

BME Design-Spring 2022 - HENRY PLAMONDON

Complete Notebook

PDF Version generated by

HAOCHEN WANG

on

May 08, 2022 @08:16 PM CDT

Table of Contents

Project Information	2
Team contact Information	2
Project description	3
Team activities	4
Client Meetings	4
2022/02/04 - First Client Meeting	4
2022/03/04 - Second Client Meeting	5
2022/03/25	6
2022/04/15 - Fourth Client Meeting	7
2022/04/29 - Fifth Client Meeting	8
Advisor Meetings	9
2022/02/04 - First Advisor Meeting	9
2022/02/11 - Second Advisor Meeting	10
2022/02/18 - Third Advisor Meeting	11
2022/03/04 - Fourth Advisor Meeting	12
2022/04/08 - Fifth Advisor Meeting	13
Design Process	14
2022/03/01 Deciding Material for Housing	14
2022/03/25 Show and Tell	15
Materials and Expenses	16
4/28/2022 Materials Spreadsheet	16
Testing and Results	17
Protocols	17
2022/04/08-Protocols for testing on depth perception	17
Experimentation	19
2022/04/08-Test with Prototype 1.2	19
2022/04/21-Testing with prototype 3.1 to determine the angle of mirrors	21
2022/04/29-Test with clients	25
Project Files	28
2022/02/11 Product Design Specifications	28
Henry Plamondon	33
Research Notes	33
Optics/Software	33
2022/03/21 OpticStudio	33
Haochen Wang	34
Research Notes	34
Materials	34
2022/02/23 - Research on Grey Pro Resin	34
2022/02/23 - Research on Tough 1500	36
2022/02/23 - Research on Acrylic	38
Design Ideas	40
2022/02/18 - New Calculation on Parameters	40
2022/03/10 - New Design Parameters and 3D Model	46
Training Documentation	61
2021/03/14-BioSafety Training Record	61
2022/02/20 - OpticStudio Training Progress	62

2022/03/16 - WARF Presentation	64
2021/03/28-Chemistry Safety Training Record	66
Nicholas Jacobson	67
Research Notes	67
3D Printing	67
2022/02/20 - SLA Printing Process	67
2022/02/20 - 3D Priting Research	69
Design Ideas	71
2022/02/25 - OpticStudio Simulation Progress	71
2022/03/25 - Improving upon the 3D Printed Housing	72
2022/03/28 - Revised Dimensions CAD Drawing	73
2022/04/08 - Laser Cut Mirrors and Revised 3D Print	74
Training Documentation	75
Red Permit	75
Biosafety and Chemical Safety Certification	76
Emma Kupitz	77
Research Notes	77
2/23/2022 Grey Pro Resin Research	77
2/23/2022 Tough 1500 Resin Research	79
2/24/2022 Laser Cut Acrylic	81
2/23/2022 Zemax optic simulations/Lens magnification	82
4/10/2022 Splitting Image	83
Training Documentation	84
WARF Lecture- 03/20/2022	84
2014/11/03-Entry guidelines	85
2014/11/03-Template	86



Team contact Information

HENRY PLAMONDON - Mar 01, 2022, 12:03 PM CST

Last Name	First Name	Role	E-mail	Phone	Office Room/Building
Hai	Aviad	Advisor	ahai@wisc.edu		2112/ECB
Ashtiani	Alireza	Advisor	ousatiashtia@wisc.edu		
Shaffrey	Ellen	Client	shaffrey@wisc.edu		WIMR
Samuel	Poore	Client	poore@surgery.wisc.edu		WIMR
Plamondon	Henry	Leader	plamondon@wisc.edu		
Jacobson	Nicholas	Communicator	nejacobson@wisc.edu		
Wang	Haochen	BSAC	haochen.wang@wisc.edu		
Kupitz	Emma	BPAG	kupitz@wisc.edu		
Albiter	Frida	BWIG	albiter@wisc.edu		



Project description

HENRY PLAMONDON - Mar 01, 2022, 12:06 PM CST

Course Number: BME301

Project Name: iPhone Virtual Reality Training Model for Microsurgical Practice

Short Name: iPhone VR for Microsurgery

Project description/problem statement:

The team has been tasked with making it easier for microsurgery students to practice by designing a training tool that uses a smartphone lens, is capable of creating depth perception, and has a high quality resolution comparable to a surgical microscope.

About the client:

Dr. Ellen Shaffrey and Dr. Ellen Poore are plastic surgeons at the Wisconsin Institute for Research and are both very passionate about the project of designing an alternative for microsurgical practice. They have worked with multiple teams to design this project and are currently supporting the fourth semester of the project.



2022/02/04 - First Client Meeting

HENRY PLAMONDON - Feb 09, 2022, 9:58 PM CST

Title: First Meeting with Client

Date: 02/04/2022

Content by: Henry Plamondon

Present: Whole group

Goals: Review progress from last semester and set goals for the coming semester

Content:

We talked with the client about the main progress that we made last semester and introduced our new team members, Emma and Frida, to Dr. Shaffrey and Dr. Zeng. We decided that the depth perception requirement was met, however, the blind spots could be significantly reduced for better visual quality. It was also mentioned that a sturdier housing for the prototype could be fabricated in the Team Lab in Wendt Commons using a 3D printer. Another point of improvement is surpassing the automatic focus of the iPhone camera in order to eliminate the automatic focusing on items in the field of view that aren't as important, such as the tweezers rather than the sutures. Finally, we decided that we hope to finish making these improvements by around mid-semester in order to spend the remaining six to eight weeks working on testing and finalizing improvements if any problems arise in the first half of the semester.

Conclusions/action items:

Begin reaching out to Team Lab in order to create a sturdy housing for the prototype. Have some team members work on eliminating the blind spots in the field of view. Remaining team members can do research into how to eliminate the automatic focus of the iPhone camera.



2022/03/04 - Second Client Meeting

HAOCHEN WANG - May 03, 2022, 7:33 PM CDT

Title: Second Meeting with Client

Date: 03/04/2022

Content by: Haochen Wang

Present: Henry, Nicholas, Haochen, Emma

Goals: Review progress from last semester and set goals for the coming semester

Content:

1. Contact Makerspace to see if we need to create an account for Dr., Pooree's lab
2. Move forward to make a prototype
3. Discussed current progress and difficulties
 - a. Choice of material
 - b. Simulation (may need eventually reuse the parameters from last semester)

Conclusions/action items:

Continue work on making new designs

**2022/03/25**

HENRY PLAMONDON - Mar 29, 2022, 12:54 PM CDT

Title: Met with Weifeng to update on progress**Date:** 3/25/2022**Content by:** Henry Plamondon**Present:** Henry Plamondon, Haochen Wang, Emma Kupitz, Nicholas Jacobson**Goals:** Update the clients on our progress**Content:**

The team updated the clients with our progress of 3D printing the housing and our difficulties with the mirror angles in the first 3D-printed housing. We picked a date for testing at WIMR once we have a second prototype with more precise mirror angles and the mirrors have been laser cut.

Conclusions/action items:

We are going to edit the CAD model to ensure the mirrors are angled correctly and we are planning to laser cut the mirrors for higher precision. We will then go to WIMR to test the new prototype using the methods we determined last semester for testing the prototype. From there, we will assess whether or not future revisions will be necessary.



2022/04/15 - Fourth Client Meeting

HAOCHEN WANG - May 03, 2022, 7:38 PM CDT

Title: Fourth Meeting with Client

Date: 04/15/2022

Content by: Haochen Wang

Present: Henry, Nicholas, Haochen, Emma

Goals: Review progress for the week

Content:

- Introduced new design with single pair of mirror
- Decided to test out the final prototype during in-person meeting next Friday

Conclusions/action items:

Continue work on improving designs



2022/04/29 - Fifth Client Meeting

HAOCHEN WANG - May 03, 2022, 7:40 PM CDT

Title: Fifth Meeting with Client

Date: 04/29/2022

Content by: Haochen Wang

Present: Nicholas, Haochen, Frida, Dr. Zeng

Goals: Test the final prototype

Content:

1. Used the dial prototype
2. The depth perception is not accurate (seems 2D)
3. Did test with two tweezers and two pieces of paper, where Weifeng tried to catch the piece of paper while holding the piece above the ground
4. Working distance – 8.5 cm
5. The Google Cardboard is proved to combine the image
6. Decide to have the phone tilted and form the angle different for the pupil distance

Conclusions/action items:

Decide to test the prototype via zoom meeting

Future work:

- a. Find an angle to tilt the smartphone and the mirrors
- b. Think of using filter on the mirrors



2022/02/04 - First Advisor Meeting

HAOCHEN WANG - Mar 02, 2022, 10:43 AM CST

Title: First Meeting with the Advisors

Date: 02/04/2022

Content by: Haochen Wang

Present: Whole group

Goals: Review progress from last semester and set goals for the coming semester

Content:

1. Went through the progress made in previous semester
2. Zemax optic simulation; Optic Studio (shoot emails for optical simulations)
3. For the next week:
 - a. Continue tweaking with the current model
 - b. Incorporate the software
4. The idea is workable
5. 12:15 next Friday

Conclusions/action items:

Continue research on ways to improve our current design



2022/02/11 - Second Advisor Meeting

HAOCHEN WANG - Mar 02, 2022, 10:45 AM CST

Title: Second Meeting with the Advisors

Date: 02/11/2022

Content by: Haochen Wang

Present: Whole group

Goals: Review progress made for the week

Content:

1. Advisor meeting
 1. https://www.opticalsoftware.net/index.php/how_to/lens_design_software/winlens3dbasic (alternative software that we could use)
 2. Zemax educational license
 3. Submit the form today to get the educational license
 4. Check the CAE website
 5. Get the simulation done in the upcoming week
2. 12:15 next Friday

Conclusions/action items:

Start learning to use OpticStudio



2022/02/18 - Third Advisor Meeting

HAOCHEN WANG - Mar 02, 2022, 10:47 AM CST

Title: Third Meeting with the Advisors

Date: 02/18/2022

Content by: Haochen Wang

Present: Henry, Haochen

Goals: Review progress made for the week and establish expectations for the preliminary presentation

Content:

1. Went through the optic basis
 - a. <https://micro.magnet.fsu.edu/optics/lightandcolor/reflection.html>
2. Talked about the preliminary presentation
3. Try to send the slides
4. Give presentation before friday (10 min) before Tuesday
5. Try a pilot test (plan on Thursday)
6. Add light path to the preliminary
7. Google "Light path" VR carton box
 - a. <https://micro.magnet.fsu.edu/optics/lightandcolor/reflection.html>

Conclusions/action items:

Start working on preliminary deliverables



2022/03/04 - Fourth Advisor Meeting

HAOCHEN WANG - May 03, 2022, 7:27 PM CDT

Title: Fourth Meeting with the Advisors

Date: 03/04/2022

Content by: Haochen Wang

Present: Henry, Nicholas, Haochen, Emma

Goals: Review progress made for the week

Content:

- Put one image for everyone on the website
- Update the website
- Simulate directly with OpticStudio
- Google Cardboard is not expensive because there is not many components
- Get simulation for the situation
- Send advisor a simulation for feedback and troubleshooting
- Software should not be a difficulty since it's a tool
- Build the simulation as best as we can during the week
- Can add a lens to parallel the light

Conclusions/action items:

Work according to the meeting notes



2022/04/08 - Fifth Advisor Meeting

HAOCHEN WANG - May 03, 2022, 7:36 PM CDT

Title: Fifth Meeting with the Advisors

Date: 04/08/2022

Content by: Haochen Wang

Present: Henry, Nicholas, Haochen, Emma

Goals: Review progress made for the week

Content:

- When through requirements of the executive summary
- Went through plans for the semester
- Whether to focus on software approach - no, this semester will be focus on testing feasibility of the concept
- Hardware approach - main focus of this semester
- https://www.opticalsoftware.net/index.php/how_to/lens_design_software/winlens3dbasic
- Search YouTube for 2D modeling with OpticStudio
- Update the website

Conclusions/action items:

Work according to the meeting notes



2022/03/01 Deciding Material for Housing

HENRY PLAMONDON - Mar 01, 2022, 11:53 AM CST

Title: Deciding Material for Housing

Date: 3/1/2022

Content by: Henry Plamondon

Present: N/A

Goals: Determine which materials to use for creating the housing of the prototype

Content:

As a team, we collectively decided we want to 3D print the housing for the final prototype. Emma reached out to the MakerSpace to determine which material would be best for the purposes of our project. She brought the feedback to the team regarding which materials they suggested and Haochen created a design matrix with the different materials shown below.

Criteria	Weight	Grey Pro Resin (Foamlab)		Tough 1500 Resin (Foamlab)		Acrylic (Laser Cut)	
		Raw Score	Score	Raw Score	Score	Raw Score	Score
Quality (Precision)	30	4/5	24	4/5	24	1/5	6
Durability (Strength)	25	5/5	25	3/5	15	5/5	25
Ease of Fabrication	20	3/5	12	3/5	12	5/5	20
Cost	15	4/5	12	4/5	12	2/5	6
Stability	5	5/5	5	5/5	5	1/5	1
Safety	5	4/5	4	4/5	4	5/5	5
Total	100	25/30	82	23/30	72	19/30	63

Figure 1: Design matrix of our materials by Haochen Wang.

Haochen completed most of the design matrix and we all agreed that the Grey Pro Resin was the best material to move forward with. We will move forward with this material and begin determining the correct angles for the mirrors to design the housing and print it before testing.

Conclusions/action items:

Finish determining the angles of the mirrors and design the blueprint of the housing in order to print and begin fabricating the final prototype. Determine a time to work with the MakerSpace to print our housing.



2022/03/25 Show and Tell

HENRY PLAMONDON - Mar 29, 2022, 1:02 PM CDT

Title: Show and Tell

Date: 03/25/2022

Content by: Henry Plamondon

Present: Henry Plamondon, Haochen Wang, Nicholas Jacobson, Emma Kupitz, Frida Albiter

Goals: Obtain insight from other BME design groups into how to improve our first 3D-printed prototype

Content:

We asked groups for feedback regarding the mirror angles and possible ways to test in the future. We gained some very helpful feedback from many of the different groups.

Mirror Angles:

Groups gave ideas regarding a knob to rotate the mirrors through the housing once fabricated for testing purposes. This could be helpful when determining the mirror angles as the mirrors would not be static once placed in the housing. We would be able to continue tweaking the angles once placed in the housing and could gain a better idea as to how the mirrors should be placed in the housing.

Ergonomics:

We had groups talk about different types of foam that are used in current virtual reality headsets to make the cardboard headset more comfortable for prolonged use. This would make using the prototype more comfortable for students who plan to practice for multiple hours at a time. Other groups mentioned possibly using a monitor, rather than a headset, an idea that we had considered before, but definitely still a future possibility.

Attaching the prototype to the phone:

The main feedback we received regarding attaching the prototype to the phone was using Velcro and also possibly using some sort of plastic grip to hold it onto the front of the camera. These were the two most viable ideas we received from other teams in this respect.

Conclusions/action items:

Take into account the feedback we received from other groups and continue modifying the CAD drawing and prototype design. Consider how to better test the mirror angles and continue to consider the possibility of displaying the image on a monitor rather than in a headset. Continue to consider attachment ideas for the lens.



4/28/2022 Materials Spreadsheet

EMMA KUPITZ - May 03, 2022, 10:20 PM CDT



[Download](#)

Materials_Spreadsheet_-_Sheet1.pdf (55.4 kB)



2022/04/08-Protocols for testing on depth perception

HAOCHEN WANG - May 02, 2022, 12:45 PM CDT

Title: Protocols for testing on depth perception

Date: 2022/04/08

Content by: Haochen Wang

Present: N/A

Goals: To qualitatively test the depth perception from the prototypes

Content:

(Adapted from protocols composed in FA21 by Haochen)

1. Purpose

1. To assess the image quality and depth perception from the final design

2. Material and equipment

1. Provided by the client

- Surgical cloth
- Sutures (5 pieces)
- Tweezers (2 pairs)
- Google Cardboard
- Phone stand
- Memory foams

2. Prototype

3. Tapes/adhesives

4. Retractable knife

5. Smartphone

6. Sharpie

7. Software

- Zoom

3. Procedure

1. Mount the smartphone onto the phone stand

1. The lens should point down toward the station
2. The phone should be placed at approximately 200 mm away from the desk

2. Align the attachment with the smartphone camera lens

1. Then secure the attachment onto the smartphone with adhesives

3. Adjust the magnification such that the inner mirrors fill up the screen

1. Take sample image of an object to ensure that two identical views are formed on the inner mirrors

4. Draw two squares on the surgical cloth

5. Put 5 sutures in one of the squares

6. Use Zoom to project the view from the recording smartphone onto another receiving smartphone

7. Insert the receiving smartphone into Google Cardboard

8. Have each team member and the client wear Google Cardboard, using tweezers to move sutures from one square to another.

1. Record the time used to complete the test
2. Repeat the test with smartphone only

3. Compare the results with data obtained from the first client meeting

Conclusions/action items:

Perform the testing on all prototypes



2022/04/08-Test with Prototype 1.2

HAOCHEN WANG - May 02, 2022, 12:48 PM CDT

Title: Protocols for testing on depth perception from Prototype 1.2

Date: 2022/04/08

Content by: Haochen Wang

Present: Henry, Nicholas, Haochen, Emma, Dr. Shaffrey, Dr. Poore, Dr. Zeng

Goals: To qualitatively test the depth perception from the prototypes according to the protocols

Content:

<p>1. Purpose</p> <p>To assess the image quality and depth perception from the final design</p> <p>1. Material and equipment</p> <ol style="list-style-type: none"> 1. Provided by the client <ul style="list-style-type: none"> ▪ Surgical cloth ▪ Sutures (5 pieces) ▪ Tweezers (2 pairs) ▪ Google Cardboard ▪ Phone stand ▪ Memory foams 2. Prototype 3. Tapes/adhesives 4. Retractable knife 5. Smartphone 6. Sharpie 7. Software <ul style="list-style-type: none"> ▪ Zoom <p>2. Procedure</p> <ol style="list-style-type: none"> 1. Mount the smartphone onto the phone stand <ul style="list-style-type: none"> • The lens should point down toward the station • The phone should be place at approximately 200 mm away from the desk <ol style="list-style-type: none"> 1. Align the attachment with the smartphone camera lens • Then secure the attachment onto the smartphone with adhesives <ol style="list-style-type: none"> 1. Adjust the magnification such that the inner mirrors fill up the screen <ul style="list-style-type: none"> ▪ Take sample image of an object to 	<p>Day 1: 04/08/2022</p> <p>Observations:</p> <p>The images were blurred to one</p> <p>Cannot distinguish the left half view from the right. The views appear to combine into one, and the image quality is poor.</p> <p>The result may be due to poor mirror quality; light reflected by the inner mirrors may be undistinguishable on the camera sensor; there may be error in ray tracing diagram.</p>
---	---

ensure that two identical views are formed on the inner mirrors

2. Draw two squares on the surgical cloth
3. Put 5 sutures in one of the squares
4. Use Zoom to project the view from the recording smartphone onto another receiving smartphone
5. Insert the receiving smartphone into Google Cardboard
6. Have each team member and the client wear Google Cardboard, using tweezers to move sutures from one square to another.
 - Record the time used to complete the test
 - Repeat the test with smartphone only
 - Compare the results with data obtained from the first client meeting

Conclusions/action items:

Make new design that solves the issue



2022/04/21-Testing with prototype 3.1 to determine the angle of mirrors

HAOCHEN WANG - May 03, 2022, 7:04 PM CDT

Title: Protocols for testing on depth perception from Prototype 3.1

Date: 2022/04/21

Content by: Haochen Wang

Present: Henry, Nicholas, Haochen, Emma

Goals: To determine the angles of the mirrors for the final prototype

Content:

- According to the PDS, the design must allow the 6-0 sutures being distinguishable from the background. Therefore, a sample image of the suture was taken from a smartphone with prototype attached to its camera.
- First, two T-shaped pins are inserted through the holes on the left side of the prototype. And an inner mirror and an outer mirror are glued to the T-shaped pins. Then, the team rotate the pins slowly to approximately 30 degrees with respect to the camera lens (same as 60 degrees with respect to the central line that is perpendicular to the camera lens) and attached to the smartphone with two 3M removable strips.
- The smartphone is set to 2x magnification, and it is mounted to a smartphone stand focusing on the testing station that is 200 mm below the camera lens. The team then fine-tuned the mirror angle to achieve clear image on the reflected view. Sample images are taken from the smartphone.
- Then the captured view is streamlined to a second device via Zoom. The second smartphone is inserted into Google Cardboard. And all teammates tried to move the suture around while wearing Google Cardboard to get sense of depth perception

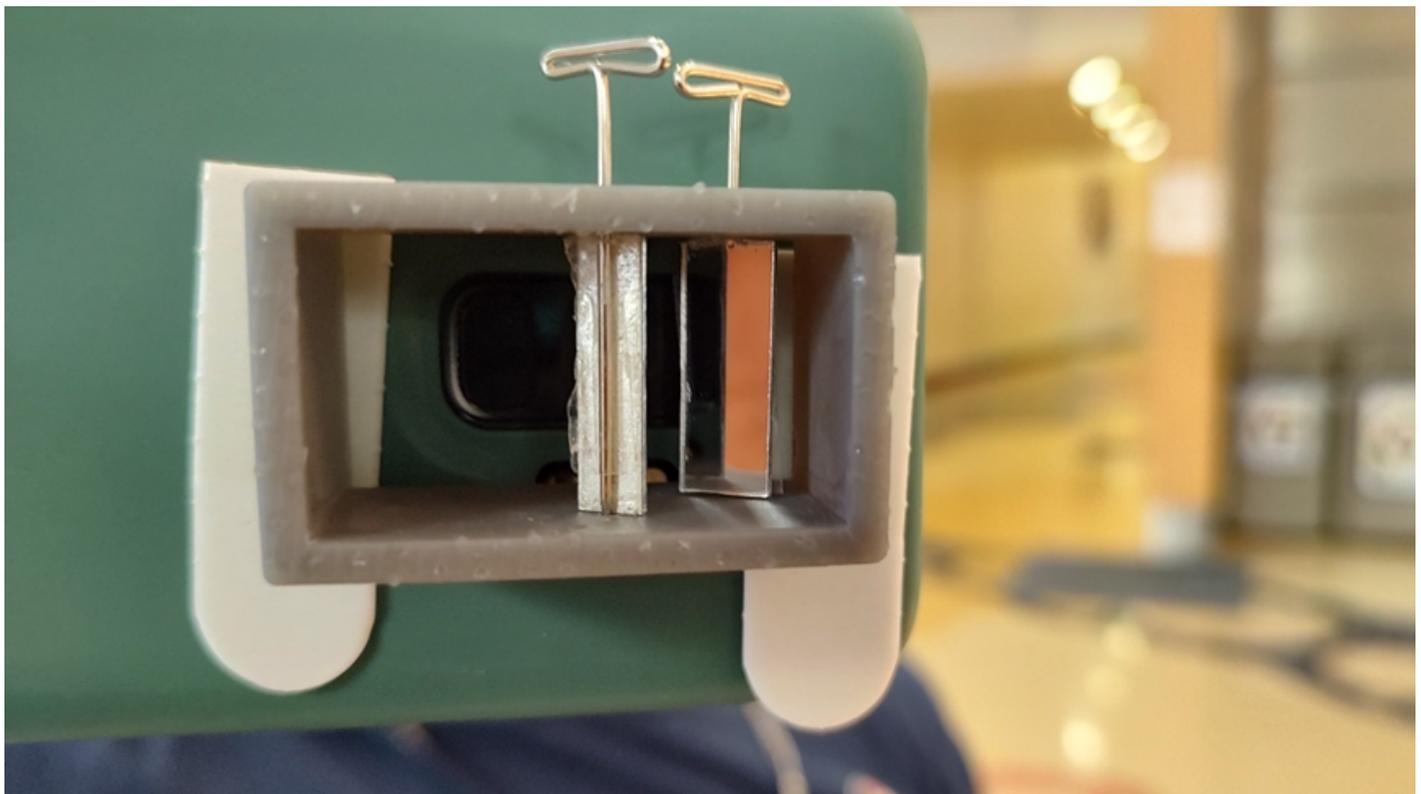


Figure 1: A smartphone with the prototype attached over the camera lens. The mirrors are glued to the T-shaped pins, which are inserted to the left half holes. With 2x magnification, the pins were first rotated to make the mirrors at 30 degrees with respect to the plane of the camera lens (same as 60 degrees with respect to the central line in Section 5.2.2). Then the prototype is fixed to the smartphone with removable 3M strips.

- Figure 1 is used to determine the angles of the mirrors via ImageJ



Figure 2: Henry is testing the prototype 3.1

Conclusions/action items:

Measure the angles and make a new CAD drawing

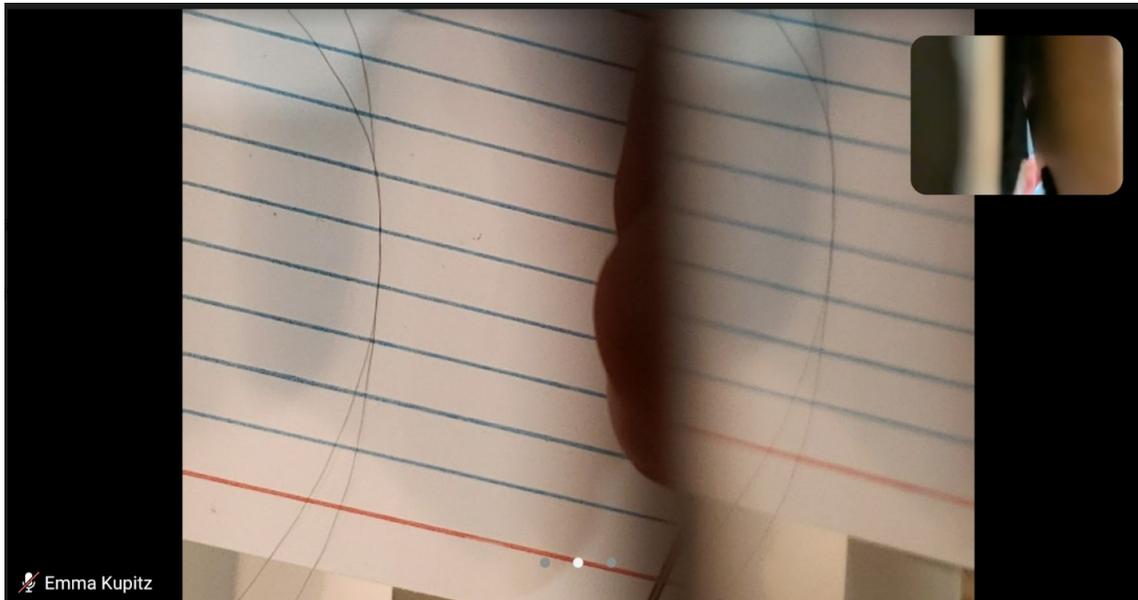
Title: Protocols for testing on depth perception from Prototype 3.1 - Results**Date:** 2022/04/21**Content by:** Haochen Wang**Present:** Henry, Nicholas, Haochen, Emma**Goals:** To demonstrate some testing photos from the testing**Content:**

Figure 1: Screenshot of zoom meeting during test, showing two sutures on a notecard. The left view is direct capture on the station, and the right is reflected view.

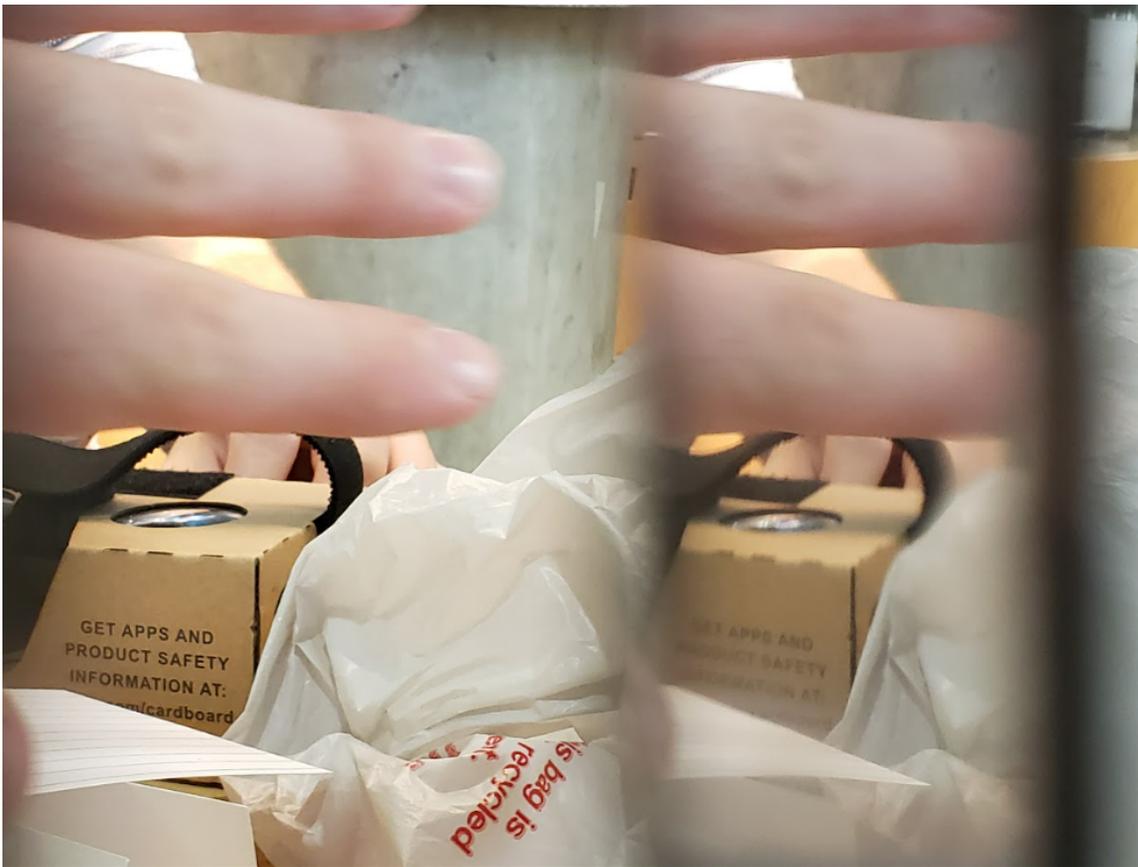


Figure 2: Photo taken to demonstrate the image quality. Though the reflected view is blurry compared to the direct captured on the left, the words on the box is still identifiable.



2022/04/29-Test with clients

HAOCHEN WANG - May 03, 2022, 7:24 PM CDT

Title: Protocols for testing on depth perception from Prototype 3.1/4.1

Date: 2022/04/29

Content by: Haochen Wang

Present: Nicholas, Haochen, Frida, Dr. Zeng

Goals: To test the feasibility of the prototype with the client

Content:

- Used the same protocol as in 04/08

<p>1. Purpose</p> <p>To assess the image quality and depth perception from the final design</p> <p>1. Material and equipment</p> <ol style="list-style-type: none"> 1. Provided by the client <ul style="list-style-type: none"> ▪ Surgical cloth ▪ Sutures (5 pieces) ▪ Tweezers (2 pairs) ▪ Google Cardboard ▪ Phone stand ▪ Memory foams 2. Prototype 3. Tapes/adhesives 4. Retractable knife 5. Smartphone 6. Sharpie 7. Software <ul style="list-style-type: none"> ▪ Zoom <p>2. Procedure</p> <ol style="list-style-type: none"> 1. Mount the smartphone onto the phone stand <ul style="list-style-type: none"> • The lens should point down toward the station • The phone should be place at approximately 200 mm away from the desk 	<p>Day 1: 04/08/2022</p> <p>Observations:</p> <p>The images were blurred to one</p> <p>Cannot distinguish the left half view from the right. The views appear to combine into one, and the image quality is poor.</p> <p>The result may be due to poor mirror quality; light reflected by the inner mirrors may be undistinguishable on the camera sensor; there may be error in ray tracing diagram.</p> <p>Day 2: 04/29/2022</p> <p>Observations:</p> <p>First tested the prototype with two pieces of paper. Dr. Zeng felt some depth perception, but not being able to promptly catch the paper in the air with a pair of tweezers.</p>
--	---

1. Align the attachment with the smartphone camera lens
- Then secure the attachment onto the smartphone with adhesives
 1. Adjust the magnification such that the inner mirrors fill up the screen
 - Take sample image of an object to ensure that two identical views are formed on the inner mirrors
 2. Draw two squares on the surgical cloth
 3. Put 5 sutures in one of the squares
 4. Use Zoom to project the view from the recording smartphone onto another receiving smartphone
 5. Insert the receiving smartphone into Google Cardboard
 6. Have each team member and the client wear Google Cardboard, using tweezers to move sutures from one square to another.
 - Record the time used to complete the test
 - Repeat the test with smartphone only
 - Compare the results with data obtained from the first

Second test of stitching with 6-0 suture on a piece of sponge.

Both tests showed clearer image than last semester. Dr. Zeng could see the suture, but depth perception is still not optimal.

Tried to rotate the smartphone by a small angle, and adjusted the mirrors accordingly to slightly shift the reflected view to the right. Dr. Zeng felt better spatial awareness, but still having hard time making a stitch.

The time delay becomes more significant (possibly due to warming battery in the smartphone, this should be taken into consideration in the future), and the video quality is obviously compromised due to video compression on Zoom.

client meeting	
-------------------	--

Conclusions/action items:

See meeting notes for future plan



2022/02/11 Product Design Specifications

HENRY PLAMONDON - Mar 01, 2022, 11:55 AM CST

Title: Product Design Specifications (PDS)

Date: 02/11/2022

Content by: Henry Plamondon

Present: N/A

Goals:

Content:

Product Design Specification (PDS)

Title: iPhone Virtual Reality Training Model for Microsurgical Practice.

Henry Plamondon, Nicholas Jacobson, Haochen Wang, Frida Albiter, Emma Kupitz, Kenzie Germanson

February 11, 2022

Function:

This training model will make microsurgical training less expensive and more accessible to a wide range of users. It eliminates the need for an expensive surgical microscope by replacing it with a smartphone equipped with the model. The prototype will utilize the zoom functionality of the smartphone for the surgeon to clearly see sutures and tissues up close. By using a smartphone, it is also possible to stream the training to Zoom or a similar platform so training can occur virtually. The design will minimize lag time between the recording phone and projecting device for simultaneous view of both the trainee and observers, while increasing spatial awareness and depth perception via binocular live video.

Client requirements:

- Must allow for depth perception with regard to where the trainee's hands are in relation to the work site.
- Must create an image with high enough zoom and resolution to see sutures (0.070 mm in diameter) clearly [1]
- Must remain inexpensive so it is widely accessible to training surgeons
- Must produce a streaming resolution of at least 10.2 megapixels
- Must have a stream delay of no more than 0.5 seconds
- Should utilize full magnification power of the smartphone

Design requirements:**1. Physical and Operational Characteristics****a. Performance requirements:**

- i. The device must be able to provide a clear image of the subject in a clinical environment. The device must be able to handle daily use and must be able to handle a load of at least 400g, the weight of the heaviest available smartphones.

b. Safety:

- i. The device should be out of the way of the surgeon to prevent interference during practice. The device also needs to be able to be sterilized in an efficient manner before and after each use.

c. Accuracy and Reliability:

- i. The device should be able to consistently maintain a magnification of 5x and the displayed magnification should be accurate with repeated trials. The device should display an accurate and clear image of the surgery area with minimal latency.

d. Life in Service:

- i. The device should withstand continued use over the duration of the training process, the longest of which can last up to 12 hours. The device should be able to withstand this use everyday over its lifespan, as many different trainees may use the device.

e. Shelf Life:

- i. The device should be stored in normal interior conditions. After six months without use, a lithium ion battery may begin to degrade. With continued use, the team would expect the smartphone being the limiting factor for the whole design. Thus, the final product should have at least one year of lifespan, which matches the lithium battery warranty provided by Apple. [2]

f. Operating Environment:

- i. The product will most likely be used in a domestic or indoor environment, so the device will not be exposed to extreme conditions.
- ii. 0-35 ° C operating temperature, - 20-45 ° C nonoperating temperature, 5-95% non-condensing, relative humidity (the specification of iPhone 8, and more restriction may be applied as other hardware is introduced to the final product) [3]
- iii. The person who will use this will be the trainee, which is the person who is practicing surgery using the iphone, and the trainer(s) who is/are watching the trainee on the headset.
- iv. Potential splash of food dye, blood, in vitro tissues, etc. [4]
- v. Components that are exposed to the operation station shall not be malfunctioned upon such splash
- vi. Potential scratches from the surgical equipment, such as tweezers or needles.
- vii. The final product should at least endure accidental damage from the aforementioned scenarios, while maintaining the resolution to recognize the suture

g. Ergonomics:

- i. The product can involve somewhat delicate technology, such as smart phones and laptops, so the same restrictions of force that cause those devices not to be damaged or break apply here.

- ii. For the iPhone 8, do not submerge in water greater than 1 meter and for longer than 30 minutes. [3]
- iii. The device should be comfortable to use for over 1 hour
- iv. Should not cause any unnecessary strain to the surgeon

h. Size:

- i. Should be able to be set up in an indoor living space (i.e. 10 x 10 sqft, approximately 3 x 3 meters)

i. Weight:

- i. Optimum weight: < 10lbs (approximately 4.5 kg). Must be easily transportable

j. Materials:

- i. No restrictions on material mechanics
- ii. Cannot be toxic upon skin contact or inhalation
- iii. Shall have minimal degradation resistance, such as from sunlight

k. Aesthetics, Appearance, and Finish:

- i. The color of the product should be dull so that it doesn't distract from the microsurgical practice it is intended for. The shape and form should be adjustable so that each user/consumer can place it into alternate positions to get a better and more comfortable practice for themselves. The texture of the finish should be flat and soft in order for it to be comfortable for the user and in order for it to not be a distraction.
- ii. Should simulate the working condition of an operation room with microscopes
- iii. Must not interfere with the operation and training performance of the user

2. Production Characteristics

a. Quantity:

- i. One final prototype as deliverable
- ii. Tens of thousands of units for mass production after approval, replacing all current expensive training mechanisms for microsurgical practice for medical residents.

b. Target Product Cost:

- i. The target cost of the product is undetermined, but shall be less than our clients budget of \$500
- ii. Cost for an iPhone, a stand, and any attachment that is necessary to put over the camera to replicate microsurgery practice are not considered as part of the budget for this project. Since the existing products cost at least \$100,000 [5] which is drastically greater than the target cost. The prototype, even considering the cost for the equipment listed above, will be a cheap alternative for medical students to use for remote training, using materials that are commonly owned.

3. Miscellaneous

c. Standards and Specifications:

- i. ISO 10936-1:2017
 - Specifies the requirements for microscopes used during surgical procedures, so the team must adhere to these specifications when creating a design. However, since this prototype will be used for practice purposes, the requirements may not all apply [6]
- ii. Code of Federal Regulations Title 21, Volume 8, Sec. 882.4525 Microsurgical instrument [7]
 - The final deliverable will fall into the Class I medical device category, which is exempt from the premarket notification procedures 510(k)
- iii. Code of Federal Regulations Title 21, Volume 8, Sec. 878.4700 Surgical microscope and accessories [8]
 - The final deliverable, under definition of this section, will be a Class I device. However, since the recording device in this design will be a DC powered smartphone, no more actions shall be made upon this regulation

d. Customer:

- i. The customer would prefer the delay of relaying the image to the headset to be minimized for enhance practicing technique (less than 0.5 s)
- ii. The quality of the camera while zooming should be clear enough to clearly see the material being worked upon. 2x zoom using an iPhone 11 Pro was tested to be the most practical. The requirement is that the trainee is able to see the suture, which is 0.070 mm [1]
- iii. The camera should be able to show the depth of the workspace in order to help determine the distance between the instruments being utilized and the suture on the workbench. This may require the use of two lenses to allow for a binocular view
- iv. The device should be comfortable to wear for extended periods of time

e. Patient-related concerns:

- i. As this is a device used for practice, there will be no requirements for patient confidentiality.
- ii. Sterilization should not be an issue with regard to the camera setup. However, it may be practical to clean the headset with a wipe between uses.

f. Competing designs:

i. Augmented Reality (Mixed Reality)

The Microsoft HoloLens is a very complex device which allows for similar types of practice. However, the HoloLens is much less accessible and much more expensive. This will be an alternative that is possible to use from many different remote locations. Meanwhile, mixed reality provided by HoloLens is rather redundant for the purpose of the clients. [9]

ii. Exoscopic Platforms

Zeiss, Olympus and Mitaka are well known medical device providers for exoscopes, featuring high definition images of the field with 8x to 30x magnifying capability. However, the price varies from 0.2 to 1.5 million dollars, resulting in limited access for trainees from less developed regions [5].

- [1] B. M. A. A; “The surgical suture,” *Aesthetic surgery journal*, Apr-2019. [Online]. Available: <https://pubmed.ncbi.nlm.nih.gov/30869751/>. [Accessed: 24-Sep-2021].
- [2] Apple, “iPhone battery and performance,” *Apple Support*, 24-Sep-2021. [Online]. Available: <https://support.apple.com/en-us/HT208387>. [Accessed: 24-Sep-2021].
- [3] Apple, “iPhone 8 - Technical Specifications,” Official Apple Support, 25-Mar-2021. [Online]. Available: https://support.apple.com/kb/sp767?locale=en_US. [Accessed: 24-Sep-2021].
- [4] “Dr. Sam POORE and team featured ON BTN LiveBIG Wisconsin,” Department of Surgery, 13-Jul-2020. [Online]. Available: <https://www.surgery.wisc.edu/2020/07/13/dr-sam-poore-and-team-featured-on-btn-livebig-wisconsin/>. [Accessed: 24-Sep-2021].
- [5] D. J. Langer, T. G. White, M. Schulder, J. A. Boockvar, M. Labib, and M. T. Lawton, “Advances in INTRAOPERATIVE Optics: A brief review of Current Exoscope platforms,” *Operative Neurosurgery*, vol. 19, no. 1, pp. 84–93, 2019.
- [6] “ISO 10936-1:2017,” ISO, 26-Jul-2017. [Online]. Available: <https://www.iso.org/standard/69819.html>. [Accessed: 24-Sep-2021].
- [7] CFR - Code of Federal Regulations Title 21 Sec. 882.4525, vol. 8. 2020.
- [8] CFR - Code of Federal Regulations Title 21 Sec. 878.4700, vol. 8. 2020.
- [9] “Microsoft mixed reality – Healthcare,” Microsoft Mixed Reality – Healthcare. [Online]. Available: <https://www.microsoft.com/en-us/hololens/industry-healthcare>. [Accessed: 24-Sep-2021].

Conclusions/action items:

Continue determining which materials to use and begin working on the preliminary presentation. Work with MakerSpace to find a time to print our housing for the prototype.



2022/03/21 OpticStudio

Title: Research on OpticStudio

Date: 03/21/2022

Content by: Myself

Present: Myself

Goals: Learn about the Zemax OpticStudio software

Content:

I looked into the OpticStudio software and what its capabilities are. It looks like we can choose the mirrors we have and align them at different angles to po

[https://www.zemax.com/pages/opticstudio?](https://www.zemax.com/pages/opticstudio?gclid=CjwKCAjwgr6TBhAGEiwA3aVulRoXmaoi3tjV_aTR85Mp_sne07UfQcJT1nXh2g4l4fkHzLhBxJONBoC28cQAvD_BwE&utm_campaign=G%3AS%3AE)

[gclid=CjwKCAjwgr6TBhAGEiwA3aVulRoXmaoi3tjV_aTR85Mp_sne07UfQcJT1nXh2g4l4fkHzLhBxJONBoC28cQAvD_BwE&utm_campaign=G%3AS%3AE](https://www.zemax.com/pages/opticstudio?gclid=CjwKCAjwgr6TBhAGEiwA3aVulRoXmaoi3tjV_aTR85Mp_sne07UfQcJT1nXh2g4l4fkHzLhBxJONBoC28cQAvD_BwE&utm_campaign=G%3AS%3AE)

Conclusions/action items:

Use Zemax to determine the angle at which the place our mirrors. We may not need a full understanding of optics to be able to use this software if we can



2022/02/23 - Research on Grey Pro Resin

HAOCHEN WANG - Mar 01, 2022, 10:34 PM CST

Title: Research on properties and fabrication process of Grey Pro Resin

Date: 02/23/2022

Content by: Haochen Wang

Present: N/A

Goals: To develop basis on assigning scores for the design matrix

Content:

1. *formlabs, "Using Grey Pro Resin," Customer_v2, 09-Jul-2021. [Online]. Available:*

https://support.formlabs.com/s/article/Using-Grey-Pro-Resin?language=en_US. [Accessed: 23-Feb-2022].

- This is the official website from formlabs. The website includes information for properties and resolution in 3D printing.
- Grey Pro resin can be printed at 50 microns and 100 microns (will choose 50 microns for better precision)
- Grey Pro resin can be used for rapid prototyping
- The Young's Modulus of Grey Pro is 2.2 GPa
- The ultimate tensile stress is 61.0 MPa

2. *formlabs, "Formlabs 3D printing cost calculator," Formlabs, 23-Feb-2022. [Online]. Available:*

<https://formlabs.com/roi/>

[industry=engineering&printer=form3%2B&part=arduinocase&quantity=1&time=day&cost=20&cy=USD&e=#/roi/](https://formlabs.com/roi/?industry=engineering&printer=form3%2B&part=arduinocase&quantity=1&time=day&cost=20&cy=USD&e=#/roi/)

[Accessed: 23-Feb-2022].

- This is the official website from formlabs to calculate estimated labor cost (ignored in this project) and time needed for specified benchmark test
- The estimated time of production for an Arduino UNO case (79 x 66 x 19 mm, similar to our target size of 50 x 50 x 25 mm) is 2 hours and 23 minutes, using printer Form 3+
 - Note that this value also applies to Tough 1500

3. *UW Makerspace, "Welcome to the Minimart," UW Makerspace, 2022. [Online]. Available:*

<https://making.engr.wisc.edu/mini-mart/#laser-cutter>. [Accessed: 23-Feb-2022].

- This is the official website from Markerspace for the cost of the materials
- The cost of the Grey Pro is \$0.26 / mL , which is approximately \$ 8.15 per prototype with 1/8 inch thickness (same thickness as the acrylic board)

4. *formlabs, "Safety Data Sheet - Formlabs," Grey Pro Photoreactive Resin for Form 2, 12-Dec-2017. [Online].*

Available: https://formlabs-media.formlabs.com/datasheets/Safety_Data_Sheet_EN_-_Grey_Pro.pdf. [Accessed: 23-Feb-2022].

- This is the safety data sheet for Grey pro
- Hazard statement includes:
 - H315 Causes skin irritation

- H319 Causes serious eye irritation
- H317 May cause an allergic skin reaction
- H335 May cause respiratory irritation
- H412 Harmful to aquatic life with long lasting effects
- Note that UV light should also be taken into consideration, the material properties listed above is after UV cure

Conclusions/action items:

Complete the design matrix based on the research


Title: Research on properties and fabrication process of Tough 1500
Date: 02/23/2022

Content by: Haochen Wang

Present: N/A

Goals: To develop basis on assigning scores for the design matrix

Content:

1. *formlabs, "Using Tough 1500 Resin," Customer_v2, 14-Jul-2021. [Online]. Available:*

https://support.formlabs.com/s/article/Using-Tough-1500-Resin?language=en_US. [Accessed: 23-Feb-2022].

- This is the official website from formlabs. The website includes information for properties and resolution in 3D printing.
- Tough 1500 resin can be printed at 50 microns and 100 microns (will choose 50 microns for better precision)
- Tough 1500 can be used for rapid prototyping
- The Young's Modulus of Grey Pro is 1.5 GPa
- The ultimate tensile stress is 33 MPa

2. *formlabs, "Formlabs 3D printing cost calculator," Formlabs, 23-Feb-2022. [Online]. Available:*

[https://formlabs.com/roi/?](https://formlabs.com/roi/)

[industry=engineering&printer=form3%2B&part=arduinocase&quantity=1&time=day&cost=20&cy=USD&e=#/roi/](https://formlabs.com/roi/?industry=engineering&printer=form3%2B&part=arduinocase&quantity=1&time=day&cost=20&cy=USD&e=#/roi/).

[Accessed: 23-Feb-2022].

- This is the official website from formlabs to calculate estimated labor cost (ignored in this project) and time needed for specified benchmark test
- The estimated time of production for an Arduino UNO case (79 x 66 x 19 mm, similar to our target size of 50 x 50 x 25 mm) is 2 hours and 23 minutes, using printer Form 3+
 - Note that this value also applies to Grey Pro

3. *UW Makerspace, "Welcome to the Minimart," UW Makerspace, 2022. [Online]. Available:*

<https://making.engr.wisc.edu/mini-mart/#laser-cutter>. [Accessed: 23-Feb-2022].

- This is the official website from Markerspace for the cost of the materials
- The cost of the Tough 1500 is \$0.26 / mL , which is approximately \$ 8.15 per prototype with 1/8 inch thickness (same thickness as the acrylic board)

4. *formlabs, "Safety Data Sheet - Formlabs," Tough Photoreactive Resin for Form 1+, Form 2, 26-Sep-2016. [Online].*

Available: https://formlabs-media.formlabs.com/datasheets/Safety_Data_Sheet_EN_-_Tough.pdf. [Accessed: 23-Feb-2022].

- This is the safety data sheet for Tough 1500
- Hazard statement includes:

- H315 Causes skin irritation
- H319 Causes serious eye irritation
- H317 May cause an allergic skin reaction
- H335 May cause respiratory irritation
- H412 Harmful to aquatic life with long lasting effects
- Note that UV light should also be taken into consideration, the material properties listed above is post UV cure

Conclusions/action items:

Tough 1500 is not so "tough." Though Tough 2000 is a more suitable substitute for Grey Pro, this material is not currently available at Makerspace.

So the choice of material may be, though unlikely, subject to change due to availability at Makerspace.

Complete the design matrix based on the research

**Title: Research on properties and fabrication process of Acrylic****Date:** 02/23/2022**Content by:** Haochen Wang**Present:** N/A**Goals:** To develop basis on assigning scores for the design matrix**Content:**

1. *Universal Laser Systems, "ILS9.150D platform," ULS. [Online]. Available:*

<https://www.ulsinc.com/products/platforms/ils9150d>. [Accessed: 02-Mar-2022].

- The ILS9.150D also supports a single 9.3 μ m laser at 30, 50 or 75 watts (If a 9.3 μ m CO₂ laser is installed, the maximum 10.6 μ m laser is 75 watts).
- This is the resolution supported by the laser cutter

2. *Kaysons, "Physical properties - builditsolar: Solar energy projects," Physical Properties of Acrylic Sheets. [Online].*

Available: <https://www.builditsolar.com/References/Glazing/physicalpropertiesAcrylic.pdf>. [Accessed: 23-Feb-2022].

- This is the spec sheet for akrylik, a cell-cast acrylic sheet
- This is chosen to show relative property of the acrylic sheet available at Makerspace (1/8 in at Makerspace, and this is the only data sheet I found with similar thickness 0.236 mm)
- According to the spec sheet, Young's modulus is 2.8 GPa
- Tensile strength is 69 MPa

3. *UW Makerspace, "Welcome to the Minimart," UW Makerspace, 2022. [Online]. Available:*

<https://making.engr.wisc.edu/mini-mart/#laser-cutter>. [Accessed: 23-Feb-2022].

- This is the official website from Markerspace for the cost of the materials
- The cost of the 1/8 in acrylic sheet is \$ 10.75 (18 x 24 in)

4. *Kern, "Frequently asked questions about laser cutting basics," Kern Laser Systems, 02-Oct-2020. [Online]. Available:*

<https://blog.kernlasers.com/blog/laser-cutting-basics>. [Accessed: 23-Feb-2022].

- This is the official website of Kern Laser Systems, a designing and manufacture company for laser cutters
- This page provides an idea on the processing speed of laser cutters
- "If you're cutting 1/8" acrylic plastic on a 150W laser, it's going to cut 3-4 inches per second. Now, if you take that same material and cut it on a 400W laser, it's going to cut at about 6-7 inches per second. "

5. *Evonik, "Material Safety Data Sheet - Tap Plastics," ACRYLITE® GP Acrylic Sheet and Blocks , 01-Jul-2010.*

[Online]. Available: <https://www.tapplastics.com/image/pdf/MSDS%20Acrylic%20Sheet-New.pdf>. [Accessed: 23-Feb-2022].

- This is the safety data sheet for acrylic sheet (provided by makerspace)
- Hazard statement includes:
 - No explicit hazard listed, except for precautions for cut due to small pieces

Conclusions/action items:

This material was chosen because I had experience with laser cutting in another institution. The durability and processing speed with laser cutter was impressive.

Complete the design matrix based on the research



2022/02/18 - New Calculation on Parameters

HAOCHEN WANG - Feb 18, 2022, 11:28 AM CST

Title: New Calculation on Parameters

Date: 02/18/2022

Content by: Haochen Wang

Present: N/A

Goals: To develop a more valid mathematical model that can be used for VisualStudio validation

Content:

Raw draft for calculating the mirror length and position with MATLAB arrays

Design Ideas
16:9

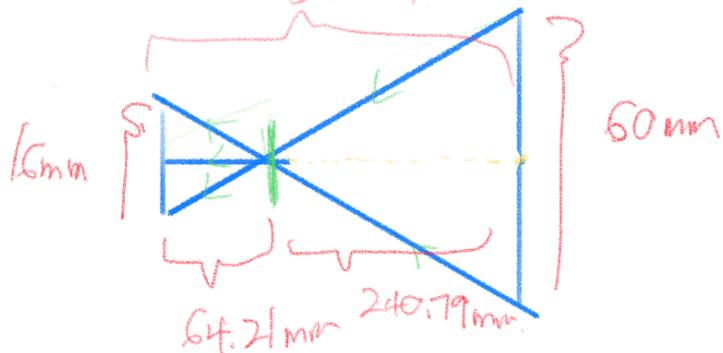
x2 magnification
10 cm



x24 magnification 10 cm.

x12 magnification 30 cm.
305 mm.

8.9



Diameter of aperture.

$$N = \frac{f}{D} = \frac{4 \text{ mm}}{D} = f/1.8 \quad \frac{28 \text{ mm}}{D} = 1.8$$

D = 15.5 mm

20 mm

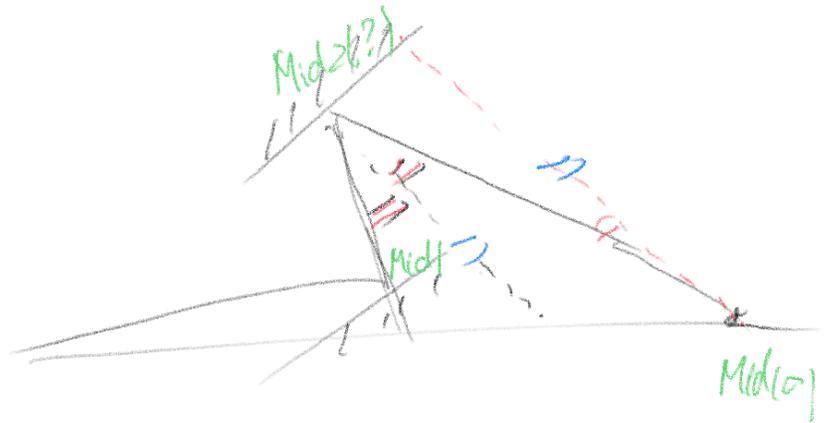
Distance between lens and object.

$D = 2.22 \text{ mm}$

$2 = M = \frac{28 \text{ mm}}{28 \text{ mm} - d}$ $d = 14 \text{ mm}$

$$\frac{22.2 \text{ mm (image h)}}{11.1 \text{ mm (actual h)}} = \frac{i}{o} = 2x \quad \frac{1}{o} + \frac{1}{20} = \frac{1}{28 \text{ mm}}$$

Obj. Distance = 42 mm. for 2x magnification
 = 56 mm for 1x magnification.



Conclusions/action items:

Complete the model during the weekend

Date: 02/23/2022

Goals: To develop a more valid mathematical model that can be used for VisualStudio validation

Content:

Update for mirror angle and position calculation/ fixed errors in previous calculation

Design Ideas
16:9

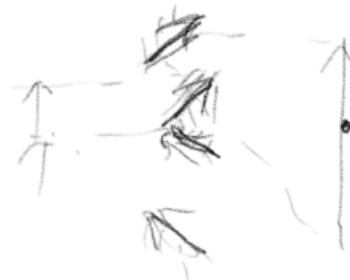
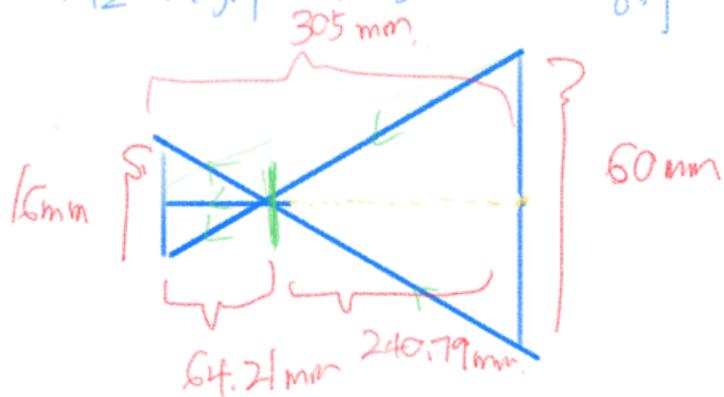
X2 magnification
10 cm

⇒

X24 magnification 10 cm.

X12 magnification 30 cm.

8:9



Diameter of aperture.

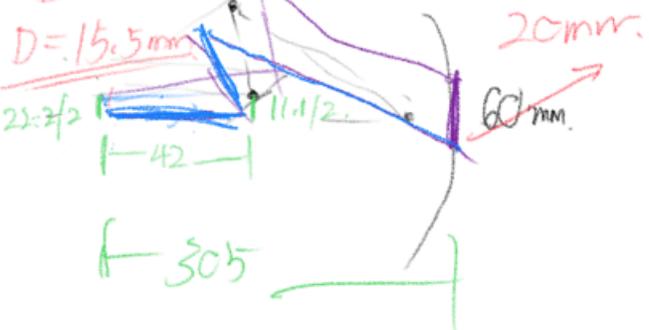
$$N = \frac{f}{D} = \frac{47\text{mm}}{D} = f/1.8 \quad \frac{28\text{mm}}{D} = 1.8$$

$$D = 15.5\text{mm}$$

$$D = 2.22\text{mm}$$

Distance between lens and object.

$$2 = M = \frac{28\text{mm}}{28\text{mm} - d} \quad \underline{\underline{d = 14\text{mm}}}$$



$\rightarrow \phi + 90^\circ$

For middle point,

$$\text{Mid2} = \text{Ref2} \times \begin{bmatrix} 42 \\ 11.1/2 \end{bmatrix}$$

$$= \begin{bmatrix} \cos 2(\phi_{\text{ref}}) \cdot 42 + \sin 2(\phi_{\text{ref}}) 11.1/2 \\ \sin 2(\phi_{\text{ref}}) 42 - \cos 2(\phi_{\text{ref}}) 11.1/2 \end{bmatrix} \Rightarrow \angle \alpha$$

$$\angle \phi_{\text{ref}} - \tan^{-1} \left(\frac{0 - b_y}{305 - b_x} \right) = \alpha - \phi_{\text{ref}}$$

For lower pt.

$$\text{Low2} = \text{Ref2} \times \begin{bmatrix} \text{Vert-x} \\ 0 \end{bmatrix} = \begin{bmatrix} -\cos 2(\phi_{\text{ref}}) \text{Vert-x} \\ \sin 2(\phi_{\text{ref}}) \text{Vert-x} \end{bmatrix}$$

$$(3) \quad \angle \phi_{\text{ref}} - \tan^{-1} \left(\frac{-10 - a_y}{305 - a_x} \right) = \beta - \phi_{\text{ref}} \Rightarrow \angle \beta$$

Conclusions/action items:

Implement the model in MATLAB for calculation

Calculate for the mirror lengths



2022/03/10 - New Design Parameters and 3D Model

HAOCHEN WANG - Mar 10, 2022, 1:13 PM CST

Title: New Calculation on Parameters

Date: 03/10/2022

Content by: Haochen Wang

Present: N/A

Goals: To determine the parameter with optic ray diagram and make a new 3D model for prototyping

Content:

Updates from previous MATLAB approach

1. There appears to be a false assumption in the model used to calculate the parameters, among which the exact false premise is not determined:
 - Assumed the smartphone camera can directly capture the virtual image from the inner mirrors
 - Ignored the magnification of the converging lens by making the first assumption, and the focus and magnification of the smartphone can be manually adjusted by the user
 - The design is symmetrical for the left and right halves of the mirrors
 - Ignored light interference from the mirror pairs on the sensor
 - Assumed that image of the station will travel as indicated by the top and bottom points in the ray diagram
 - (Confirmed to be wrong) Ignored resolution of the smartphone camera
2. Things to be solved in this new model
 - Reduce the working distance from 305 mm to 200 mm (temporarily, **needs to be confirmed with the clients**)
 -

Conclusions/action items:

Complete the model during the weekend

Title: New Calculation on Parameters (Cont.)

Date: 03/10/2022

Content by: Haochen Wang

Present: N/A

Goals: To determine the parameter with optic ray diagram and make a new 3D model for prototyping

Content:

2. Things to be solved in this new model

- Reduce the working distance from 305 mm to 200 mm (temporarily, **needs to be confirmed with the clients**)
- Design an alternative prototype that allows free rotation on the mirrors
- Precise cutting on the mirrors
- Secure fixation of the mirrors

Conclusions/action items:

Complete the model during the weekend

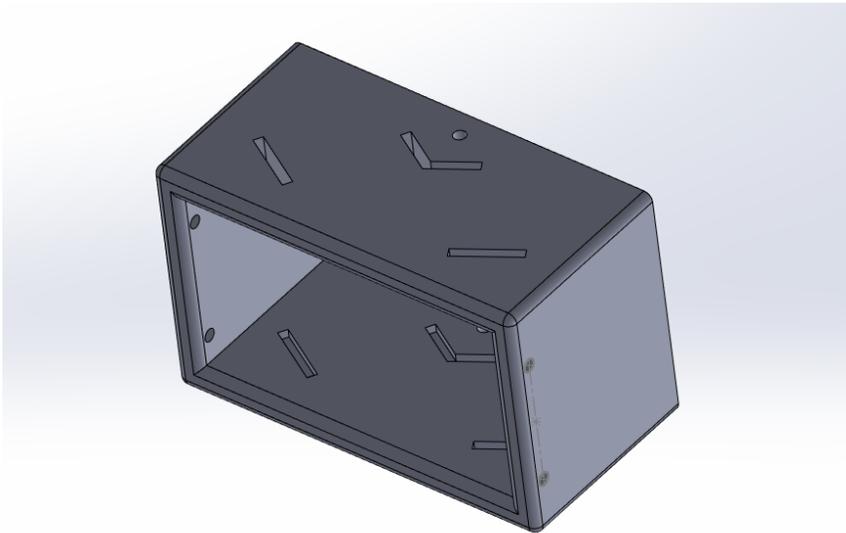
Title: Model 1.1**Date:** 03/10/2022**Content by:** Haochen Wang**Present:** N/A**Goals:** Create the CAD model for the first prototype**Content:**

Figure 1: First prototype

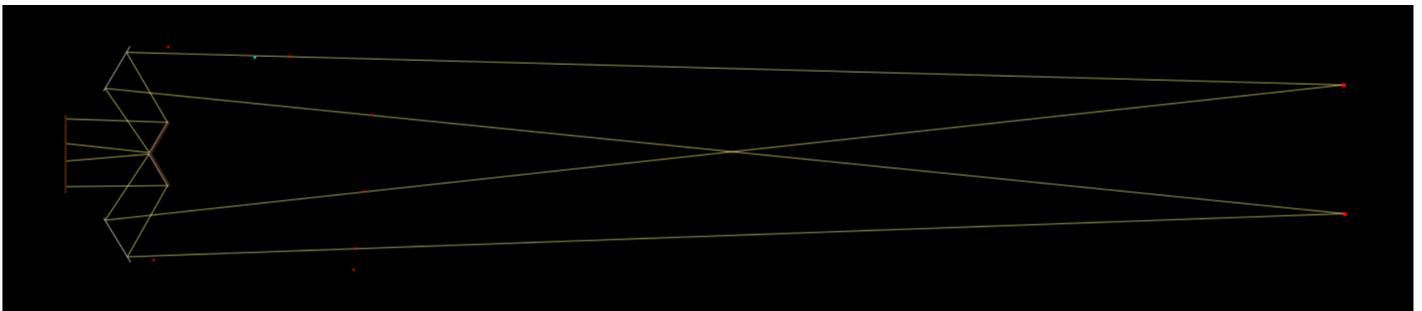


Figure 2: ray tracing diagram for the design

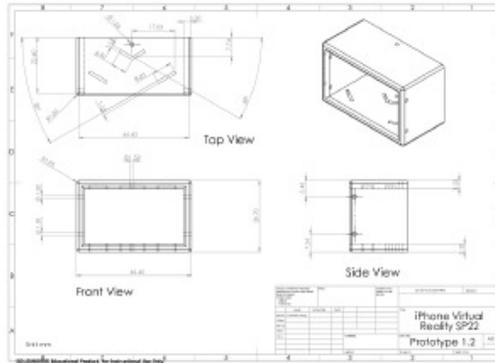
Features:

1. Expected working distance: 200mm
2. Symmetrical design (60 degrees for all mirrors, with respect to the central line)
3. Mirror positions adopted from measurements from last semester (see mechanical drawing attached)

Conclusions/action items:

Print the prototype after the spring break

HAOCHEN WANG - May 01, 2022, 9:47 PM CDT

[Download](#)

Prototype_1_1_.pdf (60.6 kB) CAD and mechanical drawing of the first prototype - symmetrical design

HAOCHEN WANG - May 01, 2022, 9:47 PM CDT

[Download](#)

Prototype_1_1_.SLDDRW (163 kB) CAD and mechanical drawing of the first prototype - symmetrical design

HAOCHEN WANG - May 01, 2022, 9:47 PM CDT

[Download](#)

Prototype_1_1_.SLDPRT (173 kB) CAD and mechanical drawing of the first prototype - symmetrical design

HAOCHEN WANG - May 01, 2022, 9:51 PM CDT

Title: Model 1.1 - printed

Date: 03/24/2022

Content by: Haochen Wang

Present: N/A

Goals: Update on the first model

Content:

Printed the prototype with Nicholas. Used hand-cut mirrors. Noticed that there was an error in the design, where the angle of mirrors were supposed to be 60 deg but drew to 30 deg. All models above were updated with the correction.

Conclusions/action items:

Print the updated prototype

(right) outer mirror was $z_2 = 3.4$ mm away from the center of the camera lens, with an angle of $\alpha_2 = 52.1$ deg from the horizontal line. Similarly, the top and bottom inner mirrors were $\phi_1 = 61$ deg and $\phi_2 = 66$ deg from the horizontal line. The figure above shows the definition of updated parameters.

New prototype according to this measurement

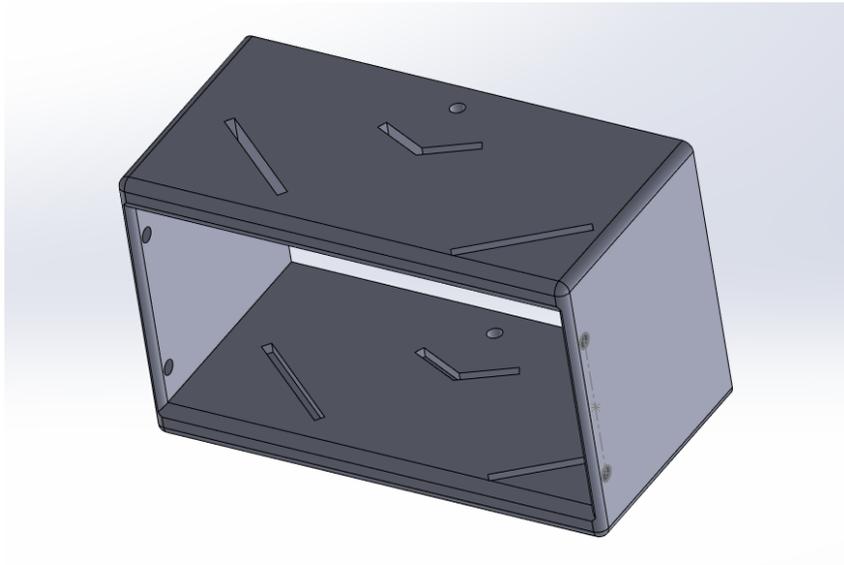


Figure 2: New CAD drawing (Asymmetrical design) according to the measurement above

Note: the holes are reserved for rubber bands that can secure the attachment onto the smartphone

Conclusions/action items:

Print the new prototype

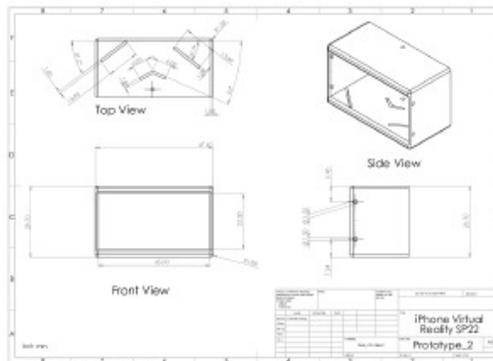
HAOCHEN WANG - May 01, 2022, 10:10 PM CDT



[Download](#)

Prototype_2.SLDDRW (159 kB) CAD and mechanical drawing of Asymmetric design

HAOCHEN WANG - May 01, 2022, 10:10 PM CDT



[Download](#)

Prototype_2.pdf (59.2 kB) CAD and mechanical drawing of Asymmetric design



[Download](#)

Prototype_2.SLDPRT (164 kB) CAD and mechanical drawing of Asymmetric design

Title: Model 3.1 - Free rotating design

Date: 04/01/2022

Content by: Haochen Wang

Present: N/A

Goals: Make a new model that allows free rotation

Content:

The design replaces the slots in Model 1.2 with the holes at the center of the mirrors, such that when the mirrors are stuck to the T-shaped pins, the mirrors can freely rotate about the axis to test out the angles.

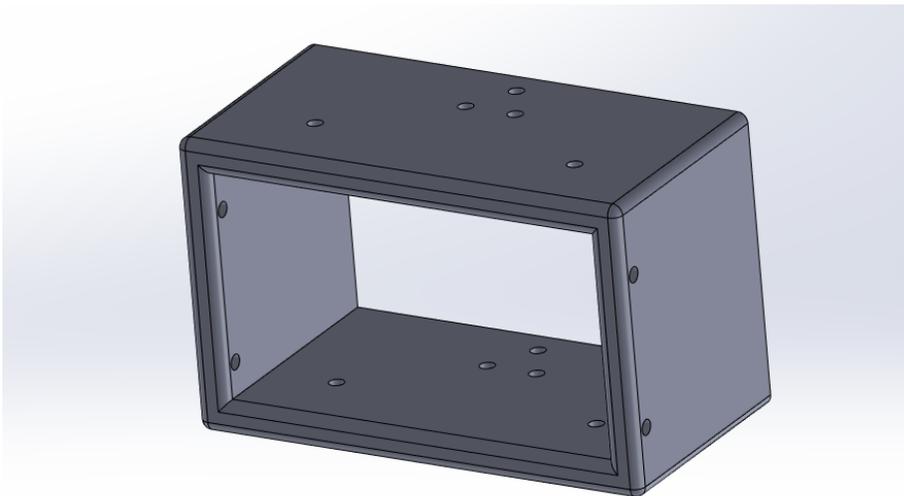
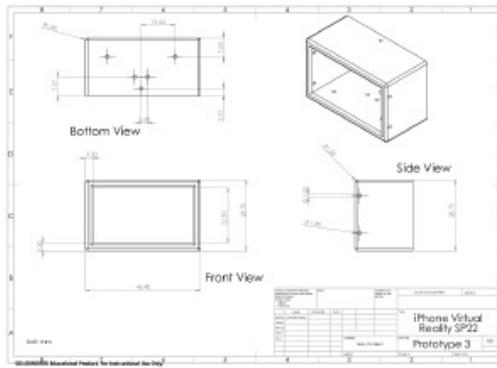


Figure 1: CAD drawing for free-rotating model

Conclusions/action items:

Print the new prototype



[Download](#)

Prototype_3_1_.pdf (57.4 kB) CAD and mechanical drawing for the freely rotating design



[Download](#)

Prototype_3_1_.SLDDRW (145 kB) CAD and mechanical drawing for the freely rotating design



[Download](#)

Prototype_3_1_.SLDPRT (152 kB) CAD and mechanical drawing for the freely rotating design

Title: Test on potential solution to the design flaws**Date:** 04/12/2022**Content by:** Haochen Wang**Present:** Haochen Wang**Goals:** Test on potential solution that achieves better image quality**Content:**

1. Test with manipulating the angle of smartphone with respect to the attachment
 1. No significant improvement
2. Removed the pair of mirrors on the left (from Prototype 1.2)
 1. The left half view is the image from mirror reflection
 2. The right half view is the direct capture on the suture, from the space in between the mirrors

Results

1. The 6-0 suture is visible, at least in the direct capture
2. There is better alignment between the left and right half views
3. The views are now distinguishable
4. However, since the attachment and the smartphone were handheld, two of the sample images (3 and 4) are blur due to hand shaking

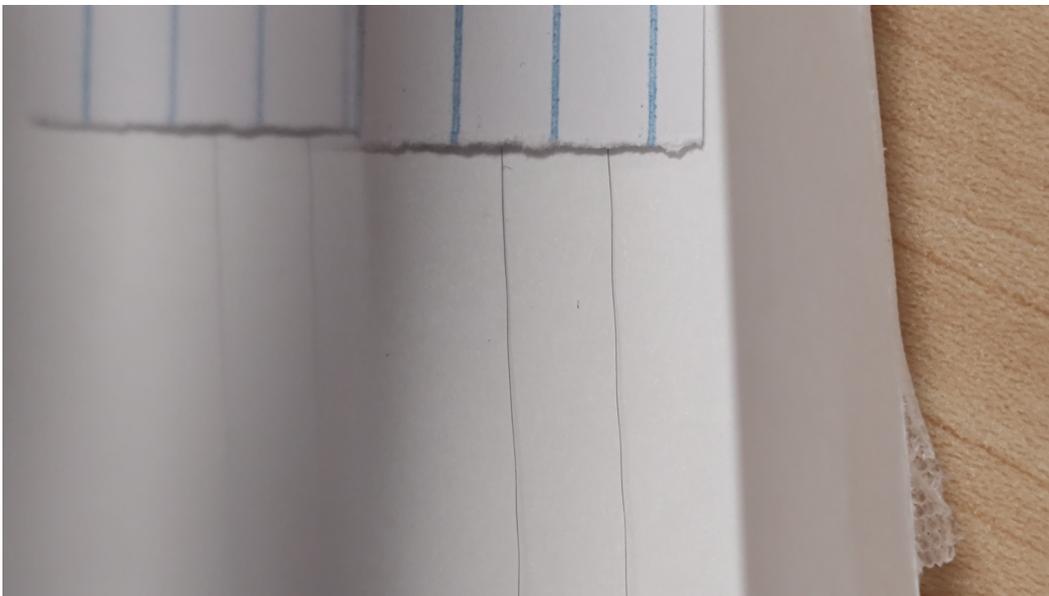


Figure 1: sample test with one pair of mirrors (left: reflection from the mirrors, right: direct capture on the station)

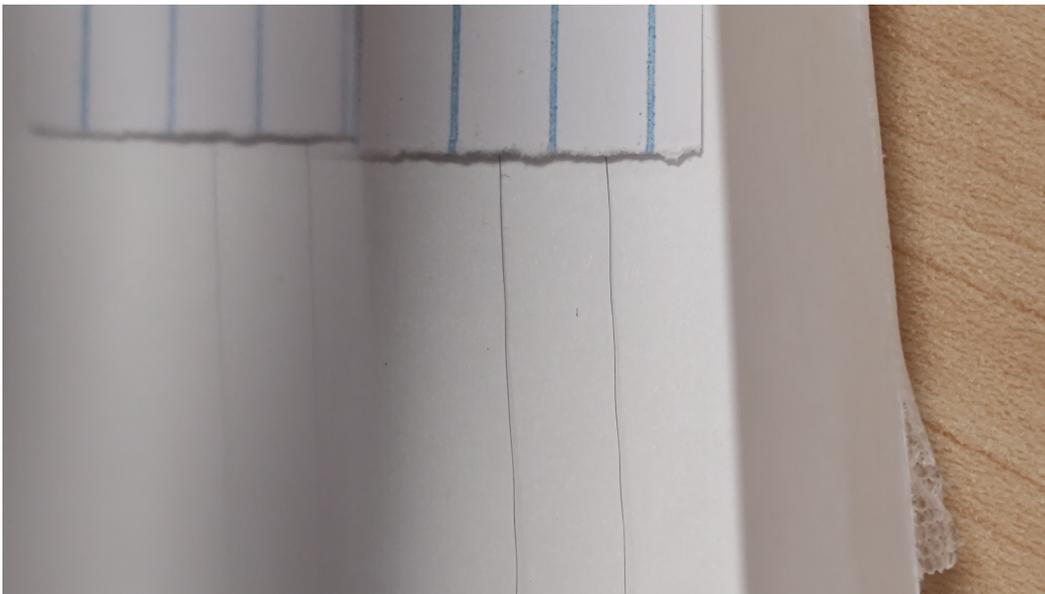


Figure 2: sample test with one pair of mirrors



Figure 3: sample test with one pair of mirrors (the camera is not stabilized, suture is not distinguishable in the reflected view and is blur in the direct capture)

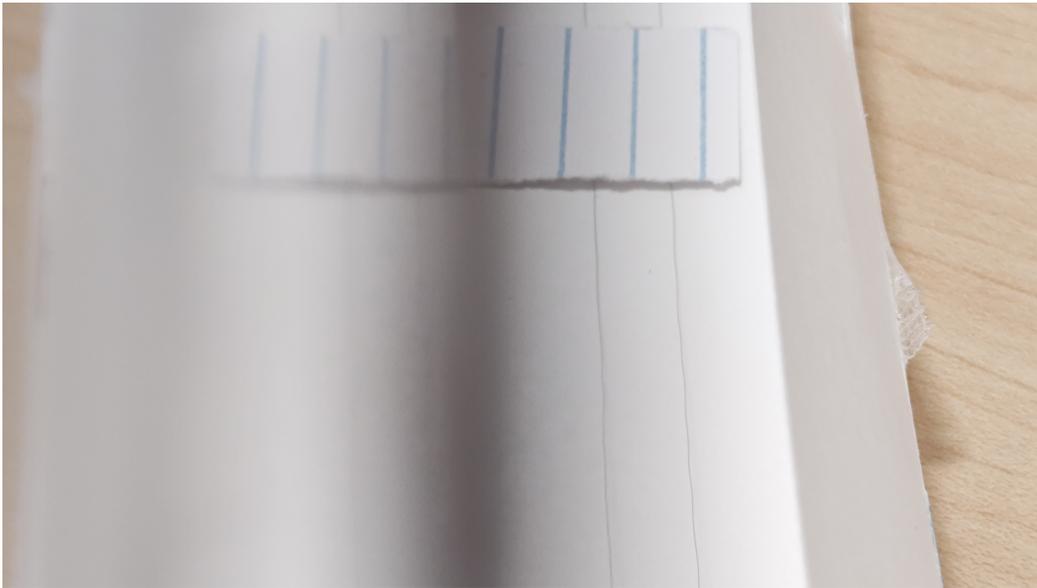


Figure 4: sample test with one pair of mirrors (the image is out of focus, suture is not distinguishable in the reflected view)

Conclusions/action items:

Make a new final design with one pair of mirrors

Title: Measurements from Team Testing on 04/21**Date:** 04/27/2022**Content by:** Haochen Wang**Present:** Haochen Wang**Goals:** Take measurements from the testing**Content:**Observations

- During the test, I noticed that there was misalignment between the direct capture and the reflected view, as is shown in figure below. Using this sample image from the test, I first calibrated the measurement in ImageJ (Fiji package, developed by Schindelin *et al.*) with the distance between two adjacent lines on the notecard (6.0 mm).
- Then I measured the difference in vertical distance of the pinpoint between the left and right half views. Meanwhile, the figure shows that the left and right view are not evenly distributed in the screen. Using the midpoint as the reference, the increase of width on the left (direct capture) and decrease on the right (reflected view) are measured relative to the central red line showing in the figure.

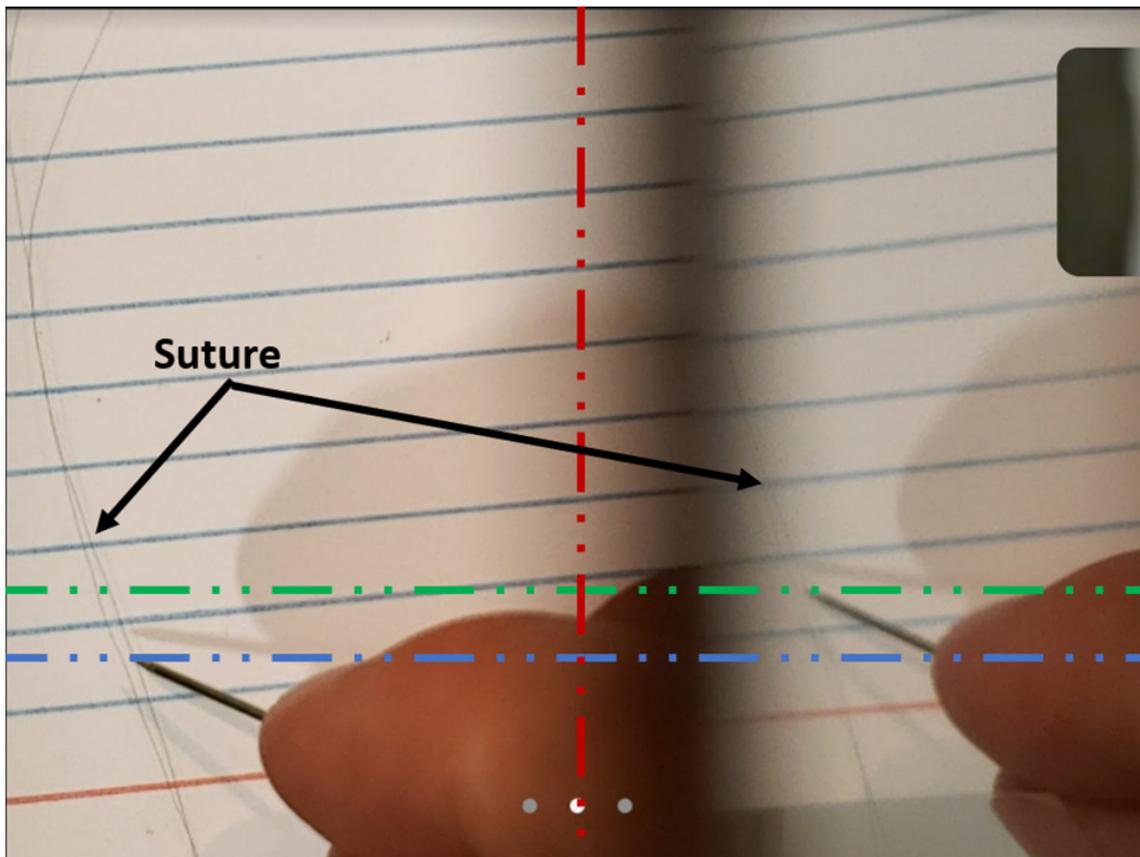


Figure 1: Screenshot from testing on the image quality, resolution, and misalignment. 6-0 suture strings are labeled with the black arrows. Note that there are two 6-0 suture strings on the notecard, and they are distinguishable in both views. The horizontal blue dashed line represents the vertical location of the pin in the direct capture, and green dashed line

represents that in the reflected view. The vertical red dashed line shows expected separation between the views, with the actual separation to the right of the right line (the shadowed area).

- The height of field of view (FOV) is the actual height of the notecard being captured in the screenshot, and the width is half of the total width of the two views.
- The angle of the mirrors are also measured via ImageJ, by using one edge on the housing as the reference

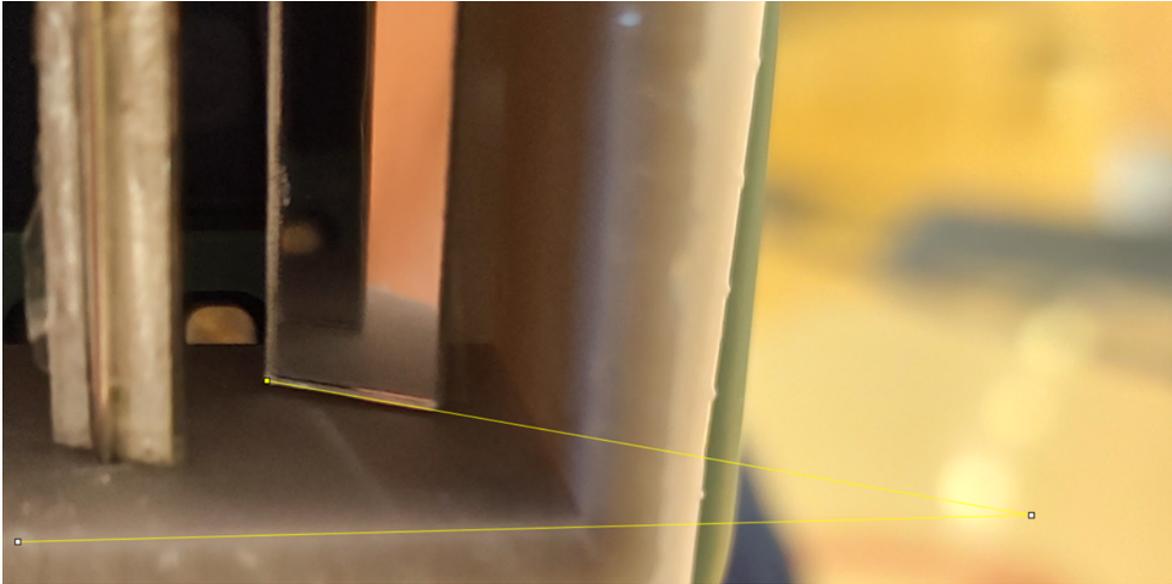


Figure 2: Screenshot of measuring the angle of outer mirror in ImageJ (the angle between thin yellow lines). The angle is measured with respect to the edge of the housing.

Results

- FOV
 - 6 cm x 7.5 cm (Previous)
 - 4.7 cm x 7.0 cm (Current)
- Direct (Left) and reflect (Right) capture misalignment
 - x-direction: + 8.45 mm Left/ -9.22 mm Right, compared to FOV
 - y-direction: +5.37 mm Right, compared to Left view
- Angles
 - Outer mirror: 11 degrees
 - Inner mirror: 9 degrees

Conclusions/action items:

Make a new final design according to the measurements

Title: Model 4.1

Date: 04/27/2022

Content by: Haochen Wang

Present: Haochen Wang

Goals: Make new CAD drawing from the measurements above

Content:

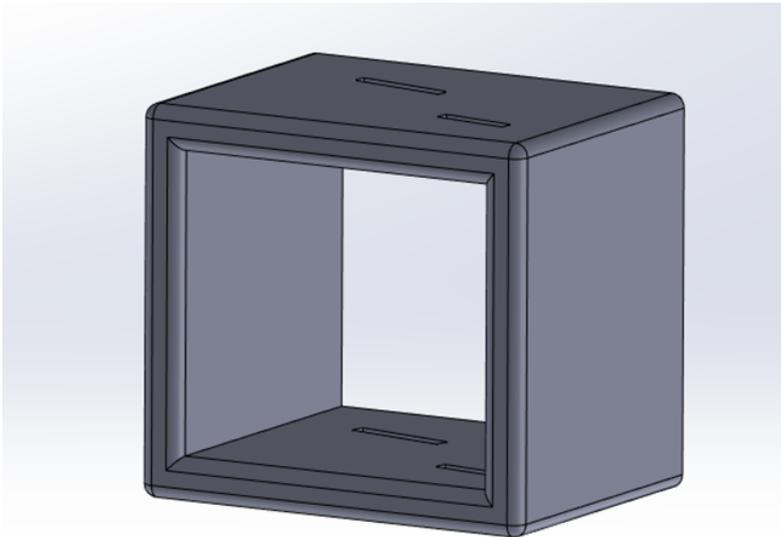


Figure 1: Isometric view of the final prototype. Two slots are created for insertion of the outer mirror (left) and inner mirror (right) respectively. See attachment below for detailed mechanical drawing.

Conclusions/action items:

Update progress with the team

HAOCHEN WANG - May 03, 2022, 7:19 PM CDT



[Download](#)

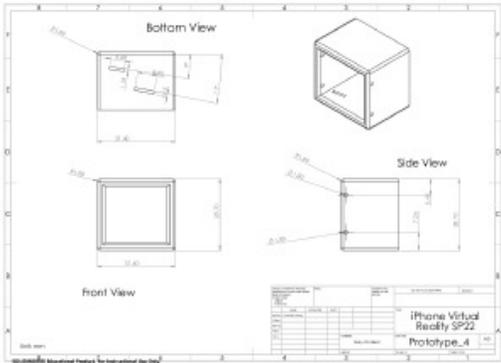
Prototype_4.SLDDRW (135 kB) CAD and mechanical drawing of the final design

HAOCHEN WANG - May 03, 2022, 7:19 PM CDT



[Download](#)

Prototype_4.SLDPRT (136 kB) CAD and mechanical drawing of the final design



[Download](#)

Prototype_4.pdf (56.9 kB) CAD and mechanical drawing of the final design



2022/02/20 - OpticStudio Training Progress

HAOCHEN WANG - Mar 01, 2022, 11:39 PM CST

Title: Training progress for OpticStudio

Date: 02/20/2022

Content by: Haochen Wang

Present: N/A

Goals: To get familiarize with opticstudio for optic simulation

Content:

See attached document for current training progress (several sections from Module 2 were viewed in advance to get better idea on the functionality)

Realized that OpticStudio requires initial calculation for the parameter, thus started derivation on the new parameters

Conclusions/action items:

Complete the training

HAOCHEN WANG - Mar 01, 2022, 11:38 PM CST

Introduction to Optical System Design and Certification with Zemax
OpticStudio

Dashboard / My courses / 95.802

General Final progress

958001 Introduction to Optical System Design and Certification with Zemax OpticStudio

Get Extra 100 Points

- View Video: 1.1 Getting started with Zemax OpticStudio
- View Video: 1.2 Getting started with Zemax OpticStudio
- View Video: 1.3 Getting started with Zemax OpticStudio
- Assignment: Added Quiz Score

To pic 1

Module 1: Introduction to Zemax OpticStudio

- Unit video: 1.1 Introduction to Zemax OpticStudio
- 1.1.1 Introduction to Zemax OpticStudio - Part 1
- 1.1.2 Introduction to Zemax OpticStudio
- View Video: 1.2 Introduction to Zemax OpticStudio
- 1.2 Introduction to Zemax OpticStudio - Part 2
- 1.2.1 Introduction
- 1.2.2 Introduction to Zemax OpticStudio
- 1.2.3 Introduction to Zemax OpticStudio
- 1.2.4 Introduction to Zemax OpticStudio
- 1.2.5 Introduction to Zemax OpticStudio
- 1.2.6 Introduction to Zemax OpticStudio
- 1.2.7 Introduction to Zemax OpticStudio
- View Video: 1.2.7 Adding a parabolic mirror
- Unit video: 1.2.7 Adding a parabolic mirror

To pic 2

Module 2: Optical Review

- Unit video: 2.1 Optical Review
- 2.1.1 Optical Review - part 1
- 2.1.2 Optical Review - part 2
- 2.1.3 Optical Review - part 3
- 2.1.4 Optical Review - part 4

[Download](#)

Haochen_Wang_Course__Introduction_to_Optical_System_Design_and_Certification_with_Zemax_OpticStudio_Module_1.pdf (258 kB) Proof for Module 1 completion



2022/03/16 - WARF Presentation

HAOCHEN WANG - Mar 16, 2022, 3:27 PM CDT

Title: WARF Presentation Thoughts

Date: 03/16/2022

Content by: Haochen Wang

Present: N/A

Goals: To have better understanding on WARF and patenting protocols

Content:

Notes

1. Cycle of innovation
 1. UW Research and discovery
 2. IP protection
 3. Licensing and startups
 4. Funding to support research and discovery
2. Protecting innovation
 1. Patents (machines and devices, compounds, processes and methods, improvements) - mostly here
 2. Copyrights (literary words, webpages, software programs)
 3. Trademarks (words and phrases, colors, pictures or logos, sound)
 4. Trade secrets (weakest of all, most of us are sharing info thus are not trade secrets)
3. Prior art
 1. Anything done before innovation
 2. Invention are evaluated against prior art
 3. Prior art by other people
 4. By oneself
 1. Presentations
 2. Posters
 5. Grace period for 1 yr
 1. from first public disclosure
 2. Including journal publication, talk or poster at conference, non-confidential department seminar, open thesis defense, cataloged dissertation, funded grant abstracts, description on an internet site
 6. Internationally, there might be absolute novelty
4. Patentability
 1. Eligible
 1. Is it naturally occurring?
 2. Novel
 3. Non-obvious
 1. Combine multiple references - then it is obvious that the invention will naturally occur
 4. Time-intensive process
5. IP management process
 1. Disclosure invention to WARF
 1. Chance of licensing

2. Timeline for licensing
3. Licensing strategy
4. Plan for the next year
5. Revenue projection
2. Disclosure committee meets monthly to review new disclosures
3. Patent application drafting, filing and prosecution
4. Technology marketing
5. Licensing
6. Licensing innovation
 1. milestone-based validation funding to speed promising technologies to a commercial license
 2. Sectors
 1. CS and engineering
 2. Medical devices and healthcare
 3. cleantech
 4. food and agriculture
 5. research tools
 3. Finding a licensee
 1. Internal
 1. inventor contacts
 2. meetings
 3. sponsored research
 2. External
 1. technology descriptions on website
 2. publications
 3. technology portals
 4. targeted outreach
 3. Inventor startup
 1. D2P - UpStart Program, Entrepreneurons (seminar series), innovation roadmap series, law and business entrepreneurship clinics
 2. e.g.: Trility Medical from BME department

Application to our project

It would be ideal to have a startup with the clients, while patenting our design with shared weight based on contribution (determined by the advisors)

Conclusions/action items:

Consider file a patent when the design is tested and finalized



2022/02/20 - SLA Printing Process

Nicholas Jacobson - May 04, 2022, 10:11 AM CDT

Title: SLA Printing Process

Date: 02/20/22

Content by: Nicholas Jacobson

Goals: Learn more about SLA Printing

Content:

Formlabs slicer software is used to slice up the part prior to printing.

SLA is best for functional prototyping which is required in our use case.

Resolution is limited by the Z-axis

High quality surface finish

Any overhangs we have may need to be held up with support structure

Parts are completely solid, this is okay for us as I don't see it adding that much extra weight

IPA wash and UV cure afterwards may add to the print time, but our part is pretty small so I don't see this being too much of an issue.

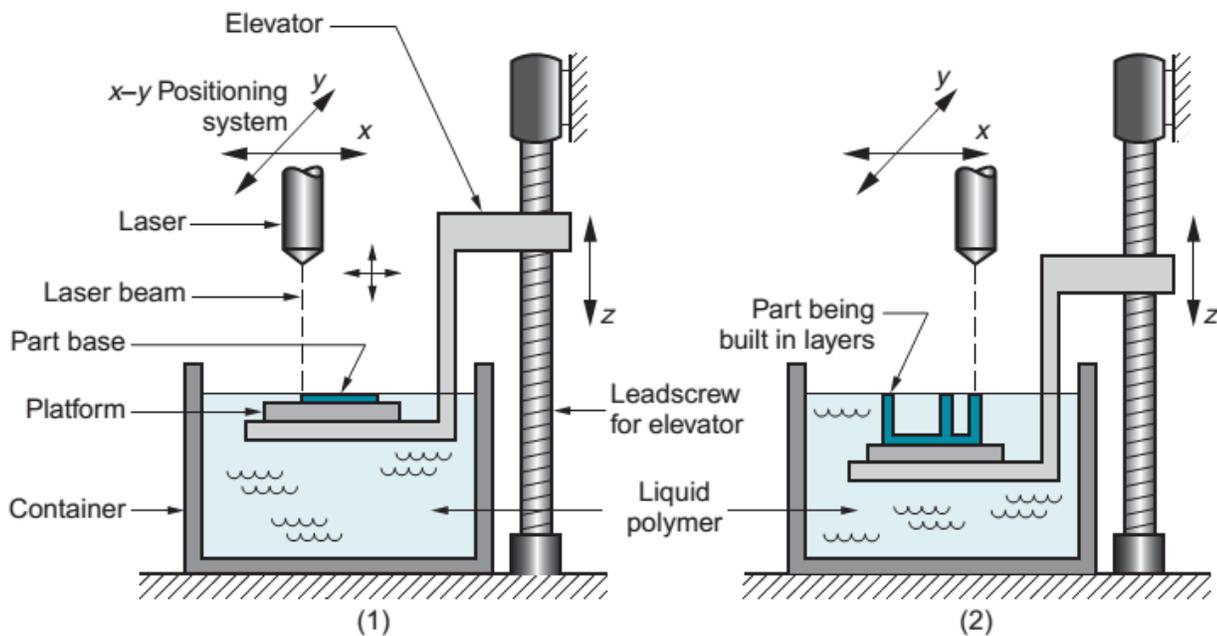


Figure 1: Diagram of stereolithography printing.

Sources: <https://making.engr.wisc.edu/>

<https://formlabs.com/3d-printers/form-3/>

<https://machine-drawing.blogspot.com/2015/11/arc-touching-two-circles-tangentially.html>

Conclusions/action items: With a better understanding of the printing process, it will be easier to design our part so it can be printed more effectively.



2022/02/20 - 3D Printing Research

Nicholas Jacobson - May 04, 2022, 10:11 AM CDT

Title: 3D Printing Research

Date: 02/20/2021

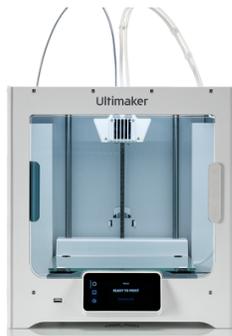
Content by: Nicholas Jacobson

Goals: Get a better understanding of what we need to do to 3D print our design.

Content:

Printers at the Makerspace:

Ultimaker 3/S3/S5



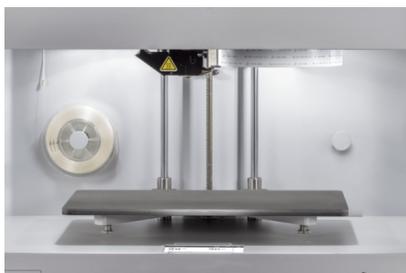
- Dual extruder allows for multiple materials
- Hobby grade

Stratasys F370



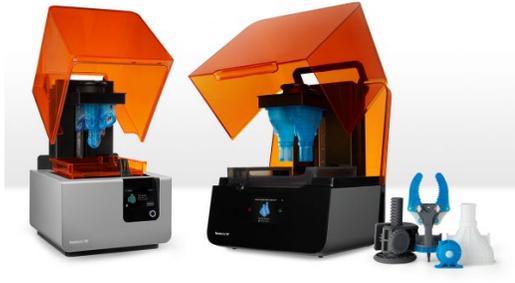
- Similar to Ultimaker but can produce higher quality parts
- Dual extruder
- Industry grade

Markforged Onyx Pro



- Reinforces parts with fiberglass, 10X stronger than plastics

Form 2/3



- SLA print
- Higher resolution
- Needs UV cure and alcohol wash
- Printing works by a laser curing a bed of resin, hardening it in select spots to make the part. The resin bed moves down as the part is being made.
- Build volume of $145 \times 145 \times 175$ mm which is easily large enough for our part.
- 100 micron precision in the least resolute axis

I think the Form printer will be our best option because it allows for the highest resolution possible. We want our design to be precise and we want the mirrors to fit perfectly in the plastic housing.

Source: <https://making.engr.wisc.edu>

<https://formlabs.com/3d-printers/form-2/>

Conclusions/action items: Present findings to the team and decide on what resin to use.



2022/02/25 - OpticStudio Simulation Progress

Nicholas Jacobson - May 04, 2022, 10:11 AM CDT

Title: OpticStudio Simulation Progress

Date: 02/25/2022

Content by: Nicholas Jacobson

Goals: Show the progress made towards creating a simulation in OpticStudio

Content:

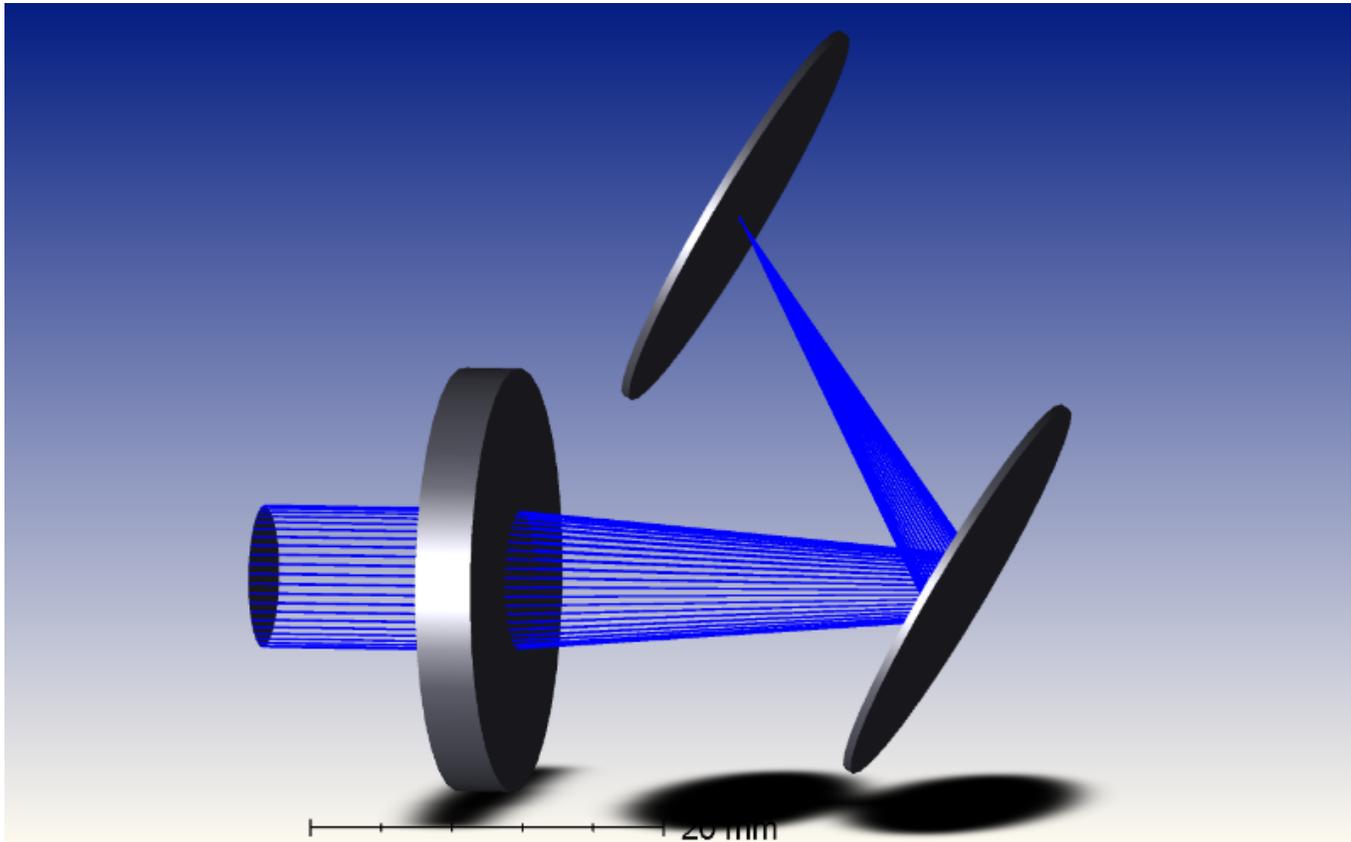


Figure 1: Double mirror design similar to our system of mirrors.

OpticStudio is a very advanced program so most of my time has been spent watching tutorials about how it works. I have created a system of mirrors similar to what our design will use, but I haven't yet found a way to simulate what an image would look like shown through the device.

Conclusions/action items: Continue learning how to use OpticStudio to finalize an optical simulation of our design.



2022/03/25 - Improving upon the 3D Printed Housing

Nicholas Jacobson - May 04, 2022, 10:11 AM CDT

Title: 3D Printed Housing Fabrication Process

Date: 2022/03/25

Content by: Nicholas Jacobson

Present: Nicholas Jacobson, Haochen Wang

Goals: Fabricate our first prototype for the semester

Content:

I 3D printed the housing at the Maker Space and today we picked up the finished print. We ended up cutting the mirrors using a glass cutter, which caused them to crack as we cut them down to size. The housing's dimensions were also incorrect and we could not get a suitable image to appear on the inner mirrors. In order to improve upon this design, I will try to laser cut the mirrors with the Maker Space laser cutter, and redraw the housing in SolidWorks to better match our prototype from last semester.

Conclusions/action items: Reprint the housing and improve upon the fabrication of the mirrors.



2022/03/28 - Revised Dimensions CAD Drawing

Nicholas Jacobson - May 04, 2022, 10:10 AM CDT

Title: Revised Dimensions CAD Drawing

Date: 2022/03/28

Content by: Nicholas Jacobson

Present: Nicholas Jacobson

Goals: Redesign the CAD drawing to match our new calculated dimensions

Content:

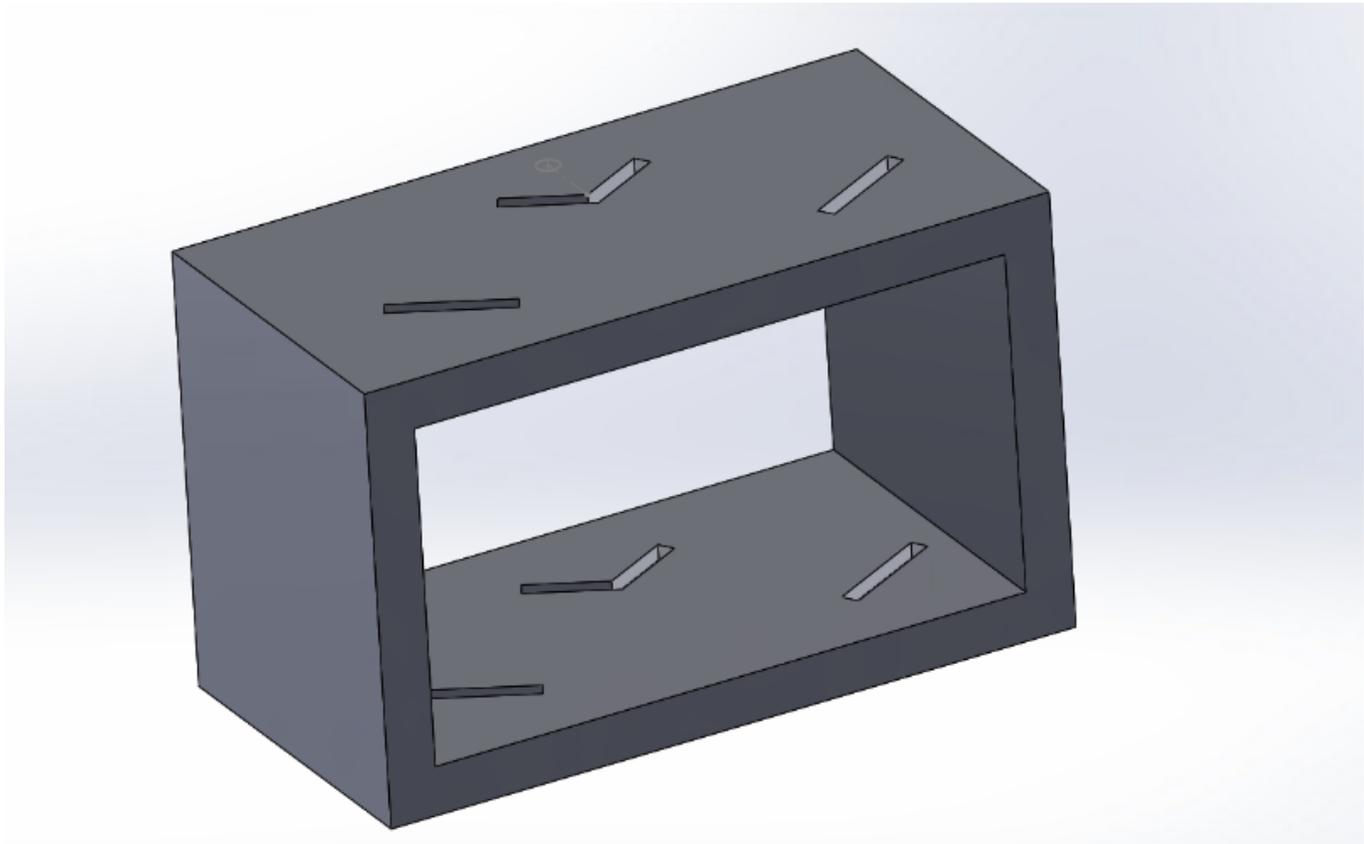


Figure 1: Revised CAD Drawing with new dimensions

Conclusions/action items: Print this drawing and laser cut the mirrors



2022/04/08 - Laser Cut Mirrors and Revised 3D Print

Nicholas Jacobson - May 04, 2022, 10:10 AM CDT

Title: Laser Cut Mirrors and Revised 3D Print

Date: 2022/04/08

Content by: Nicholas Jacobson

Present: Nicholas Jacobson

Goals: Laser cut the mirrors and fabricate the new design

Content:

Today I went to the Maker Space and laser cut the acrylic mirrors that we are inserting into the revised 3D printed housing. Using the laser cutter with such a small piece of acrylic was a challenge and required precise placement and lining up of the laser. Because I had to eyeball where the laser was aligned to, the dimensions weren't as exact as I was hoping for. However, all of the mirrors fit snug within our new housing and had straight edges with no cracks, so there was still a significant improvement over cutting them manually.

Conclusions/action items: Bring the new prototype to the client meeting for testing. Continue to revise the dimensions to achieve a more precise image.



Nicholas Jacobson - Oct 07, 2020, 11:36 AM CDT



[Download](#)

Screenshot_2020-10-07_EMU_Account_Status_-_EMU_-_UW-Madison.png (203 kB)



Biosafety and Chemical Safety Certification

Nicholas Jacobson - Dec 15, 2021, 12:38 PM CST

University of Wisconsin-Madison

This certifies that NICHOLAS JACOBSON has completed training for the following course(s):

Course Name	Curriculum or Quiz Name	Completion Date	Expiration Date
BIO SAFETY REQUIRED TRAINING	BIO SAFETY REQUIRED TRAINING QUIZ	3/14/2021	
CHEMICAL SAFETY: THE OSHA LAB STANDARD	FINAL QUIZ	3/28/2021	

Data Effective: Sun Mar 28 17:40:00 2021
Report Generated: Thu Apr 1 10:05:25 2021

[Download](#)

Screenshot_2021-04-01_Certificate_of_Completion_for_NICHOLAS_JACOBSON.png (46 kB)



2/23/2022 Grey Pro Resin Research

EMMA KUPITZ - Mar 01, 2022, 9:09 PM CST

Title: Grey Pro Resin Research

Date: 2/23/2022

Content by: Emma Kupitz

Present: Self

Goals: Learn about a possible material for the final product

Content:

https://support.formlabs.com/s/article/Using-Grey-Pro-Resin?language=en_US

- Versatile material
- concept modeling and functional prototyping
- Highly resistant to deformation over time
- Intended for repeated use or handling
- 50 microns
- form and fit testing
- Mold masters for plastics, silicones, and more
- Jigs and fixtures for manufacturing
- Not recommended for high impact applications
- relatively higher elongation and lower creep
- designed for aesthetic
- ultimate tensile strength: 61MPa
- 2.6 GPa Tensile Modulus

<https://making.engr.wisc.edu/3d-printers/>

- Using Formlabs Form 2 and 3 (SLA) printers
- Formlabs Grey Pro is \$0.26/mL

Conclusions/action items: place this material in the design matrix to find the best option for our design



[Download](#)

Grey_Pro_Technical.pdf (476 kB)



Grey Pro

Photoreactive Resin for Form 2

SAFETY DATA SHEET
Prepared: 12/12/2017



0011 FORMLBS

[Download](#)

Safety_Data_Sheet_EN_-_Grey_Pro.pdf (121 kB)



2/23/2022 Tough 1500 Resin Research

EMMA KUPITZ - Mar 01, 2022, 9:08 PM CST

Title: Tough 1500 Resin

Date: 2/23/2022

Content by: Emma Kupitz

Present: Self

Goals: Learn about a possible material for the final design

Content:

https://support.formlabs.com/s/article/Using-Tough-1500-Resin?language=en_US

- produces stiff and pliable parts that bend and spring back quickly under repeated use
- functional prototypes, jigs, and fixtures
- Connectors undergoing temporary deflection or high impacts
- bridge the gap in mechanical properties between durable resin and tough 200 resin
- performs similarly to polypropylene in terms of strength and stiffness
- snap fits, hinges
- not recommended for high temp applications and fine features
- ultimate tensile strength: 33 MPa
- tensile modulus: 1.5GPa
-

<https://making.engr.wisc.edu/3d-printers/>

- cost is same as grey pro resin with \$0.26/mL

Conclusions/action items: Put this material into the design matrix to find which is the best for our design



[Download](#)

Tough_1500_TDS_EN.pdf (312 kB)

formlabs 

Safety Data Sheet

According to GHS/HA Hazard Communication Standard, 29 CFR 1910.1200

Initial preparation date: 11.08.2019 Page 1 of 10

Tough 1500

SECTION 1: Identification

Product identifier
 Product name: Tough 1500
 Product code: FLT01501

Recommended use of the product and restriction on use
 Relevant identified uses: For use in Formlabs SLA Printers
 Uses advised against: Not determined or not applicable.
 Reasons why uses advised against: Not determined or not applicable.

Manufacturer or supplier details
 Manufacturer:
 United States
 Formlabs, Inc.
 35 Piedford Ct
 Suite 201, Somerville, MA 02143
 617.950.7952
 info@formlabs.com

Emergency telephone number
 United States
 CHEMTREC
 1-800-424-9300 (24 hours)

SECTION 2: Hazard(s) identification

GHS classification
 Skin Irrit. (Cat 2), Category 2
 Skin Sensitization, Category 1
 Chronic Aquatic Toxicity, Category 2

Label elements

Hazard pictograms



Signal word: Warning

Hazard statements
 H315 Causes skin irritation
 H317 May cause an allergic skin reaction
 H411 Toxic to aquatic life with long lasting effects

Precautionary statements

[Download](#)

Tough_1500_SDS_EN.pdf (226 kB)



2/24/2022 Laser Cut Acrylic

EMMA KUPITZ - Mar 01, 2022, 9:17 PM CST

Title: Laser Cut Acrylic

Date: 2/24/2022

Content by: Emma Kupitz

Present: Self

Goals: Learn about acrylic as a possible material

Content:

<https://www.tapplastics.com/image/pdf/MSDS%20Acrylic%20Sheet-New.pdf>

1. Specific gravity: 1.19g/cm^3

<https://www.builditsolar.com/References/Glazing/physicalpropertiesAcrylic.pdf>

1. tensile modulus: 2.8GPa

<https://making.engr.wisc.edu/mini-mart/#laser-cutter>

1. \$10.75 for a 18x24x1/8 inch sheet

Conclusions/action items: Use this information to determine the best possible material for the device



2/23/2022 Zemax optic simulations/Lens magnification

Title: Zemax OpticStudio

Date: 2/23/2022

Content by: Emma Kupitz

Present: Self

Goals: Learn about a possible optics software

Content:

https://www.zemax.com/pages/opticstudio?gclid=CjwKCAiApeQBhAUEiwA7K_UH8FbCZ71AGjw9I53x3S-o3W4zythh6xxqxounUMayurMxgPDZzkjBoCq9EQAvD_BwE&utm_campaign=G%3AS%3ABR%3ARoot%3ANA_EN%3AE%3A&utm_content=%7Bcontent%7D&utm_medium=cpc&utm_source=3W4zythh6xxqxounUMayurMxgPDZzkjBoCq9EQAvD_BwE

- optical engineering tools
- improve freeform designs; contrast analysis for MTF optimization; and Image Simulation to produce photorealistic images of object scenes
- improve the performance of optical designs based on user based constraints and design goals
- accurately simulate their designs
- create standalone application, build own analyses and control opticstudio externally using C#, C++, MATLAB and python
- Zemax programming language enables you to write your own macros to automate repetitive processes
- stand: for basic sequential ray tracing and analysis, best for designing and optimizing simple lenses

Conclusions/action items: Learn more about Zemax as a way to simulate the design and about the calculations done for our design



4/10/2022 Splitting Image

EMMA KUPITZ - May 03, 2022, 10:18 PM CDT

Title: Creating a Splitting Image with mirrors

Date: 4/10/2022

Content by: Emma Kupitz

Present: Self

Goals: Learn more about how stereoscopic vision is achieved

Content:

Google Scholar: stereoscopic images created

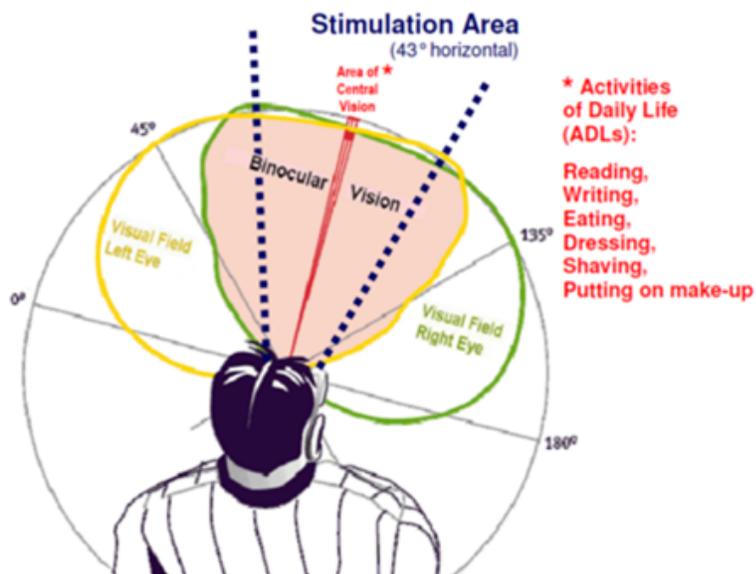
link: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3490636/>

- "to recreate this situation on a stereo 3D display, we have to recreate such an epipolar plane."
- "horizontal lines on the screen are parallel to the line joining the two eyes"
- "irrespective of where the eyes are looking, the rays joining each eye to a single object in space intersect the screen at points that are displaced horizontally on the screen"
- "to simulate objects physically present in front of the viewer, the left and right images must be presented on the display screen with no vertical separation"
- "sources of vertical parallax cause a change in the vertical disparities at the viewer's retinas and are likely to affect the 3D percept"

Search: "stereoscopic vision"

Link: <https://novavision.com/stereoscopic-vision-how-does-it-work/>

- "When you look straight into distance, your eyes are parallel to each other. The areas seen with the right and with the left eye overlap to a certain extent. With the left eye you see not only what happens at the left side of your body, but also what happens at the center and partially at the right side and vice versa"



- "we receive two different pictures of our environment from the left and from the right eye. The brain "computes" the spatial information from the difference between the two pictures on the retina and creates a joint overall image, which provides extra information about distance to an object."

Conclusions/action items: Try to fix the overlap in the two images in the prototype



WARF Lecture- 03/20/2022

EMMA KUPITZ - Mar 20, 2022, 10:31 PM CDT

Title: WARF Lecture

Date: 3/20/2022

Content by: Emma Kupitz

Present: Self

Goals: Learn about WARF and patents

Content:

- Vision: enable University of Wisconsin-Madison research to solve the world's problems
- Mission: to support scientific research within the UW-Madison community by providing financial support, actively managing assets, and moving innovations to the marketplace for a financial return and global impact
- Focus on patents, intellectual property protection
- Patents: machines and devices compounds, processes and methods improvements
- Trademarks: words and phrases, colors, pictures or logos, sound
- Copyright: literary works, webpages, software programs
- Prior Art: "references" created before a specific date
- requirements: eligible, useful, enabled, described, novel, non-obvious
- Management Process: disclose your invention to WARF, disclose Committee meets monthly to review new disclosures, Patent application drafting, filing, and prosecution, Technology Marketing, Licensing
- Licensing: chance of licensing, timeline, licensing strategy, plan for the next year, revenue projections

The way we placed the mirrors and attached the device to the phone could possibly be an original idea that could be considered intellectual property that needs to be protected

Conclusions/action items: Consider if any of the design could be considered for a patent



2014/11/03-Entry guidelines

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

Use this as a guide for every entry

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

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

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

Date: 9/5/2016

Content by: The one person who wrote the content

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

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

Content:

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

Conclusions/action items:

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



Title:

Date:

Content by:

Present:

Goals:

Content:

Conclusions/action items: