BME Design-Spring 2020 - Alexander Truettner
Complete Notebook

PDF Version generated by

Payton Parmett

on

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Team contact Information

Kurt Vanderheyden - Jan 27, 2020, 5:37 PM CST

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Project description

Payton Parmett - Feb 26, 2020, 3:10 PM CST

Course Number: 301

Project Name: Model for pre-surgical intracerebral hemorrhage planning

Short Name: Phantom brain

Project description/problem statement:

In the past there was very little that could be done for patients experiencing Intracerebral Hemorrhaging. Recently, efforts are being made to remove as much of the brain clot as possible before damage can occur. However, characteristics of different clots vary and the differences in rigidity can affect the clinical approach used. Research is being done to map the rigidity of clots pre-op. A physical, gel model that simulates the interior of the brain with various clots would allow researchers to validate whether or not their mapping techniques are functional.

About the client:

Dr. Block is a BME faculty member with additional associations with the ECE department and Materials Science program. His primary focus is around MR technology, signal and image processing, and distributed computing. He teaches many advanced courses at UW about medical imaging systems and his lab does work in this field as well.

1/30/20 - Initial Meeting

Payton Parmett - Jan 30, 2020, 9:15 AM CST

Title: Initial Meeting

Date: 1/30/20

Content by: Payton Parmett

Present: Whole team

Goals: Establish a starting point for the semester and a plan with Dr. Block.

Content:

-The size of the clot affects the accuracy of the imaging

-Phantom is so much more powerful than just inferring/clot biopsies

-One gel "normal brain" vs one gel "clot"

How to image outside of sample holder

-Suspend clot in water with string attached to bar across rim?

-Fill beaker with "normal brain" gel, put in some plastic blocks that are removable for "wells," then make "clot" gel blocks to insert into wells, then cover with normal brain layer

-Start with a few, big clots (maximum 4), 2-4 clot blocks of range of rigidity

Preliminary plan - Testing elastic resolution on a large scale:

-Phantom 24-28cm across

-Make "normal" brain gel basis, then varying rigidity

-Get rid of the plastic of our current device basically

-Can we get a homogenous gel of that size? - will need to go back and forth with Dr. Block

-Dr. Block has people who can tell us how to make gel of a "normal brain"

-Range: less rigidity than normal, 2x, 4x, 10x rigidity

Version 2 - Testing elastic resolution on a smaller scale:

-Once we have confidence that we're measuring correctly, still do cube of less rigidity than control, 20%, 40%, 60% more rigid

Version 3 - Testing spatial resolution:

-Work different sizes of clot, test how low we can go in terms of clots

(Microhemorrhages)

-Take our confidence level from Version 2 (say it's x% higher), then make all clots of V3 at x%

Version 4 - Change anatomical model

-Make it into a brain sample holder

-Two halves, put our stuff in, seal it together

Range of percentages of clot gels we did: 2%, 3%, 5%

*5 gets pretty tough to work with, making a big 5% may be difficult

Huge differences have been seen with confidence levels/thresholding when using 2D independent measurements vs 3D relative measurements

NMR susceptibility

variation of measurement is only 1/3 part per million, avg 128 million so only 42ish Hz variation

different tissues have different magnetic field susceptibilities, air is way different (12 ppm), so air is a huge problem

SO: if we put a top on our thing to get rid of air, it gets rid of a ton of work

(Don't have to seal it, just don't expose clots to top)

Iron creates inhomogeniety, can be used to find iron buildup if body can't process

helps to find microhemorrhages, susceptibility-weighted image shows veins in brain/all vasculature, blood vessel ruptures: useful when imaging for repeated head trauma (football), post-car accident, etc.

Clinical imaging: spin-echo imaging - instead of taking all measurements in one go, spin it one way and then spin it back and then measure, gets rid of artifact that is seen in shear waves in MRE. Called epi-imaging (echo-planar imaging).

Mechanical testing:

-Make some compression measurements on MTS machine for preliminary project

-Take young's modulus and shear wave?

-Can be relative measurements to one another, numbers aren't always useful/possible

> Since we have the brain as reference, we can just make it relative if possible (but numbers would be nice)
>
> ie if our young's modulus doesn't line up with our MTS, just make it relative until we figure out how to fix it

Housekeeping:

Dr. Block's number: 608-772 - 5642

Dr. Block will send us:

1. Imaging of clots over time and how we can see the air heterogeniety problem (called B1 inhomogeniety - field is distorted)

2. Paper of grad student working on this

Conclusions/action items:

Moving forward, we will begin making a the new sample holder that Dr. Block requested to avoid the inverse imaging results we were getting previously. We will also make some clots to image in this device ASAP. Simultaneously, we will make some clots that we can do compression testing on with the MTS machine at ECB.

3/5/20 - Gel Drop Off

Payton Parmett - Mar 05, 2020, 10:04 AM CST

Title: Gel Drop Off

Date: 3/5/2020

Content by: Payton Parmett

Present: All

Goals: Drop off gels to Dr. Block, update each other, make sure the plan moving forward is solidified

Content:

Dr. Block said that our gel phantom is "superb"! :-) He hopes to get us some images back by the end of the week, maybe early next case. He thinks doing mechanical testing and coming up with our own young's modulus would be a good thing to do moving forward. He will identify the shear modulus during imaging. One potential concern (probably and hopefully not an issue) is that we didn't measure the distance of the clots from the wall.

To be able to start on our anatomical model phantom, Dr. Block plans to take a scan of a bag of water in the MRI coil to get the right curvature of the coil so that we can make it sit perfectly (then it won't wobble when being scanned).

We took some preliminary images of the gel phantom and they looked pretty good! We left it at WIMR so that the grad student Robert can work with them and send us some images. In the meantime, we can begin working on making some gels to do mechanical testing at ECB ourselves.

Conclusions/action items:

Waiting for feedback from Dr. Block and team, we can start on mechanical testing on our own. We should meet to discuss (and probably email Dr. Block) about which rigidities we should test.

1/31/2020 - Advisor Meeting 1

Payton Parmett - Jan 31, 2020, 12:54 PM CST

Title: Advisor Meeting 1

Date: 1/31/2020

Content by: Payton Parmett

Present: Whole team

Goals: Get on the same page with Dr. Hai and get any initial advice on our first steps

Content:

We told Dr. Hai that Dr. Block gave us a good, clear path of what he wants for the semester (see our first client meeting notes for more info)

Dr. Hai told us to do some research on what actual cerebral hemorrhage imaging looks like (T1 and T2) so that we can compare for ourselves the real to gel clots instead of just relying on Dr. Block's and the research team's word. He also asks how we plan to decide our stiffnesses to test so that we aren't picking irrelevant values, which is a good thing to consider.

He also told us to note temperatures (room, fridge, hot plate) during our gel preparation because if it isn't constant, it could be messing with the homogeniety/stability of the gels while they set and as a result the stiffnesses could be off. He stresses that our conditions be consistent.

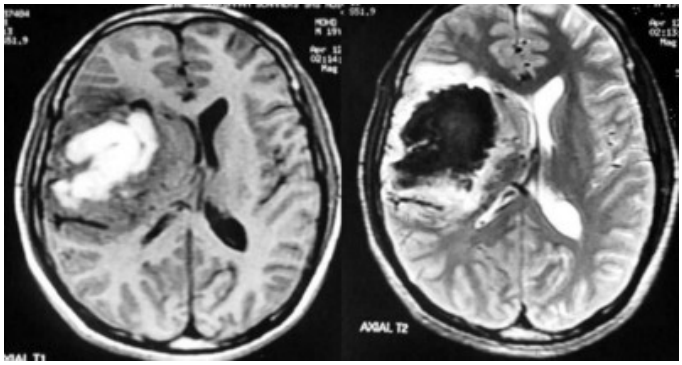
We all decided that it could also be very cool to lowkey make the anatomical model anyway on the side.

In terms of materials, we will either need to order more or potentially can make buffer/get some resources from Dr. Hai.

Conclusions/action items:

We will get started on our timeline at our team meeting on Monday, where we will start making clots for imaging and mechanical testing. On the side, we will continue to research clinical relevance.

Payton Parmett - Jan 31, 2020, 1:31 PM CST



T1_T2_MRI_acute_phase_hemorrhage_right_tempoparietal.png(55 KB) - download This image is an example of what Dr. Hai meant when he wanted us to compare our T1/T2 of the clots to a clinical example. This image has more complexity than ours due to the other vasculature/etc, but the clots do have comparable difference and this image serves as a good reference for us to keep in mind.

2/6/2020 - Advisor Meeting

Payton Parmett - Feb 06, 2020, 8:36 AM CST

Title: Advisor Meeting

Date: 2/6/2020

Content by: Payton Parmett

Present: Whole group

Goals: Get some more advice from Dr. Hai before we begin our gel process

Content:

We updated Dr. Hai with the following:

-The solidworks file for the new sample holder will be dropped off at the makerspace today

-We have the materials that we need between old materials/what is in the lab at ECB

-We have a plan to make the gels

-We will do the PDS by tomorrow!

Things Dr. Hai gave us to consider:

-What are we expecting as a 'successful' measurement?

- -Noticeably different contrast (T1 and T2 clear contrast between gels)
- -What difference in gels stiffnesses give us the best contrast?
- -We were planning on doing 4 different stiffnesses, maybe we should do more. Like 8. (We can use the wall dividers we were talking about)

-What is the size of a normal clot? How small do we need to go that is reasonable?

-Human brain is less stiff than a muscle, we should use less than 2% for the rigidity of our brain model

- -Agar is often used as a brain phantom, but then there's the whole difference in contrast

-He urged us to get going sooner than later so that our semester will be stress-free :-)

-He also is very interested in the brain model

- -He can send us MRI sets
- -Figure out how to do the gray/white matter and place the clot in it

Conclusions/action items:

We will update the sample holder to have those wall dividers so that we can make 8 or 16 gels instead of 4 so that we can find our ideal contrast sooner

2/28/2020 - Advisor Meeting

Payton Parmett - Feb 28, 2020, 12:42 PM CST

Title: Advisor Meeting

Date: 2/28/2020

Content by: Payton Parmett

Present: Whole team

Goals: Get caught up to speed, take advice moving forward

Content:

Our plan for next week is to meet our client Dr. Block on Thursday morning. We hope to bring the finished clot combination (1% brain base, gel clots, and top layer) to the meeting to give him for imaging. This would put us in a good spot for our timeline for the semester. One possible concern is that Robert (the main grad student) was going to Australia for a presentation, and we weren't sure when this was. Although, we don't anticipate this being an issue since there are other grad students that can help us.

We also reviewed a competing design that Dr. Hai read about in our notebook and ensured that our project is different and that we don't need to worry about the things they accounted for (mostly preventing gel "bleeding" into others instead of staying as clots and brain separately). We do not anticipate this being an issue either as the team has not run into this yet, but we plan to make the gels the night before dropping them off and to store them in the fridge so that they stay rigid, so it will hopefully be fine. Additionally, Dr. Block has never voiced this as a concern.

Since our project is mostly relative in terms of our data, we have a few ideas as to how to add numerical meaning to our data. Our primary plan is to do compression testing on the clots with the MTS machine and to calculate the Young's Moduli of the clots to give numerical meaning to the images in terms of rigidity. Dr. Hai also proposed using photospectroscopy to take advantage of the opacity difference in the gel rigidities.

Conclusions/action items:

We will continue with our timeline and try this new numerical testing!

3/6/2020 - Advisor Meeting

Payton Parmett - Mar 09, 2020, 9:07 AM CDT

Title: Advisor Meeting

Date: 3/6/2020

Content by:

Present: All

Goals: Meet with Dr. Hai, catch each other up, take advice for future work

Content:

**Many of us anticipate being absent next Friday due to spring break, so we will not meet next week.

We caught Dr. Hai up with our activities this week and got our preliminary presentation feedback, which we will be sure to incorporate into our future work. We need to work on finalizing our protocol even more (e.g. refridgeration time and temperature) and need to add dimensions to our drawings. We feel very on track and will get going with mechanical testing soon (probably this week). We also plan to make a new holder once Dr. Block sends us the scans of a bag of water in the head coil to get the perfect radius of curvature. The will allow him to place the gels right into the head coil instead of an imperfect setup with room for error.

Conclusions/action items:

Dr. Hai will send us our midterm grades soon and we will get going on our mechanical testing.

1/27/20 Initial Meeting

Payton Parmett - Jan 27, 2020, 6:03 PM CST

Title: Initial Team Meeting

Date: 1/27/20

Content by: Payton Parmett

Present: Whole team

Goals: Establish where we're at for the beginning of the semester and plan what to discuss at our meeting with Dr. Block.

Content:

Kurt and Payton were caught up to speed with the project. Our plan moving forward from here is to focus on testing of the gels and refining the imaging (one obvious first place to start is testing the gels suspended in water to fix the MRI photos). Another place to move forward is with mechanical testing of the gels. Another path that can be started immediately is to create a brain housing that we can then run images with.

We also set up our team drive/timeline/templates for the semester.

Conclusions/action items:

Our plan moving forward is to meet first with Dr. Block this week and solidify our plans, but we predict to do more testing as well as getting started on a more anatomically correct model.

2/19/20 Pre-presentation and Gels

Payton Parmett - Feb 19, 2020, 6:07 PM CST

Title: Pre-Presentation and Gels

Date: 2/19/2020

Content by: Payton Parmett

Present: All

Goals: Finalize powerpoint for preliminary presentations, create 1% gel

Content:

We got together and finalized our plan for the preliminary presentation on Friday. We also created our 1% gel "brain" layer, which we will bring to our presentation for a demo.

The gel process was documented; see the team activities -> fabrication folder.

Conclusions/action items:

Continue working on gel layers for imaging. Next time we meet, we will make the next layer of gels.

2/24/20 Midterm Deliverables

Payton Parmett - Feb 25, 2020, 10:53 AM CST

Title: Midterm Deliverables Meeting

Date: 2/24/2020

Content by: Payton Parmett

Present: Whole team

Goals: Work on midterm deliverables

Content:

The team met to finish the midterm deliverables (team notebook and midterm report). We had to make a change to the overall format of the report since we do not have a ton of new background information and also had no design matrix from this semester. Instead, we focused the report on the slight design updates and project timeline we have created.

We also plan to meet with our client Dr. Block this week.

Conclusions/action items:

Continue work on gels, meet with client, turn in midterm deliverables by Wednesday at 4pm.

3/3/20 Clot Gels

Payton Parmett - Mar 03, 2020, 9:25 PM CST

Title: Clot Gels

Date: 3/3/20

Content by: Payton Parmett

Present: All

Goals: Document team meeting activities (creating clot gels)

Content:

The team met Tuesday night to create the "clot" gels to be suspended in the "brain" base layer. These clot alginate concentrations were 0.5%, 2%, 4%, and 5% alginate. These will sit overnight and the team will meet up again tomorrow (Wednesday night 3/4/20) to put the clots in the base layer and put the top "brain" layer seal over. This will be delivered to Dr. Block at our meeting on Thursday morning.

Conclusions/action items:

Meet up again tomorrow to make the top layer.

3/4/20 Top Brain Gel Layer

Payton Parmett - Mar 04, 2020, 8:04 PM CST

Title: Meeting - Top Brain Gel Layer

Date: 3/4/2020

Content by: Payton Parmett

Present: All

Goals: Make top "brain" layer to cover "clots" that we made yesterday

Content:

Today we made the top 1% "brain" layer to cover the "clot" gels, which we removed from the old sample holder (which we used as the template). They turned out great, the pour of top layer over the clots went very smoothly. We plan to let the gels set overnight and we will drop off the complete layered phantom to our client at our meeting tomorrow morning (Thursday 3/5).

Conclusions/action items:

Drop clots off tomorrow morning at our meeting.

2/24/2020 - Stage 1 Outline

Payton Parmett - Feb 24, 2020, 12:22 PM CST

Title: Stage 1 Outline

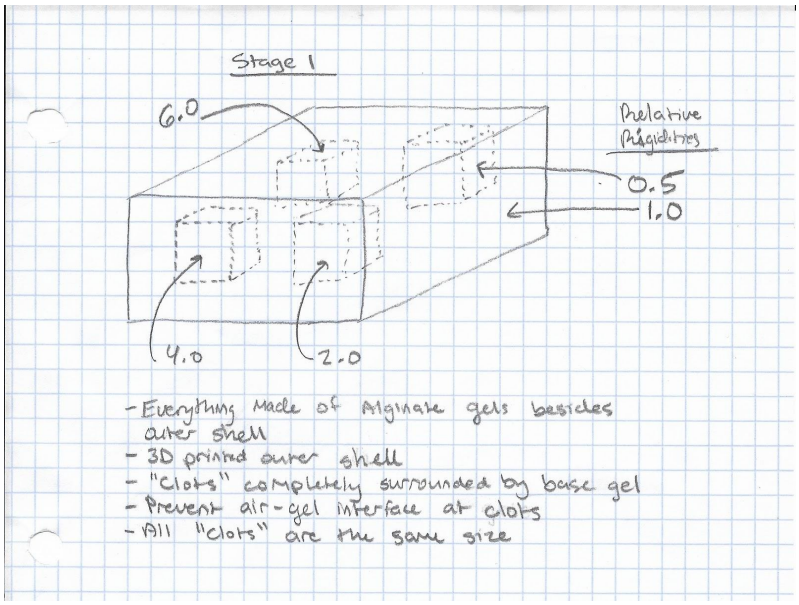
Date: 2/24/2020

Content by: Alex Truettner

Present: Alex Truettner

Goals: Document a drawing/plan for stage 1 of the timeline

Content:



This is the drawing for stage 1 of our timeline for the semester. We will test "clots" of the same size with varying rigidity and a "brain" surrounding gel rigidity of 1% alginate. The "clot" gels will be completely surrounded by the "brain" gels so that there is only gel-gel interface for rigidity testing. The rigidity of the best image will be refined in the next stage.

Conclusions/action items:

This plan was added to our project outline and will be executed later in the semester

2/24/2020 - Stage 2 Outline

Payton Parmett - Feb 24, 2020, 12:24 PM CST

Title: Stage 2 Outline

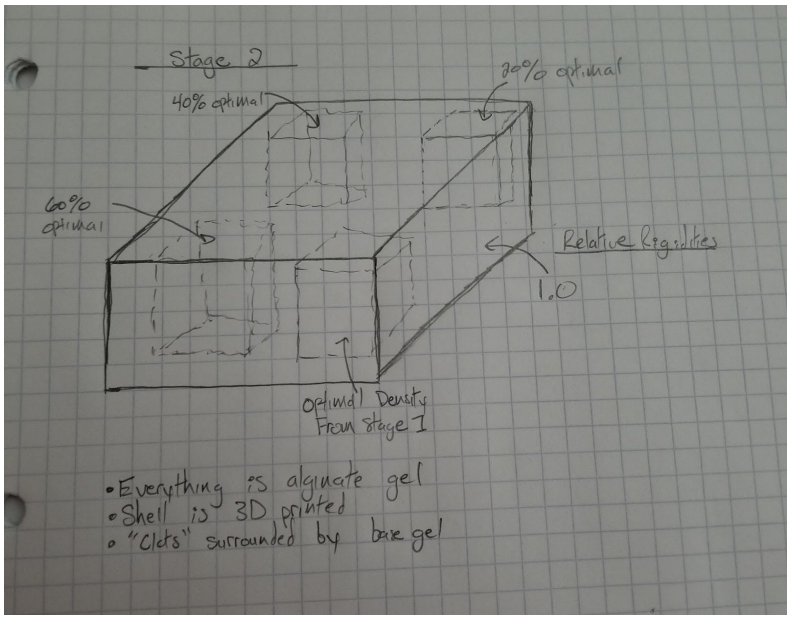
Date: 2/24/2020

Content by: Joe Kerwin

Present: Joe Kerwin

Goals: Document a drawing/plan for stage 2 of the timeline

Content:



This is the drawing for stage 2 of our timeline for the semester. We will refine the "clot" rigidities based on the optimal rigidity from stage 1. This will help to further refine the optimal density to use for imaging moving forward. This stage consists of the same setup as before (all gel-gel interface, 1% "brain" gel, same size clots)

Conclusions/action items:

This plan was added to our project outline and will be executed later in the semester

2/24/2020 - Stage 3 Outline

Payton Parmett - Feb 24, 2020, 12:25 PM CST

Title: Stage 3 Outline

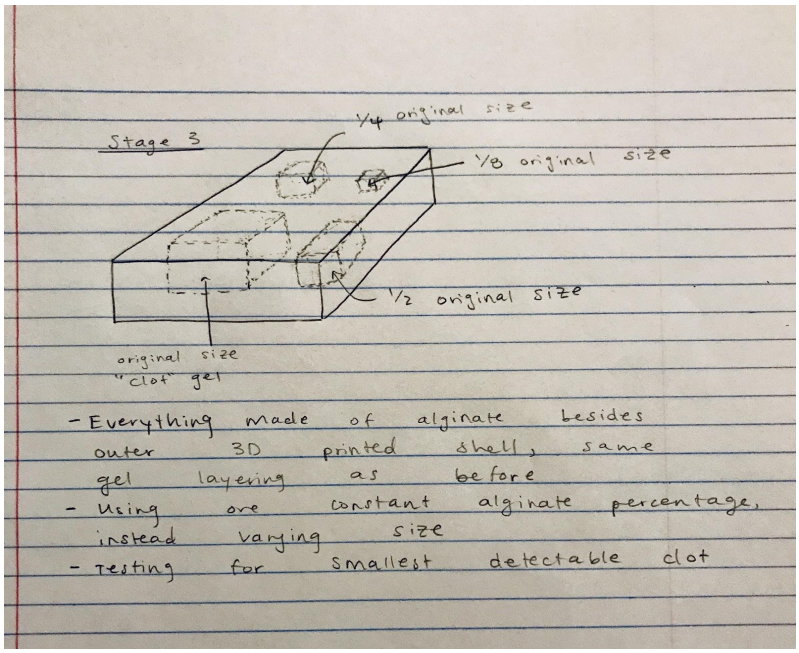
Date: 2/24/2020

Content by: Payton Parmett

Present: Payton Parmett

Goals: Document a drawing/plan for stage 3 of the timeline

Content:



This is the outline of stage 3 of our plan for the semester. This stage consists of testing "clots" of different sizes to see how small we can go before we no longer get a clear image. This will test the capabilities of the imaging technology/our model. We will use one constant rigidity for all of the clots (this rigidity will be determined in stage 2).

Conclusions/action items:

This plan was added to our project outline and will be executed later in the semester

2/24/2020 - Stage 4 Outline

Payton Parmett - Feb 24, 2020, 12:29 PM CST

Title: Stage 4 Outline

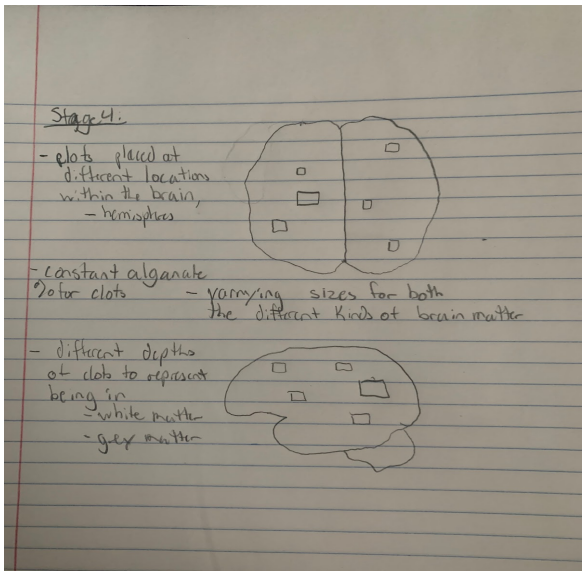
Date: 2/24/2020

Content by: Kurt Vanderheyden

Present: Kurt Vanderheyden

Goals: Document a drawing/plan for stage 4 of the timeline

Content:



This image outlines stage 4 of the plan for the semester. This stage consists of changing the sample holder for the first time, rather than the clots. We will aim to make the sample holder anatomically relevant by 3D printing a brain shell and potentially accounting for different layers of gray or white matter or other vasculature. The clots can be played with at varying rigidities or depths, etc.

Conclusions/action items:

This plan was added to our project outline and will be executed later in the semester

2/25/2020 - Expense Table

JOSEPH KERWII

Title: Expense Table

Date: 2/25/2020

Content by: Team

Present: Team

Goals: Document material purchases and information.

Content:

Item	Description	Manufacturer	Part Number	Date	QTY	Cost Each	Total	Link
Sodium Alginate	250g of Sodium Alginate	Acros Organics	AC177772500	11/8/2019	1	$46.53	$46.53	https://solutions.sciquest.com/apps/Router/Home?CatalogSea
3D Printed Case	3D Printed Model	Makerspace Lab	N/A	10/24/2019	1	$28.49	$28.49	N/A
						TOTAL:	$75.02	

- 3D Printed Case 2.0	Makerspace Lab	N/A	1/28/2020	1	$27.08
- 3D cavity Fillers	Makerspace Lab	N/A	2/10/2020	1	$7.98

- New Total = $110.08

This is the most up-to-date material purchase records we have so far. We do not anticipate a significant change to this table throughout the rest of the semester.

Conclusions/action items:

N/A

2/19/20 - 1% Gel Fabrication Process

JOSEPH KERWIN - Feb 26, 2020, 12:55 PM CST

Title: 1% Gel Fabrication Process

Date: 2/19/20

Content by: Payton Parmett

Present: All

Goals: Document detailed steps of how we created 1% "brain" gel layer.

Content:

1. Dissolve alginate in warm water
2. Add CaCO3 and Glucono-δ-lactone
3. Mix gel thoroughly
4. Pour gel into holder for base layer
5. Place fillers in desired location for cavities
6. Allow the clot gel to set in a fridge
7. Repeat steps 1-4 for gel iterations
8. Pour the base gel into the cavity and allow the gel to set in the fridge
9. After second 1% layer is made slowly pour over the "clot gels" and the base layer gel.
10. Let whole phantom set in fridge

Conclusions/action items:

- This is the best way we have found to make the gels as homogenous and sturdy as possible.

1/26/2020 - Gel procedure

Payton Parmett - Feb 24, 2020, 6:58 PM CST

Title: Gel formation procedure

Date: 1/26/2020

Content by: Payton Parmett

Present: Payton Parmett

Goals: Catch myself up on how to make the gels

Content:

**Taken from notebook in the fall:

Alginate gel formation:

From old notebook

1. Dissolve alginate in water

    -Alginate comes as sodium alginate dust from supplier

2. Add $CaCO_3$ and glucono-휎-lactone

3. Mix gel thoroughly

4. Before gel sets, scoop into a fingertip of a latex glove

5. Tie the top of the latex glove off, ensuring no air gets in

6. Allow clot gel to set in a fridge

7. Repeat steps 1-4 to get 2% base gel

8. Suspend clot in cavity of container using a wooden stick

9. Pour base gel into cavity and let set in fridge

MSDSs:

Sodium alginate powder:

https://www.fishersci.com/store/msds?partNumber=AC177770050&productDescription=ALGINIC+ACID+SODIUM+SALT+5G&vendorId=VN00032119&countryCode=US&language=en

Conclusions/action items:

Use this information to make gels this semester

2/26/2020 - Solidworks Files for Simple Container v3

Alexander Truettner - Feb 26, 2020, 11:10 AM CST

Title: Solidworks Files

Date: 2/26/2020

Content by: Alex

Present: Myself

Goals: Document solidworks files for the container and cavity fillers for future reference.

Content:

Files attached below.

Conclusions/action items:

Files are here so the whole team can access them.

Alexander Truettner - Feb 26, 2020, 11:10 AM CST

Large_Cavity_Fillers.SLDPRT(83 KB) - download

Alexander Truettner - Feb 26, 2020, 11:10 AM CST

Simple_Container_v3.SLDPRT(79.8 KB) - download

2/12/2020 - Relevance research

Alexander Truettner - Feb 24, 2020, 1:50 PM CST

Title: Relevance Research

Date: 2/12/2020

Content by: Alex

Present: Myself

Goals: Do some more research to supplement what has been done in fall of 2019.

Content:

[1] Research project on using anticoagulants on thrombosis in the cerebral sinus

- Two trials -- one with IV unfractionated heparin, and the other with high dose LMW heparin
- After trials, there were no new symptomatic intracerebral hemorrhages
- Anti-coagulant treatment appeared to be safe to treat thrombosis.
- Use of anti-coagulants increases risk of bleeding out due to blood thinning
- Results not completely conclusive, did not reach statistical significance
- Shows promise of this type of treatment of this kind of clot

[2] Does Acute Endoscopic Evacuation Improve the Outcome of Patients with Spontaneous Intracerebral Hemorrhage?

- Suction irrigation system evacuation technique using 6-mm endoscope
- 38% evacuated completely, 53% subtotally, and 9% partially
- 1 complication with re-bleeding
- Good technique to evacuate bleeding in the brain
- Small study was completed so again hard to state if results showed statistical significance

Conclusions/action items:

This research helped clarify types of evacuation that neurosurgeons use for patients with intracerebral hemorrhaging. Will be of good use for further reference throughout this project.

Sources:

[1] https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD002005/abstract

[2] https://doi.org/10.1159/000115804

2/24/2020 - Competing Designs

Alexander Truettner - Feb 24, 2020, 9:19 PM CST

Title: Research on possible competing designs

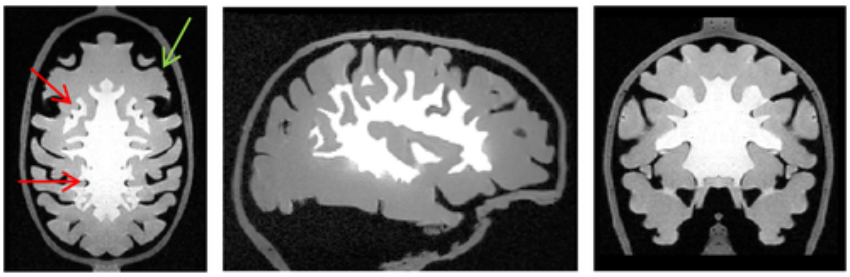
Date: 2/24/2020

Content by: Alex

Present: Myself

Goals: Look into any competing designs to ensure that we don't make something someone else has already worked on.

Content:

- Article [1]
    - This research focused on a new material used for brain phantoms, specifically a new hydrogel composition to mimic brain tissue.
    - This used PVA (hydrophilic synthetic polymer), PHY (gelling agent), and DI water.
    - Mechanical testing was done on their new hydrogel to see if it mimicked properties of brain tissue
    - Overall, this project mainly focused on producing a new hydrogel rather than mimicking brain clots or ICH. I do not believe our project will be in competition with this, as we are not creating new gels, rather, attempting to create differences in rigidity.
- Article [2]
    - Focused on creating a brain phantom that had two compartments, both to be used in T1 scanning, where one simulated gray matter T1 properties and the other simulated white matter T1 properties.
    - Gels made with agar containing contrasting agent
    - 3D printed casts, silicone molds utilized for creation of gels
    - Three phantoms made, each one differing the interface between the two gels
        - #1 used no separation
        - #2 used a varnish layer between gels
        - #3 used a thin wax layer between gels
    - They found that with no barrier, contrasting agent easily diffused between the two gels
    - The varnish layer provided protection from diffusion for a short time period
    - The wax layer provided multiple days of protection against diffusion
    - 
    - Shown here, you can see their results, and very clear differentiation between white and gray matter
    - This is a very interesting study, however it is apparent that this research was not done to mimic rigidity, rather, the T1 properties of white/gray matter. This may be nice for reference if we want to have a gel-gel interface that resists diffusion of gels. Overall, continue to check back on this reference throughout the project to ensure that we don't start doing work that they have done.

Conclusions/action items:

- Continue to keep these designs documented so that they are not replicated
- Research more should we decide to change our design in the future

References:

[1] https://www.sciencedirect.com/science/article/pii/S0264127516312370

[2] https://www.ncbi.nlm.nih.gov/pubmed/30221790

4/6/20 - Mechanical Testing Research

Alexander Truettner - Apr 29, 2020, 10:49 AM CDT

Title: Mechanical Testing Research

Date: 4/6/20

Content by: Alex

Present: Myself

Goals: Look into mechanical testing to see how we can do it with gels

Content:

- Compression testing
    - used to measure material behavior under compressive loads
    - applies pressure to a material
    - measurements are taken by machine to create a stress-strain diagram
    - elastic modulus can be calculated from that stress-strain diagram
        - (slope of linear region)
- this type of testing is used all over the world for many different applications, such as car windshields, concrete samples, almost everything.
- Compression testing usually used on brittle materials or ones that don't hold up well under tension
- Compression tests are usually done on a material that is already in its finished form
- Machine in tissue engineering lab will allow us to do this type of test on the gel clots

Conclusions/action items:

Apply knowledge from BME 315 labs using the MTS machine to apply to this project. Compare to shear modulus results from MRE scans.

Source:

[1] “What is Compression Testing?,” *Instron*. [Online]. Available: https://www.instron.us/en-us/our-company/library/test-types/compression-test. [Accessed: 29-Apr-2020].

4/14/20 - Shear Wave Research with MRE

Alexander Truettner - Apr 29, 2020, 10:32 AM CDT

Title: Shear Wave and MRE Research

Date: 4/14/20

Content by: Alex

Present: Myself

Goals: Research MRE and how shear waves are used for analysis

Content:

- Wave length is equal to wave speed divided by frequency
- stiffness is directly related to wave speed squared times density of tissue
- if shear wavelength can be estimated, shear modulus can be calculated.
- When we get to mechanical testing, we will get shear modulus
- use equation
    - E =2G(1+v)
    - where E is elastic modulus, G is shear modulus, v is Poisson's ratio
- MRE uses Dynamic Mechanical Analysis to analyze the shear modulus during a scan
- Computer does a lot of the work for us

Conclusions/action items:

When we get results from scan, including shear modulus readings, we can compare those to our tested elastic modulus readings

Sources:

[1] S. I. Ringleb, Q. Chen, D. S. Lake, A. Manduca, R. L. Ehman, and K.-N. An, “Quantitative shear wave magnetic resonance elastography: Comparison to a dynamic shear material test,” *Magnetic Resonance in Medicine*, vol. 53, no. 5, pp. 1197–1201, Apr. 2005.

2/25/2020 - Simple Container v3

Alexander Truettner - Feb 25, 2020, 7:09 PM CST

Title: Simple Container v3

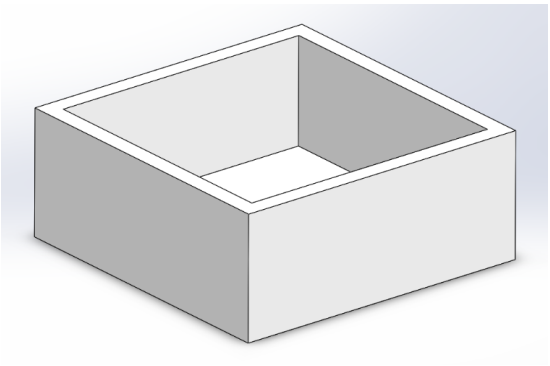
Date: 2/25/2020

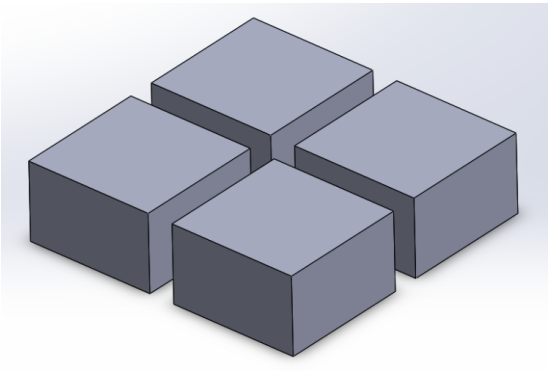
Content by: Alex

Present: Myself

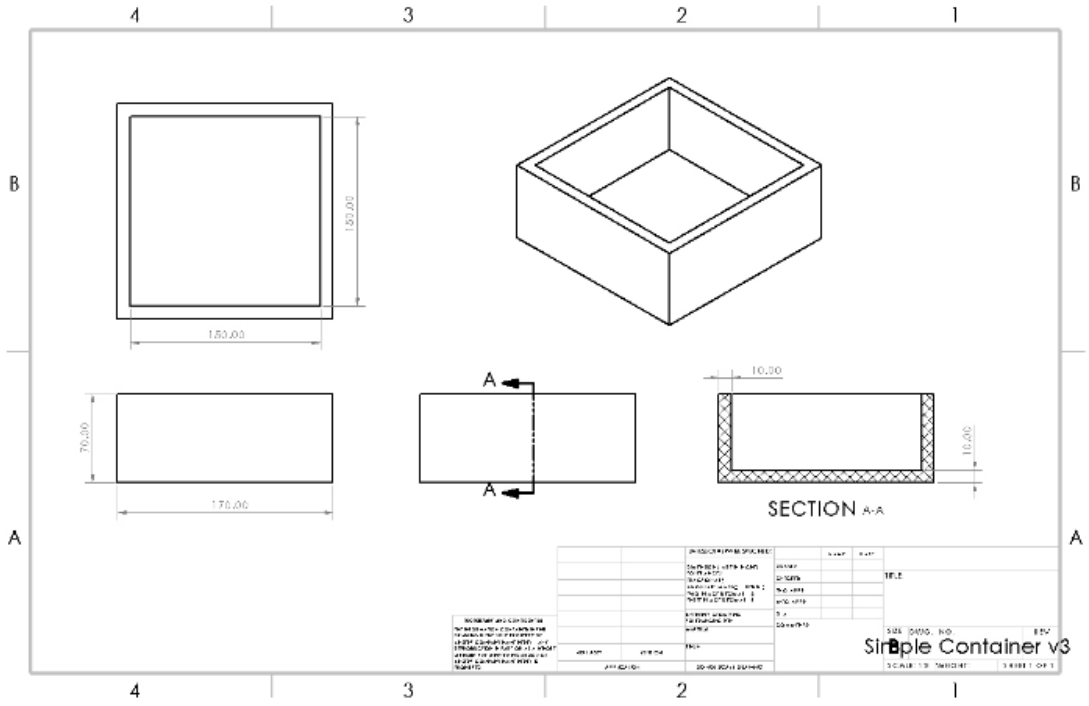
Goals: To document the Solidworks files for this holder as well as show images of what the design is.

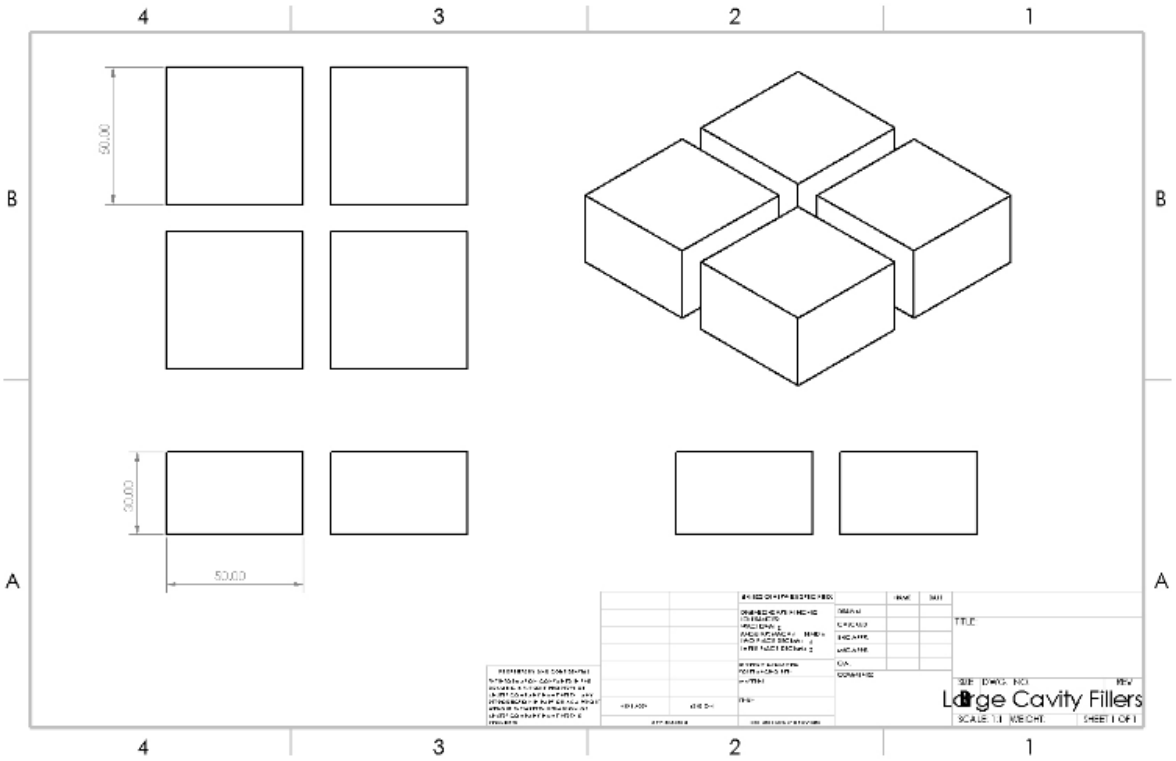
Content:





Isometric views of the container and the cavity fillers to create holes for clot gels.





Drawings of each part showing dimensions. Dimensions are in mm.

Conclusions/action items:

Good to have these documented for future reference and so other team members can access the files.

Alexander Truettner - Feb 25, 2020, 7:09 PM CST

Simple_Container_v3.SLDPRT(79.8 KB) - download

Alexander Truettner - Feb 25, 2020, 7:09 PM CST

Large_Cavity_Fillers.SLDPRT(83 KB) - download

2/24/2020 - Green Pass

Alexander Truettner - Feb 24, 2020, 9:13 PM CST

Title: Green Pass

Date: 2/24/20

Content by: Alex

Present: Myself

Goals: Document green pass

Content:

TEAMLab Green Shop Permit Makerspace

Name: Alexander Truettner

Woodworking 1: Woodworking2: Woodworking3:

Welding1: Welding 2: Welding 3:

CNC Mill 1: CNC Mill 2: CNC Mill 3: CNC Mill 4:

CNC Lathe 1: CNC Lathe 2: Haas1: Laser1:

Ironworker 1: Coldsaw1: CNC Router 1: CNC Plasma1:

College of Engineering
UNIVERSITY OF WISCONSIN-MADISON

TEAMLab
Technical Education and Manufacturing

makerspace

Green Permit

Permit No: KU-11510-G

Issue Date: 2-26-2019

Name: Alexander Truettner

User Signed:

Display Other Side in Holder

Conclusions/action items:

2/24/2020 - Biosafety

Alexander Truettner - Feb 24, 2020, 9:15 PM CST

Title: Biosafety Documentation

Date: 2/24/2020

Content by: Alex

Present: Myself

Goals: Show that I have biosafety level 1 to use tissue lab.

Content:

University of Wisconsin-Madison

This certifies that ALEXANDER TRUETTNER has completed training for the following course(s):

Course Name	Curriculum or Quiz Name	Completion Date	Expiration Date
Biosafety Required Training	Biosafety Required Training Quiz	3/7/2019	

Data Effective: Thu Mar 7 16:02:41 2019
Report Generated: Sun Mar 10 12:04:56 2019

Conclusions/action items:

Research on MRI functioning 2-10-20

JOSEPH KERWIN - Feb 26, 2020, 1:00 PM CST

Title: Research on MRI functioning

Date: 2/10/20

Content by: Joe Kerwin

Present: Me

Goals: To understand how MRI functions and the different types of images produced in order to better understand the images we will be obtaining later in the semester.

Content:

I went to the National Institute of Biomedical Imaging and Bioengineering's page about MRI in order to better understand the images that we have received in the past and will be receiving.

“Magnetic Resonance Imaging (MRI),” *National Institute of Biomedical Imaging and Bioengineering*. [Online]. Available: https://www.nibib.nih.gov/science-education/science-topics/magnetic-resonance-imaging-mri. [Accessed: 05-Dec-2019].

Summary:

MR creates a powerful magnetic field that causes protons in the body to align with the field. As the MR machine is turned off, the protons are temporarily thrown out of equilibrium and take time to get back into equilibrium. The MR machine then measures the energy released during realignment , and the time taken to realign. This information is then relayed into the images we received. Hence the difference in stiffness between the base gels and clot gels are distinguishable in the images due their differing responses to realignment.

Conclusions/action items:

- The observable differences in stiffness we have and will observe come from the difference in response properties of the two gels during realignment with the magnetic field.

- We should prioritize getting our first batch of samples in so we can begin looking at and interpreting the MRI images from the gel-gel interface.

Research on PET/SPECT scans of Brain Phantom 2/19/20

JOSEPH KERWIN - Feb 26, 2020, 1:02 PM CST

Title: Research on Similar project involving PET/SPECT scans of Braing Phantom

Date: 2/19/20

Content by: Joe Kerwin

Present: Myself

Goals: To understand other research done on this topic.

Content: Relevant Research

Three-dimensional brain phantom containing bone and grey matter structures with a realistic head contour

Hidehiro, Iida. et al. 2013

PMC3549246

Notes: Essentially this same project has been done except testing for PET/SPECT scans.

Info From Article: The team that conducted this experiment found positive results. They created a remarkably accurate 3D phantom of the brain which even included blood flow values accurate to the average human and had a head contour accurate to humans. The team used a hydrophobic photo-curable polymer that was laser-modeled. The inside of the brain phantom accurately modeled grey matter, the skull, and the trachea spaces. They ran tests with X-ray, CT, SPECT, and PET in order to test their software and the accuracy of the phantom. Their results were very positive and the phantom was found to be well-adapted to the imaging software.

Conclusions/action items:

- Clearly what we are trying to do is entirely feasible. However, it is highly unlikely we will meet this level of complexity or success in two semesters alone. The research team above consisted of 14 members. Along with this they had access to highly technological techniques like the laser-modeling they used. Even though the research team had access to far more equipment and resources then we will have access to, it is neat to see that we are not the only ones doing research on this and that other teams have found success with brain phantoms.

4/29/20 Importance of MRI Analysis

JOSEPH KERWIN - Apr 29, 2020, 12:51 PM CDT

Title: Importance of MRE Imaging Analysis

Date: 4/29/20

Content by: Joe Kerwin

Present: Just Joe

Goals: To discuss the importance of MRE imaging in the analysis of relative stiffnesses of clots in gel Brain Phantoms

Content:

Using MRE imaging, the relative stiffnesses of the clot gels to the base gels can be obtained and analyzed. MRE imaging uses shear waves sent through the gels to measure their propagation and create stiffness maps in order to compare the relative stiffnesses between the clot gels and the base gels. MRE imaging can be used to generate data on the T1 and T2 measurements of the gels. T1 and T2 relaxation measurements measure the time it takes for the material being imaged to be relaxed in the z-axis and x and y-axes respectively. Along with that, MRE imaging produces an elastogram image that gives an in depth comparison of the relative stiffenesses. The analysis of the T1 and T2 measurements along with the Elastogram image allows for in-depth data collection on the properties of clot gels suspended in base gels, that can be used as comparisons for MRE imaging uses in real patients.

Conclusions/action items:

- The use of MRE imaging in the data collection of stiffness measurements for gel Brain Phantoms can provide extremely insightful and useful benchmarks when compared to images of patients experiencing ICH.

2/24/2020 - Stage 2 Outline

JOSEPH KERWIN - Feb 26, 2020, 1:03 PM CST

Title: Stage 2 Outline

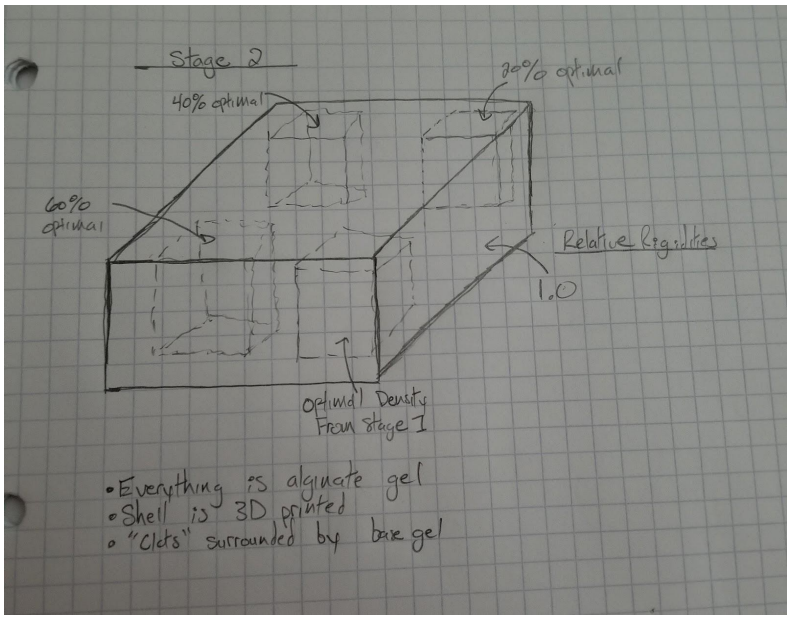
Date: 2/24/2020

Content by: Joe Kerwin

Present: Joe Kerwin

Goals: Document a drawing/plan for stage 2 of the timeline

Content:



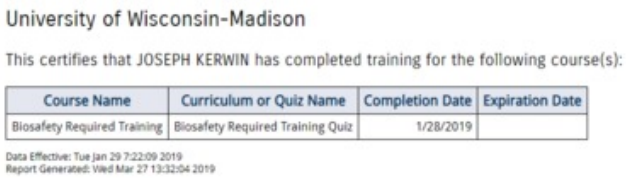
This is the drawing for stage 2 of our timeline for the semester. We will refine the "clot" rigidities based on the optimal rigidity from stage 1. This will help to further refine the optimal density to use for imaging moving forward. This stage consists of the same setup as before (all gel-gel interface, 1% "brain" gel, same size clots)

Conclusions/action items:

This plan was added to our project outline and will be executed later in the semester

Biosafety Training

JOSEPH KERWIN - Dec 11, 2019, 1:03 PM CST



University of Wisconsin-Madison

This certifies that JOSEPH KERWIN has completed training for the following course(s):

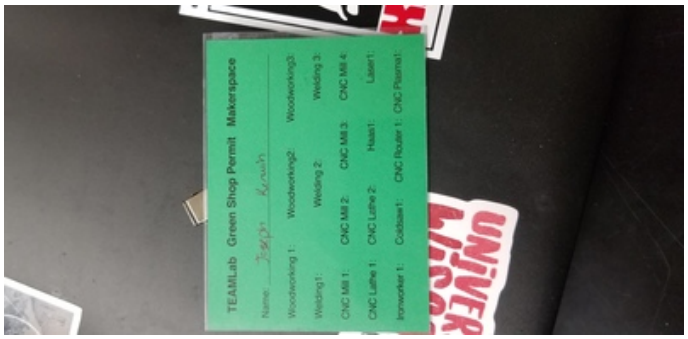
Course Name	Curriculum or Quiz Name	Completion Date	Expiration Date
Biosafety Required Training	Biosafety Required Training Quiz	1/28/2019	

Data Effective: Tue Jan 29 7:22:09 2019
Report Generated: Wed Mar 27 13:32:04 2019

Biosafety_2.PNG(24 KB) - download

Green Pass

JOSEPH KERWIN - Dec 11, 2019, 1:04 PM CST



Green_Pass_1.jpg(2.2 MB) - download

JOSEPH KERWIN - Dec 11, 2019, 1:04 PM CST

Green_Pass_2.jpg(2 MB) - download

1/26/2020 - Initial Research

Payton Parmett - Jan 26, 2020, 5:03 PM CST

Title: Initial Research

Date: 1/26/2020

Content by: Payton Parmett

Present: Payton Parmett

Goals: Catch myself up to speed with the prior work done on this project

Content:

What is ICH [1]:

-Blood suddenly bursts into brain tissue, causing brain damage by blood buildup blocking normal brain-oxygen flow

-Symptoms include headache, weakness, confusion, paralysis

-Immediate crisis, can lead to permanent brain damage if not treated quickly

-necrosis: cell death caused by external factors, such as infections, toxins, or trauma (in comparison to apoptosis, which is programmed cell death)

-Ischemic stroke: blood vessel to brain is blocked by blood clot (more common and less serious than ICH)

-Causes include high blood pressure, head trauma, ruptured cerebral aneurysm (weak spot in blood vessel bursts), bleeding disorders (hemophilia or sickle cell anemia), bleeding tumors, cocaine use

MRI scan types [2] [3] [4]:

The difference between T1 and T2-weighted images is the timing of radio-frequency pulse sequences, making them each highlight different things:

-T1: highlights fat tissue within the body (protein-rich fluids, melanin, subacute hemorrhage, MRI contrast, blood)

-T2: highlights fat AND fluid within the body (bile, urine, kidneys and gallbladder)

e.g. CSF is dark in a T1 but bright in a T2 image.

T1 imaging is effective when visualizing normal anatomy (e.g. musculoskeletal system or brain structure) because of the fat tissue within bone marrow. This makes T1 useful in diagnosing conditions such as leukemia and multiple sclerosis. The fact that water/other fluid glows brighter on T2 images, T2 is preferable when looking for inflamed regions or general pathology (e.g. reviewing condition of kidneys or looking for signs of kidney disease). T1 is most common when looking at the brain.

-MRE: Magnetic resonance elastography, new technique being explored by the Mayo. Very similar to MRI but has been slightly tweaked to send vibrations through muscles/etc to measure their vibration; a more elastic substance vibrates more and a more rigid substance vibrates less.

Conclusions/action items:

Use this information as a basis to understand the context of the device and to educate design decisions moving forward.

References:

[1] https://www.healthline.com/health/lobar-intracerebral-hemorrhage#causes

[2] https://www.radiologymasterclass.co.uk/tutorials/mri/t1_and_t2_images

[3] https://blog.healthcare.oxinst.com/t1-vs-t2-mri-imaging-guide-to-understanding-the-primary-difference/

[4] https://www.scandirectory.com/article/scan-basics/mri-mra-mre

2/9/2020 - Clinical Relevance Research

Payton Parmett - Feb 10, 2020, 10:14 PM CST

Title: Clinical Relevance Research

Date: 2/9/2020

Content by: Payton Parmett

Present: Payton Parmett

Goals: Identify the answers to some of the questions Dr. Hai proposed during our advisor meeting so that our project is clinically relevant

Content:

Q: What is the size of a normal clot? How small do we need to go that is reasonable?

A: There seems not be little to no literature on size of blood clots since the definition between embolus (loose clots) and thrombus (solidified in one spot) is not clear and often clots can span on and off throughout a whole branch of a vessel. I did, however, find literature on the size of normal vasculature in the brain: In one study done on the cerebral artery diameters of human fetuses, the smallest recorded diameter was found to be 0.7mm [1]. The clots that our model would represent are more likely to occur at an older age, so this number is likely smaller than we need to go in terms of clot diameter, but it would arguably be relevant and nice to do, if possible.

Q: Is there any precedence on a brain model accounting for gray/white matter?

A: I also could not find a lot on any precedence for a brain model, which is consistent with research the team did last semester. I did find a good image of an MRSI showing white matter, gray matter, and CSF in their respective regions, which may serve as a good basis for what the phantom can model when we get to that stage down the line. See attached image [2].

Conclusions/action items:

Sources:

[1] https://anatomypubs.onlinelibrary.wiley.com/doi/abs/10.1002/ar.1091500108

[2] https://onlinelibrary.wiley.com/doi/full/10.1002/1522-2594%28200009%2944%3A3%3C401%3A%3AAID-MRM10%3E3.0.CO%3B2-W

Payton Parmett - Feb 10, 2020, 10:16 PM CST

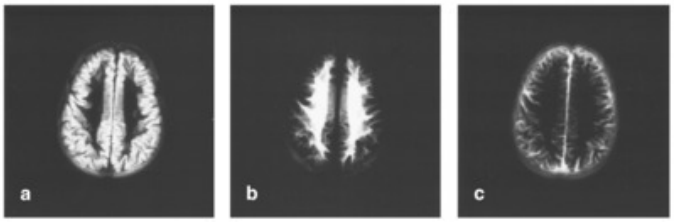


image.png(240.4 KB) - download This image shows a) gray matter b) white matter c) CSF in MRSI. This can serve as a basis for what our phantom will represent when we get to the phase of making our phantom more anatomically relevant.

4/16/20 - Clot extraction method

Payton Parmett - Apr 28, 2020, 9:56 PM CDT

Title: Clot extraction method

Date: 4/16/20

Content by: Payton Parmett

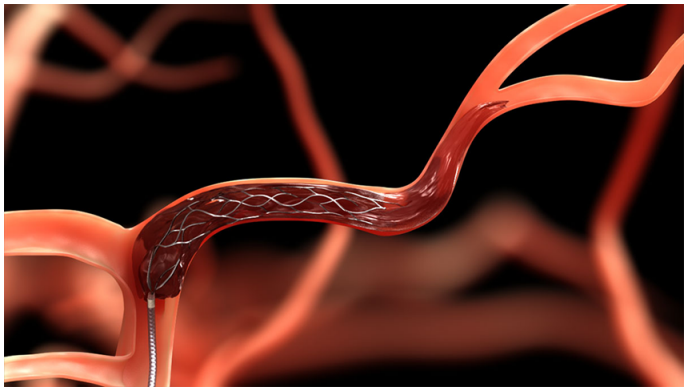
Present: Payton Parmett

Goals: Research a common method of clot extraction for some background knowledge

Content:

As this semester is winding down, I feel like I have a good grasp on the project but realized I have relatively little background knowledge on what a brain blood clot extraction procedure even consists of. What follows is my research of one main method of clot extraction for my own personal knowledge.

I found that since around 2015 (FDA approval 2012), a device called a stent retriever has been a prominent, effective method of clot removal that has shown quicker and fuller recovery in patients following ischemic stroke. The stent is inserted through an artery, often in the groin, collapsed within a catheter all the way up to the brain. The cage is then pushed out of the catheter and expands, ensnaring the clot, and is then pulled back into the catheter and out of the body. Apparently, suction is also applied from the catheter to improve clot removal.



Pictured above is an example of the stent cage capturing a clot in a blood vessel.

The whole procedure takes between 60 and 90 minutes and only leaves a 2mm incision in the leg, which allows for extremely fast recovery time in comparison to having to enter through the chest, neck, or brain. This is such an interesting concept and seems like there is so much potential that will be built on moving forward.

Conclusions/action items:

Now that I know more about how blood clots in the brain may be extracted, I feel slightly more prepared to handle problems within my career. I should work on researching procedures like this every once in a while in case I am ever in a position where I am working on a device to perform these procedures or could potentially adapt these concepts to some other procedure/device.

Source:

https://labblog.uofmhealth.org/health-tech/setting-a-trap-to-treat-stroke

2/26/2020 - Competing Designs

Payton Parmett - Feb 26, 2020, 12:38 PM CST

Title: Competing Designs

Date: 2/26/2020

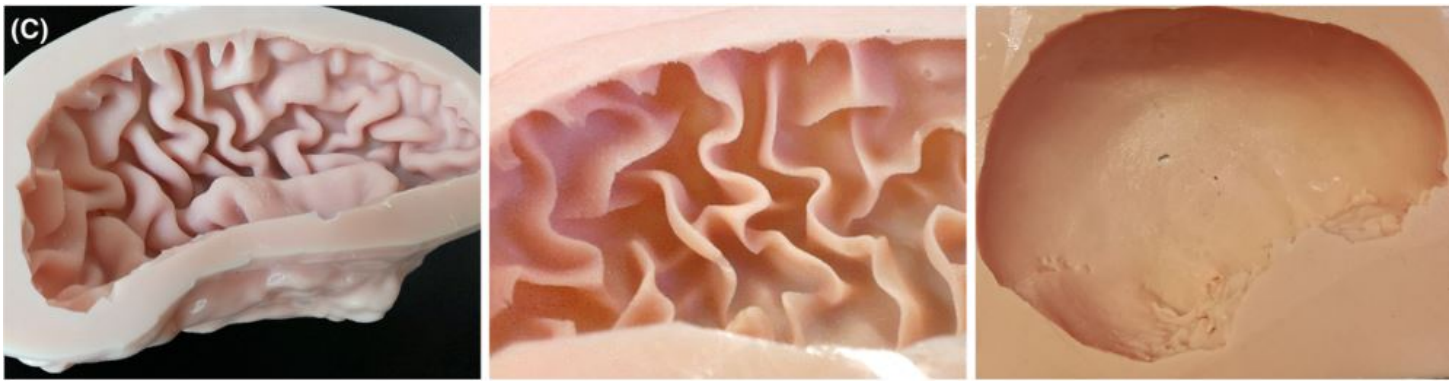
Content by: Payton Parmett

Present: Payton Parmett

Goals: Document literature on similar designs/concepts to our MRI phantom clot image database

Content:

There was not much I could find in general on competing designs. I did find one brain phantom, however, that will be a very useful concept for stage 4 of our outline, which is making the phantom anatomically relevant. This team from 2018 used agar gels to image their silicone mold phantom (in combination with MR contrast). Their design requires a hydrophobic layer between the gel and the contrast to keep the contrast from diffusing where it shouldn't. Their model was designed for T1 imaging exclusively, so it would be a good improvement if ours can do both (which we anticipate it being able to). They also discussed many uses for their phantom, including needle placement, tissue mimicking, etc, but nowhere did they mention clot stiffness analysis. Their brain size is also not accurate as they had to piece different parts together to make it hold; they also only created the model using the left hemisphere of the brain so it is not entirely accurate in terms of anatomical size of certain parts of the brain (and sulci placement are slightly off).



Pictured above is the silicone brain model that the team came up with. This is an interesting concept that gives more precision and accurate material properties than a 3D printed model would, which is something we should maybe consider moving forward. However, I'm sure the cost of this model is much higher than a 3D printed plastic holder. This was their approach to making the phantom:

-Whole-brain isotropic T1-weighted healthy patient images taken

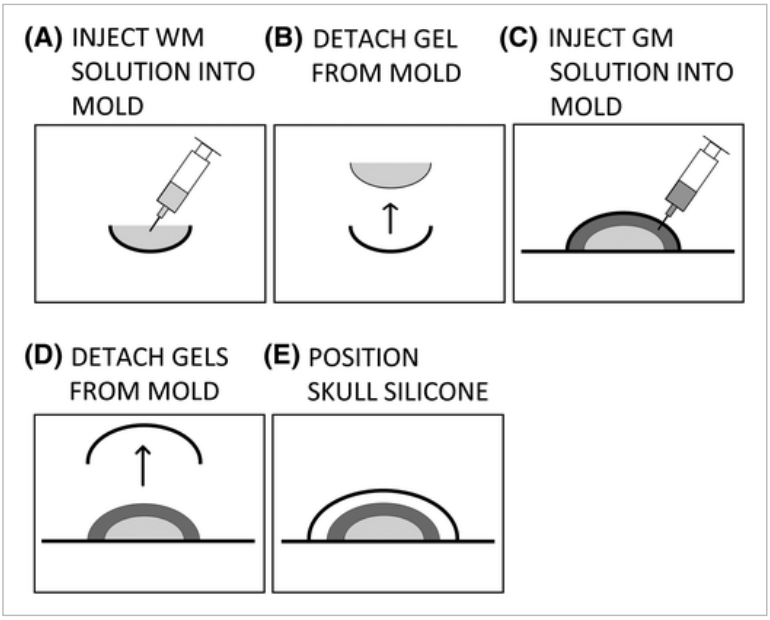
-3D slicer used to extract the inner skull mesh using thresholding and "change island" tools

-Final formatting, changed to STL file

-3D printed using PLA thermoplastic (white matter: resolution = 77,974 vertices, print time = 14 h 16 min, gray matter: resolution = 78,077 vertices, print time = 20 h 59 min, skull: resolution = 48,558 vertices, print time = 29 h 22 min, 0.2 mm slice thickness and including support for all prints).

-Brush on silicone rubber layer (3x)

-Below is the final stages of creating the phantom:



This process seems to have created a very detailed, useful phantom (see first image set), but this may be beyond what our client needs and also much more expensive/demanding than this course allows. Specifically, the long print times of the different parts of the phantom would probably not go well at the makerspace, as I have tried to do long prints in the past and the printers often run out of filament because no one is there watching them around the clock, which resulted in restarting the prints many times (one intricate print took about two weeks to finally get the full piece). Therefore, we would likely not have time to complete these prints. However, this process does serve as good insight into how we can create our anatomically relevant phantom.

Conclusions/action items:

This study involved the creation of an anatomically relevant phantom brain for T1 imaging. The phantom is a silicone rubber mold where white and gray matter gels can be placed. It is mostly anatomically accurate with some regions of error and requires a long and expensive process for production. At the very least, this information serves as a good basis for what we can do to make our phantom anatomically relevant later in the semester.

Article:

A. Altermatt et al., "Design and construction of an innovative brain phantom prototype for MRI", *Magnetic Resonance in Medicine*, vol. 81, no. 2, pp. 1165-1171, 2018. Available: 10.1002/mrm.27464.

1/26/2020 - Gel procedure

Payton Parmett - Feb 24, 2020, 11:59 AM CST

Title: Gel formation procedure

Date: 1/26/2020

Content by: Payton Parmett

Present: Payton Parmett

Goals: Catch myself up on how to make the gels

Content:

**Taken from notebook in the fall:

Alginate gel formation:

From old notebook

1. Dissolve alginate in water

    -Alginate comes as sodium alginate dust from supplier

2. Add CaCO3 and glucono-휎-lactone

3. Mix gel thoroughly

4. Before gel sets, scoop into a fingertip of a latex glove

5. Tie the top of the latex glove off, ensuring no air gets in

6. Allow clot gel to set in a fridge

7. Repeat steps 1-4 to get 2% base gel

8. Suspend clot in cavity of container using a wooden stick

9. Pour base gel into cavity and let set in fridge

MSDSs:

Sodium alginate powder:

https://www.fishersci.com/store/msds?partNumber=AC177770050&productDescription=ALGINIC+ACID+SODIUM+SALT+5G&vendorId=VN00032119&countryCode=US&language=en

Conclusions/action items:

Use this information to make gels this semester

2/24/2020 - Stage 3 Outline

Payton Parmett - Feb 24, 2020, 12:16 PM CST

Title: Stage 3 Outline

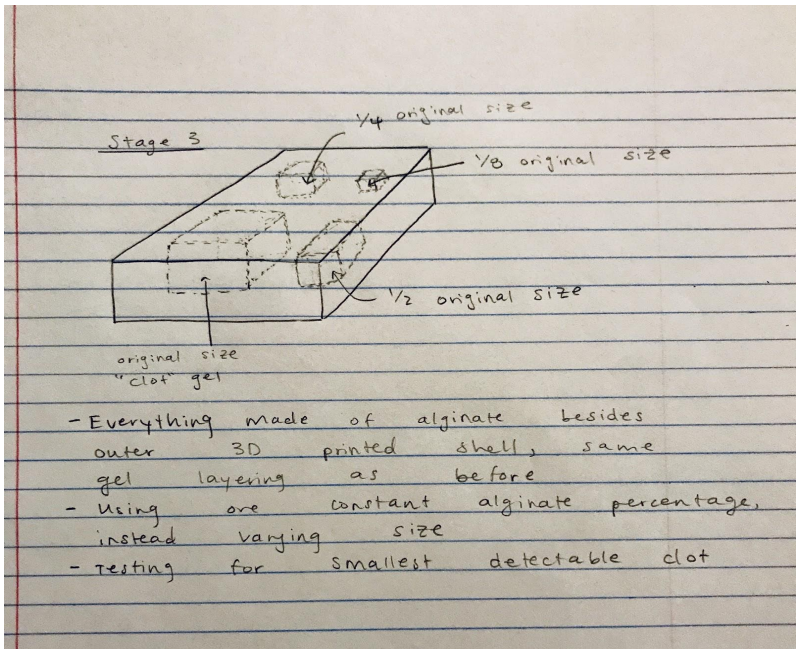
Date: 2/24/2020

Content by: Payton Parmett

Present: Payton Parmett

Goals: Document a drawing/plan for stage 3 of the timeline

Content:



This is my outline of stage 3 that I was assigned to do for our project outline for Dr. Block. This stage consists of testing "clots" of different sizes to see how small we can go before we no longer get a clear image. This will test the capabilities of the imaging technology/our model. We will use one constant rigidity for all of the clots (this rigidity will be determined in stage 2).

Conclusions/action items:

This plan was added to our project outline and will be executed later in the semester

3/9/2020 - Gel mechanical testing

Payton Parmett - Mar 09, 2020, 11:38 AM CDT

Title: Gel mechanical testing research notes

Date: 3/9/2020

Content by: Payton Parmett

Present: Payton Parmett

Goals: Research methods of testing mechanical properties of alginate gels.

Content:

After some research, I was able to find an article on compression testing done to an ionically crosslinked alginate hydrogel using an MTS machine, which is similar to what we plan on doing. I wanted to know about their methods so that we had an idea on where to start instead of just guessing. I also hoped to gain insight on things that could go wrong so that we could be prepared when we try this testing.

The article I found (see reference at end of entry) used an MTS Synergie 200. They did uniaxial compression testing at a crosshead speed of 4.8 mm/min and initial strain rate of 0.01 s^-1. We can use this as a basis for our machine settings. They also coated their gels in silicone oil from Aldrich. The goal of this was to reduce friction effects between the gel and the compression plates. This is something that we could potentially consider doing for ours as well; we will have to discuss as a team if this is important for our data.

Conclusions/action items:

This article gave good insight as a basis for our compression testing that we plan to do with the gels soon. We need to figure out which alginate %s we wish to test and can start playing in the lab soon.

Reference:

C. Kuo and P. Ma, "Maintaining dimensions and mechanical properties of ionically crosslinked alginate hydrogel scaffoldsin vitro", *Journal of Biomedical Materials Research Part A*, vol. 84, no. 4, pp. 899-907, 2008. Available: 10.1002/jbm.a.31375.

4/26/20 - Ideas for software integration of image database

Payton Parmett - Apr 28, 2020, 9:45 PM CDT

Title: Ideas for software integration of image database

Date: 4/26/20

Content by: Payton Parmett

Present: Payton Parmett

Goals: Brainstorm/research how a simple software could be created to make the comparison between patient scan and database image as smooth as possible

Content:

While we still have a lot of work to do on this timeline, it is fairly straightforward and planned out, so I was considering what else we would have to do after the phantom was complete. Once an entire database of images with known mechanical properties of clots was created, we would need an efficient way to go through all of these images to match the patient's to the sample instead of flipping through potentially hundreds of photos, depending on how specific the photos needed to be. There are a lot of unknowns with regard to how specific of a match the image would need, the variance within images that we would take and between different clots of the same rigidity/size, etc., but I thought it would be useful to at least look into how image comparison works. I found an article and took some notes on this process.

The basic concept that most image-comparison algorithms follow is some form of pixel-by-pixel comparison. The main characteristic compared between pixels is the color, which in our case would be completely grayscale. Different parameters to refine the algorithm of whether or not an image matches include the number of dissimilar pixels (pixel tolerance), a range of acceptable color difference to still be considered a match (color tolerance), and pixel transparency tolerance. So, the range of stiffnesses of clots and how specific the cutoff is between stiffnesses/methods of clot extraction will determine how specific the pixel matching needs to be. It is also worth considering how much of the image is going to be compared. For example, it may be much easier to zoom in on the clots as much as possible to avoid unnecessary comparison between matching tissue/CSF/etc and therefore runtime would be improved. Also, how will varying depths be accounted for? Would we do this by having images at all different ranges of depths and then compare within the right section of images, or would we make the software good enough to account for depth. How much do the images even vary with depth? This would likely all have to be explored via trail and error after a working anatomical phantom was created.

Conclusions/action items:

Researching the basics of software image comparison raised a bunch of new questions to eventually consider once a working phantom is made. It would be so nice for the surgeon to take the image of the clot, quickly put it through a software and receive material properties of the clot, allowing for the decision of which extraction type to use much faster and easier. These questions, mostly on what the variance between different clots is like, will have to be explored via trial and error after the working phantom is made.

Source: https://support.smartbear.com/testcomplete/docs/testing-with/checkpoints/regions/how-image-comparison-works.html

1/26/20 - Green Permit Documentation

Payton Parmett - Jan 26, 2020, 4:39 PM CST

Title: Green Permit Documentation

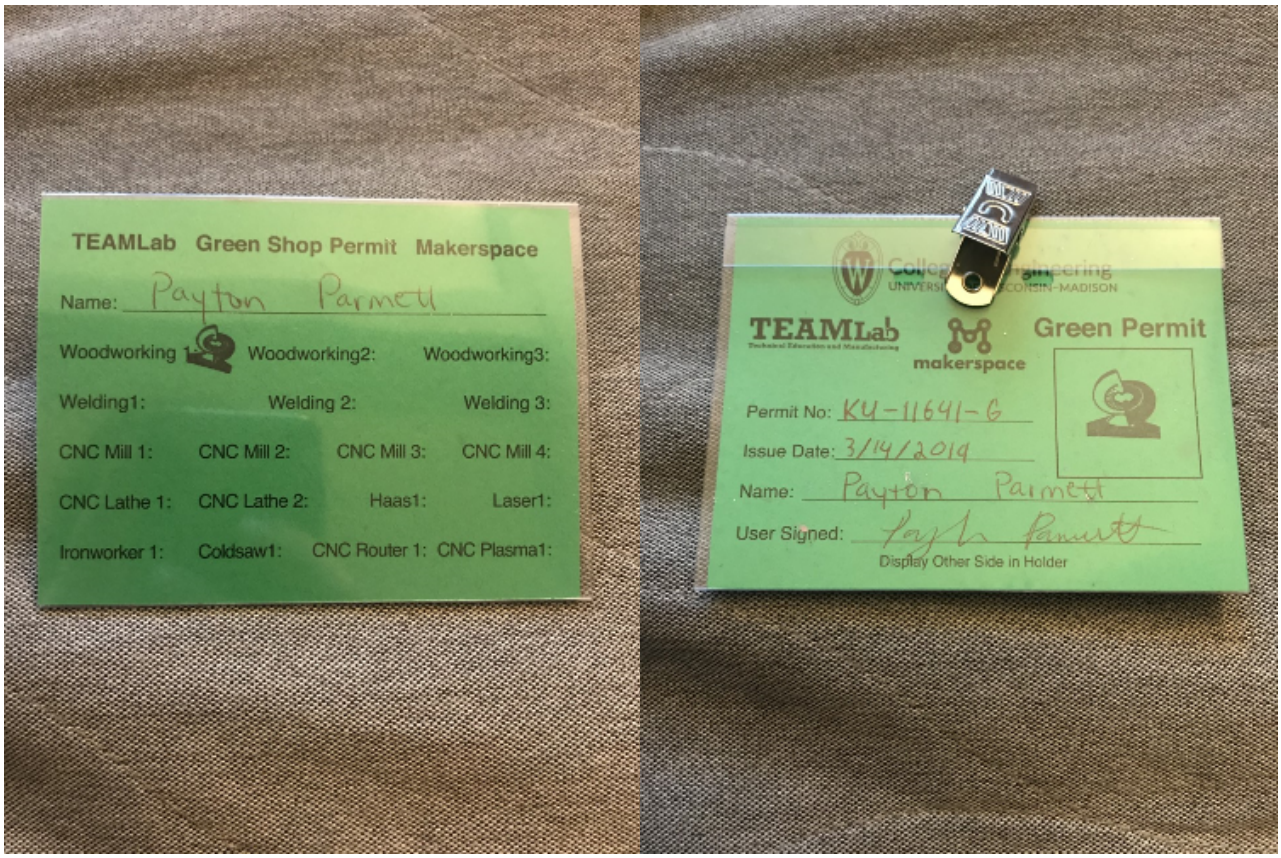
Date: 1/26/20

Content by: Payton Parmett

Present: Payton Parmett

Goals: Document green pass

Content:



Conclusions/action items:

This shows that I have the necessary training to work in the makerspace for anything we may need, e.g. 3D printing, housing construction for clots, etc.

2/24/2020 - Biosafety Training Documentation

Title: Biosafety Training Documentation

Date: 2/24/20

Content by: Payton Parmett

Present: Payton Parmett

Goals: Document my biosafety training

Content:

University of Wisconsin-Madison

This certifies that PAYTON PARMETT has completed training for the following course(s):

Course Name	Curriculum or Quiz Name	Completion Date	Expiration D
BIOSAFETY REQUIRED TRAINING	BIOSAFETY REQUIRED TRAINING QUIZ	3/20/2019	
RISK COMMUNICATION IN ANIMAL FACILITIES	RISK COMMUNICATION IN ANIMAL FACILITIES QUIZ	2/27/2019	
SAFETY FOR PERSONNEL WITH ANIMAL CONTACT	ANIMAL CONTACT PERSONNEL QUIZ	2/27/2019	

Data Effective: Thu Mar 21 7:25:13 2019
Report Generated: Mon Feb 24 12:01:05 2020

Conclusions/action items:

This documentation shows my biosafety training and completion dates; this shows that I am able to perform any lab tasks we will need this semester.

2/6/2020-Anatomical Clot Location

Kurt Vanderheyden - Feb 26, 2020, 12:04 PM CST

Title: Anatomical Clot Location

Date: February 6, 2020

Content by: Kurt Vanderheyden

Present: Kurt Vanderheyden

Goals: To find out more about blood clots that are normally located inside of the brain.

Content:

- clots generally begin by platelets causing a plug then proteins in the blood signal other clotting factors to come to the location causing the clot to grow
- Generally the body slowly breaks down the clot after it stops it growth, but sometimes this occurs too late
- blood clots can occur by blood not flowing properly or like in strokes, plaque inside of the brain suddenly bursts
- people with blood clots in their brain tend to have problems with vision, speech, seizures, and general weakness of the body
- G. Pichardo, “Blood Clots - How They Form and Common Causes,” *WebMD*, 20-Jan-2020. [Online]. Available: https://www.webmd.com/dvt/blood-clots#2. [Accessed: 6-Feb-2020]

Conclusions/action items:

This provided background to me on why the brain blood clots occur and possible outcomes of them. This allows for the real world connection to the problem we are trying to solve by showing the negatives of clots if they don't fully dissolve on their own. The goal of Dr. Block's work is to figure out ways to safely remove clots based on their location in the brain, and with our help and his overall work, prevention of strokes and other side effects of brain blood clots can hopefully be prevented.

2/13/2020-MRE Machine

Kurt Vanderheyden - Feb 26, 2020, 12:21 PM CST

Title: MRE Machine

Date: February 13, 2020

Content by: Kurt Vanderheyden

Present: Kurt Vanderheyden

Goals: To learn about the MRE machine that Dr. Block told us about.

Content:

- Magnetic resonance elastography is down by combining MRI with sound waves to show the stiffness of body tissues
- this was created by the Mayo Clinic primarily to detect liver hardening, but is also used to diagnose other diseases in the body
- MRE is used because it is noninvasive and more comfortable for the patient than a biopsy would be
- some risks of MRE are if there are metal parts in the body like prostheses, pacemakers, cochlear implants, artificial heart valves, etc.
- MRE examinations of the liver generally take less than 5 minutes and work by a small pad being placed on your body that emits a low frequency vibration, and then a computer measures the time it takes to pass through the organ being examined
- the stiffer the tissue, the faster the vibrations travel. The different stiffness are then plotted on a color coded map to show the stiffness in different regions of the organ
- “Magnetic resonance elastography,” *Mayo Clinic*, 17-May-2018. [Online]. Available: https://www.mayoclinic.org/tests-procedures/magnetic-resonance-elastography/about/pac-20385177. [Accessed: 13-Feb-2020].

Conclusions/action items:

From this information, I was able to understand what the MRE machine is, how it works, and why it is used. Since this a continuation from last semester, Joe and Alex knew information about this machine so I did some research to be caught up to speed. The main reason that this machine is used for the research we are working with is to show how the different stiffnesses of the gels are accurately measured, and to be able to apply this information in comparing normal brain material and clots found inside the brain.

2/6/2020- Stage 4

Kurt Vanderheyden - Feb 26, 2020, 12:08 PM CST

Title: Stage 4 of the process

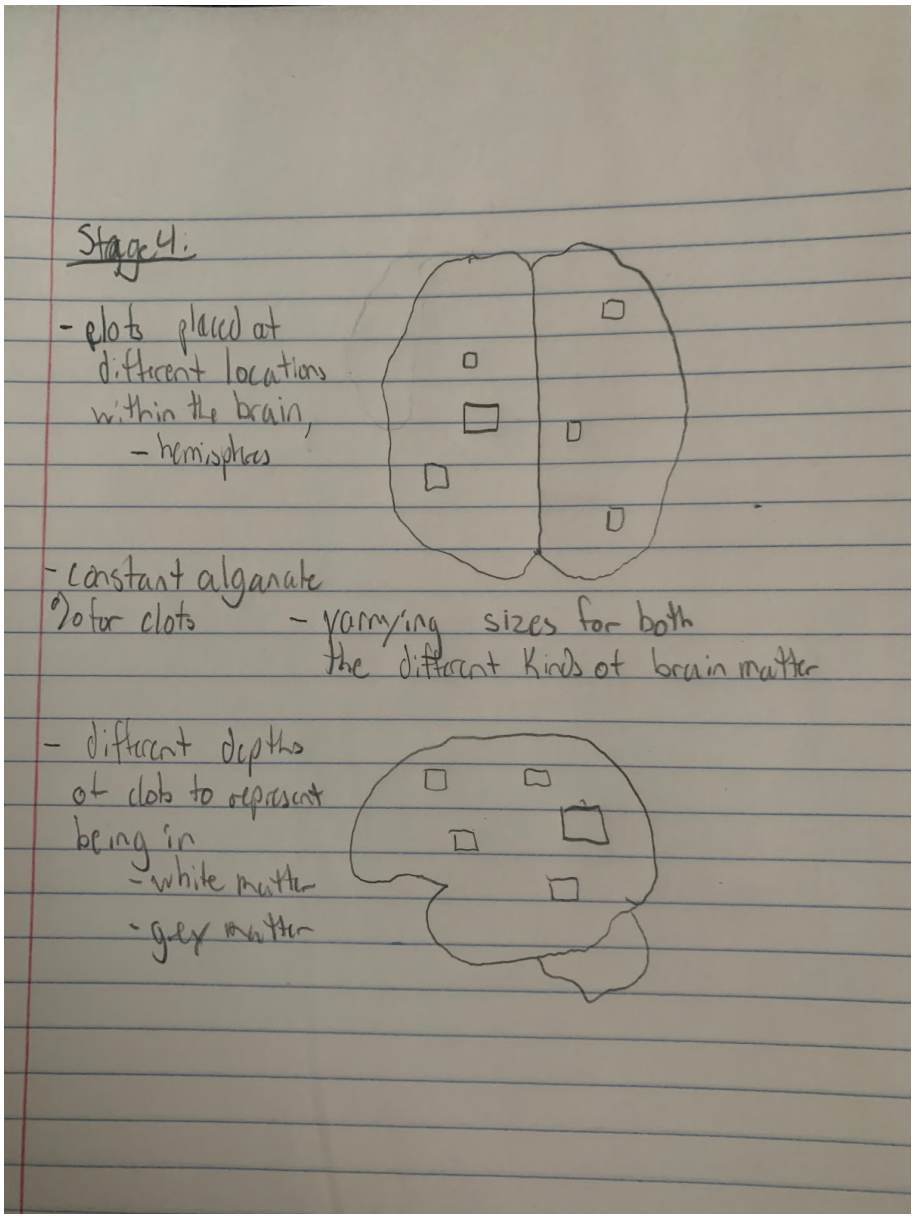
Date: February 6, 2020

Content by: Kurt Vanderheyden

Present: Kurt Vanderheyden

Goals: To draw out the 4th stage of the project

Content:



Conclusions/action items:

The final stage will be to update the phantom to incorporate anatomical relevance. The sample holder could be a 3D printed skull rather than a plastic bin, and the model could account for gray/white matter and any other important anatomical features. We can get more into the specifics of this model once we get closer to this stage.

2/26/2020- Green Pass

Kurt Vanderheyden - Feb 26, 2020, 12:23 PM CST

Title: Green Pass

Date: 2/26/2020

Content by: Kurt Vanderheyden

Present: Kurt Vanderheyden

Goals: To document my green pass.

Content:

Conclusions/action items:

Kurt Vanderheyden - Feb 26, 2020, 12:26 PM CST

IMG_0592.pdf(15.9 MB) - download

2014/11/03-Entry guidelines

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

Use this as a guide for every entry

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

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

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

Date: 9/5/2016

Content by: The one person who wrote the content

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

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

Content:

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

Conclusions/action items:

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

2014/11/03-Template

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

Title:

Date:

Content by:

Present:

Goals:

Content:

Conclusions/action items:

Notebook PDF from Fall 2019

Alexander Truettner - Jan 26, 2020, 10:58 AM CST

BME Design-Fall 2019 - JOSEPH KERWIN
Complete Notebook

PDF Version generated by

JOSEPH KERWIN

on

Dec 11, 2019 @ 03:26 PM CST

Table of Contents

Final_Notebook-Brain_Phantom.pdf(9.4 MB) - download

09/26/2018 3D Printing Skull from MRI Scans

JENNA EIZADI (eizadi@wisc.edu) - Dec 12, 2018, 3:38 PM CST

Title: 3D Printing Skull from MRI Scans

Date: 09/26/2018

Content by: Jenna Eizadi

Present: Jenna Eizadi

Goals: Learn about possible 3D printing map of skull from MRI scans

Content:

- video demonstrates that it is possible to 3D print a skull from MRI scans using certain technology
- https://www.youtube.com/watch?v=P5XM5_uxTjA

Conclusions/action items:

Research options for 3D printing that would work with our type of printers.

3D Print from MRI Scans

JENNA EIZADI (eizadi@wisc.edu) - Dec 04, 2018, 11:43 AM CST

Title: 11/03/2018 3D Print from MRI Scans

Date: 11/03/2018

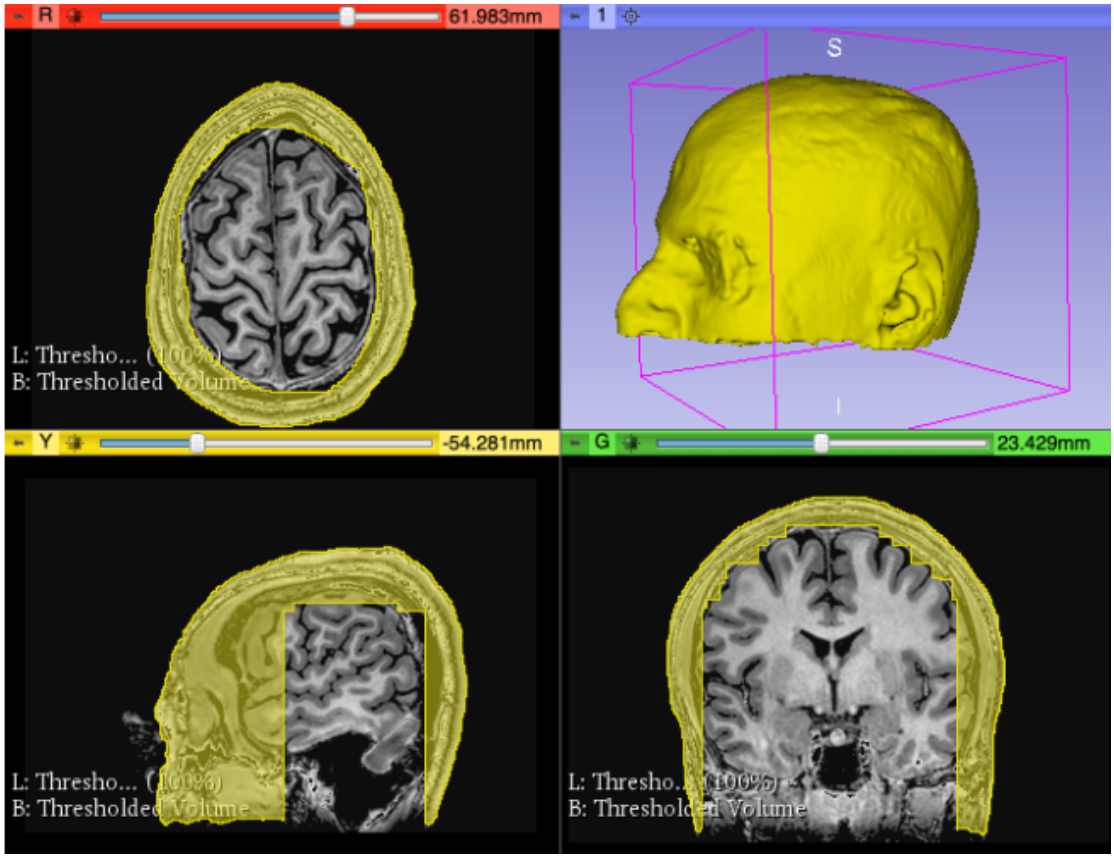
Content by: Jenna Eizadi

Present:

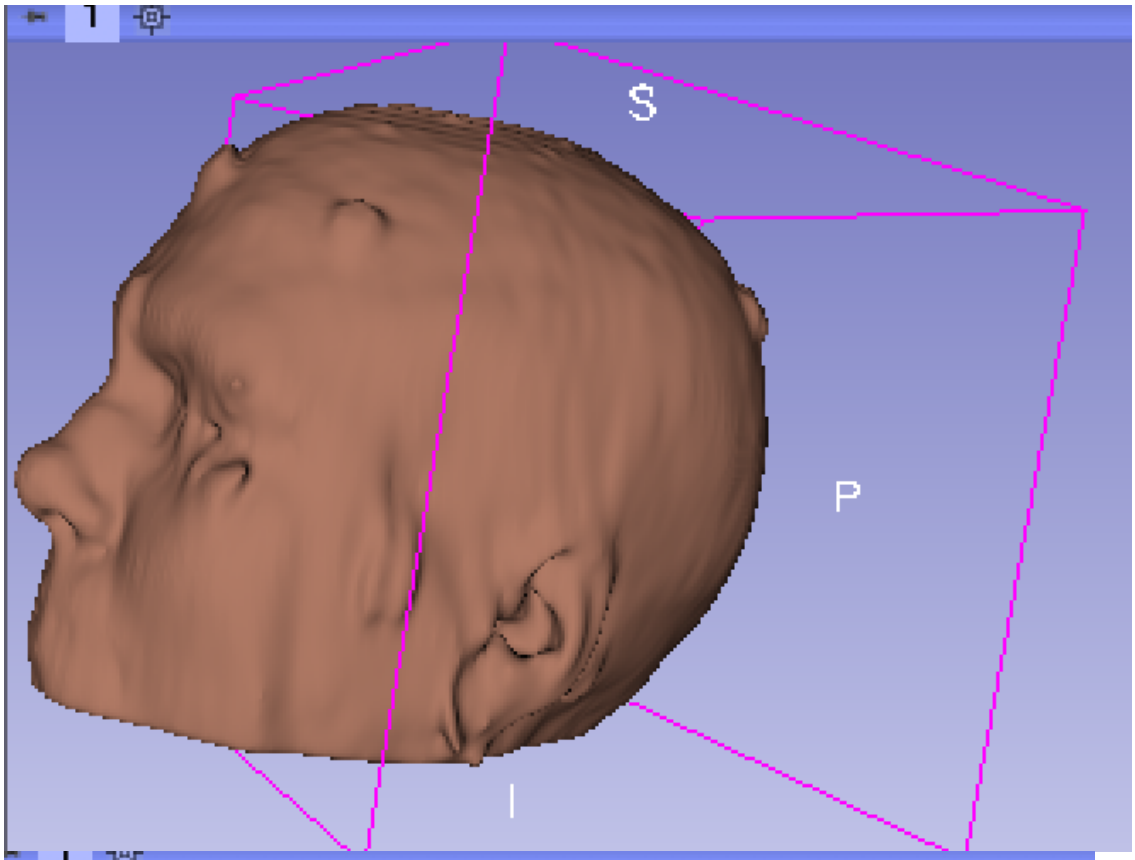
Goals: Use Slicer technology to create a printable model from MRI scans that is accurate and able to be 3D printed through the application Cura.

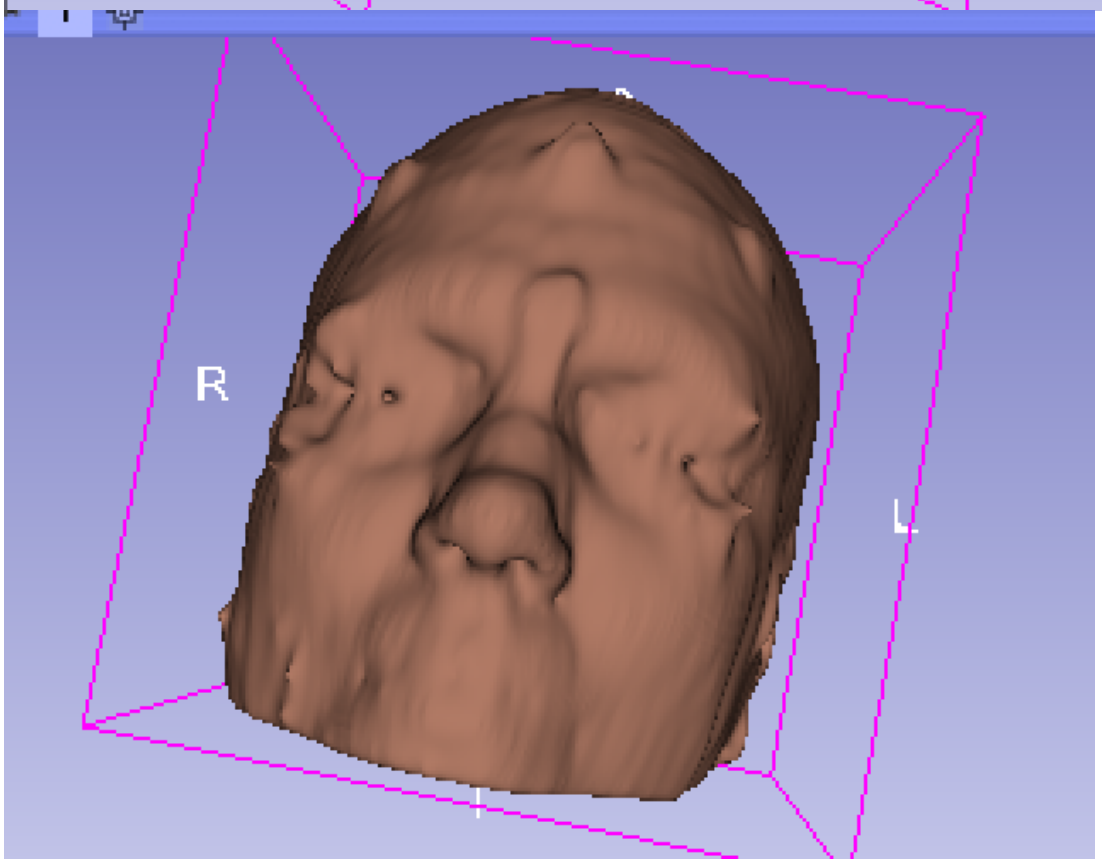
Content:

- can load files into Slicer by dragging and dropping the folder into the application and it will identify all DICOM files
- once loaded, the MRI scans are visible in three different configurations and begin modeling with the *segment editor* module selected from the drop down menu
- Segment editor
    - first step is to add a new segment by clicking the green plus sign and selecting *skin*
    - then below there is an option for *threshold* which is used to ensure that only the MRI material within the threshold is selected for the 3D rendering
    - once done, select *show 3D* which will build a 3D model and display it in the upper right box
    - can edit the 3D image with the function "smoothing" which has the sub-functions "closing" and "median"
        - closing fills holes of the selected size on the image and median removes small contours to smooth the image slightly but keeps most details the same
- Rehaan's 3D rendering from MRI scans



- Rehaan's MRI scans contained noise around his eyes and nose which made the editing done to the rendering very difficult, I checked to see if this would be a common problem as it was quite problematic with retaining the overall shape of the head and these are the results I experienced





- These are 3D rendering from a sample MRI I found online that used fiducial markers and it came out much cleaner than Rehaan's did

Conclusions/action items:

3D rendering from MRI scans using Slicer is a relatively straight forward process that requires some time and patience but with proper training shouldn't be difficult to accomplish. I need to look further into MRI scans and why they sometimes have unnecessary noise that is difficult to remove through thresholding.

2018/11/09 3D Head Model Fabrication

Gabriella Medeiros Simas - Dec 12, 2018, 2:58 PM CST

Title: 3D Head Model Fabrication

Date: 11/09/2018

Content by: Bledat and Gabi

Present: Team

Goals: Our goal is to fabricate the 3D model of Rehaan's head to use for testing via 3D printing using an Ultimaker, as the actual method of our device requires that a head print be made of each patient.

Content:

- A stealth file was downloaded onto a CD at UW Hospital, where Rehaan received an MRI scan of his head.
- File uploaded to 3D Slicer software, which is an open source software platform for medical image informatics, image processing, as well as 3D visualization.
- Converted to STL file type in Slicer software in order to make scan 3D printer compatible.
- Using the threshold feature on 3D Slicer, the software model of Rehaan's head was hallowed out and the scalp was kept intact for printing; leaving the scalp makes for more accurate modeling of the actual head.
- Artifacts were found in the file as well due to non-ideal conditions during the scan. Moreover, Rehaan may have shifted inside the coil, causing substantial artifacts near the sinuses.
- Gabi and Jeena removed these artifacts using the scissor and threshold features of 3D Slicer.

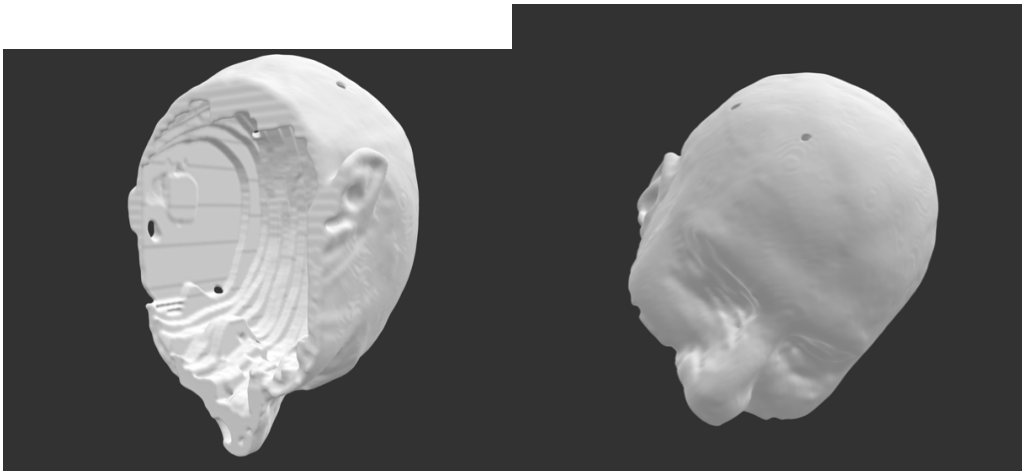


FIGURE I. Pictured above is what the STL file looked like when it was ready for print.

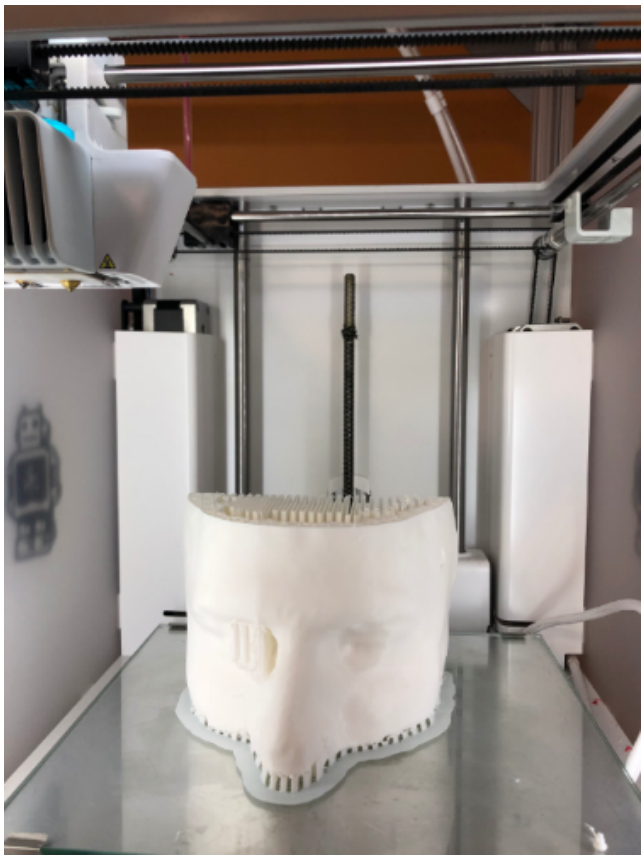


FIGURE II. The 3D head model in the process of being printed in an Ultimaker 3D printer with PLA plastic.

- Print was done in two halves because none of the 3D printer models could handle the size of the head.
- Epoxy adhesive was used to glue together the two halves after printing.

FIGURE III. Epoxy glue was utilized in order to fasten the two halves of the print. Gyration was placed on the model after Epoxy application to ensure that the halves stuck together.

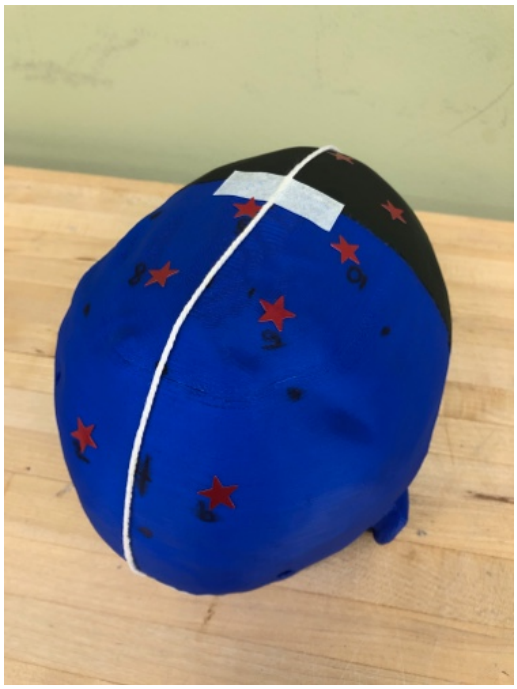


FIGURE IV and V. Pictured above is the head finalized and glued together. Stars represent the holes used for testing the accuracy of gyration later.

REFERENCES: N/A.

Conclusions/action items: We need to allow the head to dry and begin fabrication of the gyration band. This will allow us to continue and do testing. Moreover, we could perhaps improve the print by making some alterations on 3D Slicer to ensure its accuracy in terms of specific contours on the skull.