 70C for 22 hrs	3%	9%	3%	9%	ASTM D 395-03 (B)
Tear strength [4]	8.9 kN/m	19.1 kN/m	51 lbf/in	109 lbf/in	ASTM D 624-00
Shore hardness	40A	50A	40A	50A	ASTM 2240

[1] Material properties can vary with part geometry, print orientation, print settings and temperature.

[2] Data was obtained from parts printed using Form 2, 100 µm, Elastic settings, washed in Form Wash for 20 minutes and postcured with Form Cure at 60C for 20 minutes.

[3] Tensile testing was performed after 3+ hours at 23 °C, using a Die C dumbbell and 20 in/min cross head speed.

[4] Tear testing was performed after 3+ hours at 23 °C, using a Die C tear specimen and a 20 in/min cross head speed

Figure 3: Elastin Resin material properties data.

Summaries:

Young's moduli ranged from 2.19 to 7.15 GPa

Bulk moduli from 12.79 to 22.43 GPa

Shear moduli from 0.74 to 2.47 GPa

Poisson's ratio ranged from 0.45 for the stiffer to 0.47 for the more compliant composites

Statistically significant differences (ANOVA and Bonferroni at $p = 0.05$) were found depending on filler volume-fraction.

Elastic moduli varied significantly and a positive correlation existed between elastic moduli and filler volume-fraction (*r*2: 0.905–0.992 and 0.940–1.000 for Young's and bulk moduli, respectively).

Solvent Compatibility

Percent weight gain over 24 hours for a printed and post-cured 1 x 1 x 1 cm cube immersed in respective solvent:

Mechanical Properties	24 hr size gain (%)	24 hr weight gain (%)	Mechanical Properties	24 hr size gain (%)	24 hr weight gain (%)
Acetic Acid, 5 %	<1	2.8	Hydrogen Peroxide (3 %)	<1	2.2
Acetone	19.3	37.3	Isooctane	<1	3.5
Isopropyl Alcohol	13.3	25.6	Mineral Oil, light	<1	<1
Bleach, ~5 % NaOCl	<1	2	Mineral Oil, heavy	<1	<1
Butyl Acetate	18.2	39.6	Salt Water (3.5 % NaCl)	<1	1.7
Diesel	1.2	4.2	Sodium hydroxide (0.025 %, pH = 10)	<1	2
Diethyl glycol monomethyl ether	12	28.6	Water	<1	2.3
Hydrolic Oil	<1	2.1	Xylene	20.4	46.6
Skydrol 5	9.9	21.7	Strong Acid (HCl Conc)	14.2	39.4

Figure 4: Elastic Resin solvent compatibility.

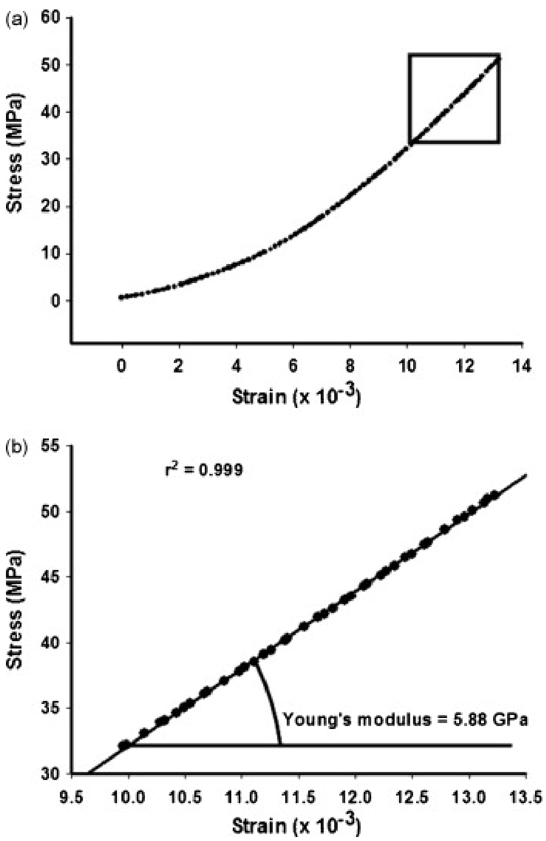

Figure 5: Young's and bulk moduli were obtained from the slope of the stress/strain curve at the higher loads for the unconstrained and constrained specimens respectively, using graphics software.

Thermoplastic Elastomers (TPE)

Properties

- Dense rubber

- Slip resistance
- Excellent weather resistance
- Shock absorption
- Outstanding ozone resistance
- Flexibility
- Soft texture
- Benefit of being co-extruded
- UL and NSF approval with certain TPE grades

Advantages

- Simplified processing - no mixing or vulcanization involved
- Lower part costs through lower density and thinner wall sections
- TPEs are colorable
- Recyclable scraps and parts
- Long-lasting

Reference:

https://www.sciencedirect.com/science/article/pii/S010956410700262X?via%3Dihub

https://formlabs.com/blog/elastic-resin-soft-resilient-3d-printing/

Conclusions/action items:

Elastic resin is a softer and more resilient 3D printing material, however, it is expensive. PLA is stronger and stiffer, and it has a lower price.

revisions print ▪ James Tang ▪ Dec 11, 2019 @11:49 AM CST


MATERIAL DATA SHEET

Elastic

Elastic Resin for Soft Flexible Parts $199 / L

Our softest Engineering Resin, this 50A Shore durometer material is suitable for prototyping parts normally produced with silicone. Choose Elastic Resin for parts that will bend, stretch, compress, and hold up to repeated cycles without tearing.

Wearables and consumer goods prototyping
Medical models and devices
Compliant features for robotics
Special effects props and models

FLELCL01 formlabs

Elastic_Resin_Technical.pdf(161.6 KB) - download

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Technical data sheet PLA

Ultimaker

Chemical composition	See PLA safety data sheet, section 3
Description	Ultimaker PLA filament provides a no-hassle 3D printing experience thanks to its reliability and good surface quality. Our PLA is made from organic and renewable sources. It's safe, easy to print with, and it serves a wide range of applications for both novice and advanced users
Key features	Good tensile strength and surface quality, easy to work with at high print speeds, user-friendly for both home and office environments, PLA allows the creation of high-resolution parts. There is a wide range of color options available
Applications	Household tools, toys, educational projects, show objects, prototyping, architectural models, as well as lost casting methods to create metal parts
Non-suitable for	Food contact and in vivo applications. Long term outdoor usage or applications where the printed part is exposed to temperatures higher than 50 °C

Filament specifications

	Value	Method
Diameter	2.85 ± 0.10 mm	-
Max roundness deviation	0.10 mm	-
Net filament weight	350 g / 750 g	-
Filament length	~ 44 m / ~ 95 m	-

Color information

Color	Color code
PLA Green	RAL 6018
PLA Black	RAL 9005
PLA Silver Metallic	RAL 9006
PLA White	RAL 9010
PLA Transparent	N/A
PLA Orange	RAL 2008
PLA Blue	RAL 5002
PLA Magenta	RAL 4010
PLA Red	RAL 3020
PLA Yellow	RAL 1003
PLA Pearl White	RAL 1013

Ultimaker_PLA_Data_Sheet.pdf(85.7 KB) - download

2019/11/18 Prototype Energy Calculations

• James Tang • Dec 11, 2019 @11:54 AM CST

Title: Prototype Energy Calculations

Date: 2019.11.18

Content by: James Tang

Present:

Goals:

Determine how well each material performs base on how much energy being absorbed by the materials.

Content:

Determine elastic or inelastic collision:

- A collision is an event where momentum or kinetic energy is transferred from one object to another
- Momentum (p) is the product of mass and velocity (p = mv)
- Kinetic energy is the energy of motion; it is defined as K = (1/2) m v^2
- calculate the total kinetic energy of the system both before and after the collision.
- kinetic energy before the collision is equal to the kinetic energy after the collision (kinetic energy is conserved), this is an elastic collision.
- In an elastic collision, both momentum and kinetic energy are conserved. Almost no energy is lost to sound, heat, or deformation.

Gravitational Potential Energy

$$PE_g = ham$$

Loss of Energy

$$\Delta PE_g = \left| PE_g^{'} - PE_g \right|$$

% of Energy Lost

$$\% \ Lost = \frac{\Delta PE_g}{PE_g} \bullet 100$$

Figure 1: formula need for energy lost.

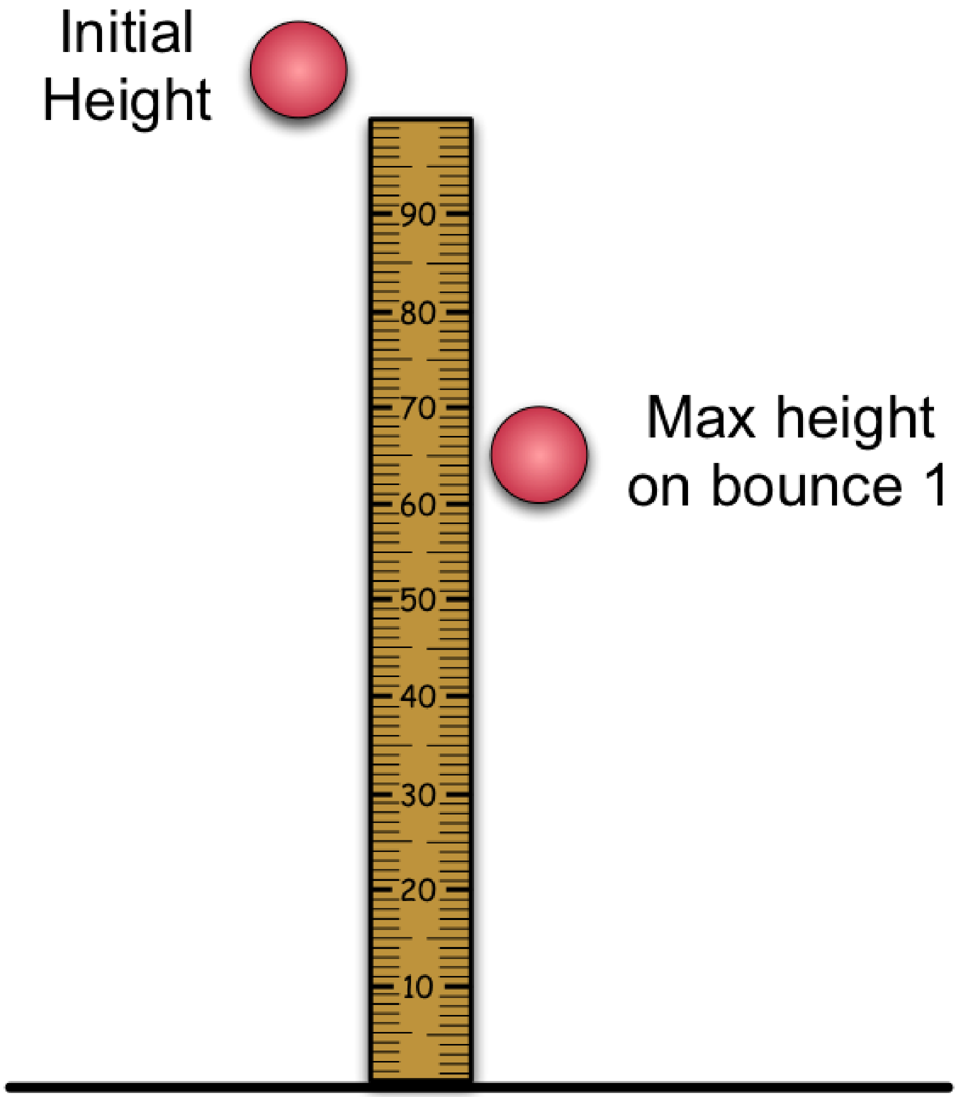

Figure 2: Initial height energy minus final height energy should be the total energy lost.

Reference:

http://ffden-2.phys.uaf.edu/211_fall2002.web.dir/ben_townsend/TypesofCollisions.htm

https://sites.google.com/site/delseaphysics1/Home/other-topics/energy/energy-loss-on-bounce

Conclusions/action items:

Use the potential energy equations to solve for energy lost during testings.

Currently Existing Competing Designs

revisions print ▪ James Tang ▪ Oct 09, 2019 @12:25 AM CDT

Title: Currently Existing Competing Designs

Date: 9.15.2019

Content by: James Tang

Present: James Tang

Goals: Look up the current products used for cutting rings in the market and their advantages & disadvantages. Learn how they work. Consider how to develop and make a better design.

Content:

The Gem Ring Cutter Emergency Ring Removal System [1]

- The Gem ring cutter relies on its unique cutting discs to abrade successive layers of material until a cut is made. It requires only light pressure for best results, and the handpiece is passed back and forth across the constriction allowing the slowly-turning abrasive disc to make cuts through soft and hard metals. The Gem ring cutter is available in both AC corded and battery-powered cordless models. A carbide disc is included for softer metals, and the diamond disc is included for harder metals like Titanium, Chromium Cobalt, and Tungsten Carbide ceramics. The Gem ring cutter also includes one finger guard.

Figure 1. The components of the Gem Ring Cutter Emergency Ring Removal System (left), when the device is applied to the rings in real surgery (right).

Tungsten Carbide Ring Cracker [1]

- It is used for very hard and resistant materials, like tungsten carbide ceramics. A ring cracker typically makes use of a sharp, hardened point that is slowly tightened against the ring until enough pressure is applied to safely crack the material.

Figure 2. A picture of a ring cracker.

Reference

[1]"Can Titanium or Tungsten Carbide ring be cut off?," Titanium Ring Cut Off | Tungsten Rings Emergency Removal. [Online]. Available: https://www.titaniumstyle.com/titanium-tungsten-ring-cut-off.htm. [Accessed: 08-Sep-2019].

Conclusions/action items:

Current competing designs already work effectively towards the materials of Titanium and Tungsten Carbide rings, but they are not perfect such as lacking of the protection systems. In addition, the way they work has to destroy the rings. So a method either refining the current designs or does not destroy the rings can be valuable.

Ring Rescue Product

revisions print • James Tang • Dec 11, 2019 @12:06 PM CST

Title: RingRescue Product

Date: 2019.11.05

Content by: James Tang

Present: James Tang

Goals: Learn about the competing design advantages and disadvantages.

Content:

How it works:

Ring Rescue is simple. Apply, inflate, and within seconds the device is working, with uniform and measurable air pressure to decrease finger swelling and therefore finger size, so that the ring can be removed. Return minutes later, remove the device, and then apply our unique ring lubricant to the ring before you attempt to remove the ring. The finger will always be smaller and patients and customers are incredibly happy when the problem is solved with this essential tool, and ring cutting can be avoided.

Price: 315$

Advantage:

- Low risk for injuring fingers
- Simple to use
- No break to the rings
- No need to cut

Disadvantage:

- Expensive

Figure 1: A flyer of the product introduction.

Figure 2: a clear look at the product.

Reference: https://ringrescue.com/

Conclusions/action items:

Overall it is a great product with perfect functions, the only concern would be its price.

Initial Design Brainstorming and Ideas

revisions print • James Tang • Sep 27, 2019 @10:33 AM CDT

Title: Initial Design Brainstorming and Ideas

Date: 9.15.2019

Content by: James Tang

Present: James Tang

Goals: Brainstorming, creating new designs for making a better ring cutter, and consider alternative ways to solve the problem without using an actual ring cutter.

Content:

A new design idea is needed that different from the current ones such as ring cracker or using a blade.

Some goals to achieve:

- Avoid hurting the patient during the ring removal process
- Less pain as possible for the patients
- Avoid breaking patients' beloved & expensive rings
- Easy to operate by the physicians
- The design should not further damage patients' injured fingers

Ideas:

- Can we make some super lubricant that can dramatically decrease the friction between the ring and the patient's finger?
- Can we make the lubricant to shrink the patient fingers?

Conclusions/action items:

Super lubricant idea can help achieve the goals. Keep research on chemical properties of commonly used lubes and how to improve them. Also, keep researching on how to be able to shrink swallowed fingers.

Super Oil Idea to Shrink Finger

revisions print

Title: How to improve current lubricant?

Date: 09.25.2019

Content by: James Tang

Present: James Tang

Goals: Figure out whether it is possible to create a super lubricant that can diminish the friction between the ring and the finger. If so, how?

Content:

The issues:

1. Swallowed finger

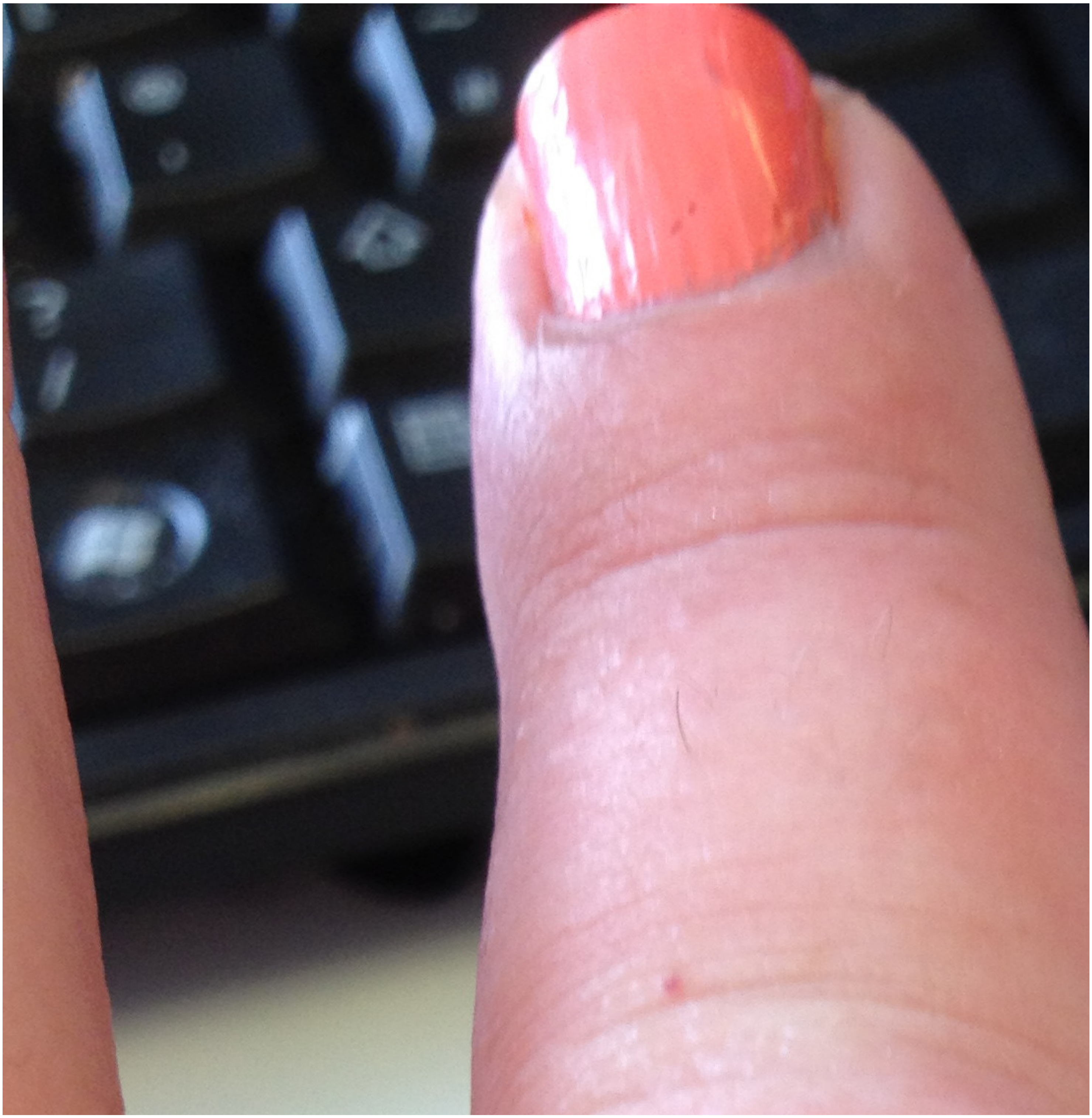

Figure 1. A very swallowed figure, the ring is stuck.

Solution: Thermal Contraction

Iced Shrinking Lubriant:

Figure 2. The general appearance of the iced shrinking lubricant.

- Improvement of current existing skin lubricant by applying thermal contraction mechanism. Changes in temperature change the physical properties of substances which, as a result, lead to th size resulting easier removal of the rings, and to reduce the pain of the finger during removing process.
- Patients are able to obtain many benefits from this design. The first benefit would be that the iced finger shrinking lubricant can rescue patients' beloved and expensive rings because it does r work or unique skills to perform.
- However, there are a few problems with this method. In some situations, the patients may have blooded injured fingers which are sensitive and fragile. The apply of iced finger shrinking lubr ending blood flow, thermal contraction also have limits on how much the finger can shrink. As a result, the method may not work effectively enough for situations that patients have extremel

Reference:

[1] https://www.google.com/url sa=i&source=images&cd=&ved=2ahUKEwjZouqdyPHkAhURvJ4KHSkiCbQQjRx6BAgBEAQ&url=https%3A%2F%2Fimgur.com%2Fgallery%2Fr7aC7dn&psig=AOvVaw2Ie-8R

[2] C. Sissons, "What are the causes of swollen hands?," *Medical News Today*. [Online]. Available: https://www.medicalnewstoday.com/articles/325207.php. [Accessed: 14-Sep-2019].

Conclusions/action items:

This design can smooth the surface between the patients' fingers and rings, to shrink the finger in size resulting easier removal of the rings, and to reduce the pain of the finger during removing proc

Fixing Current Design Ideas

revisions print • James Tang • Dec 11, 2019 @12:13 PM CST

Title: How to fix the current prototype?

Date: November 8th

Content by: James Tang

Present: James Tang

Goals: Find a way to adjust the current prototype based on the feedback from the show and tell.

Content:

So from the show and tell, we have received some valuable comments saying our shields are too thick so when inserting the finger in, the ring may not reach the ring cutter inside.

Here is a side look of the current prototype:

Figure 1: The thick width prototype we have now.

Ways to solve the problem:

- Change one side to a flat sheet but keep the same function
- Get rid of one side totally

Conclusions/action items:

We need to make one piece of the shield thinner obviously, make it to a flat sheet may be the best solution.

A Future Design Idea

revisions print • James Tang • Dec 11, 2019 @12:21 PM CST

Title: A Future Design Idea

Date: 2018.12.06

Content by: James Tang

Present: James Tang

Goals: A possible improvement for the current design to avoid uncomfortness for the other fingers.

Content:

For the final prototype we have so far, it works well. However, there is a problem may deserve some concerns.

When inserting one finger into the shields, the other fingers need to deflect a lot. So what if the patient get the whole finger injured?

Brainstormed Solution:

- Maker a bigger product with a big hole where the whole finger can put into the shields.
- The ring cutter can freely located at the finger which has the ring

Conclusions/action items:

In this way, doctors do not have to worry about further injuring other fingers without the ring.

Green Pass

revisions print ▪ James Tang ▪ Oct 10, 2018 @01:34 PM CDT

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Background Research - Tungsten carbide properties

revisions print • Kavya Vasan • Dec 11, 2019 @08:12 AM CST

Title: Properties of Tungsten Carbide

Date: September 13, 2019

Content by: Kavya Vasan

Present: NA

Goals: To learn about the properties of Tungsten carbide

Content:

- Implications: More people are wearing Tungsten carbide rings due to their indestructible nature and resistance to scratches. Tungsten is 3 times stiffer than steel and more dense than titanium and steel. This is also important because people who are allergic to gold and silver opt for tungsten carbide rings.
- Tungsten Carbide has a Young's Modulus of 94, 800,000 psi.
- High resistance to deformation and deflection means there is minimal elasticity and will break at the fracture point. Good ultimate strength.
    -
- High rigidity and therefore is impact resistance.
    - Therefore, when using the ring cracker, rings must always be checked with a magnifying glass to see if there are scratches. Tungsten carbide doesn't get scratched,
- Heat resistant up to 1500 deg F in non oxidation temperatures, 1000 deg F in oxidation temperatures.
- Retains toughness and strength at low temperatures upto -453 deg F.
- Thermal conductivity twice that of carbon steel and tool steel.
- Tungsten carbide can retain room temperature hardness at 1400 deg F.
- low coefficient of friction
- Fracture point of Tungsten carbide is about 900-1100 MPa. The hardness value of WCo is 100 GPa. It varies by alloys, which are definitely present in rings.

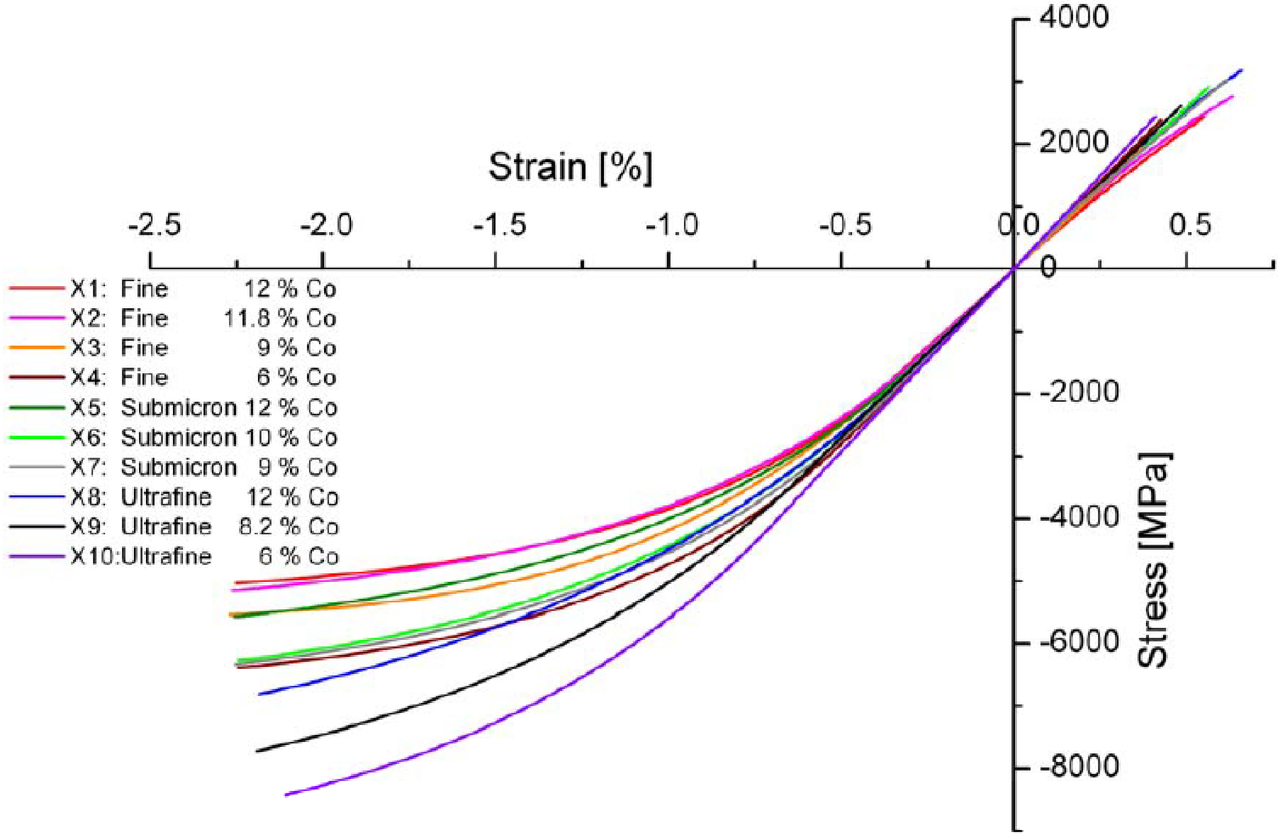


Fig 1. Stress-strain curve at different cobalt compositions for WCo.

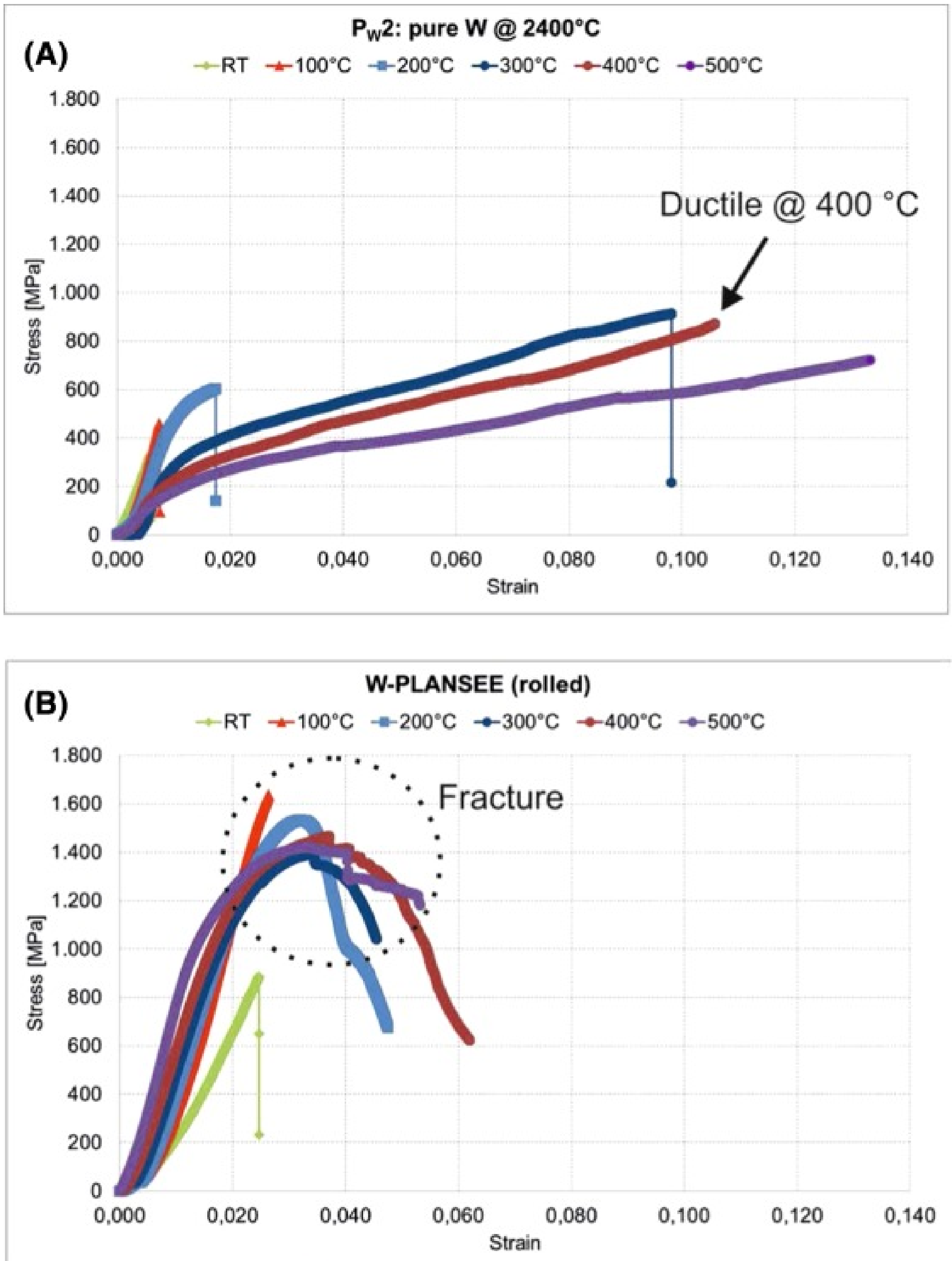


Fig 2. Stress-strain curves showing the fracture point of Tungsten carbide alloy and ductility of pure Tungsten

R. W. Armstrong, “The Hardness and Strength Properties of WC-Co Composites,” *Materials*, vol. 4, no. 7, pp. 1287–1308, Jul. 2011.

T. Klünsner, S. Marsoner, R. Ebner, R. Pippan, J. Glätzle, and A. Püschel, “Effect of microstructure on fatigue properties of WC-Co hard metals,” *Procedia Engineering*, vol. 2, no. 1, pp. 2001–2010, Mar. 2010.

S. Antusch, D. E. Armstrong, T. B. Britton, L. Commin, J. S.-L. Gibson, H. Greuner, J. Hoffmann, W. Knabl, G. Pintsuk, M. Rieth, S. G. Roberts, and T. Weingaertner, “Mechanical and microstructural investigations of tungsten and doped tungsten materials produced via powder injection molding,” *Nuclear Materials and Energy*, vol. 3-4, pp. 22–31, Aug. 2015.

Conclusions/action items: It is clear from this research that Tungsten Carbide is an extremely strong metal and highly resistant to impact and heat. Breaking tungsten carbide rings off patients' fingers is the only option as we cannot tackle to heat aspect of this metal. A device that breaks the ring, but protects the finger from the pressure applied is the goal. We should also prevent the possibility of lacerations on the patient's finger as tungsten carbide doesn't deform, so when it breaks the metal pieces are very sharp.

Why are Ring Removal Methods needed?

revisions print · Kavya Vasan · Dec 11, 2019 @08:12 AM CST

Title: Why Ring Removal Methods are needed

Date: September 15, 2019

Content by: Kavya Vasan

Present: Kavya Vasan

Goals: To learn why ring removal devices are needed and the biological implications.

Content:

- Most common reason for ring removal is swelling (edema).
- Causes of swelling: pregnancy, soft tissue injuries, fractures, dislocation, allergic reactions or anaphylaxis.
- If swelling is too much, need to cut the ring to prevent loss of the digit. This is a problem for tungsten carbide rings because of hardness.
- There was a patient who had a Tungsten carbide ring stuck because of swelling. After physicians failing to remove the ring, an ED physician used locking pliers.
    - Locking pliers were inserted around the ring. Tightening screws used to increase pressure applied on the ring, with quarter right turns of a screw. Pressure kept being applied until the sound of the ring fracture was heard. Finger squeezing was minimal during the procedure.
- The locked pliers technique took about 30 seconds, which is faster than other techniques.
- The ring was destroyed and the metal ring fragments flew up to 70 cm.

Fig 1. Finger swelling with Tungsten Carbide ring

Fig 2. Tungsten carbide ring shards

A. Moser, A. Exadaktylos, and A. Radke, “Removal of a Tungsten Carbide Ring from the Finger of a Pregnant Patient: A Case Report Involving 2 Emergency Departments and the Internet,” *Case Reports in Emergency Medicine*, vol. 2016, pp. 1–2, Feb. 2016.

Conclusions/action items: From the client meeting, it was stated that he wants patients and physicians to be protected from flying metal shards. That will be the main component of our design if we make a device designed to break the ring. Tis technique seems similar to an existing device called the Ring cracker. Another requirement of the client is to make the process automated so that the removal time is faster. This process took 30 seconds, but the ring cutter takes longer with all the screw turns. Therefore, I think that an automated ring cracker with a protection component would be the best design according to the client requirements.

Effects of rings stuck on fingers

revisions print · Kavya Vasan · Dec 11, 2019 @08:13 AM CST

Title: Effects of rings stuck on fingers

Date: October 7, 2019

Content by: Kavya Vasan

Present: Kavya Vasan

Goals: To understand the biological implications of this problem

Content:

- Rings may need to be removed due to swelling from trauma, infections or burns and allergic reactions.
- The ring acts as a tourniquet, impeding blood flow.
- Removing the ring from a swollen finger prevents long term effects. This is due to edema in the finger.
- Medical issues that can arise are: ischemia, infection, tendon attrition, skin breakdown, or even amputation due to necrosis (cell death) of the finger.
- The ring can cause lymphatic drainage to stop, which exacerbates the edema.
- More swelling doesn't allow venous drainage and therefore progresses to congestion. This compromises artery blood flow.

Fig 1. Ischemia on a finger with prolonged edema

< Kumar, A., Edwards, H., Lidder, S., & Mestha, P. (2013). Dangers of neglect: partially embedded ring upon a finger. *Case Reports*, *2013*(may09 1), bcr2013009501-bcr2013009501. doi:10.1136/bcr-2013-009501>

Conclusions/action items: To prevent these extreme and possibly life threatening circumstances, there needs to be an effective method to remove tungsten carbide rings. Skin necrosis and ischemia are the biological implications of allowing edema to persist. Tungsten carbide specifically, is very hard to break, so this issue is very important to solve for those rings.

Edema Research

revisions print · Kavya Vasan · Nov 30, 2019 @08:35 PM CST

Title: What is Edema

Date: October 8, 2019

Content by: Kavya Vasan

Present: Kavya Vasan

Goals: To understand the biology and causes of edema

Content:

- Edema is the medical term for swelling. It is the accumulation of lots of fluid in intercellular tissue spaces.
- An edema arises when fluid builds up in tissue in the extremities.
- Types of Edema:
  - Puffiness or swelling from water retention: This is the puffiness of hands, feet or face. It is temporary and doesn't need to be treated. It can arise from standing, sitting, or being in an airplane for a long time. This type of edema is also common during pregnancy.
  - Edema from heart or liver issues:
    - Venous insufficiency: edema can form in feet and ankles due to lack of blood transport from veins to the feet and back to the heart. The blood builds up in the legs and fluid comes out of the blood vessels into the tissues.
    - Congestive Hearth failure: in this case, the heart is too weak to pump blood to different parts in the body, so blood builds up in front of the heart. The increased blood pressure in veins along with the blood build up, causes fluid to come out into the tissue around. This causes swelling in the stomach or leg. This type of edema can also form in the lungs, which is life threatening.
    - Kidney disease: can cause edema in legs and around eyes if kidneys can't remove sodium and water from our body and the blood vessel pressure increases.
    - Low protein levels: If there is low albumin in blood, fluid can seep out of blood vessels easily. This can happen from malnutrition and kidney and liver diseases.
    - Liver disease: Liver tissue scarring (cirrhosis) from alcohol abuse or inflammation can result in abdomen edema. Cirrhosis leads to less proteins and more congestion in lever which increases blood vessels pressure and fluid leaks in the abdomen.
    - Lung conditions: emphysema can cause lung and heart pressure to increase resulting in edema in legs and feet.
  - Lymphedema: This is from problem in lymphatic system. Will affect one body part.

"Causes and signs of edema," *InformedHealth.org*, 30-Dec-2016. [Online]. Available: https://www.ncbi.nlm.nih.gov/books/NBK279409/. [Accessed: 10-Oct-2019].

Conclusions/action items: Edemas can be caused from capillary hypertension. Attempts are made to reduce edemas with ice packs and if successful, lubrication or string wrapping can be used to remove rings. But if the swelling doesn't go down, which is often the case with large amounts of swelling caused from water retention (stuck ring), the ring (specifically tungsten carbide for our purposes) needs to be broken off to allow the fluid to drain.

Ring Cutters for Soft Metals

revisions print · Kavya Vasan · Dec 11, 2019 @08:14 AM CST

Title: Ring Cutting Devices used for Soft Metals

Date: September 12, 2019

Content by: Kavya Vasan

Present: Kavya Vasan

Goals: To learn about the different existing devices for the problem and see what needs improvement

Content:

- Blade Ring Cutter
  - This has a manual twisting knob for older designs.
  - There is a safety lever that protects the finger from the blade.
  - $ 9-15 dollars for the thumb screw cutters (not motor powered).
  - Good for silver and gold rings.
  - The medline ring cutter is made of steel and can cut through titanium.

Fig 1. Thumb screw Ring cutter

Fig 2. Medline Blade ring cutter

"Ring Cutters and Replacement Blades," *Medline Industries, Inc.* [Online]. Available: https://www.medline.com/product/Ring-Cutters-and-Replacement-Blades/Ring-Cutters/Z05-PF10100. [Accessed: 12-Sep-2019].

- Electric Ring Cutter
  - Cordless battery powered ring cutter.
  - Takes 10 seconds to break the ring.
  - Costs $200
  - Cuts strong alloys within 10 seconds
  - Blade guard for protect fingers

Fig 3. Electric ring cutter with battery powered drill

“Electric Ring Cutter,” *Stuller, Inc.* [Online]. Available: https://www.stuller.com/products/48-18030/groupId=193092&recommendationSource=CategoryBrowse&categoryId=9938. [Accessed: 12-Sep-2019].

- Locking Pliers
    - These have jaws that some emergency rooms use to put around the ring.
    - Gripping power
    - Gives maximum torque without high applied force
    - Trigger gives maximum locking force
    - Made from alloy steel
    - Hardened teeth provide grip on the object to be broken at different angles
    - They have been used on Tungsten carbide rings

Fig 4. Locking Pliers used to break Tungsten Carbide Rings

“All Tools,” *The Original™ Curved Jaw Locking Pliers - Tools - IRWIN TOOLS*. [Online]. Available: https://www.irwin.com/tools/locking-tools/the-original-curved-jaw-locking-pliers. [Accessed: 12-Sep-2019].

Conclusions/action items: These existing devices in the market work for certain situations. Most of them work well for rings made of softer metals such as gold and silver, but they won't be able to break Tungsten Carbide rings. The locking pliers aren't specifically made to cut rings, so ergonomically they could be painful for the patient and they don't ensure patient safety. The electric powered idea can be used in conjunction with another existing design idea to break Tungsten Carbide rings.

String wrapping method

revisions print · Kavya Vasan · Dec 11, 2019 @08:14 AM CST

Title: Ring Removal using string wrapping

Date: October 12, 2019

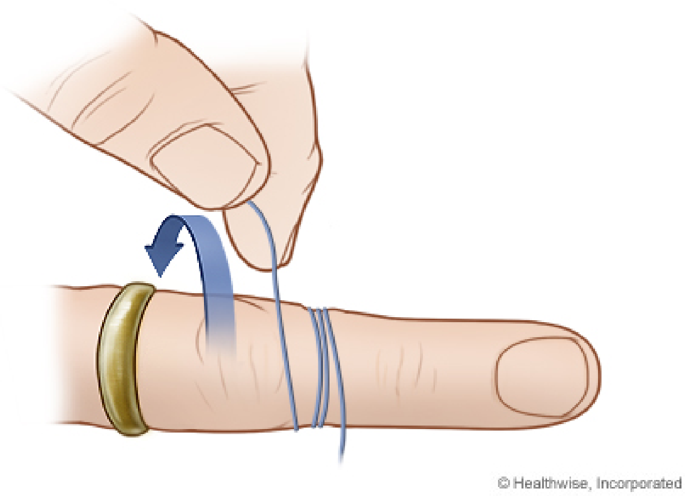
Content by: Kavya Vasan

Present: Kavya Vasan

Goals: To learn about this ring removal technique

Content:

- In emergency rooms, surgeons first try to keep the ring intact by applying ice on the swelling, and either using lubricant to remove the ring or string wrapping to move the ring up the finger.
- The surgeon takes dental floss and wraps it around the finger from the knuckle until the floss reaches the ring. He/she then inserts one end through the ring.
- Take the end of the floss that is inserted through the ring and start unwrapping the floss. The ring will move up the finger the floss unwinds.
- Tungsten carbide rings are hard for surgeons to remove, so they start with this method as it is the easiest and safest.
- The article by Gardiner, Mazzillo, Reichman, King and Chathampally suggests that locking pliers remove the ring faster than string wrapping by about 110 seconds. But the locking pliers were less safe as the rings were destroyed and the shards were thrown up to 94 cm.



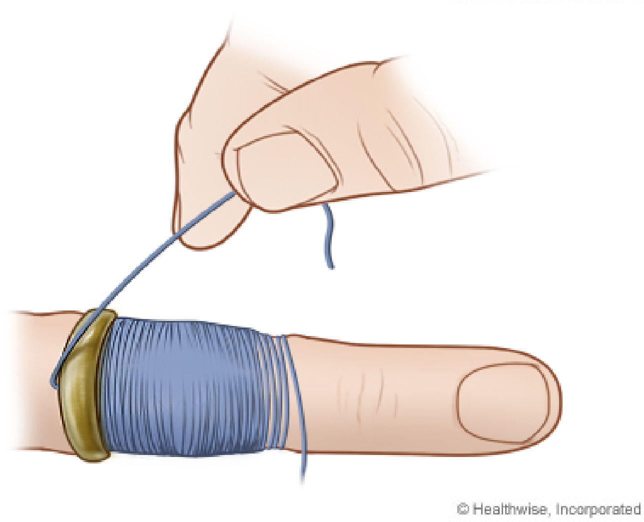


Fig 1. Wrapping finger with string from the top of the finger towards to ring

fig 2. unwinding the string from the bottom of the ring, to move the ring up

"Removing a Ring From a Finger or Toe," *HealthLink BC*, 23-Sep-2018. [Online]. Available: https://www.healthlinkbc.ca/health-topics/tp9593. [Accessed: 12-Oct- 2019].

C. L. Gardiner, K. Handyside, J. Mazzillo, M. J. Hill, E. F. Reichman, Y. Chathampally, and B. R. King, "A comparison of two techniques for tungsten carbide ring removal," *The American Journal of Emergency Medicine*, vol. 31, no. 10, pp. 1516–1519, Oct. 2013.

Conclusions/action items: This is one of the methods that Dr. Glazer, a trauma surgeon at the children's hospital, showed us and he said patients would prefer to keep rings intact for sentimental reasons. Safety is one of the concerns for our design, so string wrapping would be better than locking plier like devices if the swelling isn't large. An automated version of this was also expressed when we met with Dr. Glazer and Dr. Green.

Ring Cracker

revisions print • Kavya Vasan • Dec 11, 2019 @08:15 AM CST

Title: Ring Cracker for Tungsten Carbide

Date: October 22, 2019

Content by: Kavya Vasan

Present: Kavya Vasan

Goals: To research existing devices in the market for the problem of removing tungsten carbide rings

Content:

- The Ring Cracker is used to break Tungsten carbide and ceramic rings. This is the only device made to cut tungsten carbide rings as diamond-blade and electric ring cutters can't cut through. Those blades get dull when trying to cut through tungsten carbide.
- Tungsten is brittle though, so the ring cracker applies enough force to crack the ring into pieces.
- A magnifying glass is needed to inspect the ring to verify that it is tungsten carbide since it cannot get scratched.
- It costs $125 at Shor International. $199 at Atlas.
- There is a handle to hold the cracker and on the bottom there is a circular knob to turn, which compresses the ring.
- The process is supposed to be painless and after about 10 turns, the ring will crack and you will hear it.

“Ring Cracker,” *Shor International Corporation*. [Online]. Available: https://www.ishor.com/ring-cutter. [Accessed: 22-Oct-2019].

- Ring Cracker Patent means that there is already a patented device that can break Tungsten Carbide rings. We would have to think of a very different design if we were to create a new device, but the client does want to focus on a protection system for the ring cracker.

https://patents.google.com/patent/US20130284785A1/en

citation: Tungsten carbide ring cracker, by T. L. Brosius. (2013, Oct. 31). *US20130284785A1.* Accessed on: Oct. 22, 2019. [Online]. Available: https://patents.google.com/patent/US20130284785A1/en

Fig 1. The Ring Cracker Device that is currently in the market. The pointed screw is turned by the black knob, tightening the Tungsten Carbide ring.

Conclusions/action items: Since there is already a device in the market to break tungsten carbide rings, we will not create a new device to break them. The client wants the focus to be on developing a protection system for this ring cracker because the tungsten carbide ring breaks in the shards without deforming, so the pieces are sharp and fly up to a meter high. We will add attachments on the sides of the ring cracker to contain the ring pieces. I need to research possible materials for the protection pieces.

PLA Research

revisions print

• Kavya Vasan • Dec 10, 2019 @12:37 PM CST

Title: Polylactic Acid (PLA) material for 3-D printing

Date: November 11, 2019

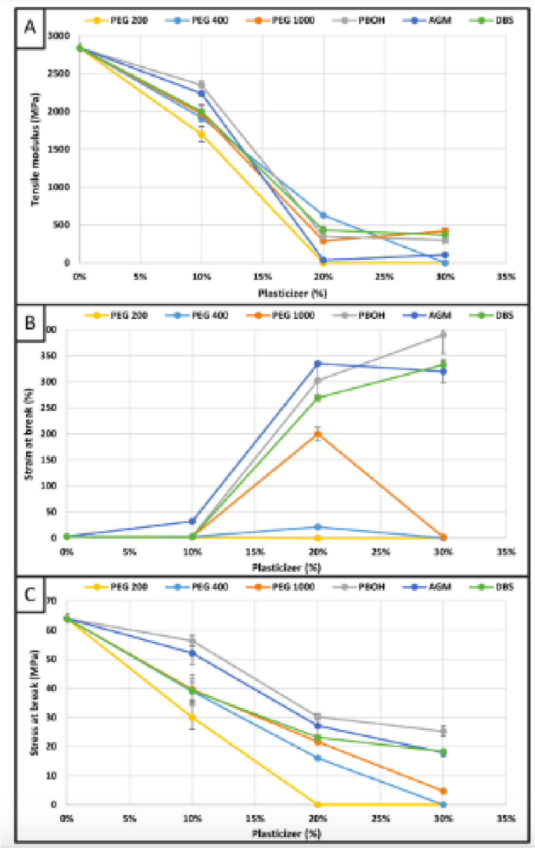
Content by: Kavya Vasan

Present: Kavya Vasan

Goals: To gain knowledge about PLA's properties for 3-D printing the protection shield.

Content:

- Sustainable plastic made from corn starch or sugar cane. PLA is a bioplastic.
- Cost efficient to produce. Therefore it is also cheap - $25/kg.
- It is used in biodegradable medical devices. Produced from lactic acid: $C_3H_6O_3$
- It constricts under heat, and has low glass transition temperature.
- Available as a 3D printing filament.
- "Thermoplastic Polymer" - melting point: 150-160 deg C. They can be heated, cooled and heated again without much degradation.
- PLA is non toxic in solid form. It's more brittle than some other plastics used for 3-D printing.
- Tensile strength: 61-66 MPa.
- Flexural/Yield strength: 48-110 MPa.
- Density: 1.24 g/cm^3
- High print speeds and good tensile strength.



Graphs of percentage of plasticizer in different PLA compositions vs Tensile modules, strain at break, and stress at break

White and clear PLA screws 3D printed

T. Rogers, “Everything You Need To Know About Polylactic Acid (PLA),” *Everything You Need To Know About Polylactic Acid (PLA)*, 07-Oct-2015. [Online]. Available: https://www.creativemechanisms.com/blog/learn-about-polylactic-acid-pla-prototypes. [Accessed: 11-Nov-2019].

S. Farah, D. G. Anderson, and R. Langer, “Physical and mechanical properties of PLA, and their functions in widespread applications — A comprehensive review,” *Advanced Drug Delivery Reviews*, vol. 107, pp. 367–392, Jun. 2016.

Conclusions/action items: This is a cheap, environmentally friendly and stable material to use for practice prototypes. This can be used to test different dimensions for the protection shield and can be compared with other materials for testing absorption of energy.

TPE Research

revisions print • Kavya Vasan • Dec 01, 2019 @02:44 PM CST

Title: Thermoplastic Elastomer (TPE) properties

Date: November 11, 2019

Content by: Kavya Vasan

Present: Kavya Vasan

Goals: To gain knowledge about the material properties of TPE

Content:

- A combination of the performance properties of rubber and the ease to process thermoplastics.
- They are diblock coploymers with one rigid and one flexible block.
    - Plastic deformation from crystalline properties (resist creep and viscous flow) from rigid block and elastic deformation from elastic block (amorphous).
    - Higher molecular weight for elastic part to have rubber properties and lower molecular weight for hard block to reduce its effects on elasticity.
- Hard part gives high temperature performance, good tensile and tear strength.
- Soft part gives low temperature performance, resistance to indentation, flexibility and tension and compression set (go back to original shape).
- Pros: Recyclable and lower costs and simple to process. Flexible.
- When under stress for long times, they get permanently deformed from viscous flow - creep. Cross-linking can reduce this but then they won't be molten and can't be recycled.
- Tensile Elongation at break: 330-560%.
- Tensile strength at yield is 12-29 MPa.
- Flexural yield strength: 48.2 MPa.
- Elastic Modulus (stiffness): 8-113 MPa.
- Melting temperature: 200.5-224 deg C.
- Density: 0.91-1.6 g/cm^3
- Flexural Modulus: 0.266-0.6 GPa
- Tear strength: 12.4-35 kN/m
- Compression set: 51.3%

"Thermoplastic Elastomers," *Polymer Properties Database*. [Online]. Available: http://polymerdatabase.com/Elastomers/TPEs.html. [Accessed: 11-Nov-2019].

"Overview of materials for Thermoplastic Elastomer, Melt-Processible Rubber," *MatWeb*. [Online]. Available: http://www.matweb.com/search/datasheettext.aspx?matguid=3190cb436efb45c0a1b4e64adfe908dd. [Accessed: 11-Nov-2019].

Conclusions/action items: This was one of the options for 3D printing the prototype at TEAM lab. It has the best of both properties - flexible, yet good tensile strength, good at low and high temperatures. But if deformed, it stays deformed. Costs $17/0.5 kg. There aren't many rubber options at TEAM lab, so it may be unavailable, so I need to compare it with elastic resin properties.

Elastic Resin Research

revisions print • Kavya Vasan • Dec 10, 2019 @12:39 PM CST

Title: Elastic Resin properties

Date: November 14, 2019

Content by: Kavya Vasan

Present: Kavya Vasan

Goals: To research the properties of elastic resin for the prototype

Content:

- The soft SLA is highly elastic but also strong so that it doesn't tear while being 3-D printed.
- It is durable, tear-resistant, and resilient. It is also translucent.
- High elongation - 160%, soft flexible, high energy return/spring back
- Tear strength: 19.1 kN/m
- It is designed to bounce back and return to original shape.
- Low durometer, so similar to parts made with silicone.
- Ultimate Tensile strength: 3.23 MPa
- Compression set: 2% at room temp and 9% at 70 C.
- Stress at 50% elongation: 0.94 MPa, stress at 100% elongation: 1.59 MPa.
- 160% elongation at failure.
- Around same shore hardness at TPE.
- Cost: $199/L
- It requires more support than other resins.
- modulus of elasticity: 2.7 GPa
- Minimum wall thickness required: 1mm.

Elastic resin model of arteries 3-D printed

"Elastic Resin," *Formlabs*, 01-Jul-2019. [Online]. Available: https://formlabs-media.formlabs.com/datasheets/Elastic_Resin_Technical.pdf. [Accessed: 14-Nov-2019].

"Using Elastic Resin," *Formlabs*, 20-May-2019. [Online]. Available: https://support.formlabs.com/s/article/Using-Elastic-Resin?language=en_US. [Accessed: 14-Nov-2019].

Conclusions/action items: Elastic resin can bend, stretch and compress under repeated cycles without tearing. It is the best option for a final prototype due to its ability to bounce back and maintain its shape. The disadvantage is that it is more expensive than the PLA and TPE and doesn't support thin walls. This is the best rubber option at TEAM lab for 3-D printing so we will use this material. For testing, I will need to perform calculations on how the prototype made of elastic resin absorbs energy.

3-D Printing

revisions print • Kavya Vasan • Dec 08, 2019 @03:33 PM CST

Title: 3-D Printing background and advantages

Date: November 22, 2019

Content by: Kavya Vasan

Present: Kavya Vasan

Goals: To learn about 3-D printing fabrication method and benefits for prototypes

Content:

- This article talks about the benefits of 3-D printing to stabilize rib fractures.
- 3-D printing can be used to manufacture prototypes quickly and efficiently at low costs from CAD models.
- It uses a layering process that keeps adding on top of the previous layer.
- Patients with application of preoperative 3D printing for SSRF (surgical stabilization of rib fractures) had shorter operation times.
- 3-D CT reconstructions have been made with acrylonitrile butadiene styrene, to simulate the patient's rib cage to determine the length and curve of the titanium plates before surgery to decrease the length of the incisions, identify the precise location of fracture sites, and easily measure the rib thickness using a caliper to determine the proper screw length.
- 3-D printing has helped in anatomy and surgical education by make precise simulations of patient anatomy.
- 3-D printing machines cost $100-200. They are becoming more popular and are though to get cheaper.
- A range of plastic and resin materials can be used to print.

Y.-Y. Chen, K.-H. Lin, H.-K. Huang, H. Chang, S.-C. Lee, and T.-W. Huang, "The beneficial application of preoperative 3D printing for surgical stabilization of rib fractures," *Plos One*, vol. 13, no. 10, Oct. 4, 2018.

- 3-D printing has grown rapidly in the last 5 years.
- This article explores the idea of feasibility of 3D printing elastomeric latex by taking into account particle size, viscosity, and surface tension. These are the 3 main variables in 3D printing for materials. XSBR latex is the most printable.
- Additive manufacturing machines include a way to solidify a material and a way to scan in X, Y, and Z directions to control the positioning of the material.
- "Rapid prototyping" started in 1980's and developed into additive technology, which is more refined.
- It can make highly complex and custom-made products, but for limited range of materials.
- Thermoplastic elastomers and thermoset elastomers are conventional elastomers used for 3-D printing.
- Rubbers and elastomers aren't very available for 3-D printing.
- Liquid silicone elastomers can be processed using extrusion.
- The material is deposited from a micro-dispensing device or syringe.
- High viscosity of the material is needed to maintain the shape of the product.
- But can't use this for majority of elastomers-soft solids with too much viscosity.
- 2 ways UV curable polymers can be 3D printing:
  - Stereolithography: object built up in liquid polymer. The object is lowered step-wise into the bath as each layer is cured.
  - Liquid polymer is printed by an inkjet process and is cured after deposition by a UV light attached to the print head. This allows many materials to be printed precisely at once.
- The use of liquid latex as ink for 3D printing material has a lot of potential and with modifications, more elastomeric materials can be printed.

M. Lukić, J. Clarke, C. Tuck, W. Whittow, and G. Wells, "Printability of elastomer latex for additive manufacturing or 3D printing," *Journal of Applied Polymer Science*, vol. 133, no. 4, Sep. 12, 2015.

Conclusions/action items: 3-D printing for the protection shield is an efficient, low cost and precise method of fabrication of our prototype. We can used our solidworks model to print the protection shield and test the prototype. If there are any errors, it is cheap to reprint the prototype ($3-$15). This is what the team is going to utilize at the makerspace. The first article shows the medical applications for which 3-D printing is useful.

Advantages of 3-D Printing and Choosing materials

revisions print • Kavya Vasan • Dec 08, 2019 @03:51 PM CST

Title: Advantages of 3-D printing and criteria for choosing material

Date: November 25, 2019

Content by: Kavya Vasan

Present: Kavya Vasan

Goals: To find out the benefits of 3-D printing to fabricate the protection shield

Content:

- Advantages of 3D printing
  - Advantages over traditional manufacturing techniques (CNC, lathe, mill).
  - Delivers design quickly and accurately
  - Much faster than traditional manufacturing. Can print a complex design within hours and more accurate than people measuring.
  - It is single-step manufacturing.
  - Fused deposition modeling (FDM) uses filament coils at $25/kg (ex: PLA). Stereolithography SLA printing of resin costs $150/L. 3-D printing is cheap, but more expensive for resin materials.
  - It gives design freedom for complex models that may not be able to be manufactured otherwise. Since components are constructed one layer at a time, design requirements such as draft angles, undercuts and tool access do not apply.
  - However, if it isn't adequately supported, the print will fail.
  - Sustainable - produces little waste.

B. Redwood, “The Advantages of 3D Printing,” *3D Hubs*. [Online]. Available: https://www.3dhubs.com/knowledge-base/advantages-3d-printing/. [Accessed: 25-Nov-2019].

- Choose right material to 3-D print
  - Compare mechanical and thermal properties of different materials.
  - Tensile Strength: Resistance of a material to breaking under tension.
  - Young's Modulus: Resistance of a material to stretch under tension (stiffness).
  - Elongation: Resistance of a material to breaking when stretched.
  - Flexural Strength: Resistance of a material to breaking when bent.
  - Flexural Modulus: Resistance of a material to bending under load.
  - Impact Strength: Ability of a material to absorb shock and impact energy without breaking.
  - Indentation Hardness (shore): Resistance of a material to deformation.
  - Compression set: Permanent deformation remaining after material has been compressed.
  - Tear Strength: Resistance of a material to growth of cuts under tension.
  - Heat deflection temperature: Temperature at which a sample deforms under a specified load.
  - Thermal Expansion: Tendency of a material to expand (or shrink) in response to a change in temperature.

“How to Choose the Right 3D Printing Material,” *Formlabs*. [Online]. Available: https://formlabs.com/blog/how-to-choose-the-right-3D-printing-material/. [Accessed: 25-Nov-2019].

Conclusions/action items: 3-D printing is an excellent option that is cheap for our budget, can use our solidworks model, accurate, can make a complex model, and is fast. This is the method we have decided to go with. When we were deciding which material to choose, I researched the Elastic resin and PLA properties and the set of criteria above are the most helpful in determining which material to use. Elastic materials use tear strength as a high factor for resistance. The plan is to use elastic resin as it can absorb more energy upon impact.

Electrochemical Machining to cut tungsten carbide

revisions print • Kavya Vasan • Dec 11, 2019 @08:15 AM CST

Title: Electrochemical Machining to cut Tungsten Carbide

Date: September 28, 2019

Content by: Kavya Vasan

Present: Kavya Vasan

Goals: To research a way to cut Tungsten Carbide

Content:

- Electrolytic processing through the concept of carbide being dissolved in NaOH electrolyte.
- It doesn't heat up a tungsten carbide rod.
- The processing speed and quality of ECM is not dependent on tungsten carbide material properties.
- Tungsten carbide piece is connected to DC positive electrode (anode), negative electrode of the tool to DC cathode.
- 10-15 V DC.
- The cemented carbide is dissolved in the electrolyte until the shape needed is attained.
- The cost is low as ECM doesn't consume tool electrodes.
- The chemical reaction equation on the anode:
  $W+O2=WO2$
  $WO2+2NaOH=Na2WO4+H2O$
  $Co+M2A=CoA+2M-2e$

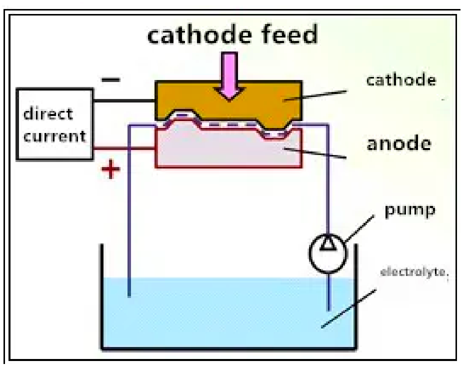


Fig 1. ECM labeled set up with current flowing through and anode and cathodes in NaOH electrolyte

J. Ning, “4 Best Methods of How to Cut tungsten carbide rod Properly?,” *Meetyou Carbide*, 06-Jun-2019. [Online]. Available: https://www.meetyoucarbide.com/single-post/how-to-cut-tungsten-carbide-rod. [Accessed: 28-Sep-2019].

Conclusions/action items: This is an interesting idea for brainstorming. The advantage is that it is cheap, snd doesn't require a lot of physical force. A big disadvantage is that current needs to be used, and don't want the patient to be electrocuted/get chemical burns.

Automatic Spool Wrapper

revisions print • Kavya Vasan • Dec 11, 2019 @08:15 AM CST

Title: Automatic String Wrapping Design

Date: October 6th 2019

Content by: Kavya Vasan

Present: Kavya Vasan

Goals: To develop a potential design to remove a ring from a swollen finger

Content:

- My design idea is the Automatic String Wrapper.
- Based off of the string method used to remove rings: one end of a string is inserted through the ring, looped around the finger above the ring and then unlooped using the end of the string under the ring.
- The automatic string wrapper improves the current method by making the string wrapping automatic. One end of string from a spool would wrap around a hollow motorized worm gear device, with the finger inserted in one end, and go through a small hole hole at the other end of the device, to be attached to the ring. When main button is clicked, the motorized device will rotate and loop the string around the finger. Once the looping is done, another button is clicked to reverse the movement of the motorized device and unloop the string automatically, moving the ring up the finger.
- Advantages:
  - ring will not be damaged - main concern that patients have sentimental value
  - automation reduces the time taken for the ring removal procedure
  - works for rings made of all metals which reduces the need for multiple devices for different types of rings based on metal strength.
- Disadvantages:
  - ineffective if there's lots of swelling and injury on the finger.
  - fabrication of the automation would be a challenge. A small motor needed to keep the device small and efficient to use,

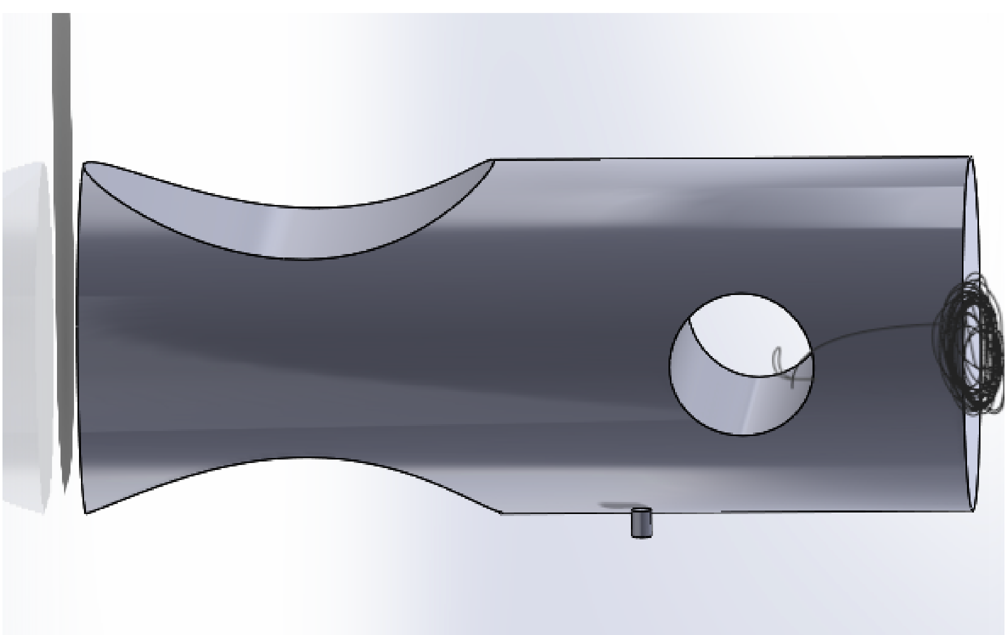


Fig 1. Solidworks Design for Automatic String Wrapper initial

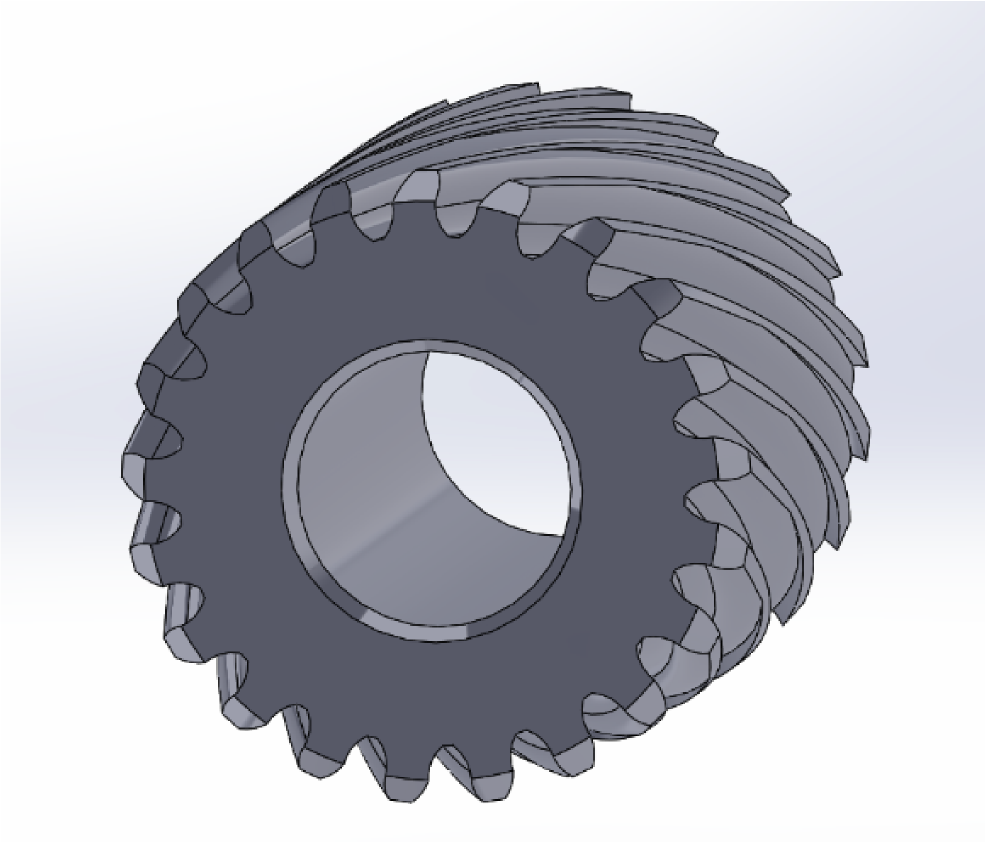


Fig 2. Revise Automatic String wrapping solidworks design

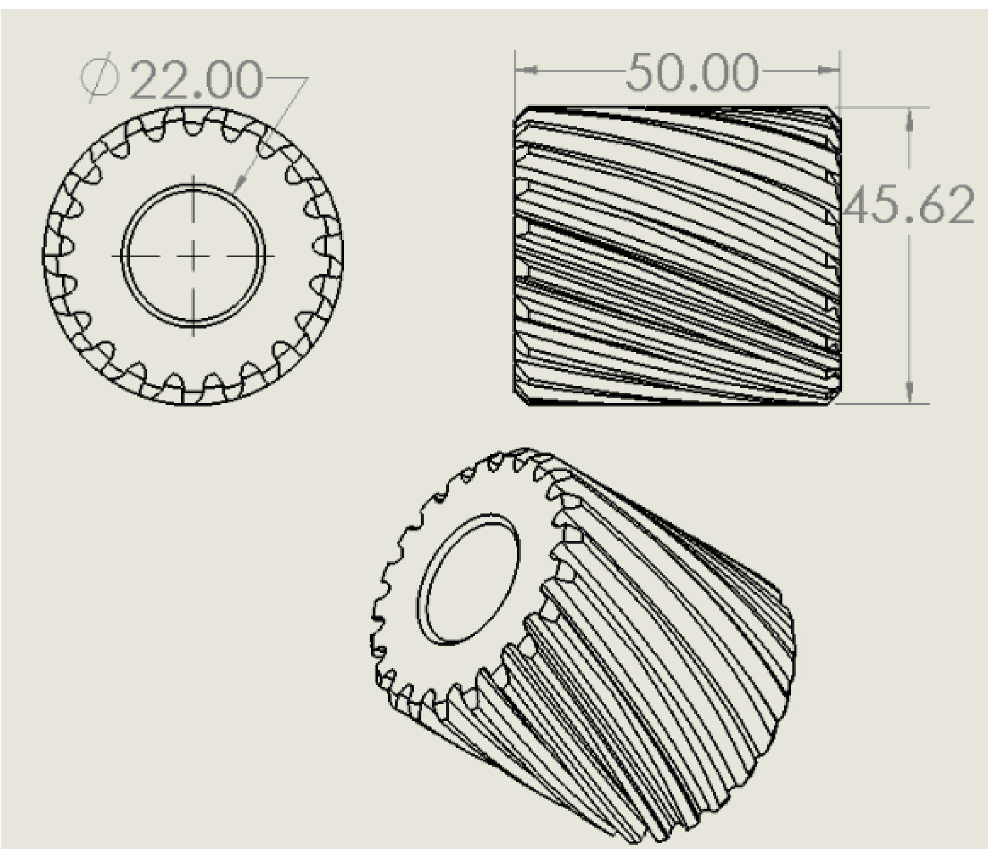


Fig 3. Revised Automatic String wrapper dimensions drawing in mm

The solidworks design was refined to look like a worm gear for better aesthetics and dimensions were added.

Conclusions/action items: The Solidworks design needed to be refined even if this design isn't chosen. The first design wasn't clear in what it was supposed to do. The revised design is much more aesthetically pleasing and clear in what it is supposed to do. It is a good and feasible design as it will be more appealing to patients, but it won't work for very swollen and injured fingers, which is a big criteria for this project. Also, the space for the swollen finger to go through may not be enough for large edemas.

Revised Final Design

revisions print · Kavya Vasan · Dec 11, 2019 @02:36 AM CST

Title: Final Prototype Design

Date: December 2, 2019

Content by: Kavya Vasan

Present: Kavya Vasan

Goals: To document final prototype design

Content:

- One side has a thickness of 11 mm and the other side of the shield has a thickness of 7mm. For each side of the shield, it has a rectangular cut with 10 mm height for the tungsten carbide handle.
- On the bottom of each shield, it has a circular cut with 27mm in diameter as the screw insertion points.
- 4 holes were added on either side for magnets so that the shield can stick together.
- The second shield is smaller than the first shield by 4 cm. This was one of the suggestions form show and tell, so that the shield fits at the bottom of the swollen finger.
- The middle circle was made bigger to be accessible for fingers with large amounts of swelling.
- This design is sent to be 3-D printed in PLA and Elastic resin materials to compare the absorption of energy from impact of Tungsten carbide ring pieces.
- The shield can contain all the broken tungsten carbide pieces, after sticking rubber sheets inside, to cover the big round holes for finger insertion.

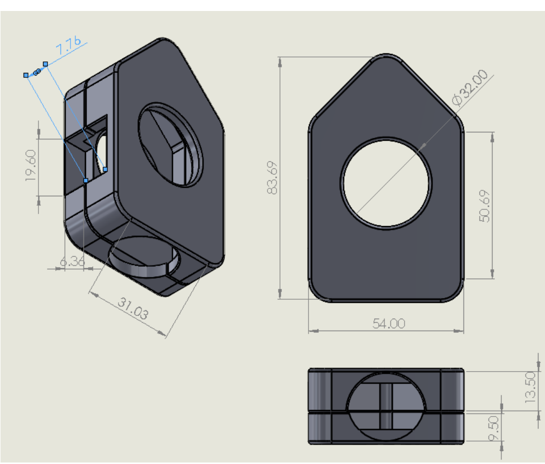


Fig 1. Final prototype drawing with dimensions pieces

Fig 2. Final Prototype with a carrot during testing containment of ring

Conclusions/action items: The final prototype was a success in covering the ring cracker accurately and containing the broken tungsten carbide ring pieces when using the ring cracker. Dr. Green was happy with our final prototype and wanted to show Dr. Glazer too. If possible in the future, we can print an elastic resin prototype for the ER.

Collision and Energy Testing

revisions print • Kavya Vasan • Dec 08, 2019 @05:10 PM CST

Title: Collision and Energy Testing Research

Date: November 20, 2019

Content by: Kavya Vasan

Present: Kavya Vasan

Goals: To research collisions and formulas to test energy change from drop testing

Content:

- Momentum or kinetic energy is transferred between objects during a collision.
- 2 types of collisions: Elastic and inelastic collisions.
- Inelastic collision: when 2 objects collide and don't bounce apart.
  - Momentum is conserved as the total momentum before and after the collision is the same.
  - Kinetic Energy is not conserved
- Elastic collision: when 2 objects bounce away after a collision.
  - Momentum and KE are conserved.
  - No energy loss to sound, heat.
- Energy Loss during a bounce
  - Change in Potential Energy: mgh2 - mgh1
  - h2 = initial height. h1= bounce height
  - Percent of energy lost: [(change in PE)/(initial PE)]*100
- To test this experimentally, hold a meter stick up from the surface off which the object will bounce.
- Drop the object on the surface to test the bounce and record the height to which the object bounces.

"Types of Collisions." [Online]. Available: http://ffden-2.phys.uaf.edu/211_fall2002.web.dir/ben_townsend /TypesofCollisions.htm. [Accessed: 28-Nov-2019].

"Energy Loss on Bounce," *Google Sites*. [Online]. Available: https://sites.google.com/site/delseaphysics1/Home/ other-topics/energy/energy-loss-on-bounce. [Accessed: 28-Nov-2019].

Conclusions/action items: These mathematical formulas will be used for our drop testing to see if a ring piece bounces more from PLA or Elastic Resin protection shields, at different heights. After that, we can perform an ANOVA test to test the statistical significance of bounce back between PLA and elastic resin at different heights.

Green Pass

revisions print ▪ Kavya Vasan ▪ Oct 08, 2019 @11:16 PM CDT

Title: Green Pass

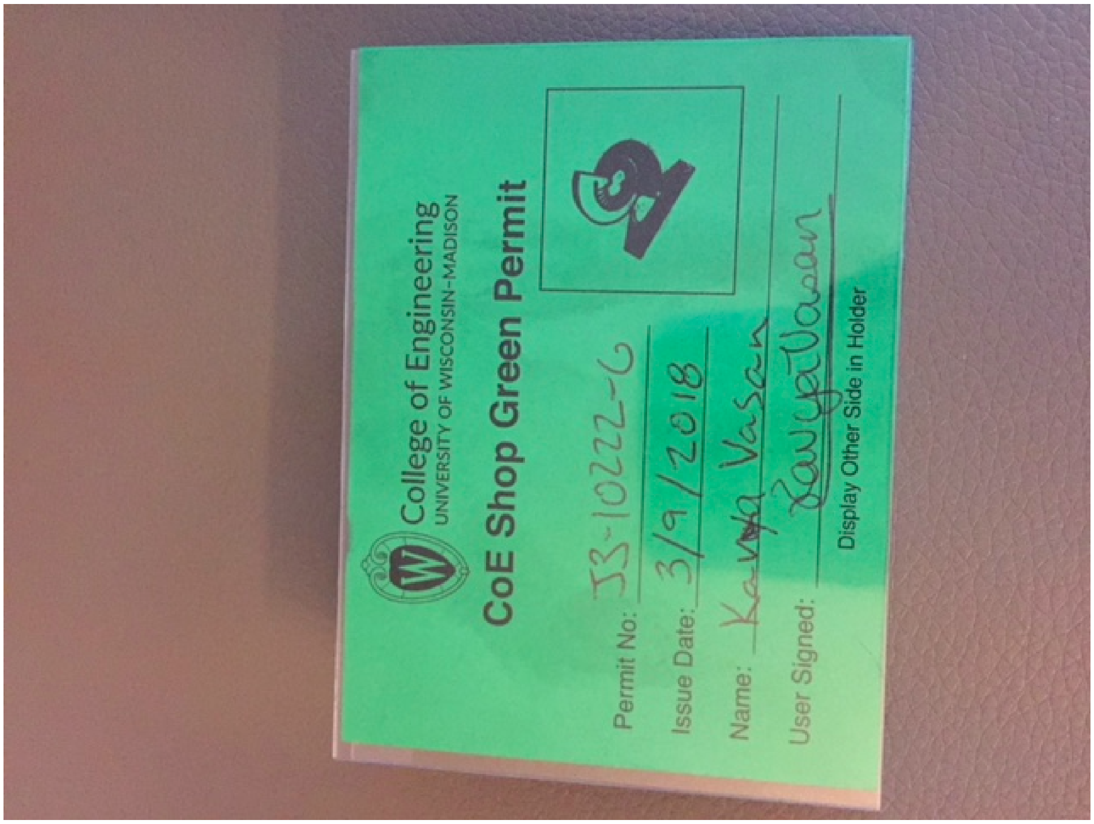
Date: March 2018

Content by: Kavya Vasan

Present: Kavya Vasan

Goals: To have access to the lathe and mill.

Content:



Conclusions/action items: I have shop access and can use the mill and the lathe. This will be a good tool for fabrication of some of our device components.

2014/11/03-Entry guidelines

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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

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· John Puccinelli · Nov 03, 2014 @03:20 PM CST

Title:

Date:

Content by:

Present:

Goals:

Content:

Conclusions/action items: