BME Design-Spring 2023 - LOUKIA AGOUDEMOS
Complete Notebook

PDF Version generated by

Charlie Fisher

on

May 03, 2023 @11:08 PM CDT

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Team Contact Information

LOUKIA AGOUDEMOS - Mar 01, 2023, 8:17 PM CST

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Project description

LOUKIA AGOUDEMOS - Mar 01, 2023, 8:43 PM CST

Course Number: BME 301

Project Name: Neonatal 22-23-week premature infant simulation mannequin

Short Name: 22-23-week Neonatal Simulation Manikin

Project description/problem statement: There are currently no 22-23 week neonatal simulation mannequins on the market, though it is vital for medical professionals to practice the skills needed to resuscitate an infant at this age. This simulation mannequin must be able to be intubated, support central umbilical line placement, and include IV access. Including a chest cavity and rib structure that allows for additional training in thoracentesis and pericardiocentesis would be ideal.

About the client: The client, Dr. Timothy Elgin is a neonatal physician affiliated with the UW Department of Pediatrics, who is passionate about improving the education surrounding the resuscitation of neonates born extremely prematurely. He requires the team to fabricate a prototype model that satisfies the needs of medical professionals training to develop proper resuscitation practices.

01/27/2023 Initial Client Meeting

LOUKIA AGOUDEMOS - Feb 10, 2023, 2:35 PM CST

Title: Initial Client Meeting (Questions, Thoughts, Goals or Concerns)

Date: 01/27/2023

Content by: Neonatal Mannequin Group

Present: [N/A]

Goals: This document will be a running list of what we would like to ask our client, Dr. Timothy Elgin, at our first meeting.

Content:

- Do you have another contact we can send quick questions regarding the project (assistant)?
- Do you have availability during the week to meet?
- We still have the mold, so we plan to utilize our 3D scan of premature Anne.
    - This mold will hopefully have arms and legs now.
- Main components of the project:
    - 1. Create and 3D Print the Mold Again (cheaper versions for testing if possible)
    - 2. Create the inner skeleton of the Neonatal Mannequin Model
        - Include laryngeal tubes, thoracic cavity, lungs
    - 3. Pour Skin
    - 4. Add Ons (aesthetics of model, testing of model, electronics etcetera)
        - Side note from me: the top three conducted in that order are what I believe to be the most important steps to making progress on this mannequin.
- Access to intubation devices for practicing--laryngoscope?
- What features should be a very accurate to real skin texture.

Conclusions/action items: Ask these questions at our first client meeting.

LOUKIA AGOUDEMOS - Feb 10, 2023, 2:48 PM CST

Average Weights: 500 g, length 28-30 cm

- Project Assistant Contact - Try to do weekly meetings a couple of times a week. Fridays at 2:30 work-- afternoons are better than mornings. Linking us with the scheduler.

- Laryngoscope -- breathing tubes in a couple of different sizes.

- Materials at different spots; sticky texture throughout-- still using PDMS. Easy to tear might note a horrible. 2-1 next Fridays office at Meriter

- Neonatal Rib and Skeleton thing-- worked on BME

04/25/2023- Meeting with Med Student

Charlie Fisher - Apr 25, 2023, 4:19 PM CDT

Title: Meeting w/ Diana Do

Date: 04/25/2023

Content by: Charlie

Goals: Get usability feedback from our supporting medical school student.

Content:

Better looking than she expected.

She asked questions about the proportions of chest cavity, mouth, and lungs.

Thought the skin texture and overall size and shape seemed good.

Will be asking other students and doctors and letting us know by Wednesday night their feedback.

Conclusions/action items:

01/27/2023 - First Advisor Meeting

LOUKIA AGOUDEMOS - Jan 27, 2023, 2:05 PM CST

Title: First Advisor Meeting

Date: 01/27/2023

Content by: Loukia Agoudemos

Present: Abbie, Charlie, Sophia, Loukia, Dr. Masters

Goals: The primary goal of this first meeting was to schedule a time to meet with our advisor.

Content:

- Our first meeting was to schedule a proper time to meet with our advisor, Dr. Kristyn Masters, which was on Fridays during the scheduled BME design block.
- We also discussed an alternate week time of Thursday mornings from 8:50 - 9 am.

Conclusions/action items:

In regards to this meeting, we will look out for an email on official meeting times from Dr. Masters and we will additionally share alternate meeting days that work for us as well.

02/09/2023 - Advisor Meeting 2

LOUKIA AGOUDEMOS - Feb 09, 2023, 11:32 AM CST

Title: Advisor Meeting 2

Date: 02/03/2023

Content by: Neonatal Mannequin Group

Present: Abbie, Charlie, Sophia, Tanishka, Dr. Masters

Goals: Discuss the project status with our advisor and come up with a loose plan of action to move forward with the project this semester.

Content:

- (Loukia's notes from what she heard about the meeting will be in red) Discussed last semester's work on the project and showed Professor Masters the picture of our prototype--not look great.
    - We really need to rethink our choice of biomaterial(s) for the skin so we do not have this problem again. Additionally, we need to rethink the mold in order to have it be compatible with the skin we pour. A lot of the complications we had was we cannot pour or use anything on the inside because we have to heat the mold up. This is something we should avoid because we waste a lot of time, money, and stress making everything heat-resistant.
    - One thing that could be beneficial is making different places of the body different materials. For example) arms and legs for intubation can be pdms because they will restore themselves after insertion of the IV. It has very skinlike properties. The body and head should be a higher elastic modulus because those will be pushed o and pulled for intubation and resuscitation practice. We also want something that will work well with the thoracic cavity, lung, and throat system we have,

Conclusions/action items: We need to complete preliminary research on how to move forward and design requirements (PDS) for this mannequin so we can begin brainstorming for our design matrix.

02/10/2023 - Advisor Meeting 3

LOUKIA AGOUDEMOS - Feb 10, 2023, 1:24 PM CST

Title: Advisor Meeting 3

Date: 02/10/2023

Content by: Loukia Agoudemos

Present: Abbie, Charlie, Loukia, Sophia, Tanishka

Goals: Discuss progress so far on project, pds, and begin discussing potential ideas for the design matric.

Content:

- We have our client meeting today.
    - Talking about our material needs-- divide and conquer.
- Discussing mold materials and PDMS effectiveness.
    - Design Matrix:
        - Lung System
        - Core skeletal system
        - Abbie-- will help us with getting access to the inner components of the model.
    - Competing designs
- Ask about an assistant.

Conclusions/action items:

- Show project design goals.

02/17/2023 - Advisor Meeting

LOUKIA AGOUDEMOS - Mar 01, 2023, 3:18 PM CST

Title: Advisor Meeting

Date: 02/17/2023

Content by:

Content:

Med Student - Diana Do

If we're going to apply a sticky material to the limbs that are a different material, why don't we just apply this material throughout the entire model?

Something like an exercise band silicone coating over some firmer material could be an easy way to replicate sticky skin.

Maybe start considering the skeletal base of the model once we determine the materials.

Conclusions/action items:

The next steps for this project are to complete remaining design matrices to evaluate all of the team's design ideas and select a chosen design to move forward with. Once this is done we can begin on the prototyping phase and start ordering materials.

03/03/2023 - Advisor Meeting

LOUKIA AGOUDEMOS - Mar 07, 2023, 12:58 PM CST

Title: Advisor Meeting

Date: 03/07/2023

Content by: Loukia Agoudemos

Present: Neonatal Manikin Team

Goals: Discuss progress with an advisor so far and receive feedback from the preliminary design presentation.

Content:

- Feedback from presentation
- Quantifying success
    - Time is taken to intubation
    - Comfort Level Testing (1 of 5 tests)
    - Elastic Modulus
        - Testing with Physicians
- Progress
    - Ballistics Gel and PDMS coating
        - Ballistics gel will be okay
        - PDMS brushing on-- adjusting concentrations
            - Samples of ballistics gel
    - Ask Raad's group about an experimental protocol and their ballistics gel
    - Limbs and 3D printing

Conclusions/action items: Continue with progress on the mold and begin testing protocols with raw skin materials.

03/10/2023 - Advisor Meeting

Charlie Fisher - Mar 10, 2023, 1:13 PM CST

Title: Advisor Meeting

Date: 03/10/2023

Goals: Get a plan and update going into spring break.

Content:

Microbubbles are okay in our situation.

Can get away without vacuum.

Continue to consider brushing PDMS on.

Practice is on samples that it can run off of (not flat).

Show and tell, Friday 03/24

Remember, all about crowd sourcing and feedback.

Not necessarily a script but a couple of points to hit on to explain.

Get questions communicated efficiently.

Have model ready for that day. Ballistics gel samples would be great.

Continue reaching out to the client whenever we return from Spring Break.

Remember to include med student in emails and meetings potentially upcoming.

04/07/2023 - Advisor Meeting

LOUKIA AGOUDEMOS - May 03, 2023, 10:27 PM CDT

Title: Advisor Meeting

Date: 04/07/2023

Content by: Loukia Agoudemos

Present: Neonatal Mannequin Team

Goals: Get advice for the PDMS Coating

Content:

- -PDMS bonding
    - Abrasion
- Gelling in the vacuum oven to get more homogenous Petri dishes.
    - Tensile Testing Analysis-- As long as we have a tensile modulus-- that is all we need.
    - Something to consider is chest movement is breathing-- but may not be possible
        - Squeezing the airbag and air doesn't go anywhere
        - Clear gels for visualization
- **Melting down Method-- needs to be done**, abrasion method, cryo-gelling method

Conclusions/action items: Consider methods to troubleshoot the ballistics gel formulation.

04/14/2023 Advisor Meeting

LOUKIA AGOUDEMOS - May 03, 2023, 10:25 PM CDT

Title: Advisor Meeting

Date: 04/14/2023

Content by: Loukia Agoudemos

Present: Neonatal Mannikin Team

Goals: Update progress on our manikin model.

Content:

- Testing
- "Getting clinicians more comfortable dealing with this delicate of an individual instead of saving lives."

Conclusions/action items: Update some wording on executive summary and think of testing

04/21/23- Advisor Meeting

LOUKIA AGOUDEMOS - May 03, 2023, 10:26 PM CDT

Title: Advisor Meeting

Date: 04/21/23

Content by: Charlie Fisher

Goals: Capture main points of meeting

Content:

Reanalyze mechanical data. Should be in hundreds or tens of kPA.

We should plot strain (x) vs stress (y). There should be linear portion at start, where we should get the slope from.

We need crosslink for PDMS however we can scrap it if needed.

Intubation testing:

Conclusions/action items: Finalize prototype and prepare for presentations and final deliverables.

02/28/2023 - Design Matrices for "Inner Workings", Mold and Skin Materials

LOUKIA AGOUDEMOS - Mar 01, 2023, 9:29 PM CST

Title: Design Matrices for "Inner Workings", Mold, and Skin Materials

Date: 02/28/2023

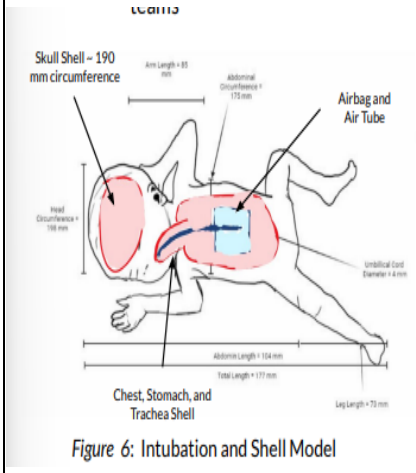
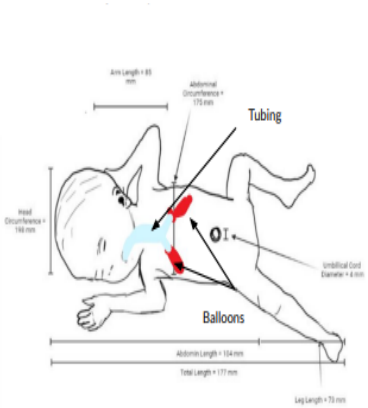
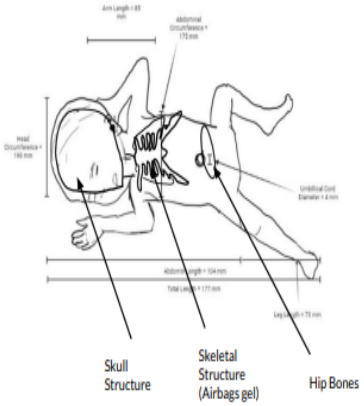
Content by: Neonatal Mannequin Team

Present: [N/A]

Goals: A design matrix is an effective way of assessing design ideas with weighted criteria in order to identify the best design for a design team to move forward with. This document will highlight the team's three most important categories pertaining to this project-- "inner workings", mold materials, and skin materials-- and assess the design ideas using the weighted criteria.

Content:

Inner Workings Design Matrix

	Design 1: Intubation and Shell	Design 2: Balloon Lungs	Design 3: Mock airway and skeleton
	 *Figure 6:* Intubation and Shell Model	 *Figure 7:* Balloon Lungs	 *Figure 8: Mock Airway and Mock Skeleton*
Feedback Mechanism/ Realism (25)	4/5 (20)	4/5 (20)	5/5 (25)
Usability(25)	4/5 (20)	4/5 (20)	5/5 (25)
Cost (20)	3/5 (12)	5/5 (20)	2/5 (8)
Durability (15)	3/5 (9)	3/5 (9)	4/5 (12)
Feasibility/ Reproducibility (15)	3/5 (9)	5/5 (15)	2/5 (6)
Total (100)	70	84	76

Criteria:

1. Feedback Mechanism/Realism (25) - How accurately the airway mechanism mimics breathing (normally and during resuscitation). This also evaluates the accuracy and realism of the structure of the inner working.
2. Usability (25): How effective is the design for use as a resuscitation training mannequin?
3. Cost (20): How cost-effective is the design?
4. Durability (15): How much use can the design withstand?
5. Feasibility/Reproducibility (15): How well can the design team produce a completed prototype during the course of the semester?

The chosen design was the balloon lungs for its simplicity and cost-effectiveness. One thing that we have learned from previous semesters in design is to keep your chosen design simple instead of choosing a complicated design to squeeze in on such a short amount of time.

Materials Design Matrix:

	Design 1: PDMS Coating on Ballistics Gel	Design 2: PDMS Only	Design 3: Sleeve Coating - Thicker silicone sleeve on top of hard plastic body
Texture(25)	5/5 (25)	3/5 (15)	4/5 (20)
Usability(25)	5/5 (25)	3/5 (15)	4/5 (20)
Cost(25)	4/5 (20)	5/5 (25)	2/5 (10)
Durability(15)	4/5 (12)	2/5 (6)	3/5 (9)
Realism(5)	4/5 (4)	2/5 (2)	5/5 (5)
Feasibility/ Reproducibility (5)	4/5 (4)	5/5 (5)	2/5 (2)
Total (100)	90	68	66

Criteria:

1. Texture (25) - How accurately does this texture mimic and reflect real 22-23 week neonatal skin?
2. Usability (25) - How comfortable is it to use for its intended purpose as a training device?
3. Cost (25) - How affordable is the cost of production?
4. Durability (15) - How well will the material hold up for its intended purpose as a training device?
5. Realism (5) - How accurately does it simulate neonatal devices?
6. Feasibility and Reproducibility (5) - How easily can we prototype this model during the span of the semester?

The PDMS Coating on ballistics gel will provide adequate physical structure, provide the sticky texture of a neonate of this age, be cheap and easy to fabricate, and finally have the ability to have IVs inserted and intubated many times over the course of its lifetime.

	Design 1: PVA Casted Mold	Design 2: Tough PLA	Design 3: Nylon Mold
Heat Resistance (25)	3/5 (15)	4/5 (20)	5/5 (25)

Cost (20)	2/5 (8)	5/5 (20)	4/5 (16)
Durability (20)	4/5 (16)	5/5 (20)	4/5 (16)
Detail Capturing (20)	4/5 (16)	5/5 (20)	4/5 (16)
Feasibility (10)	3/5 (6)	4/5 (8)	1/5 (2)
Ease of Use (5)	3/5 (3)	4/5 (4)	1/5 (1)
Total (100)	64	92	76

Criteria:

1. Heat Resistance - How well the mold material tolerates high temperatures.
2. Cost- How affordable the mold material is.
3. Durability - How many use the mold material can withstand for prototyping?
4. Detail Capturing - How well are details of the manikin model captured?
5. Feasibility - How easily can this mold be fabricated on campus?
6. Ease of Use- How easy is it to pour the manikin mold and remove the manikin after it is cured?

(Taken from the design team's design matrix explanation) The team narrowed down potential mold materials to three contenders that can be utilized to fabricate the mold for the neonatal body cavity. The three material options were rated on a variety of design criteria which were weighted based on relevance to this specific project. The highest-ranked criterion was heat resistance. This is important as the material will need to be able to withstand a variety of temperatures during the curing process. The next highest-ranked criteria were durability during the curing process, detail capturing, and cost. It is essential that the mold material has the capability to maintain structure during the curing process while also possessing characteristics that don’t pose a threat of reaction with the material that will be cured within it. The material must also have the ability to display intricate features necessary for the formation of the neonatal mannequin. Cost is also an important consideration as the team aims to create a reasonably priced prototype that is competitive with market values. The next ranked criterion was feasibility. Finally, ease of use is something to be taken into account as the utilization of the material should be efficient and effective, especially when time is of the essence for a project.

Conclusions/action items: From the design matrix, the team will be moving forward with a chosen preliminary design with a neonatal manikin made of ballistics gel with a PDMS coating to model the outer layer of skin tissue. This model will have a cavity for a trachea and chest cavity and have the balloon lung system as its inner workings. The mold for this manikin will be printed in Ultimaker tough PLA.

02/10/2023 - Product Design Specification

LOUKIA AGOUDEMOS - Feb 28, 2023, 9:14 PM CST

Title: Product Design Specification

Date: 02/10/2023

Content by: Neonatal Mannequin Team

Present: [N/A]

Goals: The intention of the product design specification (PDS) is to specify and address the project with detailed requirements so both the client and the design team can reference this document for guidance and mutual understanding about design expectations.

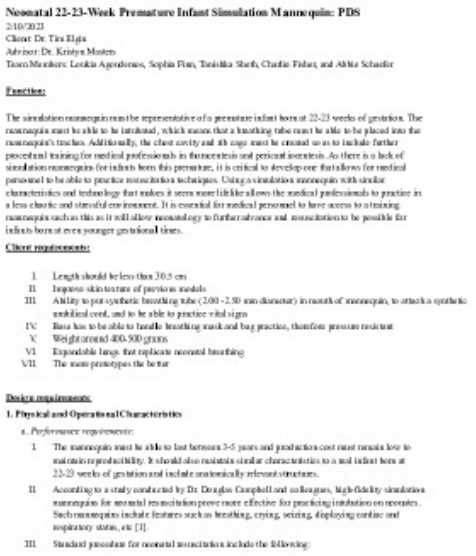
Content:

Please see the following link or attached sections below to view the PDS.

Conclusions/action items:

This document will be frequently referenced by the design team to ensure the most effective design that achieves these design requirements, or evaluate the current design to achieve these design requirements.

LOUKIA AGOUDEMOS - Feb 28, 2023, 9:15 PM CST



Neonatal 22-23-Week Premature Infant Simulation Mannequin: PDS
2/10/2023
Client: Dr. Tim Elgin
Advisor: Dr. Kristyn Masters
Team Members: Loukia Agoudemos, Sophia Finn, Tanishka Sheth, Charlie Fisher, and Abbie Schaefer

Function:

The simulation mannequin must be representative of a premature infant born at 22-23 weeks of gestation. The mannequin must be able to be intubated, which means that a breathing tube must be able to be placed into the mannequin's trachea. Additionally, the chest cavity and rib cage must be created so as to include further procedural training for medical professionals in thoracentesis and pericardiocentesis. As there is a lack of simulation mannequins for infants born this premature, it is critical to develop one that allows for medical personnel to be able to practice resuscitation techniques. Using a simulation mannequin with similar characteristics and technology that makes it seem more lifelike allows the medical professionals to practice in a less chaotic and stressful environment. It is essential for medical personnel to have access to a training mannequin such as this as it will allow neonatology to further advance and resuscitation to be possible for infants born at even younger gestational times.

Client requirements:

I. Length should be less than 30.5 cm
II. Improve skin texture of previous models
III. Ability to put synthetic breathing tube (2.00 - 2.50 mm diameter) in mouth of mannequin, to attach a synthetic umbilical cord, and to be able to practice vital signs
IV. Base has to be able to handle breathing mask and bag practice, therefore pressure resistant
V. Weight around 400-500 grams
VI. Expandable lungs that replicate neonatal breathing
VII. The more prototypes the better

Design requirements:

1. Physical and Operational Characteristics

a. *Performance requirement:*

1. The mannequin must be able to last between 3-5 years and production cost must remain low to maintain reproducibility. It should also maintain similar characteristics to a real infant born at 22-23 weeks of gestation and include anatomically relevant structures.
II. According to a study conducted by Dr. Douglas Campbell and colleagues, high-fidelity simulation mannequins for neonatal resuscitation prove more effective for practicing intubation on neonates. Such mannequins include features such as breathing, crying, setting, displaying cardiac and respiratory status, etc. [1].
III. Standard procedure for neonatal resuscitation include the following:

Download

Neonatal_Infant_Mannequin-PDS-version1.docx.pdf (107 kB)

05/03/2023- Expenses

Charlie Fisher - May 03, 2023, 10:39 PM CDT

Title: Expenses Table

Date: 05/03/2023

Content by: Group

Content: Expenses for materials

Expenses

[redacted]

Component 1								
Gelatin Powder	1lb of unflavored gelatin	Knox	B001UOW7D8	3/23	1	19.49	19.49	gelatin
Component 2								
Mold	PLA mold used for fabrication	UW Makerspace	N/A	4/21	1	25.00	25.00	N/A
Component 3								
Balloons	Colorful balloons	Hafree Store	B0BDRDCJLL	4/21	1	7.37	7.37	balloons
Component 4								
⅜” T-connector	Plastic T-connector	ANPTGHT Store	aww-1231006904	4/21	1	6.99	6.99	connect
Component 5								
Nasopharyngeal Airway	Nasopharyngeal Airway 28F with Lubricant	Rusch Inc	B074BDN6G8	4/21	1	12.99	12.99	airway
TOTAL:								**$71.84**

Fabrication Protocol

Charlie Fisher - May 03, 2023, 10:18 PM CDT

Title: Fabrication Protocol

Date: 05/03/2023

Content by: Charlie Fisher

Goals: Record our steps so somebody else can replicate them

Content: Protocol for Prototype Fabrication

Baby Mold Construction Protocol

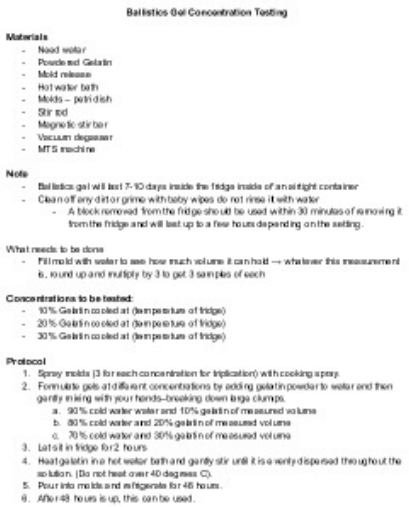
1. Mix 160 mL of water and 40 g of ballistics gel powder into a beaker to make 200 mL of ballistics gel [1]
2. Stir the mixture in a beaker until fully liquid
3. Let sit in fridge for 2 hours
4. Heat ballistics gel in a beaker over a hot plate at 260 degrees Fahrenheit while stirring, until consistent
5. Put the beaker in a vacuum degasser for 30 minutes to eliminate bubbles
6. Apply a layer of “Smooth-On Universal Mold Release”, to the inside of each half of the Tough Polylactic Acid (PLA) mold of the baby
7. Let sit for two minutes
8. Apply second layer of Smooth On to each half
9. Let sit for two minutes
10. Pour 70 mL of previously made ballistics gel into each half of the mold.
11. Cover each half in parafilm covering
12. Put it in the fridge for 24 hours
13. Removed from fridge
14. Hollow out the chest cavity of the model
15. Put lungs with t-connector in cavity and run it through the mouth hole
16. Acquire beaker to make gelatin based glue
17. Mix 15 g of gelatin powder with 240 mL of cold water in a bowl [2].
18. Once the gelatin powder is completely dissolved, add in 15 mL of boiling water, stirring continuously until the mixture is blended.
19. Allow glue to cool and thicken.
20. Spread a layer of glue on each half of the ballistics gel
21. Press together each half of the ballistics gel neonate and refrigerate again.
22. Wait a couple hours and the model is complete

Conclusions/action items:

[1] Y. Wen, C. Xu, Y. Jin, and R. C. Batra, “Rifle bullet penetration into ballistic gelatin,” *Journal of the Mechanical Behavior of Biomedical Materials*, vol. 67, pp. 40–50, Nov. 2016.

[2] Damon A;Clifton W;Dove C;Stein R;Simon LV; “Investigation of a cost-effective and durable material for containing ballistic gel in the construction of Ultrasound Phantoms,” *Cureus*. [Online]. Available: https://pubmed.ncbi.nlm.nih.gov/31565623/. [Accessed: 03-May-2023].

LOUKIA AGOUDEMOS - May 03, 2023, 10:24 PM CDT



Ballistics Gel Concentration Testing

Materials
- Nood water
- Powdered Gelatin
- Mold release
- Hot water bath
- Molds – petri dish
- Stir rod
- Magnetic stir bar
- Vacuum degasser
- MTS machine

Note
- Ballistics gel will last 7-10 days inside the fridge inside of an airtight container
- Clean off any dirt or grime with baby wipes do not rinse it with water
  - A block removed from the fridge should be used within 30 minutes of removing it from the fridge and will last up to a few hours depending on the setting.

What needs to be done
- Fill mold with water to see how much volume it can hold → whatever this measurement is, round up and multiply by 3 to get 3 samples of each

Concentrations to be tested:
- 10% Gelatin cooled at (temperature of fridge)
- 20% Gelatin cooled at (temperature of fridge)
- 30% Gelatin cooled at (temperature of fridge)

Protocol
1. Spray molds (3 for each concentration for triplication) with cooking spray.
2. Formulate gels at different concentrations by adding gelatin powder to water and then gently mixing with your hands–breaking down large clumps.
   a. 90% cold water water and 10% gelatin of measured volume
   b. 80% cold water and 20% gelatin of measured volume
   c. 70% cold water and 30% gelatin of measured volume
3. Let sit in fridge for 2 hours
4. Heat gelatin in a hot water bath and gently stir until it is evenly dispersed throughout the solution. (Do not heat over 40 degrees C).
5. Pour into molds and refrigerate for 48 hours.
6. After 48 hours is up, this can be used.

Download

Complete_fabrication_and_testing_protocol.pdf (111 kB) Complete fabrication and testing protocol for the manikin.

03/07/2023 - Ballistics Gel Concentration Expirement Protocol

LOUKIA AGOUDEMOS - Apr 07, 2023, 2:05 PM CDT

Title: Ballistics Gel Concentration Experiment Protocol

Date: 03/07/2023

Content by: Loukia Agoudemos

Present: [N/A]

Goals: Identify the ballistics gel concentration that most closely matches the elastic modulus of human skin.

Content:

Materials

- Need water
- Powdered Gelatin
- Cooking spray
- Hot water bath & Fridge
- Molds – a petri dish
- Air-tight containers for storage

Note

- Ballistics gel will last 7-10 days inside the fridge inside an airtight container
- Clean off any dirt or grime with baby wipes do not rinse it with water
    - A block removed from the fridge should be used within 30 minutes of removing it from the fridge and will last up to a few hours depending on the setting.

What needs to be done

- Fill the mold with water to see how much volume it can hold → whatever this measurement is, round up and multiply by 3 to get 3 samples of each

Concentrations to be tested:

- 10% Gelatin cooled at (temperature of the fridge)
- 20% Gelatin cooled at (temperature of the fridge)
- 30% Gelatin cooled at (temperature of the fridge)

Protocol

1. Spray molds (3 for each concentration for triplication) with cooking spray.
2. Formulate gels at different concentrations by adding gelatin powder to water and then gently mixing with your hands– breaking down large clumps.
    1. 90% cold water and 10% gelatin of measured volume

    2. 80% cold water and 20% gelatin of measured volume
    3. 70% cold water and 30% gelatin of measured volume
3. Let sit in the fridge for 2 hours
4. Heat gelatin in a hot water bath and gently stir until it is evenly dispersed throughout the solution. (Do not heat over 40 degrees C).
5. Pour into molds and refrigerate for 48 hours.
6. After 48 hours is up, this can be used.

Compression Testing

1. Test each sample using MTS compression testing.
2. Compare elastic moduli between gelatin concentration.

*Can reuse by melting and rechilling (within 48-56 hours)

*Use a vacuum oven to remove micro bubbles.

Conclusions/action items: Run the experimental protocol for this experiment.

05/03/2023 - Tensile Testing Protocol

Charlie Fisher - May 03, 2023, 10:21 PM CDT

Title:

Date:

Content by:

Present:

Goals:

Content:

- Brushing on PDMS

- Focus on PDMS needing feedback for show and tell

- needing a script - use two minutes as best as you can
- for preparing the sample allow it to run off

Conclusions/action items:

4/16/2023 Ballistics Gel Compression Testing Protocol

Charlie Fisher - May 03, 2023, 10:21 PM CDT

Title: Ballistics Gel Compression Testing Protocol

Date: 04/16/2023

Content by: Loukia Agoudemos

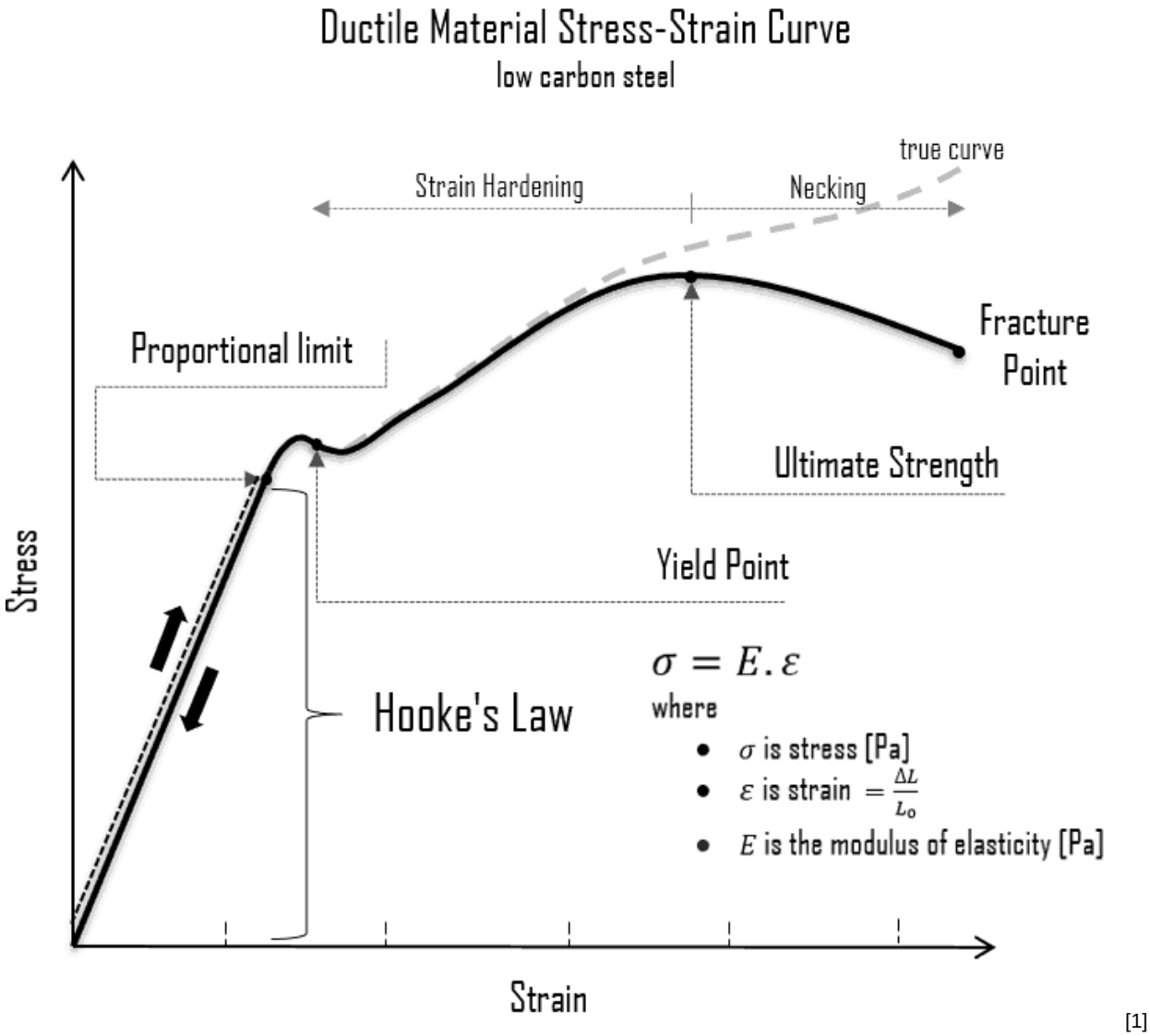
Goals: Describe the testing protocol used for MTS compression testing on our agar hydrogel so testing could be repeated in the future.

Content:

Compression testing is a mechanical test to characterize the mechanical properties of the desired material. This involves applying vertical load over time, measuring the displacement of the material, and creating a stress-strain curve from this data until mechanical failure. This makes it easy to characterize the elastic modulus of the agar ballistics gel and the greatest load it can hold before failure.

The protocol is as follows:

1. Select 3 samples of ballistics gel of appropriate thickness and area for use on the MTS machine in ECB, and do your best to ensure that the sample is as uniform as possible within the sample and among the other sample.
2. Equip appropriate compression testing plate heads onto the MTS testing loads.
3. Power up the MTS machine and open the MTS software. Open a new test.
4. For each sample, conduct the following...
    1. Measure and record the length, width, and thickness of the agar sample.
    2. Put this information in the appropriate text-entry prompts in the MTS software for your new test.
    3. Place the sample centered on the compression plates.
    4. Double-check that everything is looking right before you run the test.
    5. Unlock the machine and select run test.
    6. Collect compression testing data until failure-- should look like a sudden dip in displacement.
    7. Stop the machine and take picture of a sample where you believe failure to be located.
5. Use data analysis to identify elastic modulus and failure load following this example.
    1. Elastic Modulus and Ultimate Strength --Yield point does not apply to the elastic material.



[1]

Citation:

[1]"What is Modulus of Elasticity – Elastic Modulus - Definition," Material Properties, Jul. 31, 2020. [Online]. Available: https://material-properties.org/what-is-modulus-of-elasticity-elastic-modulus-definition/. [Accessed: Apr. 16, 2023]

Conclusions/action items: Use this testing protocol to conduct any future compression testing on hydrogel samples to identify the most appropriate ballistics gel concentration for the model. Compression testing can be conducted on elastomer and any other material used in the manikin.

03/01/2023 -Testing and Expiremention Ideas

LOUKIA AGOUDEMOS - Mar 01, 2023, 10:02 PM CST

Title: Testing and Experimentation Ideas

Date: 03/01/2023

Content by: Loukia Agoudemos

Present: [N/A]

Goals: Make notes of which testing ideas we want to employ to evaluate material choices and prototype designs that will later need protocols. This is a high-level overview of the testing that is planned to be conducted.

Content:

- Ballistics Gel Concentration Experimentation - ballistics gel compression testing to evaluate the concentration with the optimal Young's Modulus.
- PDMS formulation experimentation-evaluate the best formulation for PDMS by doing a tensile strength test on this material.
- Intubation testing- design team members and client incubating the prototype with the laryngoscope, placing an umbilical line, and placing IVs.
    - Quantitative: time taken
    - Qualitative: comfort levels and success.

Conclusions/action items: This is not a complete list, more ideas will be considered throughout the entirety of the design process, and to further plan the testing protocols for future testing and prototype assessment.

04/16/2023 - MTS Testing Data

LOUKIA AGOUDEMOS - May 03, 2023, 10:44 PM CDT

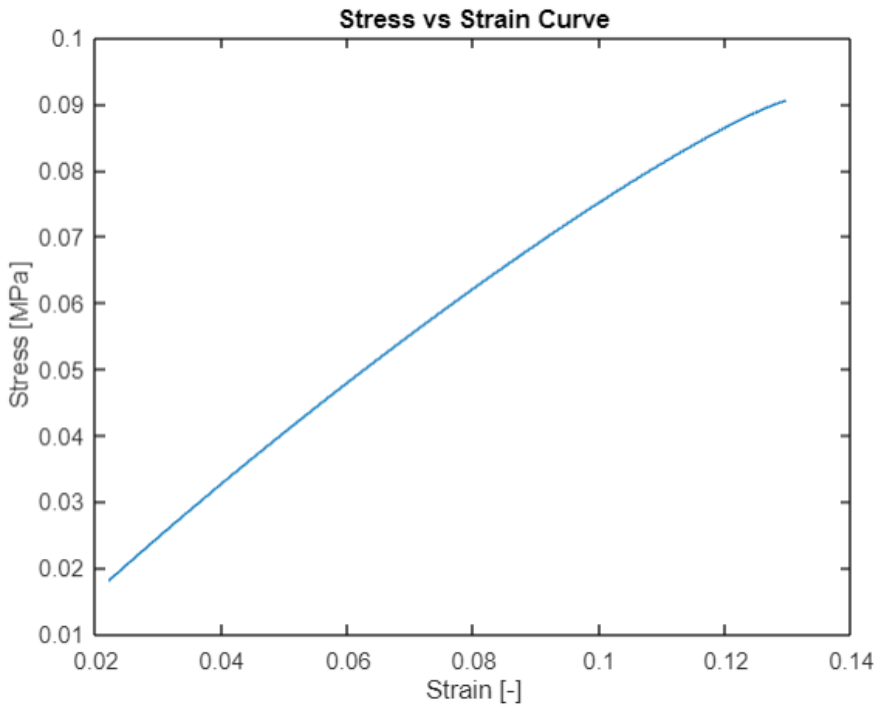
Title: MTS Testing Data

Date: 04/16/2023

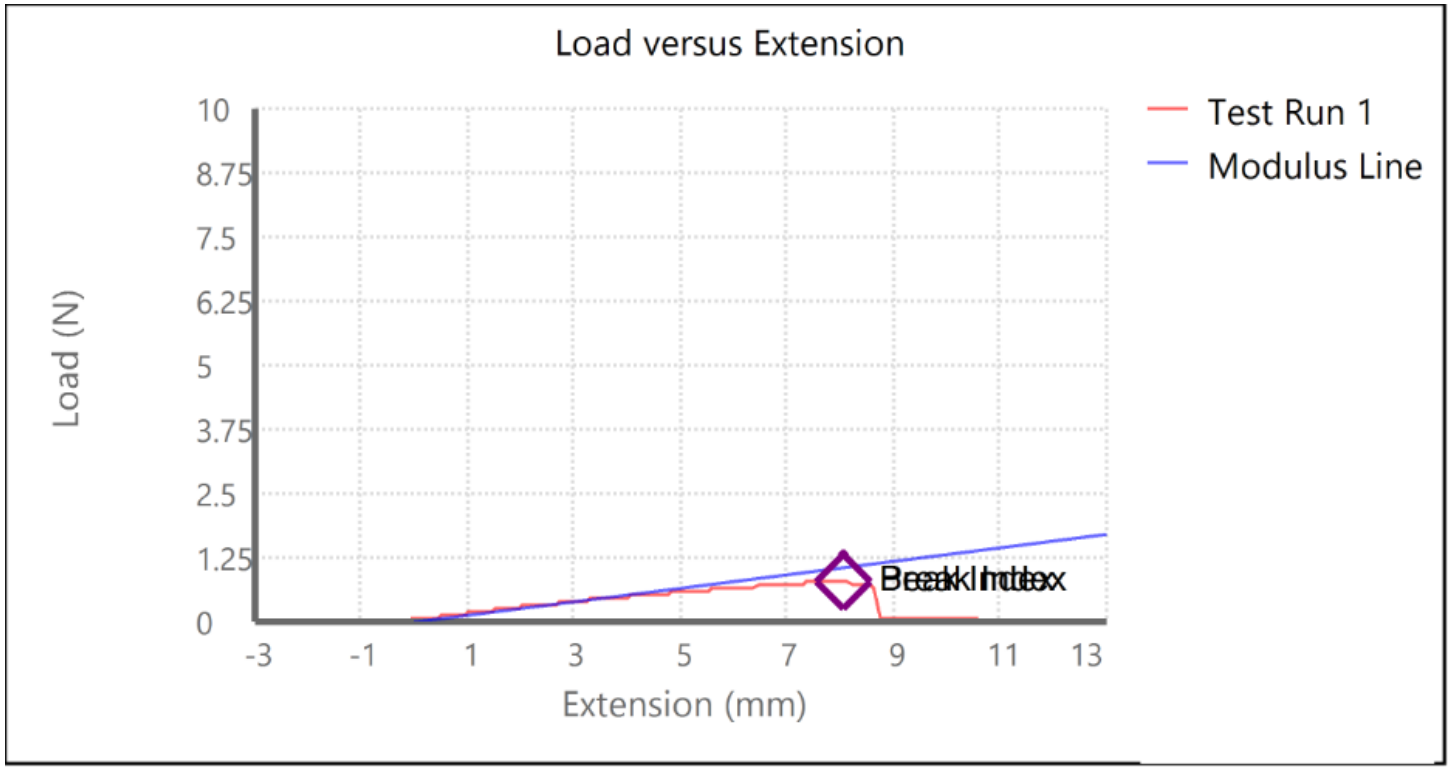
Goals: Acquire MTS testing data for ballistics samples without PDMS coating.

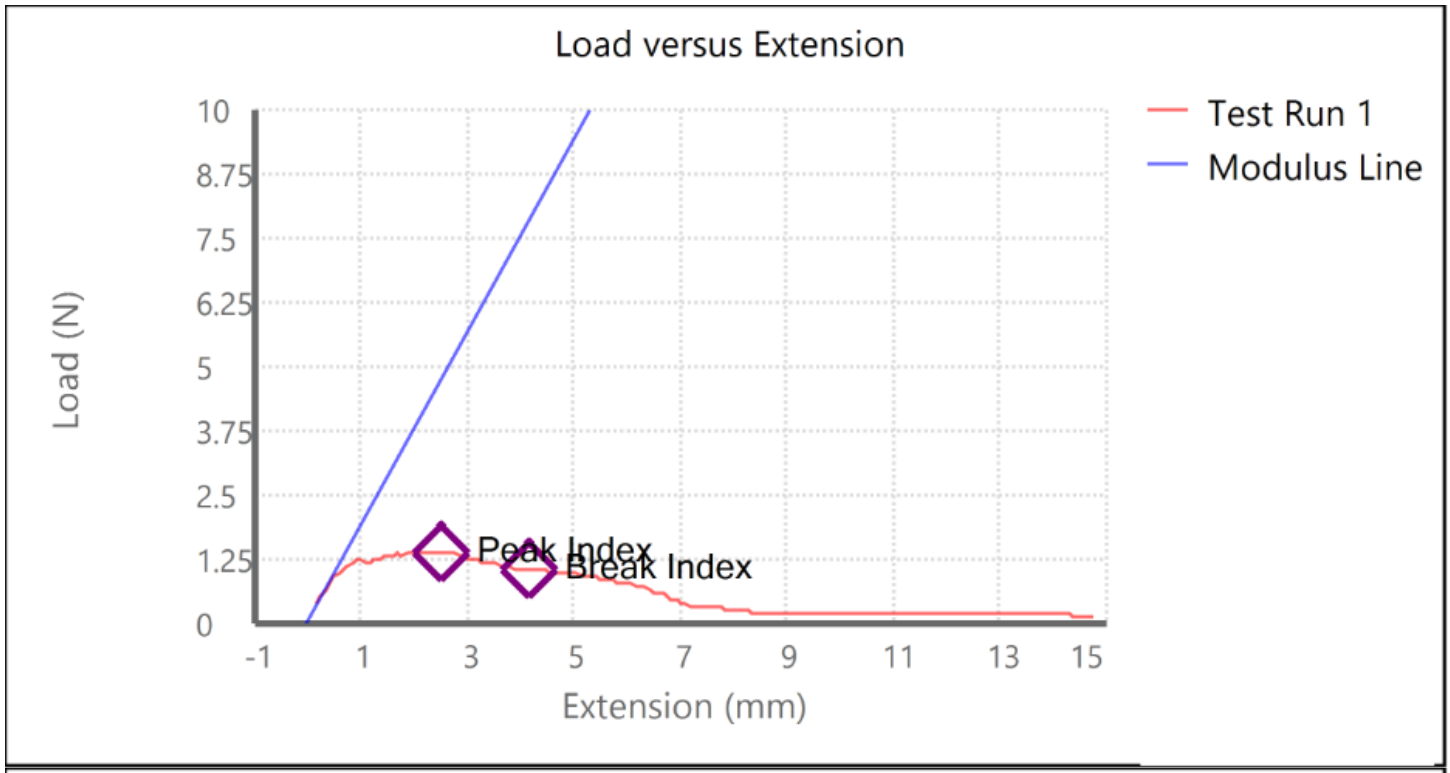
Content:

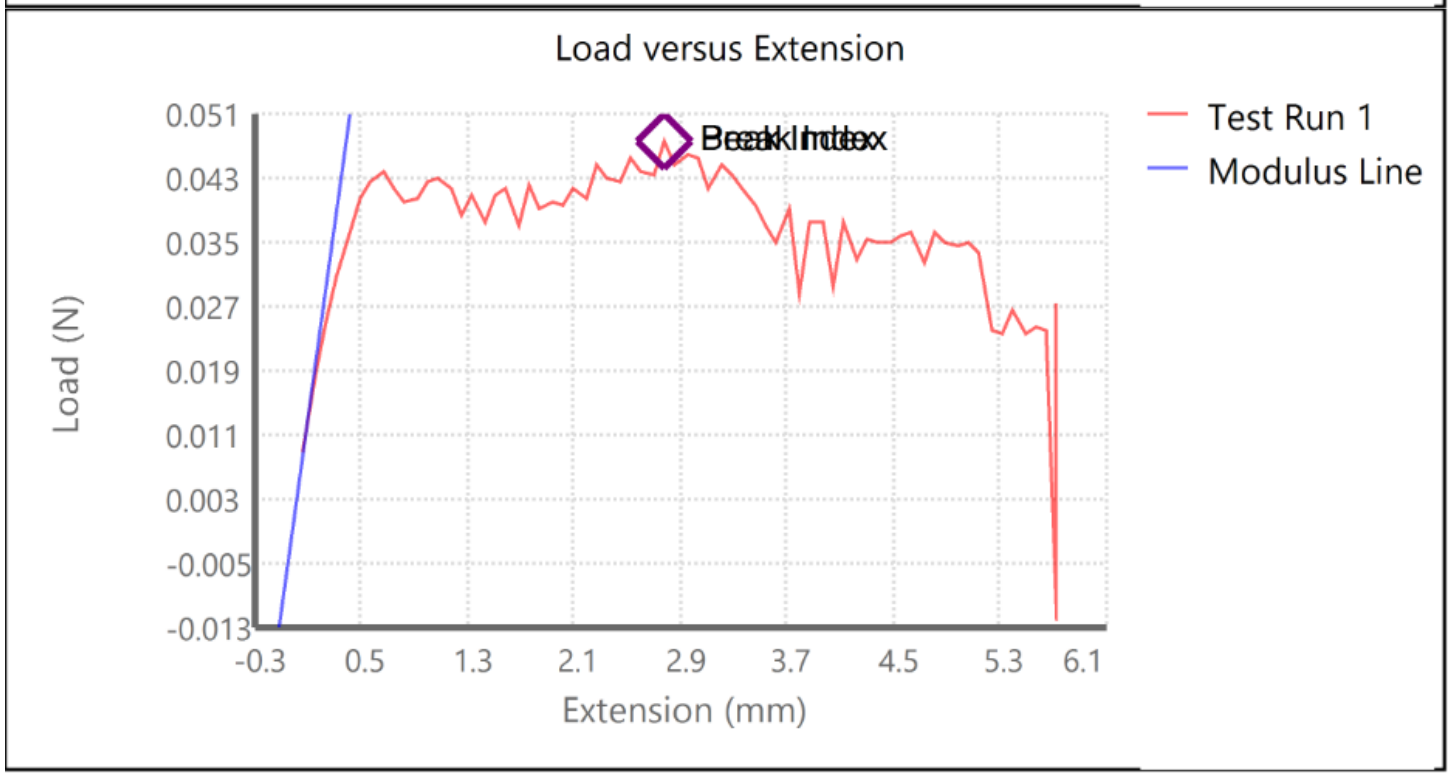
Model Stress-Strain curve:



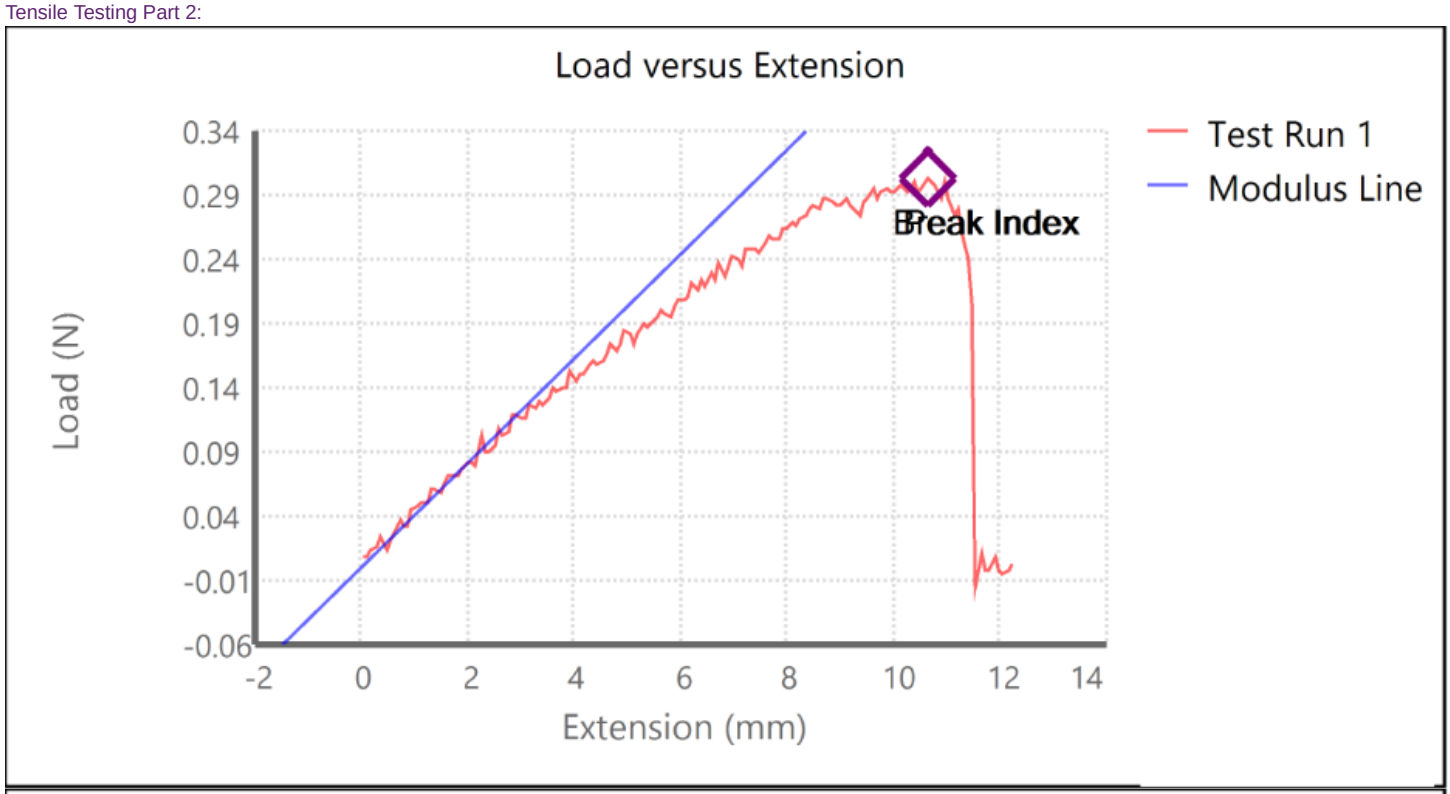
Tensile Testing Results:

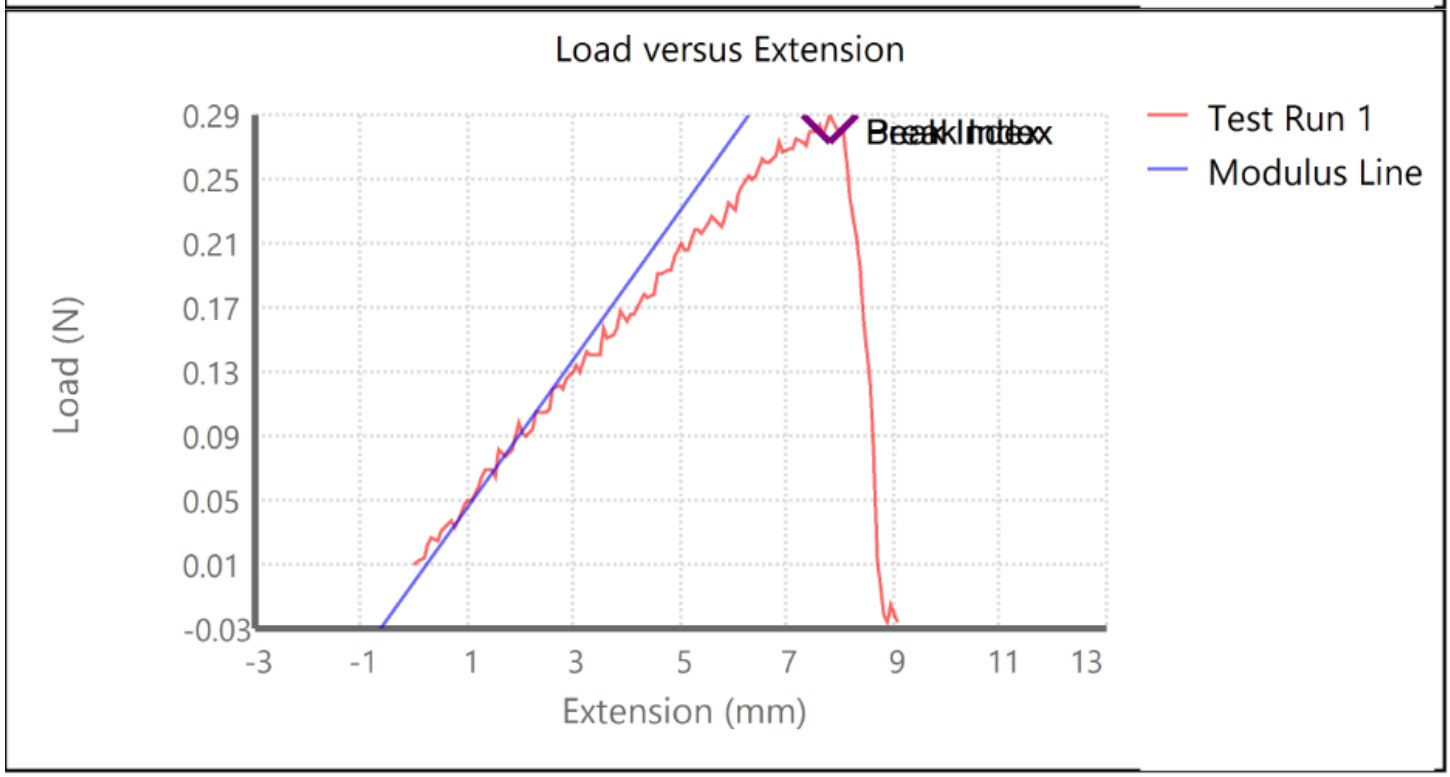


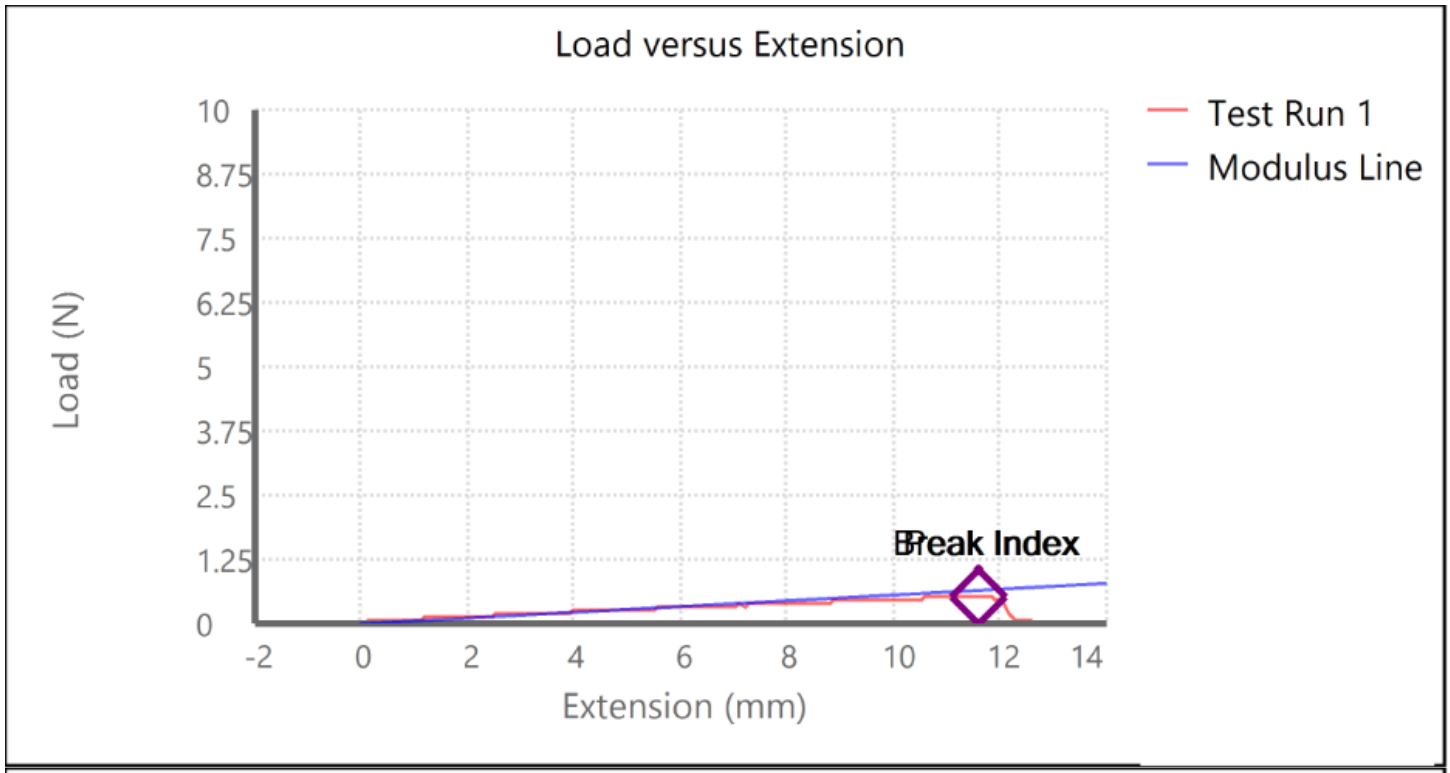

Load versus Extension
Load (N)
10
8.75
7.5
6.25
5
3.75
2.5
1.25
0
-1
1
3
5
7
9
11
13
15
Extension (mm)
Peak Index
Break Index
Test Run 1
Modulus Line

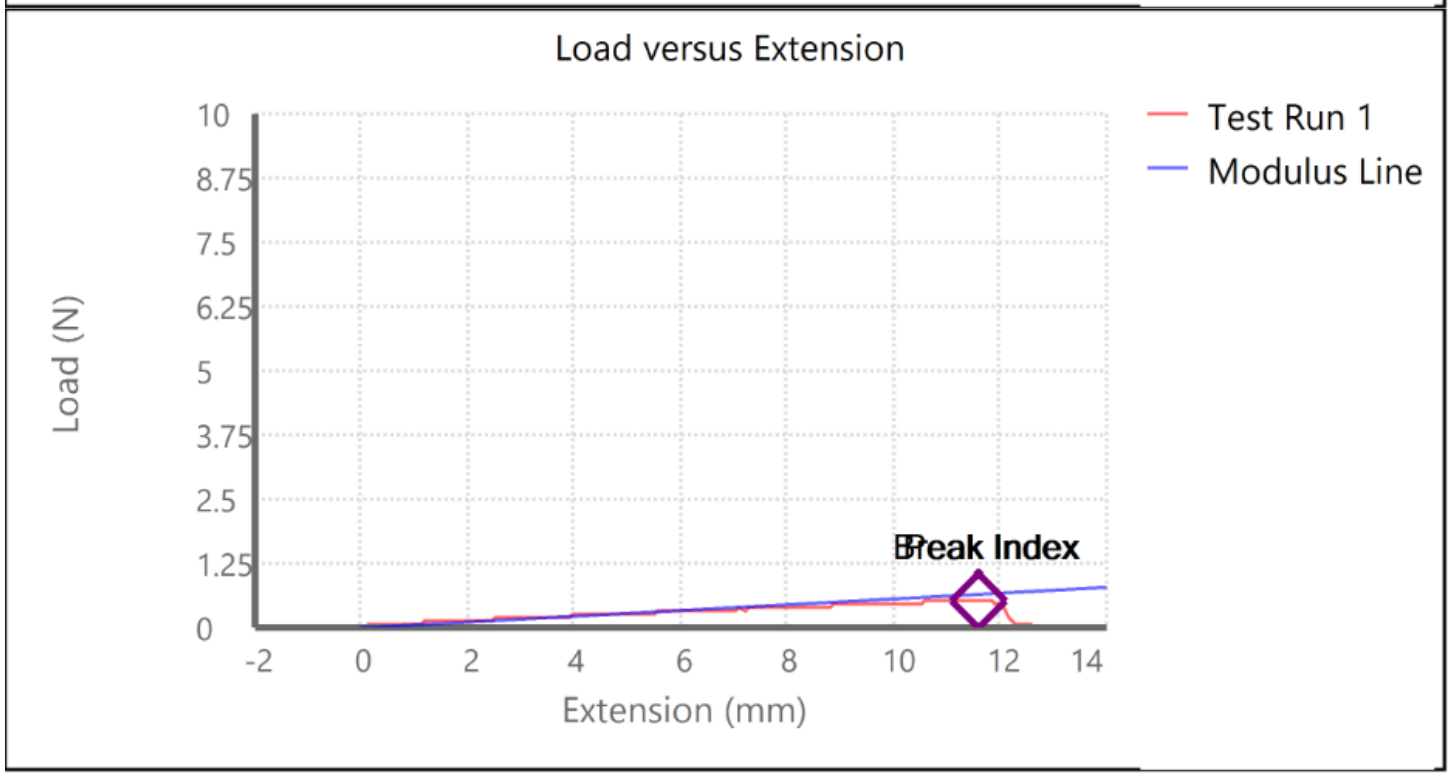

Load versus Extension
Load (N)
0.051
0.043
0.035
0.027
0.019
0.011
0.003
-0.005
-0.013
-0.3
0.5
1.3
2.1
2.9
3.7
4.5
5.3
6.1
Extension (mm)
Test Run 1
Modulus Line

Tensile Testing Part 2:

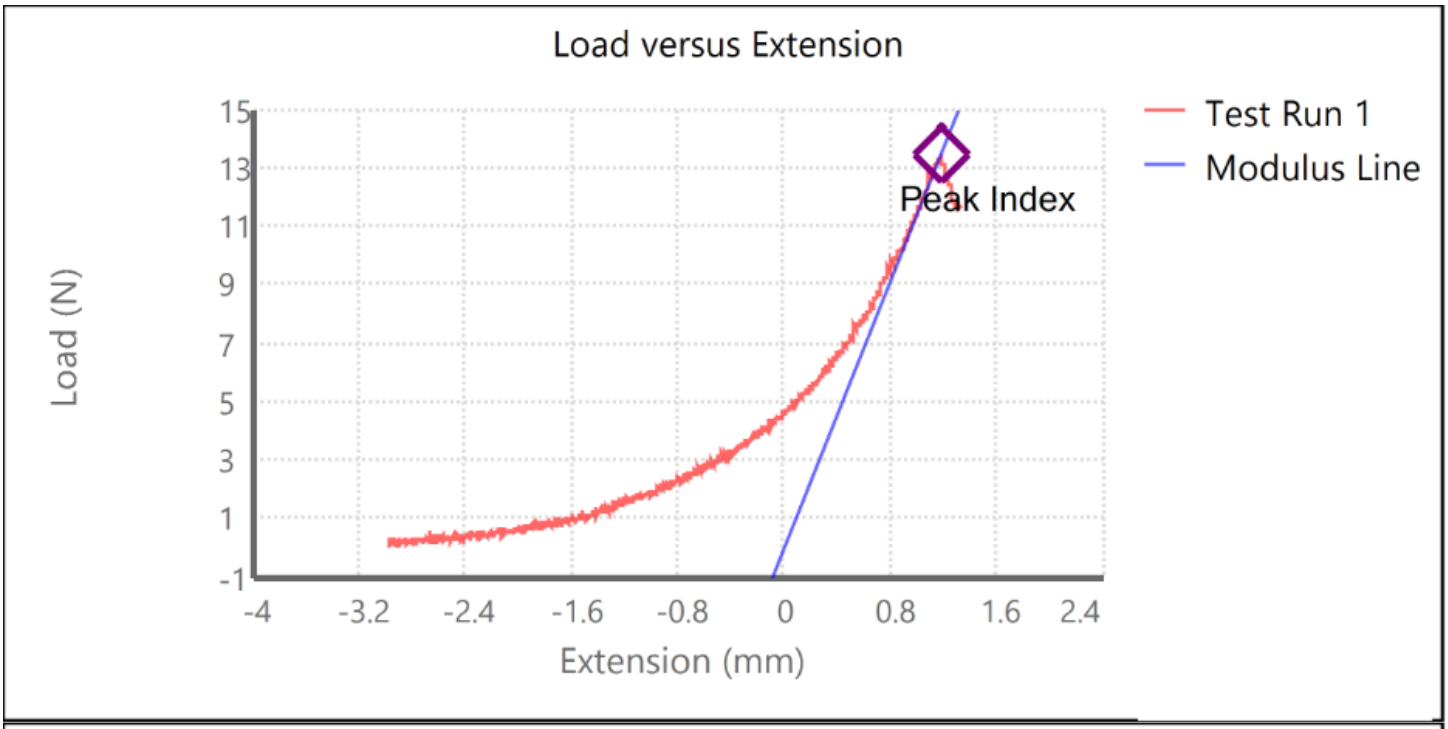


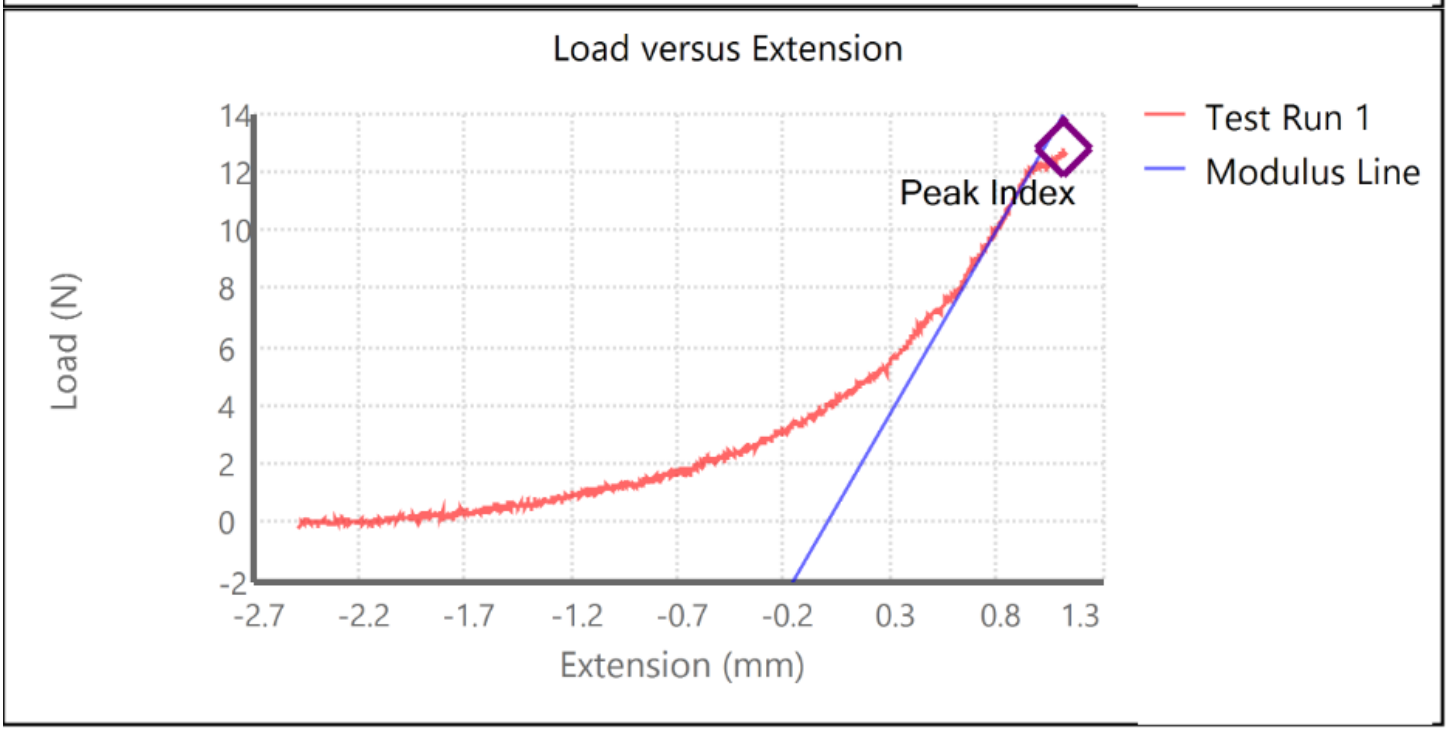


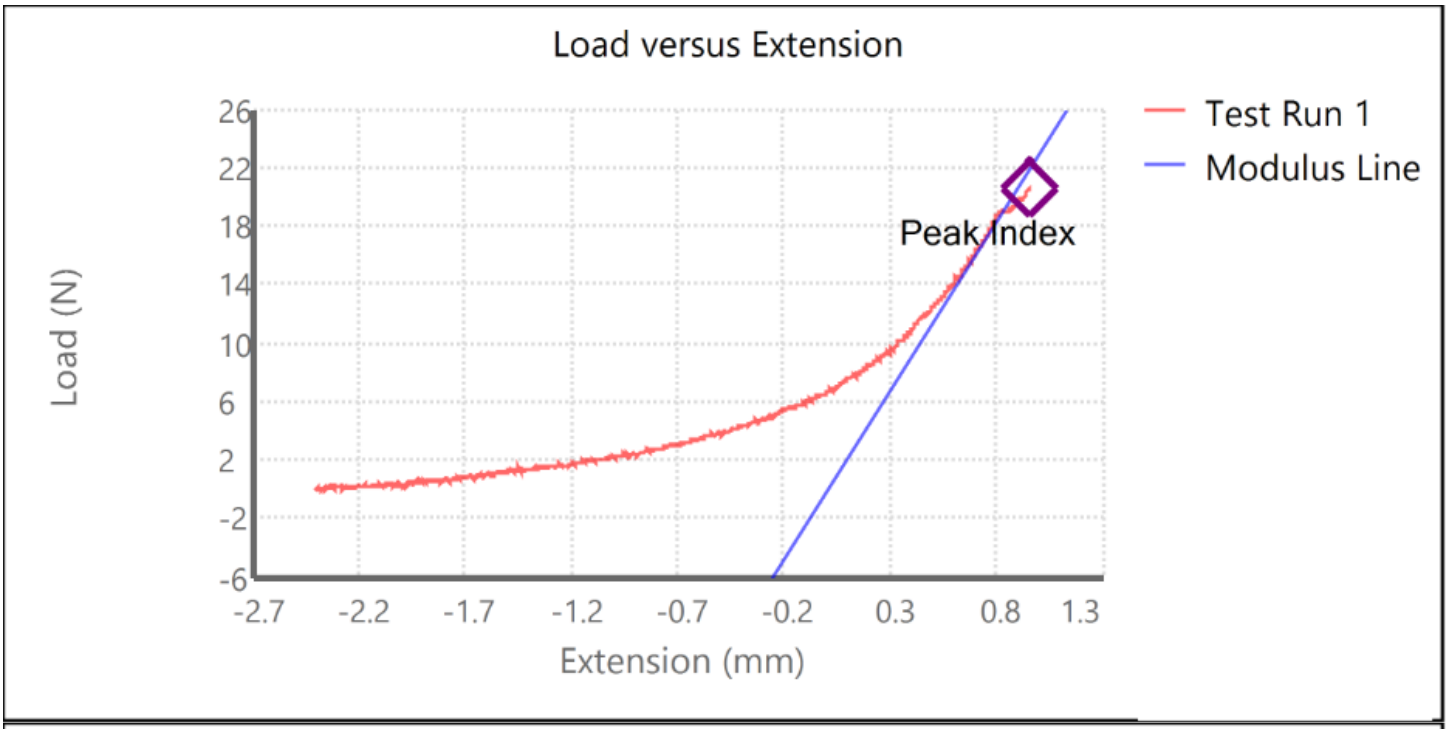


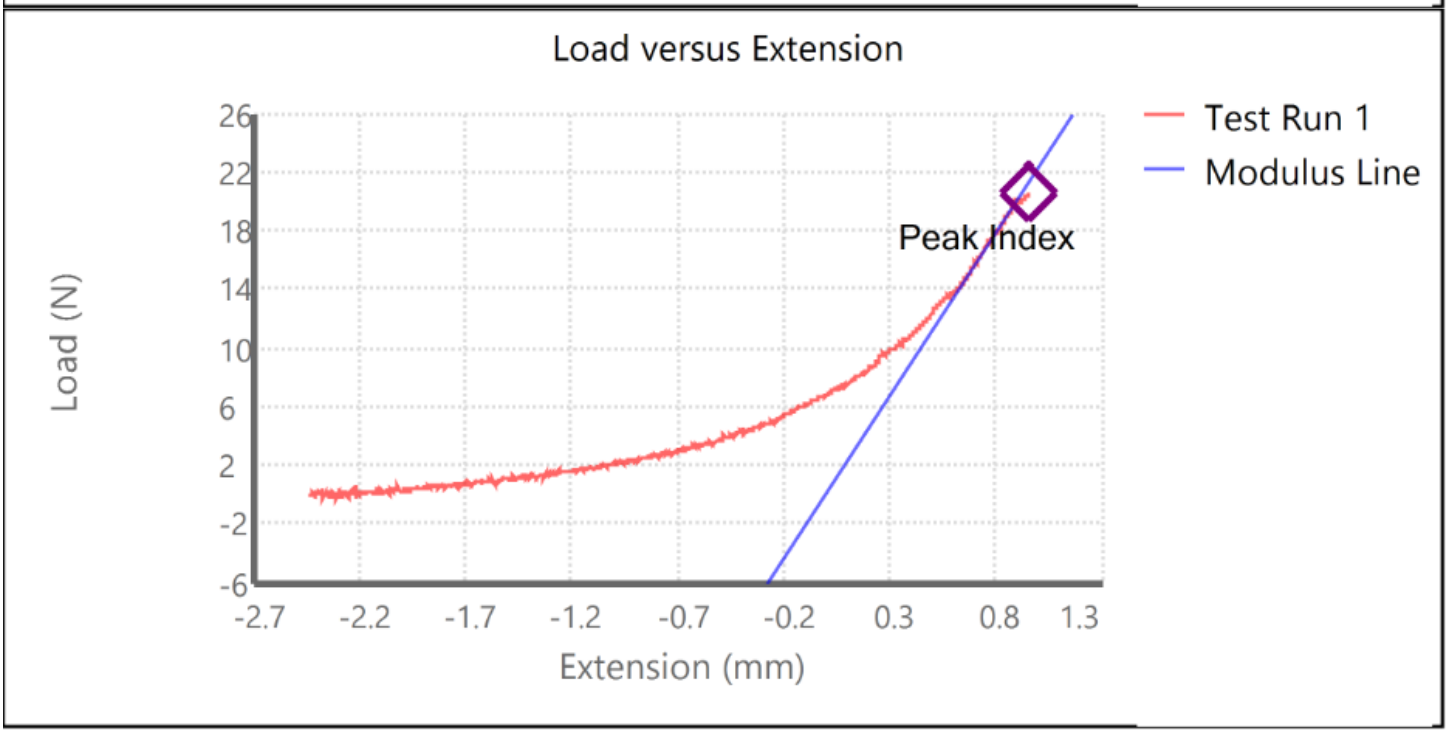


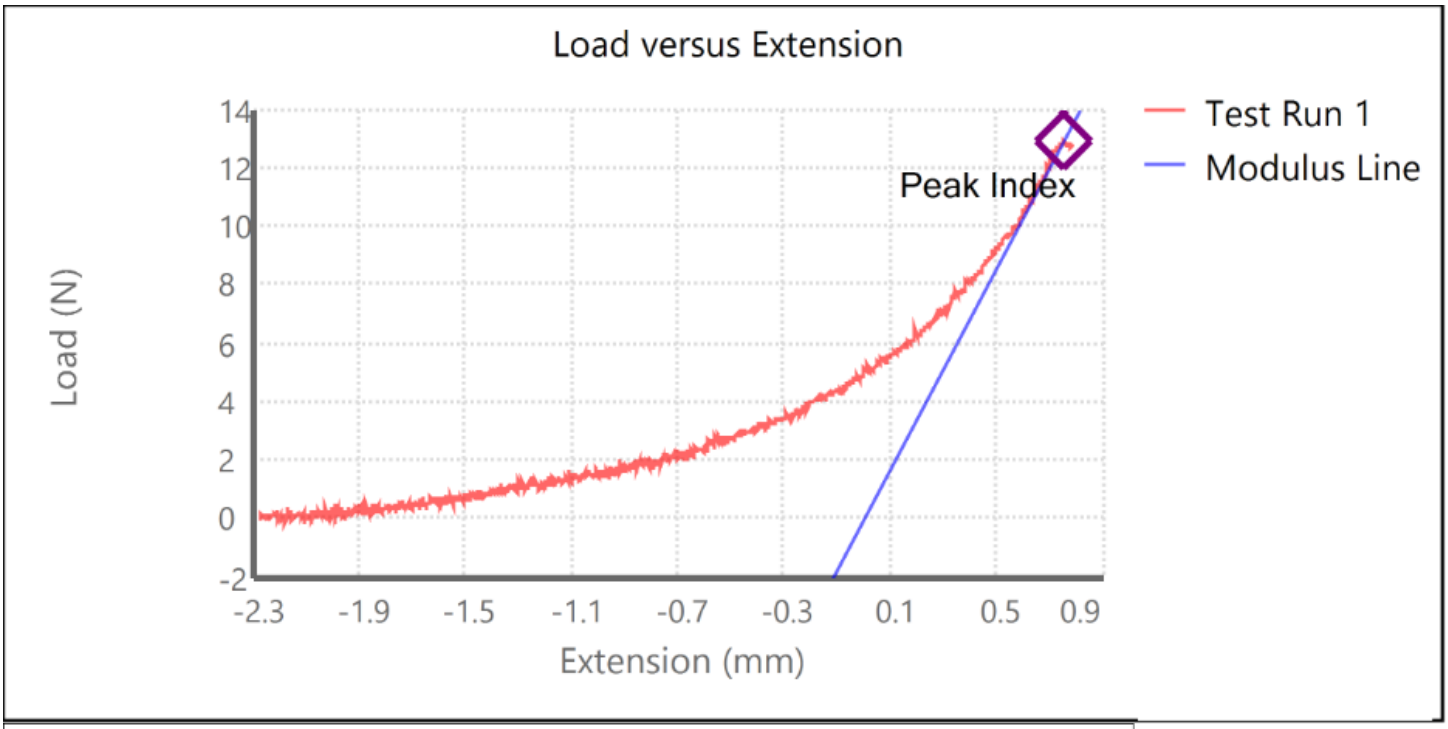
Compression Testing:

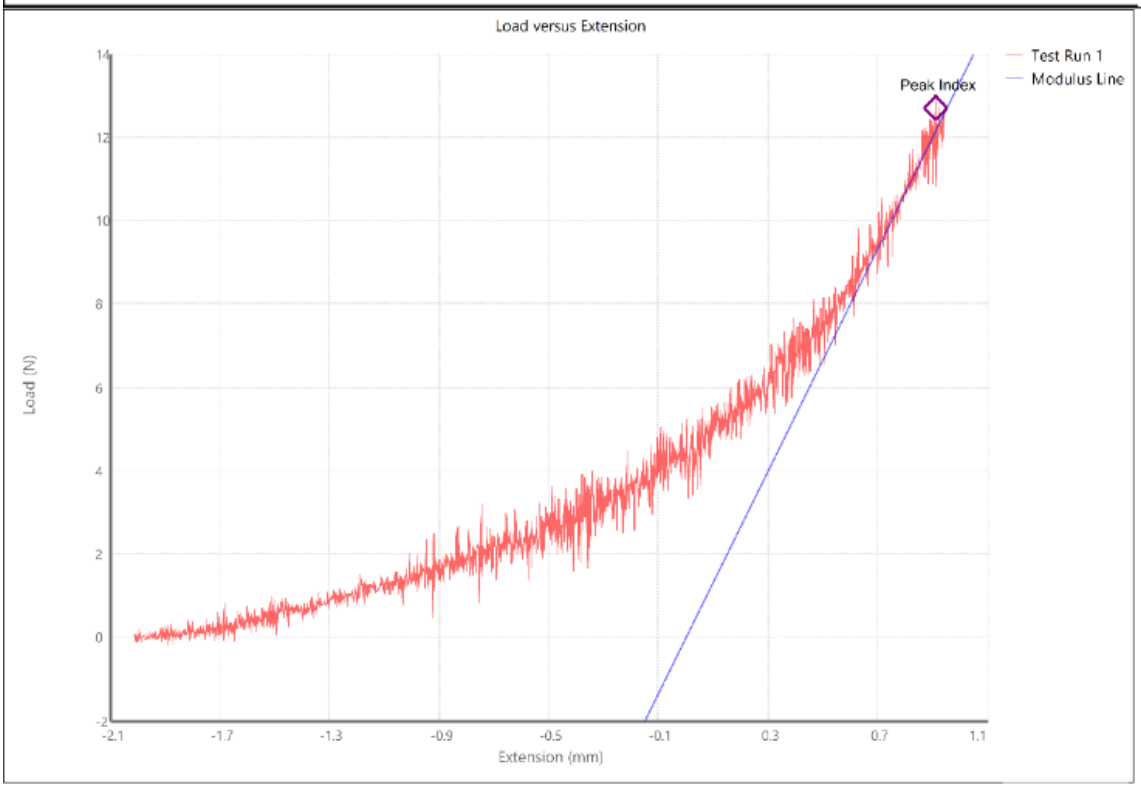

Load versus Extension
Load (N)
15
13
11
9
7
5
3
1
-1
-4
-3.2
-2.4
-1.6
-0.8
0
0.8
1.6
2.4
Extension (mm)
Peak Index
Test Run 1
Modulus Line


Load versus Extension
Load (N)
14
12
10
8
6
4
2
0
-2
-2.7
-2.2
-1.7
-1.2
-0.7
-0.2
0.3
0.8
1.3
Extension (mm)
Peak Index
Test Run 1
Modulus Line


Load versus Extension
Load (N)
26
22
18
14
10
6
2
-2
-6
-2.7
-2.2
-1.7
-1.2
-0.7
-0.2
0.3
0.8
1.3
Extension (mm)
Peak Index
Test Run 1
Modulus Line


Load versus Extension
Load (N)
26
22
18
14
10
6
2
-2
-6
-2.7
-2.2
-1.7
-1.2
-0.7
-0.2
0.3
0.8
1.3
Extension (mm)
Peak Index
Test Run 1
Modulus Line

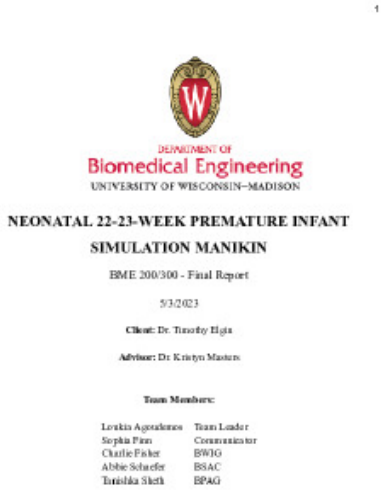




Conclusions/action items: Assess the elastic modulus and discuss the results of the testing in the final report.

05/03/2023 - Final Report

Charlie Fisher - May 03, 2023, 11:06 PM CDT



DEPARTMENT OF
Biomedical Engineering
UNIVERSITY OF WISCONSIN–MADISON

NEONATAL 22-23-WEEK PREMATURE INFANT SIMULATION MANIKIN

BME 200/300 - Final Report

5/3/2023

Client: Dr. Timothy Elgin

Advisor: Dr. Kristyn Masters

Team Members:

Loukia Agoudemos	Team Leader
Sophia Finn	Communicator
Charlie Fisher	BWIG
Abbie Schaefer	BSAC
Tanishka Sheth	BPAG

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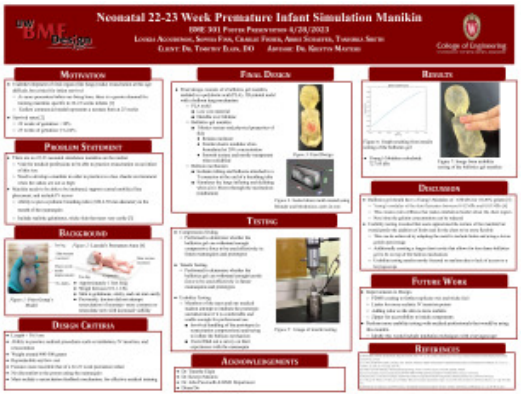
Neonatal_Manikin-Final_Report..pdf (2.62 MB)

05/03/2023 - Final Presentation

LOUKIA AGOUDEMOS - May 03, 2023, 10:21 PM CDT



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22-23_Week_Premature_Infant_Simulation_Manikin.pptx.pdf (1.9 MB)

04/21/2023- Tong Executive Summary

Charlie Fisher - May 03, 2023, 10:44 PM CDT

Title: Tong Executive Summary

Date: 04/21/23

Content by: Whole team

Charlie Fisher - May 03, 2023, 10:43 PM CDT

Neonatal 22-23-Week Premature Infant Simulation Manikin

Executive Summary: Design Excellence

Loukia Agouridemos, Sophia Finn, Charlie Fisher, Abbie Schaefer, Tanishka Sheth
Advisor: Dr. Kristyn Masters **Client**: Dr. Timothy Elgin

Neonates born at 22-23 weeks are rare, and thus medical professionals often have minimal experience with these infants. This creates a demand for medical simulation manikins that accurately and reliably represent neonates born at this stage of gestation. There are currently no neonatal manikins for infants born between 22-23 weeks, the earliest model represents a neonate born at 28 weeks. Due to the significant size difference between these ages, an accurate manikin could reduce the likelihood of trauma caused by improper intubation and UV insertion during critical medical procedures. To improve upon this, the team will consider the anatomy of a neonate born at 22-23 weeks as well as training needs. These needs have been outlined and identified by the client and the team.

There are several design specifications that the team must meet with anatomic and functional accuracy. Accurate replication allows doctors and students to get effective practice when using the model. The manikin must be able to be intubated, meaning a breathing tube must be able to be placed into the manikin's trachea. The model's trachea is a tube from mouth to lungs, with a T-connector to replicate the branching between right and left lungs. Additionally, a chest cavity must be created to allow further procedural training for medical professionals in chest compressions, thoracentesis, and pericardiocentesis. The team chose to use ballistics gel for the body structure of the infant, and will use 3D printed polylactic acid (PLA) to create an anatomically accurate mold. The ballistics gel will allow for the support the rib cage would give, and a balloon will be inserted into the chest cavity and attached to the breathing tube to replicate lungs. Another benefit of ballistics gel is that it retains moisture and can thus replicate a neonate's skin. If too much tearing or compression is applied, the gel will break like neonatal skin and further provide feedback to the user.

The prototype will undergo various testing procedures. Medical professionals will be surveyed in order to collect data about the accuracy and ease of the intubation procedure. The ballistics gel and PDMS skin will undergo MTS testing in order to ensure it has properties similar to real neonatal skin. The team will also experiment with several fabrication procedures, varying curing times and gelatin powder to water ratios to develop the most realistic skin-like texture.

The Neonatal 22-23-Week Premature Infant Simulation manikin helps fulfill the need for training devices representing one of medicine's most critical and underserved populations. It fills a dire healthcare need at a fraction of the current cost of manikins on the market while ideally improving the outcomes of

Download

Tong_Competition_Executive_Summary_2_.pdf (71.3 kB)

02/24/2023- Preliminary Presentation

Charlie Fisher - May 03, 2023, 10:42 PM CDT

Title: Preliminary Presentation

Date: 02/24/2023

Content by: Whole Group

Charlie Fisher - May 03, 2023, 10:42 PM CDT

Download

22-23-Week_Premature_Infant_Simulation_Mannequin_Preliminary_Presentation_2_.pdf (1.19 MB)

2/9 - Newborn Characteristics

ABBIE SCHAEFER (aaschaefer2@wisc.edu) - May 03, 2023, 6:58 PM CDT

Title: Newborn Characteristics

Date: 2/9

Citation:

> “Newborn characteristics,” *Pediatric Web Websites and Marketing Solutions for Pediatricians*. [Online]. Available: https://www.pediatricweb.com/webpost/iframe/Newborns_460.asp?tArticleId=3. [Accessed: 10-Feb-2023].

Link: https://www.pediatricweb.com/webpost/iframe/Newborns_460.asp?tArticleId=3

Search Terms: Neonate characteristics

Search Engine: Pediatric web

Content:

-Diamond shaped soft area at top of skull

- skin often has red blotches with occasional white lumps in the center

- After two weeks acne is common

-dry skin is also common as their outer layer of skin flakes off

- milia are common on face

Conclusions/action items:

This short article was helpful to gain a bit more information about typical physical characteristics of newborns. This will be helpful as we design and focus on the exterior of our mannequin.

2/13 - Neonatal Endotracheal Intubation

ABBIE SCHAEFER (aaschaefer2@wisc.edu) - Feb 13, 2023, 6:33 PM CST

Title: Neonatal Endotracheal Intubation

Date: 2/13/23

Content by: Abbie Schaefer

Present: N/A

Goals: Learn more about neonatal intubation

Citation:

J. P. Wyllie, “Neonatal endotracheal intubation,” *Archives of Disease in Childhood - Education and Practice*, vol. 93, no. 2, pp. 44–49, 2008.

Link: https://ep.bmj.com/content/93/2/44.full

Search Terms: neonatal intubation

Webpage: google scholar

Content:

- ET intubation is an emergency procedure

- 1/500 babies need intubation at birth and therefore many trained practitioners do not have adequate training in this procedure

- Neonatal airways consist of relatively large tongues, high anterior larynx and a narrow u shaped epiglottis

- Compared to older persons, these young babies have proportionally greater O2 consumption and a small reserve

- Equipment needed for intubation includes: endotracheal tubes, mask for ventilation, laryngoscope

- Confirmation that an intubation has been done correctly can be done by visualizing the endotracheal tube in place, noticing the increase of heart rate if it was low or continuation of a steady heart rate, recognizing the exhalation of CO2 through a carbon dioxide detector

- Neonatal intubation should take no longer than 20 seconds

- Intubation can be done through the nose or mouth depending on the circumstances and skills of the practitioner

- Oral intubation tends to be faster in neonates and also is more likely to be successful in the first attempt, less traumatic

- there are still no realistic models to train on for intubation

2/14 - Neonatal Intubation Practice and Outcomes: An International Registry Study

ABBIE SCHAEFER (aaschaefer2@wisc.edu) - Feb 14, 2023, 4:03 PM CST

Title: Neonatal Intubation Practice and Outcomes: An International Registry Study

Date: 2/14/23

Content by: Abbie Schaefer

Goals: Learn more about neonatal intubation

Citation:

E. E. Foglia, A. Ades, T. Sawyer, K. M. Glass, N. Singh, P. Jung, B. H. Quek, L. C. Johnston, J. Barry, J. Zenge, A. Moussa, J. H. Kim, S. D. DeMeo, N. Napolitano, V. Nadkarni, and A. Nishisaki, “Neonatal intubation practice and outcomes: An international registry study,” *Pediatrics*, vol. 143, no. 1, 2019.

Link: https://publications.aap.org/pediatrics/article/143/1/e20180902/37256/Neonatal-Intubation-Practice-and-Outcomes-An

Search Terms: neonatal intubation

Webpage: google scholar

Content:

- Neonatal intubation is considered to be a necessary but dangerous operation

- in the NICU of this study first attempt success rate of neonatal intubation was 49%

- Although tracheal intubation is not as prominent current day due to the change in neonatal methods

- Successful airway management is defined by: ET tube placement in the trachea, visibal chet rise, ausculation, CO2 detection, chest radiograph, second independent laryngoscopy

- Study found that increased training level was associated with inreased first attempt success rate

2/7 - High Fidelity Simulation in Neonatal Resuscitation

ABBIE SCHAEFER (aaschaefer2@wisc.edu) - Feb 10, 2023, 12:38 PM CST

Title: High Fidelity Simulation in Neonatal Resuscitation

Date: 2/7/23

Goals: Get a background on neonatal simulation mannequins

Citation:

D. M. Campbell, T. Barozzino, M. Farrugia, and M. Sgro, “High-fidelity simulation in neonatal resuscitation,” *Paediatrics & Child Health*, vol. 14, no. 1, pp. 19–23, 2009.

Search Terms: neonatal mannequin

Webpage: google scholar

Content:

- A few different neonatal mannequins currently are available on the market: two examples include the hi-fi mannequin or simple plastic mannequins

- hi-fi mannequin is an interactive child that can breathe, cry, mimic seizure activity and can have vital signs changed on real time to adjust to the doctors actions

- This study showed that residents that tested resuscitation skills on the hi-fi mannequin reported a higher rating of experience when compared to those who used the plastic babies

- Companies that create such mannequins include Laerdal

- Studies have shown that residents have relatively few opportunitites to lead resuscitations on neonatal babies before their training has concluded

Conclusions/action items:

This article was interesting as it showed an interesting study relating two different mannequins and doctors analysis of them. Overall it showed that more realistic mannequins offer a higher quality of training for doctors as they simulate a body more similar to that of a real life human. This will be helpful research as we continue to work on our own project creating a neonatal mannequin.

2/8 - Simulation in Neonatal Resuscitation

ABBIE SCHAEFER (aaschaefer2@wisc.edu) - Feb 10, 2023, 12:42 PM CST

Title: Simulation in Neonatal Resuscitation

Date: 2/8

Goals:

Citation:

A. A. Garvey and E. M. Dempsey, “Simulation in neonatal resuscitation,” *Frontiers in Pediatrics*, vol. 8, 2020.

Search Terms: Neonatal Mannequin

Search Engine: Google Scholar

Link: https://www.frontiersin.org/articles/10.3389/fped.2020.00059/full

Content:

- 1/10 newborns need to be resuscitated at birth

- Simulation is "an instructional strategy used to replace or amplify real experiences with guided experiences that evoke or replicate substantial aspects of the real world in a fully interactive manner"

- Neonatal resuscitation is a high pressure high risk situation

- Simulation can not only be used to teach learning doctors but also for currently practicing doctors to get refreshed on certain skills

- Most intubation models are low fidelity and real life neonatal dimensions vary from those in simulation meaning that trainees sometimes do now show improved clinical performance following simulation practice

-

Conclusions/action items:

This article was helpful in giving me a bit of background on simulation medicine and helping me to understand some typical procedures that are practiced on neonatal mannequins.

2/5 - Simulation in neonatal care

ABBIE SCHAEFER (aaschaefer2@wisc.edu) - Feb 10, 2023, 12:36 PM CST

Title: Simulation in neonatal care: towards a change in traditional training?

Date: 2/2/23

Content by: Abbie Schaefer

Present: N/A

Goals: Get a background on neonatal simulation mannequins

Citation:

> N. Yousef, R. Moreau, and L. Soghier, “Simulation in neonatal care: Towards a change in traditional training?,” *European Journal of Pediatrics*, vol. 181, no. 4, pp. 1429–1436, 2022.

Search Terms:

Webpage: google scholar

Content:

- There is a lack of neonatal simulators that allow doctors to practice neonatal scenarios
- There is a need for more advanced neonatal simulators
- Neonatal resuscitation is a high acuity, high occurrence situation
- simulation is an important tool to teach medical professionals skills and allow them to practice

Conclusions/action items:

4/10/23- Ballistics gel

ABBIE SCHAEFER (aaschaefer2@wisc.edu) - May 03, 2023, 6:59 PM CDT

Title: A novel method for creating custom shaped ballistic gelatin trainers using plaster molds

Date: 4/10/23

Citation:

Doctor, Michael, et al. “A Novel Method for Creating Custom Shaped Ballistic Gelatin Trainers Using Plaster Molds.” *Journal of Ultrasound*, vol. 21, no. 1, 2017, pp. 61–64., https://doi.org/10.1007/s40477-017-0274-1.

Link: https://link.springer.com/article/10.1007/s40477-017-0274-1

Goals: Gain more information about ballistics gel molding

Content:

- Ballistics gel is cost effective and easy to utilize in a variety of settings (doesn't require machinery, etc)

- Can be easily molded in a variety of materials using a mold release agent

- Can be made harder or more ductile by using different ratios of gelatin to water

- Used to mold medical trainers due to its elasticity comparable to that of human skin

Airway tract ideas

Sophia Finn - Mar 01, 2023, 9:15 PM CST

Title: Intubation/airway tract ideas

Content:

- To allow for medical professionals to successfully intubate the mannequin it is necessary that the mannequin possesses a mouth area connected to a larynx and trachea that branches off into lungs

- The trachea tubing should be made of a softer material such as a silicone to properly mimic the airway tract found in babies

- the lungs should be a material that can expand so that the intubation can be deemed successful - a potential idea is a balloon type structure

- A potential other aspect could be to add an esophagus that would lead to the stomach - this would allow for a more realistic intubation experience as a common mistake during intubation is sticking the ET tube down into the stomach instead of into the lung area

4/20/23 - airway tract updated

ABBIE SCHAEFER (aaschaefer2@wisc.edu) - May 03, 2023, 7:06 PM CDT

Title: Updated airway tract ideas

Date: 4/20/23

Goals: Design an airway tract for the mannikin

Content:

- the client wanted the team to create an anatomically accurate airway tract within the neonate mannequin for medical professionals to practice intubation on

- Main components required for this airway tract include: opening beginning at the neonate mouth the connects to a tube representing the trachea which then branches off into two openings where the lungs connect

- Best way to model this:

1. carve an opening in the ballistics gel from the mouth curved downwards at an angle as well as an opening in the body of the mannikin to represent the chest cavity

2. use a 2mm wide and 40 mm long ductile tube (made of silicone preferably) to represent the trachea and place the tube at the end of the mouth opening

3. use a T connector (to scale) to connect the end of the tracheal tube to the lungs

4. Use water balloons to represent the two lungs, which will be connected to the trachea by the T connector

A larger version of this airway can be created for the team to test the concept before scaling it down to fit inside the mannikin. This will also be a good model for presentations.

PDMS molding on ballistics gel ideas

ABBIE SCHAEFER (aaschaefer2@wisc.edu) - May 03, 2023, 7:18 PM CDT

Title: PDMS coated on ballistics gel

Goals: Brainstorm and look into ways to coat the PDMS on the ballistics gel

Content:

- Goal: the team is seeking to coat the ballistics gel baby with PDMS in order to create a more wet, sticky finish on the mannikin to more closely replicate neonate skin

- Encountered Issue: when the team attempted to cure PDMS on top of ballistics gel samples in petri dishes, the PDMS refused to cure and was still wet days after coating (the PDMS should cure within 2 days)

- Ideas: try to texture the ballistics gel or make it more porous to promote more integration of the PDMS within it, add more curing agent to the PDMS, add the PDMS coating slightly before the ballistics gel is fully cured itself to try to cure them together

Warf Lecture

ABBIE SCHAEFER (aaschaefer2@wisc.edu) - Mar 10, 2023, 6:31 PM CST

Title: Warf Lecture

Date: 3/10

Content by: Abbie Schaefer

Present: N/A

Goals: Learn about intellectual property

Content:

Take notes on the above video link and finish with a short 1-2 sentences on how you think your design might have intellectual property.

- WARF helps to manage intellectual property seen on UW campus

- Innovation begins with the research and discovery of an idea followed by patenting and licensing or a startup followed by funding and support to research and discovery which then continues the cycle

- There are three main ways to protect ideas - patent, copyright, trademark and sometimes a trade secret

- Prior art is anything that has been done before your invention

- USA gives us a 12 month period to get a patent after publicly announcing art

- Patentability requirements: is it new, is it obvious, is it eligible

- It takes a long long time to get a patent (years and years sometimes)

- A US patent costs on average $30,000

- Working with WARF allows them to help you get a patent for your idea - there is a variety of funding and financial agreements associated with working with them

- License is an agreement that allows a company to use somebodies patent

- Most of the money comes from royalties gained when the products are sold

- There are a variety of start up resources available to us as students

I believe that my project this semester focused on creating a 22-23 week old neonatal mannequin has intellectual property as there are no current models on the market for simulation mannequins of this age range. This product would therefore be a brand new idea item that doesn't currently exist.

3/31/23 - Tong lecture

ABBIE SCHAEFER (aaschaefer2@wisc.edu) - Mar 31, 2023, 12:31 PM CDT

Title: Tong lecture

Date: 3/31/23

Content by: N/A

Present: BME students

Content:

- Jinger Zeng

- graduated with a degree in mechanical engineering

- began a startup robotics company Dronesmith which focuses on creating things for flying drones

- Works for Hackster.io as a contest manager

4/28/23 - Usability testing

ABBIE SCHAEFER (aaschaefer2@wisc.edu) - May 03, 2023, 7:10 PM CDT

Title: Usability testing of the mannikin

Date: 4/28/23

Goals: Create a survey for medical professionals to use to test our mannikins usability

Necessary items to include in the survey:

- how accurate is the mannikin (in terms of intubation (airway), compression testing (chest cavity), skin texture, size, weight)

- Areas that need improvement

How was the overall intubating experience?	Highlight the rating 1-5 (5 being the best):
	5 4 3 2 1
How was the overall compression experience?	Highlight the rating 1-5 (5 being the best):
	5 4 3 2 1
How accurate was the mannequin compared to a 22-23 week neonate in terms of size?	Highlight the rating 1-5 (5 being the best):
	5 4 3 2 1
How accurate was the mannequin compared to a 22-23 week neonate in terms of skin texture and quality?	Highlight the rating 1-5 (5 being the best):
	5 4 3 2 1
How accurate was the mannequin compared to a 22-23 week neonate in terms of anatomical features?	Highlight the rating 1-5 (5 being the best):
	5 4 3 2 1
If you could add one portion to make it more realistic, what would it be?	List your suggestion below: (write N/A if not applicable)

Limb Material and IVs

Charlie Fisher - Feb 10, 2023, 1:21 PM CST

Title: Limb Material and IVs

Date: 2/10/23

Content by: Charlie Fisher

Goals: Learn more about the materials we could potentially use for the limbs to allow for IVs to flow through the mannequin.

Content:

The skin of infants is thin, and the skin of premature infants is even thinner. The thickness of a premature infants skin is approximately 0.9 mm with an epidermal thickness ranging from 20-25 μm, and a stratum corneum 5-6 cells thick which is approximately 4-5 μm thick[1]. This is a very frail organ to simulate on a mannequin. Many biomaterials with skin like properties aren't this thin so that poses some challenges to us. The mannequin will need a spot for IV access. The best spot for this would likely be in the dorsal arch veins in the back of the hand. It's hard to find a vein that is visible and in a safe spot for infants, but this one is larger and easier to see or feel [2]. We can simulate this system of veins in the hand.

Conclusions/action items:

It will be hard to simulate the infants skin while not having a mannequin that is too gentle for multiple uses. A good plan would be to have the limbs of the mannequin made from a different material than the core. This material also needs to be strong enough to hold in the veins that will be simulated with tubes and ready to have IVs inserted into them. The mannequin will have a structure that will simulate the skeletal system that has to be taken into account as well.

[1] “Skin of the premature infant,” *Clinical Gate*, 09-Mar-2015. [Online]. Available: https://clinicalgate.com/skin-of-the-premature-infant/. [Accessed: 10-Feb-2023].

[2] “Peripheral intravenous (IV) catheter insertion for neonates,” *Safer Care Victoria*. [Online]. Available: https://www.safercare.vic.gov.au/clinical-guidance/neonatal/peripheral-intravenous-iv-catheter-insertion-for-neonates. [Accessed: 10-Feb-2023].

Canalicular Stage of Lung Development

Charlie Fisher - Mar 01, 2023, 10:02 PM CST

Title: Canalicular Stage of Lung Development

Date: 9/5/2016

Content by: Charlie Fisher

Goals: Learn more about the lungs of infants at 22-23 weeks.

Content:

Infants 22-23 weeks in development are in the canalicular stage of lung development. This stage occurs from 16-25 weeks. During this stage, the lung is turning from a nonfunctioning lung to a lung that could be viable outside the uterus. This is due to the formation of the acinus, which is a region of the lung that's supplied by the first-order respiratory bronchiole, and contains the respiratory bronchioles, alveolar ducts, and alveolar sacs. Also the air-blood barrier is being formed.

Conclusions/action items:

Infants in the early parts of this stage have a much less likely chance of surviving prematurely than 25 week old infants.

References:

“Acinus,” *Acinus - an overview | ScienceDirect Topics*. [Online]. Available: https://www.sciencedirect.com/topics/medicine-and-dentistry/acinus#:~:text=A%20pulmonary%20acinus%20is%20usually,1.6). [Accessed: 01-Mar-2023].

“Lung Development - College of Medicine » University of Florida.” [Online]. Available: https://neonatology.pediatrics.med.ufl.edu/files/2016/04/LUNG-DEVELOPMENT.pdf. [Accessed: 02-Mar-2023].

Guidelines for Neonatal Intubation

Charlie Fisher - Mar 01, 2023, 10:34 PM CST

Title: Guidelines for Neonatal Intubation

Date: 3/1/23

Content by: Charlie Fisher

Goals: Research guidelines for intubation.

Content:

In NICU intubations, pre-medication must be given to the infant. First, 5 microgram/kg of fentanyl must be given to the infant over a slow push from 3-4 minutes trough IV. Next, 15 micrograms/kg of Atropine and 2 mg/kg of Suxamethonium should be given through an IV Bolus over a 10-20 second time span in order to get the drugs working quicker. Next, the intubation tube used depends on the size in the baby in grams. For babies under 1000 grams and under 28 weeks, the intubation tube must be 2.5 diameters in mm. A virtual laryngoscopy helps success rates if appropriate.

Conclusions/action items:

22-23 week old babies range in age from 300-500 grams, which is in the under 1000 gram and 28 week range that calls for a 2.5 mm in diameter intubation tube. Also, we must consider the virtual laryngoscope as a thing out model might want to be prepared for.

References:

“Neonatal intubation,” *NHS choices*. [Online]. Available: https://www.clinicalguidelines.scot.nhs.uk/nhsggc-guidelines/nhsggc-guidelines/neonatology/neonatal-intubation/. [Accessed: 01-Mar-2023].

CHARLIE manikin

Charlie Fisher - Mar 01, 2023, 9:44 PM CST

Title: C.H.A.R.L.I.E manikin

Date: 3/1/23

Content by: Charlie Fisher

Goals: Compare different models of infant manikins with the plan and requirements that we have for our 22-23 week old manikin.

Content:

The C.H.A.R.L.I.E. Neonatal Resuscitation Simulator with Interactive ECG Simulator is a manikin made by Nasco Healthcare that does a great job replicating infants. It has a lot of features that are similar to some that we want to add to our model. However this model is for an infant that is closer to 40 weeks. the manikin is 19.5 inches long and approximately 8.5 lbs. It has some features that we would like to include in our model. This include has an airway that allows for breathing, intubation, and ventilation. It also includes limbs with IV insertions in the hand and the foot, and a chest that allows for CPR. This manikin is much for advanced than something that could be developed this semester for us. The manikin has blood, interchangeable genitalia, bone structure, and allows for a variety of measurements to be taken from it. It has a built in ECG and palpable manual pulse points in seven locations. This manikin costs around $2000 to purchase.

Conclusions/action items:

Overall, this manikin is a great reference point and goal for where this project may eventually end up. However, it happens to be for a different age and size of infant, so changes must be made according to certain structures.

References

“C.H.A.R.L.I.E. neonatal resuscitation simulator with interactive ECG simulator [SKU: LF01420],” *Nasco Healthcare*. [Online]. Available: https://shop.nascohealthcare.com/products/lf01420. [Accessed: 01-Mar-2023].

Prestan Infant Ultralite Manikin

Charlie Fisher - Mar 01, 2023, 9:43 PM CST

Title: Prestan Infant Ultralite Manikin

Date: 3/1/23

Content by: Charlie Fisher

Goals: Write about another competitor.

Content:

Prestan offers it's own model with the Prestan Infant Ultralite Manikin. This manikin is made specifically for CPR training, therefore it doesn't have some of the features that our project should. This product has a chest cavity and an airway that allows for airflow. It has a plastic chest that allows compression that replicates the expansion and contraction of the ribcage. These manikins are only 1.8 lbs and are a cheap alternative to most infant manikins. They cost $131 per each unit. A good feature that these manikins offer is a feedback system through a light. When the user is successfully giving 100-120 compressions per minute, the light is green. If it is outside of that range, the light will be red.

Conclusions/action items:

This model doesn't have many features that apply to our project, however its mobile chest and feedback system is something that will be considered in our project.

References:

“Infant ultralite® manikin,” *PRESTAN Products*. [Online]. Available: https://www.prestan.com/products/cpr-training-manikins/infant-ultralite-manikin/. [Accessed: 01-Mar-2023].

Intubation and IV design

Charlie Fisher - Mar 03, 2023, 1:23 PM CST

Title: Chest Cavity Design

Date: 2/28/23

Content by: Loukia Agoudemos

Goals: Establish our clear design intentions

Content:

Balloons and an airway will be used as the trachea and lungs for the model. The balloon lungs include a breathing tube with T-connectors to mimic airways. These “airways” would be connected to two small balloons which can inflate and deflate to replicate breathing. These balloons would represent the lungs. This idea is simplistic in that it does not include any skeletal components.

The limbs aren't currently apart of the mold, so those need to be fastened on somehow in order to attach the IVs.

Mold design

Charlie Fisher - Mar 03, 2023, 1:24 PM CST

Title: Mold Material

Date: 2/29/23

Content by: Tanishka and Sophia

Goals: Establish our clear design intentions

Content:

Tough PLA was determined to be an acceptable design for the mold because it is one of the most commonly used plastics for 3D printing. It is heat resistant and would be able to withstand the curing process for PDMS, which is the material that will be poured and cured in the mold. Additionally, it is durable and can be reused for multiple prototypes.

The mold is currently just made of a torso and head, so limbs may need to be added to the torso, or the mold will have to be remade with the same material.

Skin material

Charlie Fisher - Mar 03, 2023, 1:24 PM CST

Title: Skin/Inside Material

Date: 2/29/23

Content by: Tanishka and Sophia

Goals: Establish our clear design intentions

Content:

Using ballistics gel and a PDMS shell is the plan for the skin and inside material. This design for the 22-23 week neonatal manikin strikes a balance between the tactile experience and realism that the properties of PDMS provides and the durability and additional realistic properties that ballistics gel provides. 3D printed PVA that is in the shape of the trachea and chest cavity will be placed in the ballistics gel solution before curing in a fashion where it is easily removed afterward. This will leave behind the desired cavities for intubation. Using the mold, the team will first fabricate the ballistics gel base. Then the team will cure a thin layer of PDMS over the ballistics gel at room temperature due to the low melting temperature of the ballistics gel.

Training Experience

Charlie Fisher - Mar 01, 2023, 8:09 PM CST

Title: Training Experience

Date: 3/1/2023

Content by: Charlie Fisher

Goals: Communicate trainings and permits I have.

Content:

I have my green permit from last year.

Conclusions/action items:

I could enter the makerspace or team lab to do fabrication if necessary.

05/03/2023- Rough Protocols

Charlie Fisher - May 03, 2023, 10:25 PM CDT

Title: Rough Protocol Documentation

Date: 05/03/2023

Content by: Charlie Fisher & Loukia Agoudemos

Goals: Get down ideas and rough overview of testing

Content:

Ballistics Gel Concentration Testing

Materials

- Need water
- Powdered Gelatin
- Mold release
- Hot water bath
- Molds – petri dish
- Stir rod
- Magnetic stir bar
- Vacuum degasser
- MTS machine

Note

- Ballistics gel will last 7-10 days inside the fridge inside of an airtight container
- Clean off any dirt or grime with baby wipes do not rinse it with water
    - A block removed from the fridge should be used within 30 minutes of removing it from the fridge and will last up to a few hours depending on the setting.

What needs to be done

- Fill mold with water to see how much volume it can hold → whatever this measurement is, round up and multiply by 3 to get 3 samples of each

Concentrations to be tested:

- 10% Gelatin cooled at (temperature of fridge)
- 20% Gelatin cooled at (temperature of fridge)
- 30% Gelatin cooled at (temperature of fridge)

Protocol

1. Spray molds (3 for each concentration for triplication) with cooking spray.
2. Formulate gels at different concentrations by adding gelatin powder to water and then gently mixing with your hands– breaking down large clumps.
    1. 90% cold water water and 10% gelatin of measured volume
    2. 80% cold water and 20% gelatin of measured volume
    3. 70% cold water and 30% gelatin of measured volume
3. Let sit in fridge for 2 hours
4. Heat gelatin in a hot water bath and gently stir until it is evenly dispersed throughout the solution. (Do not heat over 40 degrees C).
5. Pour into molds and refrigerate for 48 hours.
6. After 48 hours is up, this can be used.

Tensile Testing

1. Make cylindrical sample of ballistics gel in petri dish
2. Use a scalpel to cut sample into three dog bone shape, smaller samples
3. Measure the samples' dimensions, specifically width and thickness (mm)
4. Put tension grips into MTS machine
5. Fasten one sample into each end of the grips
6. Set the program onto tensile testing and add the measurements for the specified sample
7. Start the program and let it run until the sample breaks
8. Save the data for future analysis
9. Repeat steps 4-8 for the other two samples

Compression Testing

1. Make cylindrical sample of ballistics gel in petri dish
2. Use a scalpel to cut sample into three cubic samples, recording length, width, and height (mm)
3. Put compression testing inserts into MTS machine
4. Place one sample in center of machine
5. Set the program onto tensile testing and add the measurements for the specified sample
6. Start the program and let it run until the graph spikes downward and the sample breaks
7. Save data for future analysis
8. Repeat steps 4-7 for the two other samples

1. Select 3 samples of ballistics gel of appropriate thickness and area for use on the MTS machine in ECB, and do your best to ensure that the sample is as uniform as possible within the sample and among the other sample.
2. Equip appropriate compression testing plate heads onto the MTS testing loads.
3. Power up the MTS machine and open the MTS software. Open a new test.
4. For each sample, conduct the following...
    1. Measure and record the length, width, and thickness of the agar sample.
    2. Put this information in the appropriate text-entry prompts in the MTS software for your new test.
    3. Place the sample centered on the compression plates.
    4. Double-check that everything is looking right before you run the test.
    5. Unlock the machine and select run test.
    6. Collect compression testing data until failure-- should look like a sudden dip in displacement.
    7. Stop the machine and take picture of a sample where you believe failure to be located.
5. Use data analysis to identify elastic modulus and failure load following this example.
    1. Elastic Modulus and Ultimate Strength --Yield point does not apply to the elastic material.

Baby Mold Construction Protocol

1. Mix 160 mL of water and 40 g of ballistics gel powder into a beaker to make 200 mL of ballistics gel
2. Stir the mixture in a beaker until fully liquid
3. Let sit in fridge for 2 hours
4. Heat ballistics gel in a beaker over a hot plate at 260 degrees Fahrenheit while stirring, until consistent
5. Put the beaker in a vacuum degasser for 30 minutes to eliminate bubbles
6. Apply a layer of “Smooth-On Universal Mold Release”, to the inside of each half of the Tough Polylactic Acid (PLA) mold of the baby
7. Let sit for two minutes
8. Apply second layer of Smooth On to each half
9. Let sit for two minutes
10. Pour 70 mL of previously made ballistics gel into each half of the mold.
11. Cover each half in parafilm covering
12. Put it in the fridge for 24 hours
13. Removed from fridge
14. Hollow out the chest cavity of the model
15. Put lungs with t-connector in cavity and run it through the mouth hole
16. Acquire beaker to make gelatin based glue
17. Mix 15 g of gelatin powder with 240 mL of cold water in a bowl.
18. Once the gelatin powder is completely dissolved, add in 15 mL of boiling water, stirring continuously until the mixture is blended.

19. Allow glue to cool and thicken.
20. Spread a layer of glue on each half of the ballistics gel
21. Press together each half of the ballistics gel neonate and refrigerate again.
22. Wait a couple hours and the model is complete

05/03/2023- Presentation Rough Script

Charlie Fisher - May 03, 2023, 10:28 PM CDT

Title: Scripts for Presentations

Date: 05/03/23

Content by: Charlie Fisher

Goals: Gain baseline of what I want to say for presentations.

Content:

- In neonates born at 22-23 weeks, underdevelopment of vital organs, such as the lungs, make resuscitation difficult, however it is critical for their survival.
- As more babies continue to be born prematurely, there is greater demand for manikins in the 22-23 week old range.
- As of now the earliest commercial model represents a neonate born at 25 weeks.
- From 22-23 weeks, the canalicular stage of lung development is occurring, which gives the babies the ability to complete gas exchange on their own.
- There is a tremendous amount of change in the survival rates of babies in this range.
    - 22 week old babies have a less than 10% chance of survival, while 23 week old babies can have as high as 64% chance of survival
    - 24 weeks it gets up to 78% and 25 weeks in gets up to 86%

- There are no 22-23 week old neonatal simulation manikins on the market.
- This age of manikins is vital for medical professionals to be able to practice resuscitation on.
- This would allow the professionals' first experience with this age range to be with minimal stakes.
- The manikin needs to be able to be intubated, support central umbilical line placement, and include IV access.
    - The intubation requires the ability to put a synthetic breathing tube, ranging from 2.00-2.50 mm in diameter, in the mouth of the manikin.
- It also must have realistic wet and sticky skin that tears very easily.

- In neonates born at 22-23 weeks, underdeveloped organs (lungs) make resuscitation difficult, crucial
- As more born, great demand for manikin of this age
- Earliest commercial model, 25 weeks
- In range, canalicular stage of lung development
- 22 weeks <10%, 23 weeks up to 64%, 24 weeks up to 78%, 25 weeks up to 86%

- No 22-23 week
- Vital for resuscitation practice

- Allow encounter, minimal stakes
- Intubated, centralized umbilical placement, IV access
- Wet, sticky gelatinous skin
- Tears easily

02/10/2023 - Mannequin Research

LOUKIA AGOUDEMOS - Feb 10, 2023, 12:05 PM CST

Title: Mannequin Research

Date: 02/10/2022

Content by: Loukia Agoudemos

Present: n/a

Goals: This research finds that hi-fidelity simulation mannequins with more resuscitation components and realistic aspects are more effective than the standard mannequin.

Content:

- This was a research study using medical residents to see which style of simulation mannequin was better for their learning. In this study they found hi fidelity- hi fi mannequins gave a better overall training experience. For our purpose though they found the mannequin that were standard to still be sufficient.
    - May be better given our time constraint.
- Link: High-fidelity simulation in neonatal resuscitation | Paediatrics & Child Health | Oxford Academic (wisc.edu)

Conclusions/action items:Hi- fi mannequin would be useful in the future. For now standard should be our focus.

LOUKIA AGOUDEMOS - Feb 10, 2023, 9:42 AM CST

ORIGINAL ARTICLE

High-fidelity simulation in neonatal resuscitation

Download

pch14019.pdf (705 kB)

02/10/2023 - Neonatal Mannequin Performance Requirements

LOUKIA AGOUDEMOS - Feb 10, 2023, 1:02 PM CST

Title: Neonatal Mannequin Performance Requirements

Date: 02/10/2023

Content by: Loukia Agoudemos

Present: n/a

Goals: This document highlights some research pertaining to specific performance requirements regarding how neonates are resuscitated. These same standards will and should apply to our neonatal mannequin and be able to reflect this.

Content:

- Positive pressure ventilation is essential for adequate resuscitation. Minimizing mask leaks will ensure that resuscitation is sufficient. The first step of the guidelines is that infants should receive 30s of IPPV- intermittent positive pressure.
    - Real-time visual feedback minimizes mask leak by up to 24%.
- Endotracheal intubation.
    - Significant on the turn out of the model-- research how to intubate-- i know they utilize laryngoscopes.
- Chest Compressions
    - Recommended compressions are 3 chest compressions to 1 breath if the heart rates goes below 60 beats per minute.
        - Direct feedback also proves that these are successful
        - Two techniques were employed for resuscitation-- two thumbs at right angles to the chest with fingers clenched in a fist. And the thumbs on sternum technique with fingers encircling the chest and back for support.

Conclusions/action items: Something to consider for our new design is that can we sufficiently be used to these standards for the mannequin. Potentially over this to accommodate for the fact that some people may use incorrect intubation techniques. Another thing to think about is how direct feedback and high fidelity play a role into the performance of the trainee. Although we need to focus small to achieve what we would like during the semester-- the effectiveness of the mannequin really gets upgraded with high fidelity features and is something that should be heavily considered.

04/05/2023 - Neonatal Manikin Questions with Rush Medical

LOUKIA AGOUDEMOS - Apr 05, 2023, 7:07 PM CDT

Title: Neonatal Manikin Questions with Rush Medical

Date: 04/05/2023

Content by: Loukia Agoudemos

Present: Loukia, Tanishka

Goals: Question from expertise in respiratory care about our manikin.

Content:

- The use of a breathing mask with heliox is very effective for babies rather than a breathing tube

Conclusions/action items: Follow up with questions.

03/01/2023 - Inner Workings Design Ideas

LOUKIA AGOUDEMOS - Mar 01, 2023, 9:49 PM CST

Title: Inner Workings Design Ideas

Date: 03/01/2023

Content by: Loukia Agoudemos

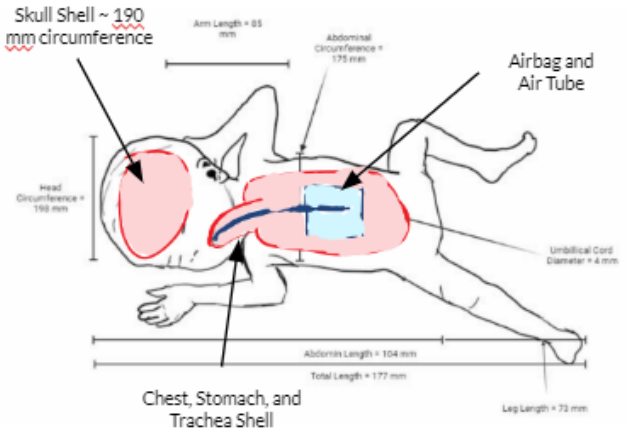
Present: [N/A]

Goals: Draft ideas for the creation of inner-working designs that provide an intubation system, a thoracic cavity, provide a physical inner structure--"a skeleton"-- and ensure adequate IV access points.

Content:

Design 1: Intubation and Shell Model

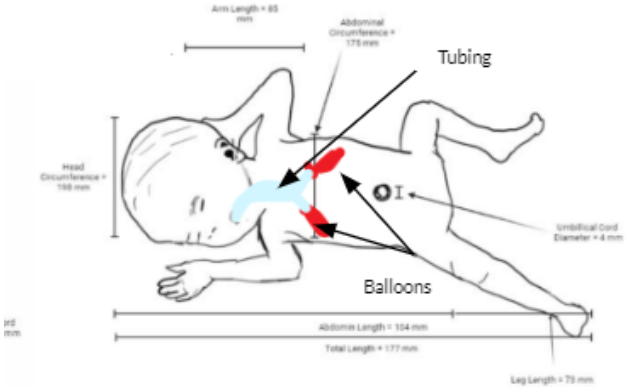
- PLA printed chest and belly cavity
- Infant-sized cpr bag for “lungs”
- Trachea model with silicone mouth & esophagus



- Previously used by First Breath & Micro Mike teams

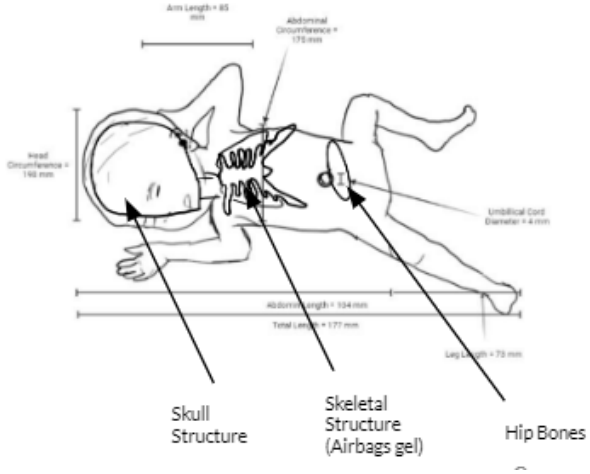
Design 2: Balloon Lungs

- Breathing tube with a T-connector to mimic airways
- Two balloons serving as lungs
- Absence mannequin’s “skeleton”



Design 3: Mock Airway and Mock Skeleton

- Includes a 3D-printed skull and skeleton as the interior structure
    - Made of an elastic-plastic– ie polyurethane



- Accurately sized lung-air bags for the rise and fall of lungs

Conclusions/action items: These three designs were evaluated using a design matrix and weighted criteria in order to choose the best inner workings design.

03/10/2023 - Notes from WARF Lecture

LOUKIA AGOUDEMOS - Mar 10, 2023, 2:09 PM CST

Title: Notes from WARF Lecture

Date: 03/10/2023

Content by: Loukia Agoudemos

Present: N/A

Goals: Learn about WARF, what it is, and how it can be applied to our project.

Content:

- It was really interesting to learn about their background with Steenbock and his discovery and how he was originally turned down. I think it is neat that Peter Tong has a seat on the board as well as the chancellor.
- Trade secrets aren't worked on at WARF because they are publically disclosed.

Our team's design has intellectual property because we are coming up with new ideas to come up with a novel solution for modeling a 22-23 week neonatal manikin. If we want to have legal IP protection of this design prior to publicly disclosing it,

Conclusions/action items: We can talk among our group and with our client about IP protection for this design if he would like to put a patent on it.

01/27/2023 - Status Report Notes Day 1

LOUKIA AGOUDEMOS - Jan 27, 2023, 2:23 PM CST

Title: Status Report Notes Day 1

Date: 01/27/2023

Content by: Loukia Agoudemos

Present: Abbie, Charlie, Loukia, Sophia

Goals: This will be my notes pad where I account for purposes and happenings of BME Design per day to add to the progress report and account for the team.

Content:

- Advisor Meeting: We met with our advisor and scheduled meeting days/times.
- Swap Enrollment: There was an issue with swapping the section so we must wait for changes to be processed to do so.
- Decided team roles: Completed and updated on the website
- Project Notebook: A new project notebook was added to lab archives and the notebook from last semester was copied into it under project information.
- Team Photo: Was taken, will need to take a picture in the future that includes all of our team members.
- Project Report: Made a project report template and made a project report for next week.

Conclusions/action items:

Complete any remaining first-day tasks and make a progress report. The things that must be done are swap enrollment, send the client our new website, begin familiarizing ourselves with the project, and conduct preliminary research. Generate and document questions for the client, start and document your research - continue all semester, discuss the project status with your new advisor and set goals and expectations for the semester

3/1/2023 Neonatal Airway

Sophia Finn - Mar 01, 2023, 9:32 PM CST

Title: 3/1/2023 Neonatal Airway

Date: Neonatal Airway

Content by: Sophia Finn

Present: Sophia Finn

Goals: I would like to understand the particular challenges and anatomical differences one must considered when intubating a neonate.

Content:

- Laryngoscopy is difficult because of the prominent occiput.
- A small mandible makes it difficult to open the mouth.
- A large tongue in relation to the mouth makes it difficult to reach the airway.
- Larger tonsils makes it more prone to obstruct the airway
- A larger epiglottis makes it more prone to obstruct the airway
- A narrow, short trachea makes the neonate more prone to obstruct the airway and to suffer from tracheal stenosis following intubation.
- A soft trachea makes the cartilage around it more prone to collapse.

Source: Differences in upper airways of neonates, children and adults | Deranged Physiology

Conclusions/action items:

Using this information, I would like to incorporate in future designs ways to emphasize the particulars of intubating a neonate. It seems that there are unique features that make this more of a challenge.

3/7/2023 Infant Laryngeal Alignment

Sophia Finn - May 03, 2023, 2:06 PM CDT

Title: Infant Laryngeal Alignment

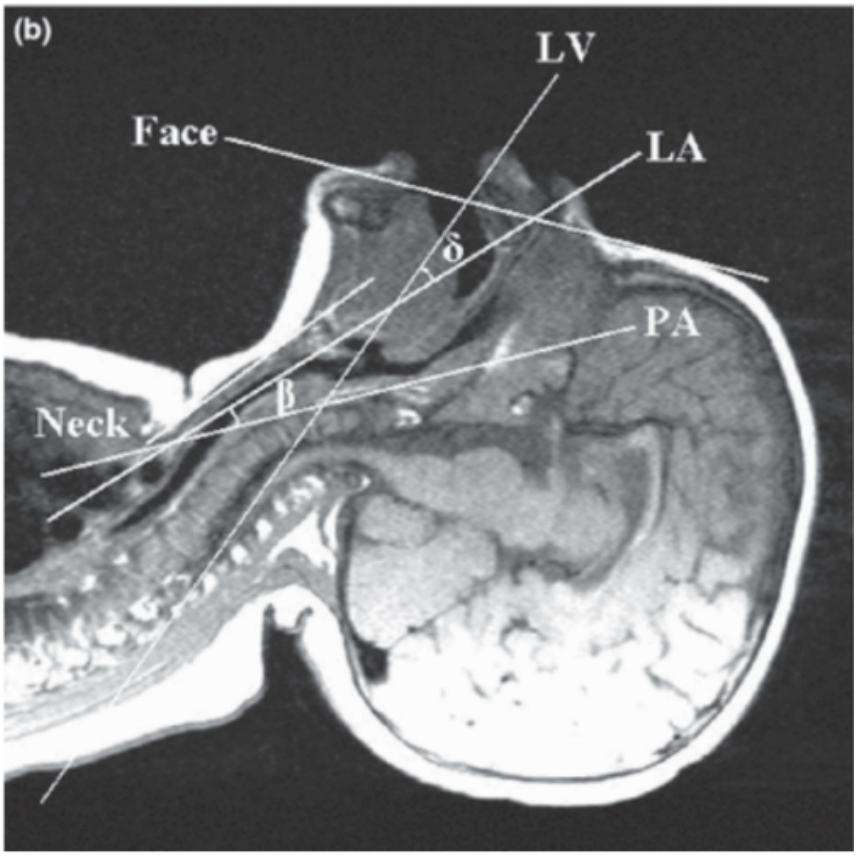
Date: 3/7/2023

Content by: Sophia Finn

Present: Sophia Finn

Goals: I aim to understand the importance and the available data around airway measurements for younger infants.

Content:

- Extending the head in young patients make sit easier for medical practitioners to gain visual with regard to the airway.
- While the practitioners were able to see the glottis and laryngeal axis better, they were not able to see the pharyngeal axis as well.
- Anatomically, laryngoscopy is improved if the angles between the line of vision and the laryngeal axis, and the angle between the pharyngeal axis and the laryngeal axis are both narrowed.
- Many experts recommend the resting position for laryngoscopy.
- 

Visual of the angles in question.

Source:

Effects of head posture on the oral, pharyngeal and laryngeal axis alignment in infants and young children by magnetic resonance imaging - PubMed (nih.gov)

Conclusions/action items:

I will discuss these findings with the team. We do need to decide on the position of the head, as our mannikin will not be flexible enough to adjust the airway position after it is cured. We will likely have to re-print a mold if we choose to incorporate this information.

3/17/2023 Properties of Skin

Sophia Finn - May 03, 2023, 2:22 PM CDT

Title: Properties of Skin

Date: 3/17/2023

Content by: Sophia Finn

Present: Sophia Finn

Goals: I wish to establish the values we should desire to see in our testing results, based on existing literature about human skin tissue.

Content:

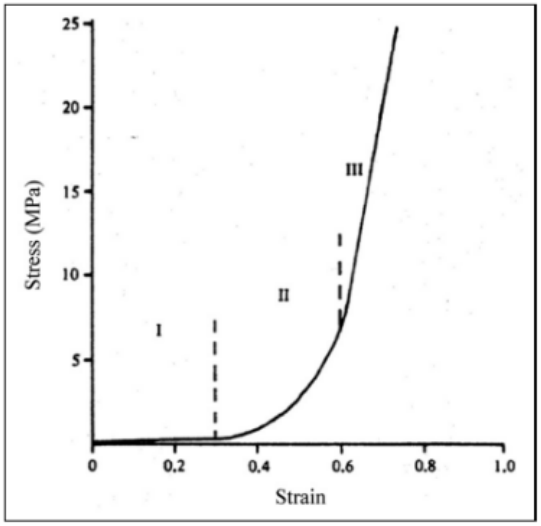


Figure 2. Stress–strain diagram for skin showing the different stages.[52] Stage I: collagen fibers are still wavy and elastin fibers are the load-bearing components; Stage II: collagen fibers are gradually getting aligned and contribute to load-bearing; Stage III: all the collagen fibers are aligned and the tissue has its highest stiffness.

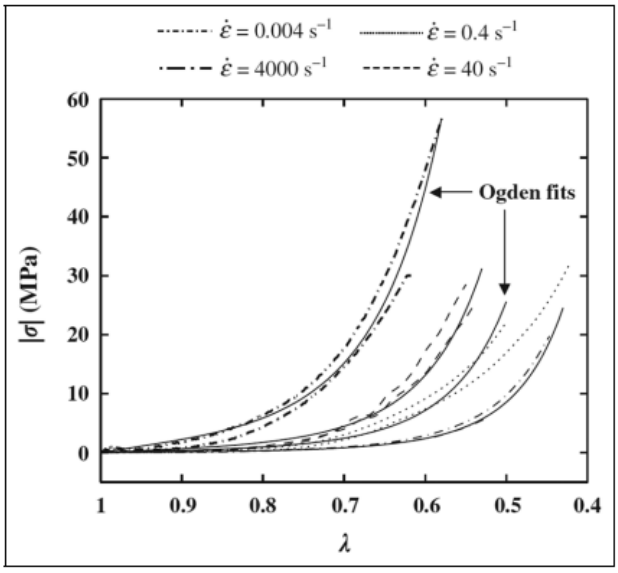


Figure 3. The engineering stress versus stretch ratio response of pig skin to uniaxial compression at different rates and the corresponding Ogden hyperelastic models.[59]

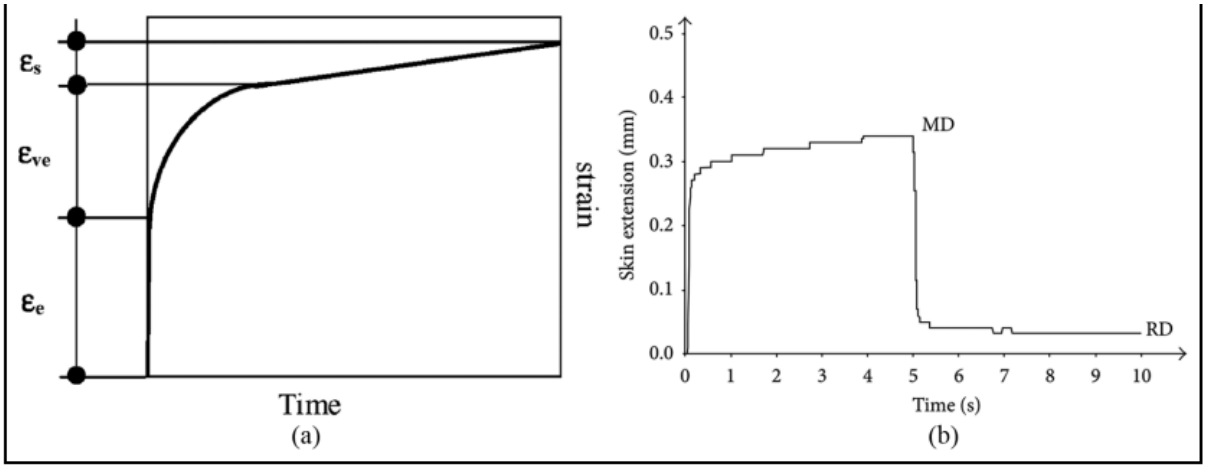


Figure 4. Skin creep curve under constant stress (a) schematic representation of three phases of skin creep test[58] and (b) deformation versus time curve obtained under the creep mode procedure.[61]

Ultimate Tensile Stress Data:

Table 1. Summary of the results of some studies on the skin failure properties.

Study	Sample source	Rate	UTS (MPa)	Failure stretch ratio
Jansen and Rottier[71]	Human abdomen	0.01/s	1.0–24.0	1.17–3.07
Dunn and Silver[72]	Human abdomen		2.0–15.0	
Vogel[73]	Various human sources		5–32	1.30–2.15

Skin Elastic Modulus Data:

"In contrary with Sanders, Agache did in vivo torsion test on human forearm skin and found that the skin elastic modulus increases with increased age (**0.42MPa** for < 30 years and **0.85MPa** for > 30 years)."

Source:

(PDF) Skin mechanical properties and modeling: A review (researchgate.net)

Conclusions/action items:

In our testing data, we will compare our MTS results to the data found in this literature and draw necessary conclusions based on this. We may also choose new ballistics gel formulations if our data is extremely different from necessary human skin values.

4/15/2023 Epithelial Tissue Properties

Sophia Finn - May 03, 2023, 10:38 PM CDT

Title: Epithelial Tissue Properties

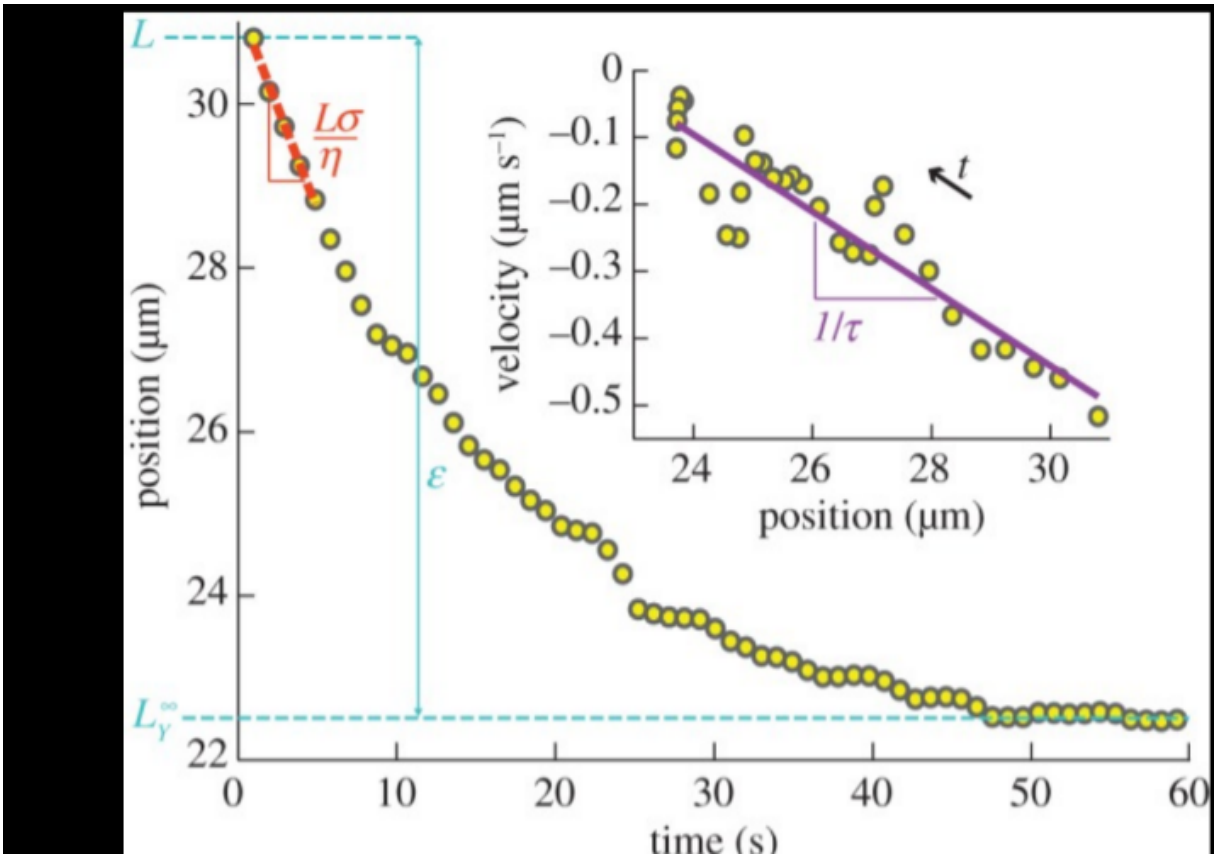
Date: 4/4/2023

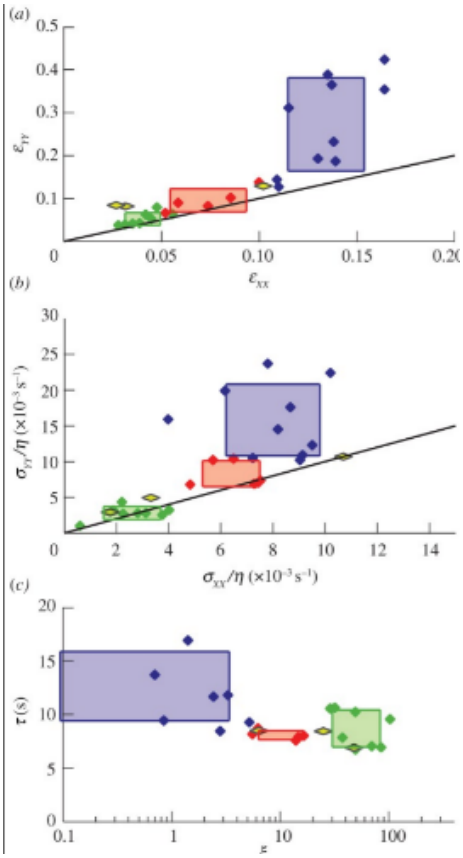
Content by: Sophia Finn

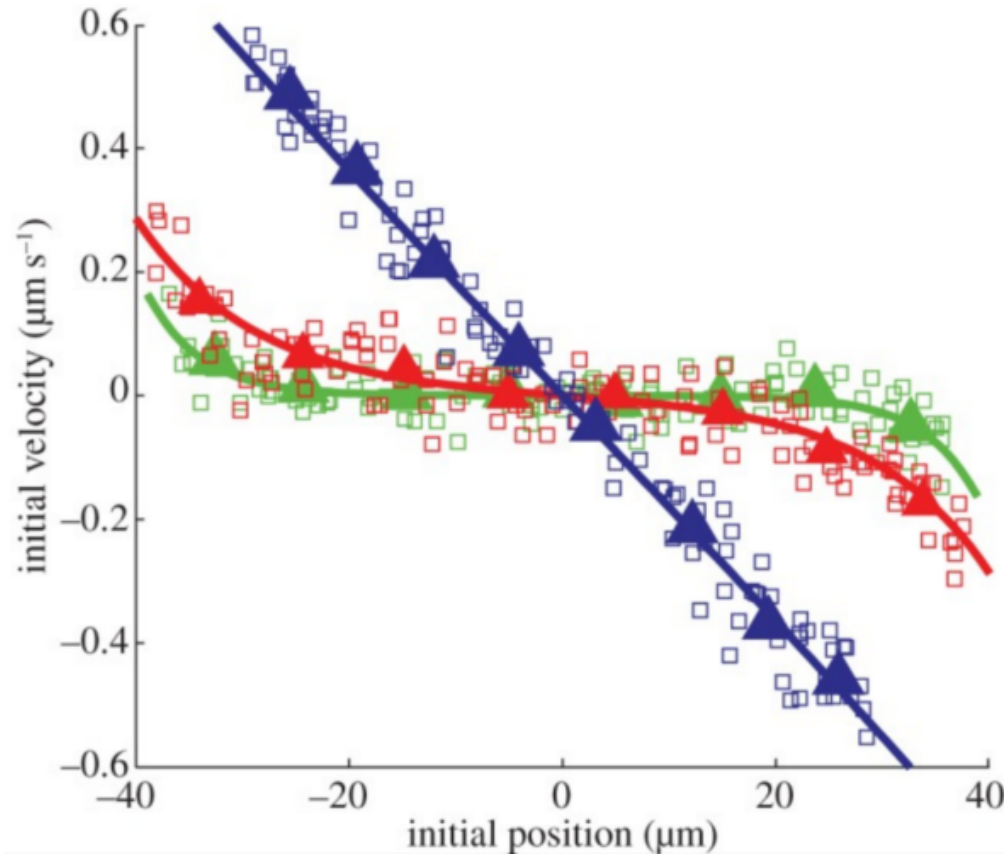
Present: Sophia Finn

Goals: Although we now understand the expectations for human skin properties, we may want to check that we are not creating too much error in terms of the tissue lining the airways and the chest cavity.

Content:







The epithelial tissue within the respiratory organs seems to be thinner and thus has a lower failure point than human skin.

Source:

Mechanical state, material properties and continuous description of an epithelial tissue - PubMed (nih.gov)

Conclusions/action items:

We should mention this in our report. Our design employs a continuous material throughout, and so it falsely asserts that the epithelial tissue within the airway is as durable as human skin.

3/22/2023 Intubation Mannikins

Sophia Finn - May 03, 2023, 10:20 PM CDT

Title: Intubation Mannikins

Date: 3/22/2023

Content by: Sophia Finn

Present: Sophia Finn

Goals: To establish what works and what doesn't work in intubation manikins. I would also like to research other design features that may inspire our design.

Content:

- **Ease of "speed" in manikin intubation does not improve results. In fact, exerts accelerated much less than novices during the manikin intubation procedures.**
- Ease of manikin intubation does not seem to improve intubation skills.
- What does improve intubation skills is only whether or not the manikin is anatomically accurate. Novices trained on anatomically inaccurate manikins that are "easier" to intubate tend to develop less smooth motions and are less careful.

Sources:

Biomechanical profiles of tracheal intubation: a mannequin-based study to make an objective assessment of clinical skills by expert anesthesiologists and novice residents - PubMed (nih.gov)

Conclusions/action items:

Although this article did not provide a ton of information, I think it gives very useful information. One of our most important results sections will be ease of use. We need to account for the caveat that ease of use isn't necessarily an important measurement of how good a manikin is.

3/26/2023 Manikin Lungs

Sophia Finn - May 03, 2023, 10:27 PM CDT

Title: Manikin Lungs

Date: 3/26/2023

Content by: Sophia Finn

Present: Sophia Finn

Goals: I would like to zero in on the design features of lung models. This is a very important component of our design, so I would like to establish the fine details of lung model fabrication.

Content:

- Manikins tend to make the same errors throughout several competing designs.
- The manikins allow for too much force and speed from those practicing on them.
- None of the manikins had a very realistic texture, especially within the oral cavity.
- The manikins had much too wide of "airway space between the epiglottis and posterior pharyngeal wall".
- The researchers in this article conclude that those who train on these manikins will be over confident in their abilities and may not be careful enough when intubating real humans.

Source:

Anatomic accuracy of airway training manikins compared with humans - PubMed (nih.gov)

Conclusions/action items:

Based on this information, I believe that our team can assert that the fragileness of our manikin is actually not a design error. In fact, much of the intubation manikin industry at large encourages too much room for error in their designs. We should not worry so much about durability within the airway, as this is simply not anatomically correct.

2/22/2023 Ballistics Gel Formula

Sophia Finn - Mar 01, 2023, 9:09 PM CST

Title: 2/22/2023 Ballistics Gel Formula

Date: 2/22/2023

Content by: Sophia Finn

Present: Sophia Finn

Goals: I aim to understand how to effectively create a ballistics gel that will accurately simulate a 22-23 week neonate. I will read literature that discusses formulas and use this to make an informed decision about our own.

Content:

- Simulating structures of soft tissue using ballistics gel are called "phantoms".
- Consistencies to mimic soft tissue range from 1:10, 1:20, and 1:30 mass ratio of gelatin to water.
- One option for the gelatin mix is Knox Gelatin, from Gelita USA Inc. Sioux City.
    - but any commercially available gelatin seems to be sufficient
- an increase in gel to water ratio increases stiffness.
- This study casted the gelatin in 10cm^3 molds for 12 hours at 4 degrees Celsius.
- Here is a table of obtained properties for the various gelatin ratios:

	REFERENCE		MYOTONPRO	
GEL:WATER MIXTURE RATIOS	**K (N/m)**	**D**	**K (N/m)**	**D**
1:30	121 ±15	0.85 ±0.06	123 ±1	0.89 ±0.00
1:20	250 ±11	0.83 ±0.04	244 ±4	0.81 ±0.02
1:10	385 ±17	0.85 ±0.03	388 ±6	0.88 ±0.01

    - Mechanical properties were measures by the MyotonPRO device.
    - K = stiffness
    - D = decrement

Source: Investigation of a Cost-effective and Durable Material for Containing Ballistic Gel in the Construction of Ultrasound Phantoms - PubMed (nih.gov)

Conclusions/action items:

Using this information, I have many more ideas about how to design testing protocols and fabrication procedures for our ballistics gel design idea. I think I will either gather data on the mechanical properties of neonate soft tissue and compare it to these mixture values, or, if this is not available, test the ability of each mixture to create the desired amount of stiffness in our prototype.

2/16/2023 Airway Design Evaluations

Sophia Finn - Mar 01, 2023, 9:08 PM CST

Title: 2/16/2023 Airway Design Evaluations

Date: 2/16/2023

Content by: Sophia Finn

Present: Sophia Finn

Goals: I would like to garner ideas for the design of our airway. I will do this by reading literature by experts who provide information on positive and negative aspects of various airway manikin designs.

Content:

- This article focuses on the feasibility of manikins to simulate procedures that use an SAD, or supraglottic airway devices.
- this occurs after tracheal intubation, so this article definitely has some variables that are not relevant for our project.
- This article studied the airway designs of TruCorp AirSim Advance and Laerdal ResusciAnne Airway Trainer.
- The results of the study found that a few factors in manikin airway design create more realistic and favorable manikins:
    - Tighter hypopharynx
    - Flexible airway material
    - Accurate laryngeal positioning

Source: Comprehensive evaluation of manikin-based airway training with second generation supraglottic airway devices - PubMed (nih.gov)

Conclusions/action items:

I had not previously considered the role of the hypopharynx in the mannikin's simulation abilities. I think that now we will have to be more intentional about our fabrication of the airway rather than it being only a very simple cavity in the manikin.

2/7/2023 PLA Properties

Sophia Finn - Mar 01, 2023, 8:18 PM CST

Title: 2/7/2023 PLA Properties

Date: 2/7/2023

Content by: Sophia Finn

Present: Sophia Finn

Goals: I would like to explore PLA as an option for the mold. To do this, I must first research the properties of PLA.

Content:

- The main appeal of PLA is that it is once of the most dense materials you can 3D print with.
- However, it is still brittle and will break under high pressure.
- There may be some amount chemical interaction between PLA and PDMS
    - Acts as a binder when synthesized together.
    - They are used together to "antifoul" paint.
- Low melting point
    - loses durability
- Cost-effective

Sources:

Are 3D Printed Parts Strong & Durable? PLA, ABS & PETG – 3D Printerly

Ecofriendly silicon-poly(lactic acid) hybrid antifouling coatings - ScienceDirect

Conclusions/action items:

PLA may be a good option if it is only used for the ballistics gel curing. However, it looks like we cannot cure at a high temperature or use it to cure the PDMS. We may have to test it with the PDMS to observe whether or not a reaction occurs.

2/2/2023 Sylgard 184

Sophia Finn - Mar 01, 2023, 9:03 PM CST

Title: 2/2/2023 Sylgard 184

Date: 2/2/2023

Content by: Sophia Finn

Present: Sophia Finn

Goals: I would like to understand the reasons that Sylgard 184 did not work for our project and how this can be improved.

Content:

The uses of Sylgard are as widespread as a “silicone encapsulant”. Some convenience is prodded by Sylgard 184 in terms of heat capacity, as objects that are not able to withstand heat can cure in Sylgard 184 even at room temperature.

Sylgard is also able to capture more detail than its competitors. It has a low viscosity and is therefore able to fill small details in mold and in objects that need to be encapsulates. However, the Sylgard 184 collusion should be made sure to have no gas bubbles within it. It may cure the gas inside the solution quickly.

If you do wish to cure the Sylgard elastomer at a quicker pace, the solution functions at a temperature range of -49 F to 392 F. This means that Sylgard is also more compatible with electronics, which will often give off heat.

Sylgard is also useful because it is clear. It allows the engineer to see errors through the cured solution and plan repairs.

However, it seems that cooking the Sylgard repeatedly or for too long will degrade it (although it technically doesn't "melt").

Sources:

Sylgard 184 by DOW is the Top Choice for a Transparent, Silicone Encapsulant. Read Why: (gluespec.com)

https://www.sciencedirect.com/topics/engineering/polydimethylsiloxane

Conclusions/action items:

I believe that we degraded our Sylgard 184 by repeatedly curing layer upon layer. Rather, it is possible to cure it at room temperature if left out for approximately 48 hours.

4/21/2023 MATLAB Code

Sophia Finn - May 03, 2023, 10:41 PM CDT

Title: MATLAB Code

Date: 4/21/2023

Content by: Sophia Finn

Present: Sophia Finn

Goals: I would like to create Matlab code that will successfully summarize our testing data into stress-strain curves as well as provide Young's Modulus.

Content:

```
% Close figures and clear out other variables that have been assigned
close all;
clear all;
% Load your data file, replacing the '...' below with your filename
file="CompressionTest.txt";
data=load(file);
% Extract the columns of interest from your data
displacement = data(:, 1) * 1000; % [mm]
load = data(:, 2);              % [N]
time = data(:, 3);              % [s]
sample_rate = 45869 / 458.984;
area = 2.642;
data_coords = readmatrix("CompressionTest.txt", "range", "A12:C45869");
[b, a] = butter(4,1/(0.5*sample_rate), 'low');
filtered_data = filtfilt(b,a,data_coords);
filtered_time=filtered_data(:,3);
filtered_force = filtered_data(:,2);
filtered_displacement = filtered_data(:,1);
stress = filtered_force ./ area;
strain = filtered_displacement ./ 52.7;
% Record the first and last frame of the linear region of the loading curve
j1 = 200;    % replace with your value
j2 = 800;    % replace with your value
% Plot stress vs strain curve
figure;
plot(strain, stress);
xlabel('Strain [-]');
```

```
ylabel('Stress [MPa]');
title('Stress vs Strain Curve');
% Plot linear region
hold on;
plot(strain(j1:j2), stress(j1:j2), 'o');
xlabel('Strain [-]');
ylabel('Stress [MPa]');
title('Stress vs Strain Curve');
% Fit linear region and display equation
p = polyfit(strain(j1:j2), stress(j1:j2), 1);
fitline = polyval(p, strain(j1:j2));
plot(strain(j1:j2), fitline, 'r');
legend('Data', 'Linear Region', 'Linear Fit');
equation = ['y = ', num2str(p(1)), 'x + ', num2str(p(2))];
text(0.1, 1.5, equation);
% Plot load vs time curve
figure;
plot(filtered_time, stress);
xlabel('Time [s]');
ylabel('Stress [MPa]');
title('Stress vs Time Curve');
```

Conclusions/action items:

This code seems to accurately create the graph and data we need. We will employ this to create data visualizations that will be used in our final delieverables.

4/25/2023 Data Collection

Sophia Finn - May 03, 2023, 10:50 PM CDT

Title: Data Collection

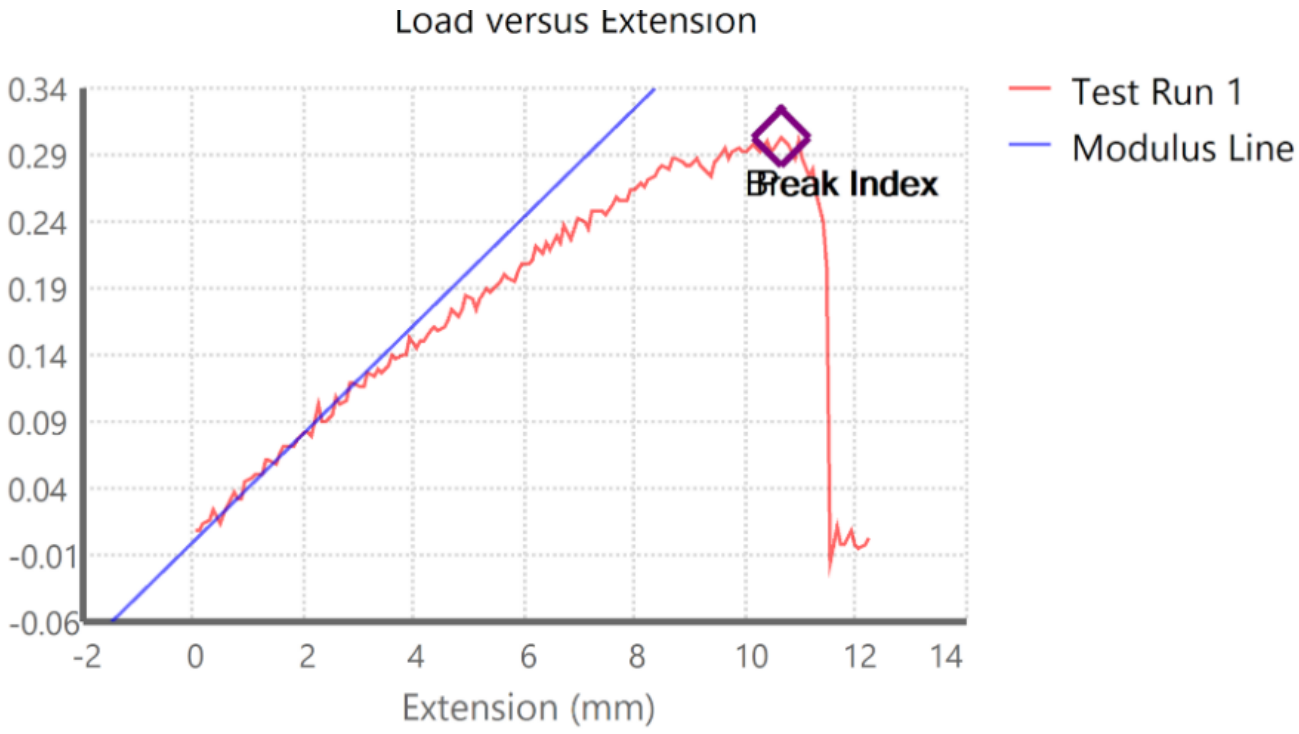
Date: 4/25/2023

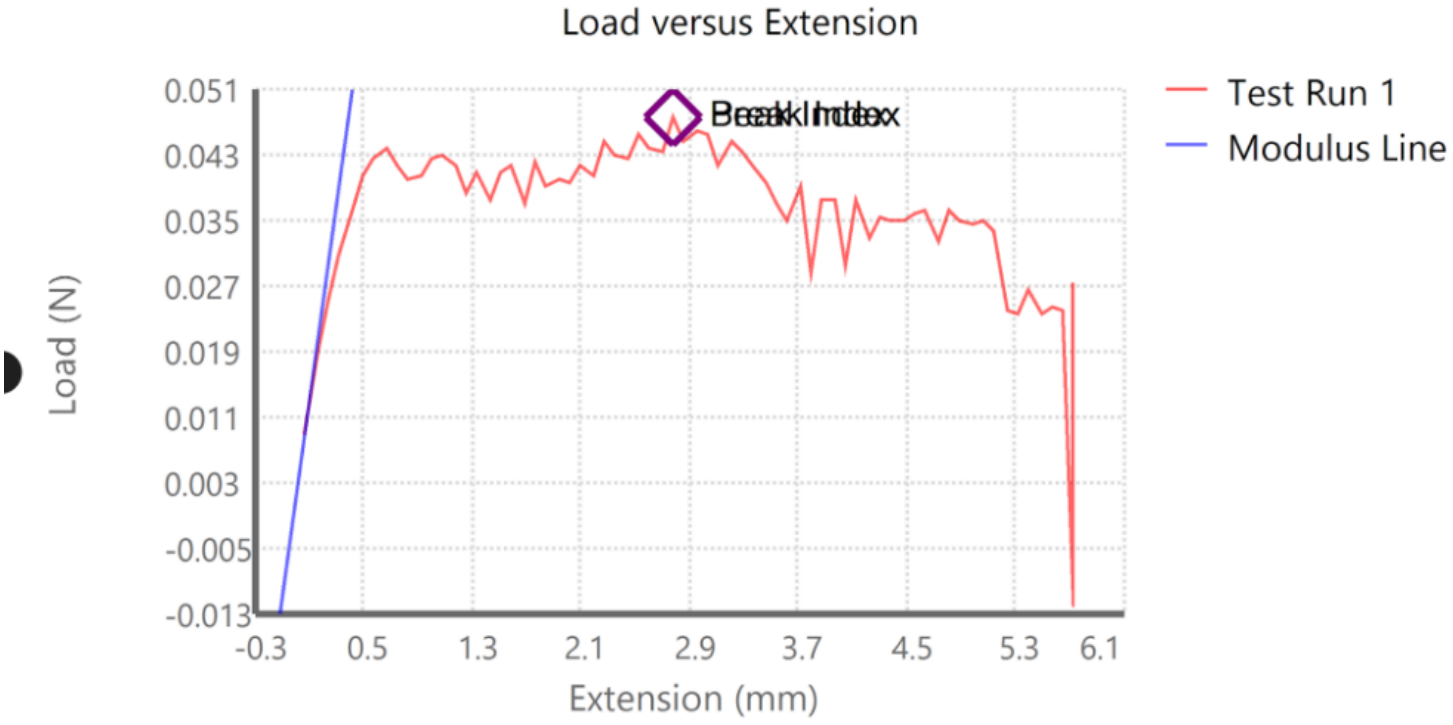
Content by: Sophia Finn

Present: Sophia Finn

Goals: This is the MTS testing data, which we hope to use to get an accurate analysis on how acceptable our materials are.

Content:





Conclusions/action items:

We need to analyze this data now and place it in our final deliverables, along with analysis of whether this is in the range for neonate skin.

3/31/2023 Tong Lecture

Sophia Finn - May 03, 2023, 10:31 PM CDT

Title: Tong Lecture

Date: 3/31/2023

Content by: Sophia Finn

Present: BME class

Goals: To listen to an experienced engineer about her experience.

Content:

The speaker, Jinger Zeng, is currently a contest manager at Hackster, where she says she enjoys the spirit of competition as well as seeing how ocntestents approach problems in unique ways. She originally worked on drones at a company called Dronesmith, where she utilized her background in mechanical engineering to create accessories for these drones.

2023/2/10 PDMS Research

TANISHKA SHETH - Feb 10, 2023, 12:52 PM CST

Title: Assessment of the Physical, Mechanical, and Tribological Properties of PDMS Thin Films Based on Different Curing Conditions

Date: 2/10/23

Content by: Tanishka

Present: N/A

Goals: Understand how PDMS cures so we can use it in future prototypes properly

Content:

Sylgard184 can be used by mixing base and crosslinking agent at 10:1 ratio

Air bubbles will form but can be eliminated by leaving at room temperature for half an hour

Hot plate or oven can be used

Conclusions/action items:

The process that we followed last semester was similar enough but de-gassing should be prioritized. Additionally, temperatures can be lower and curing can be done for longer to avoid melting and creating a sticky texture. However, PDMS still seems like a viable option for the skin condition of the mannequin.

TANISHKA SHETH - Feb 10, 2023, 12:48 PM CST

materials

Article

Assessment of the Physical, Mechanical, and Tribological Properties of PDMS Thin Films Based on Different Curing Conditions

Gang-Min Kim, Sung-Jun Lee and Chang-Lae Kim *

Download

materials-14-04489.pdf (3.44 MB)

2023/2/10 Comparison of Manikin Use in Healthcare

TANISHKA SHETH - Feb 10, 2023, 12:59 PM CST

Title: Comparison of the use of manikins and simulated patients in a multidisciplinary in situ medical simulation program for healthcare professionals in the United Kingdom

Date: 2/10/23

Content by: Tanishka

Present: N/A

Goals: Understand how medical professionals would prefer to use mannequins in medical settings

Content:

58% of respondents believed they would feel more comfortable working with an actor, while 17% would feel more comfortable using a manikin.

Participants felt that both modalities were beneficial to learning, but simulated patients provided significantly more benefits because of greater realism

Conclusions/action items:

It seems that the most important thing is to make the mannequin seem as realistic as possible. This might change our priorities to focus more on skin tinting and enforcing the realism of the face. Since it is not possible to include simulated patients in our scenario, we should aim to replicate as many features and textures as possible.

TANISHKA SHETH - Feb 10, 2023, 12:54 PM CST

Research article

Jeehp

Comparison of the use of manikins and simulated patients in a multidisciplinary *in situ* medical simulation program for healthcare professionals in the United Kingdom

Introduction

Download

jeehp-18-08.pdf (234 kB)

2023/2/24 Ballistics Gel Research

TANISHKA SHETH - Feb 28, 2023, 1:37 PM CST

Title: Ballistics Gel Research

Date: 2/24/23

Content by: Tanishka

Present: N/A

Goals: Understand the feasibility of curing PDMS on top of ballistics gel

Content:

Begins surface melting at 105 F / 45.5 C. Normal melting temperatures range from 200 F to 270 F / 93.33 C to 132.22 C. The flash point of our ballistic gelatin is 325 F /162.77 C. (https://www.clearballistics.com/faq/#:~:text=What%20are%20the%20melting%20temperatures,is%20325%20F%20%2F162.77%20C.)

Currently, the curing techniques of PDMS elastomers by the hydrosilation reaction are very well developed. The curing condition for the pristine PDMS is approximately two days at room temperature, 45 min at 100 °C, 20 min at 125 °C, or 10 min at 150 °C (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6415383/#:~:text=Currently%2C%20the%20curing%20techniques%20of,150%20%C2%B0C%20%5B12%5D.)

Ultimaker's Tough PLA melts around 152C (https://makerbot.my.salesforce.com/sfc/p/#j0000000HOnW/a/5b000004UgTE/z40nDBo3Clypj7u9xI7MbeVe.CNpDM_Mq0nhvbpyne8)

Conclusions/action items:

To avoid melting the ballistics gel when curing the PDMS on top of it, it will be beneficial to cure the PDMS over a long period of time at lower temperatures. If we set the ballistics gel in the mold and then coat it with the PDMS, we will be able to cure the PDMS at room temperature for a couple days. After this, we will likely have an even and cured layer of PDMS without degrading the ballistics gel base.

2023/4/12 Human Skin Tensile Information

TANISHKA SHETH - May 02, 2023, 3:30 PM CDT

Title: Young's Modulus for Human Skin

Date: 4/12/23

Content by: Tanishka

Present: Tanishka

Goals: Determine what range the ballistics gel testing should be in to fall within actual skin modulus.

Content:

M. Pawlaczyk, M. Lelonkiewicz, and M. Wieczorowski, “Age-dependent biomechanical properties of the skin,” Advances in Dermatology and Allergology, vol. 5, pp. 302–306, Oct. 2013.

In the literature, the Young's modulus (E) of the skin fluctuates between 0.42 MPa and 0.85 MPa

These values differ if torsion tests are performed or suction tests.

Conclusions/action items:

Since we were performing tension and compression testing, we should use the range of 0.42 MPa and 0.85MPa. This is a good number to keep in mind when performing tensile testing in the next week.

2023/2/3 Ethical Considerations

TANISHKA SHETH - Mar 01, 2023, 8:42 PM CST

Title: Ethical Considerations as outlined by the World Health Organization

Date: 2/3/23

Content by: Tanishka

Present: N/A

Goals: Gain a comprehensive understanding of the ethical considerations to provide a basis for design improvement.

Content:

The document outlines neonatal resuscitation. It is not relevant to extremely premature neonates, but includes specifications that devices should adhere to. Neonatal mortality represents approximately 44% of under-5 child deaths, of which one quarter of overall neonatal deaths (around 700 000) is attributed to birth asphyxia, defined as the failure to initiate and sustain breathing at birth. Effective neonatal resuscitation; immediate care, including thorough drying, suction and stimulation after assessment; and positive-pressure ventilation, if needed, can prevent a high number of neonatal deaths.

Conclusions/action items:

Consider the inner workings of the mannequin and ensure that they would be able to withstand resuscitation in the manner outlined in the document.

TANISHKA SHETH - Mar 01, 2023, 8:37 PM CST

Download

9789241510264_eng.pdf (2.03 MB)

2023/4/22 Usability Testing

TANISHKA SHETH - May 02, 2023, 3:49 PM CDT

Title: Usability Testing

Date: 4/22/23

Content by: Tanishka

Present: Tanishka

Goals: Understand how to conduct adequate usability testing of our manikin.

Content:

M. E. Wiklund, M. G. Jackson, and J. I. Tilliss, “Conducting effective summative usability tests of medical devices,” Biomedical Instrumentation & Technology, vol. 44, no. s1, pp. 40–48, Jan. 2010.

1. Start things off by introducing themselves to the test participant and orienting him or her to the research environment and test objectives to put the participant at ease.

2. Obtain the test participant's informed consent and commitment to keep details about the test and the medical device confidential.

3. Conduct an interview focused on the test participant's background and experience pertinent to using the given medical device to put the participant's ensuing task performance in context.

4. Direct the test participant to perform various tasks that will help test personnel judge the device's use-safety and usability.

5. Conduct an interview focused not only on the device's use-safety at a minimum, but also on usability and satisfaction issues of primarily commercial interest.

Conclusions/action items:

These steps are good ways to utilize the medical student on our team. Additionally, we can utilize some of her contacts to fill out a survey about how our prototype holds up in different areas.

2023/4/10 PDMS Peeling

TANISHKA SHETH - May 02, 2023, 4:12 PM CDT

Title: Thin Film PDMS Release

Date: 4/10/23

Content by: Tanishka

Present: Tanishka

Goals: Understand why the PDMS might have peeled off of the samples that we tested

Content:

S. Vudayagiri, M. D. Junker, and A. L. Skov, “Factors affecting the surface and release properties of Thin Polydimethylsiloxane Films,” Polymer Journal, vol. 45, no. 8, pp. 871–878, 2013.

Though the surface energy reduced by the addition of PFE, the peel force values did not decrease. The reason for this is because the elastic contribution to the peel force is much higher than the potential and the surface energy contribution. For the investigated elastomer films, the Young’s moduli are low, which makes them even out against surfaces easily and make good contact. This contact increases the adhesive forces, making the release hard. The samples with low Young’s moduli have a higher adhesive energy between the film and the substrate than those with higher Young’s modulus. So, tuning the elasticity of the networks is actually the easiest path for reducing the release problems of thin silicon films, when other solutions like using a release agent is not an option.

Conclusions/action items:

There are peel forces that are found in PDMS and that causes thin films to peel off of materials. Looking into ways to decrease these peel forces would be a good to add the PDMS on top. Alternatively the group can move forward with just the ballistics gel samples and determine if the texture is acceptable for our uses.

2023/2/17 Mold Materials

TANISHKA SHETH - Feb 17, 2023, 12:52 PM CST

Title: Ideas for Mold Materials

Date: 2/17/23

Content by: Tanishka

Present: N/A

Goals: Compile ideas for materials that fit the criteria for making a new mold of the same design

Content:

T. Axsom, “Top heat resistant plastics: Differences & classifications,” *Fictiv*, 14-Dec-2022. [Online]. Available: https://www.fictiv.com/articles/top-5-heat-resistant-plastics. [Accessed: 17-Feb-2023].

PEI:

Property	Value
Tensile Strength (MPa)	117
Hardness (Rockwell R)	R125
Density (g/cm3)	1.28
Softening Point (°C)	200
Heat Deflection Temperature (@264 PSI) (°C)	204.4
Continuous Service Temperature in Air (°C)	171.1
Short-term Service Temperature (°C)	182.2
Glass Transition Temperature (°C)	210
Flammability (UL 94)	V-0

PEEK:

Property	Value
Tensile Strength (MPa)	110.3
Hardness (Rockwell R)	126
Density (g/cm3)	1.31
Heat Deflection Temperature (@264 PSI) (°C)	160
Continuous Service Temperature in Air (°C)	248.8
Plastic Melting Temperature (°C)	340
Flammability (UL 94)	V-0

PTFE:

Property	Value
Tensile Strength (MPa)	20.7
Hardness (Rockwell R)	60
Density (g/cm3)	2.22
Heat Deflection Temperature (@66 PSI) (°C)	121.1
Continuous Service Temperature in Air (°C)	287.8
Plastic Melting Temperature (°C)	325–335

Flammability (UL 94)	V-0

PAI:

Property	Value
Tensile Strength (MPa)	138
Hardness (Shore D)	90
Density (g/cm3)	1.41
Heat Deflection Temperature (@264 PSI) (°C)	278
Continuous Service Temperature (°C)	200–220
Plastic Melting Temperature (°C)	275
Flammability (UL 94)	V-0

PPS:

Property	Value
Tensile Strength (MPa)	50–80
Hardness (Shore D)	90–95
Density (g/cm3)	1.35
Glass transition Temperature (°C)	85–95
Heat Deflection Temperature (@264 PSI) (°C)	100–135
Continuous Service temperature (°C)	200–220
Plastic Melting Temperature (°C)	275–285
Flammability (UL 94)	V-0

Conclusions/action items:

Based on the material properties, it makes sense to use a plastic, specifically PTFE as it best fits our mold material criteria. I will begin to look into pricing and the Makerspace.

2023/3/1 Mold

TANISHKA SHETH - Mar 01, 2023, 8:33 PM CST

Title: MeshMixer FIles of the Mold

Date: 3/1/23

Content by: Tanishka

Present: N/A

Goals: Finalize the mold design and get it ready to print

Content:

Attached files

Conclusions/action items:

I will have sent the mold to print at the Makerspace using Tough PLA by the end of the week.

TANISHKA SHETH - Mar 01, 2023, 8:33 PM CST

Download

neonatefront_3_.stl (12.6 MB)

TANISHKA SHETH - Mar 01, 2023, 8:34 PM CST

Download

neonateback_3_.stl (11.6 MB)

2023/3/9 PDMS Bonding

TANISHKA SHETH - Mar 09, 2023, 12:46 PM CST

Title: BDMS Bonding Technologies

Date: 3/9/23

Content by: Tanishka

Present: N/A

Goals: To understand ways to coat the ballistics gel with PDMS

Content:

> A. Borók, K. Laboda, and A. Bonyár, “PDMS bonding technologies for microfluidic applications: A Review,” *Biosensors*, vol. 11, no. 8, p. 292, 2021.

1. Surface Activation by Oxygen Plasma Treatment- this involves removing contaminants and generating reactive chemical groups for covalent bonding by creating a silanol rich surface for the PDMS to bond.

2. Surface Activation by Corona Treatment- corona treater is a device that generates a high voltage across an electrode at the tip of the unit. This handheld device is usually supplied with electrodes in different shapes for various applications. The high potential of the electrode ionizes the surrounding air, creating a localized plasma called corona discharge.

3. Surface Activation by UV/Ozone Treatment- enriching the PDMS surface with silanol groups is UV/ozone treatment. Although this technique is significantly slower compared to both plasma and corona treatment, due to the greater penetration of photons, deeper surface modification (i.e., several 10 μm) could be achieved without any surface damage

4. Chemical Gluing- To bond PDMS with other materials, e.g., thermoplastics, functional groups should be created either only on the target substrate or on both materials. These techniques are often referred to as chemical gluing, where molecular monolayers (acting as coupling agents) are anchored on the surfaces with specific terminal functional groups

5. Adhesive-Based Gluing- Depending on the target substrate, applying epoxy or silicone-based adhesives might prove significantly weaker than chemical gluing methods. However, since adhesives are sometimes used in combination with chemical gluing methods to improve bond quality, these hybrid techniques are worth mentioning

Conclusions/action items:

For our purposes, it would probably simplest and most feasible to attempt to use chemical or adhesive based gluing. Using these techniques, we can test different amounts of adhesion between the materials. This will allow for sufficient testing before trying to use these techniques on the prototype itself.

2023/3/24 Dragon Skin

TANISHKA SHETH - Mar 28, 2023, 12:01 PM CDT

Title: Dragon Skin Research

Date: 3/24/23

Content by: Tanishka

Present: N/A

Goals: Determine if dragon skin is something we can use to coat the ballistics gel instead of the PDMS

Content:

At Show and Tell, another group recommended looking into Dragon Skin which is a high performance silicone

Technical and Buying Information (https://www.smooth-on.com/product-line/dragon-skin/)

Select a Product Below Hardness Pot Life Cure Time
› Dragon Skin™ 10 VERY FAST 10 A 4 mins 30 mins
› Dragon Skin™ 10 FAST 10 A 8 mins 75 mins
› Dragon Skin™ 10 MEDIUM 10 A 20 mins 5 hrs
› Dragon Skin™ 10 SLOW 10 A 45 mins 7 hrs
› Dragon Skin™ 10 NV 10 A 15 mins 75 mins
› Dragon Skin™ 10 AF Anti Fungal 10 A 20 mins 5 hrs
› Dragon Skin™ 15 15 A 40 mins 7 hrs
› Dragon Skin™ 20 20 A 25 mins 4 hrs
› Dragon Skin™ 30 30 A 45 mins 16 hrs
› Dragon Skin™ FX- Pro™ 2 A 12 mins 40 mins

It seems like it would work in terms of realism. Based on the information provided it's hard to tell if the dragon skin will adhere to the ballistics gel and it's also hard to determine if the texture will be similar to what we want or if it will have more of a faux skin feel like Premature Anne.

Conclusions/action items:

I will continue comparing the material properties of the dragon skin and the pdms. From this I will also develop ways to adhere them to the ballistics gel and determine which of these will function the best for our purposes.

2023/3/28 Ballistics Gel Fabrication

TANISHKA SHETH - May 02, 2023, 4:01 PM CDT

Title: Ballistics Gel Fabrication

Date: 3/28/23

Content by: Tanishka

Present: Tanishka

Goals: Understand how to create ballistics gel samples and what concentrations of gelatin work best.

Content:

N. R. Maiden, W. Fisk, C. Wachsberger, and R. W. Byard, “Ballistics ordnance gelatine – how different concentrations, temperatures and curing times affect calibration results,” Journal of Forensic and Legal Medicine, vol. 34, pp. 145–150, Jun. 2015.

Neither of the NATO 20% concentrations of gelatine at 10 °C, or a 20% concentration of 285 Bloom gelatine at 10 °C, met the same calibration standard as the FBI recommended 10% formulation at 4 °C. A 20% concentration of 285 Bloom at 20 °C met the same calibration/penetration criteria as a 10% concentration of 250 Bloom at 4 °C after 100 h of curing. Therefore, it can be classed as matching the FBI calibration standard for a soft tissue simulant for wound ballistics research.

As a result of the findings in this study the ideal ballistics gel concentration results are between 10% and 20%.

Conclusions/action items:

The team should test different concentrations between 10-20% and determine which fits our criteria the best through tensile testing.

Biosafety and Chemical Safety Training

TANISHKA SHETH - Mar 01, 2023, 8:45 PM CST

Title: Proof of Completion-Biosafety and Chemical Safety Training

Date: 3/1/23

Content by: Tanishka

Present: N/A

Goals: Provide documentation of completed safety trainings

Content:

See Attached.

Conclusions/action items:

Continue prototyping.

TANISHKA SHETH - Mar 01, 2023, 8:44 PM CST

WISCONSIN
UNIVERSITY OF WISCONSIN-MADISON

This certifies that Tanishka Sheth has completed training for the following course(s):

Course	Assignment	Completion	Expiration
Biosafety Required Training	Biosafety Required Training Quiz	10/27/2021	10/27/2026
Chemical Safety: The OSHA Lab Standard	Final Quiz	10/27/2021	

Data Last Imported: 01/25/2023 07:34 AM

Download

Training_Information_Lookup_Tool_1_.pdf (89.7 kB)

2023/3/10 WARF Lecture

TANISHKA SHETH - Mar 10, 2023, 3:08 PM CST

Title: WARF Lecture

Date: 3/10/23

Content by: Tanishka

Present: N/A

Goals: Gain an understanding of IP and how it can be used for our 301 project this semester.

Content:

There are three main ways to protect an invention. These are copyright, patent, and trademark. Copyrights are for things such as software, and webpages. Patents are used for devices and processes/methods. Trademark is used for words/phrases, colors, logos, and even sound. Prior art is what the invention will be evaluated against. Prior art can be from other people that have filed for patents or it could be from the inventor. In the US, the grace period is 1 year meaning that if the design/idea was shared today I would be given one calendar year to file a patent for it. This is only true if the prior art is done by the inventor, and is not valid if the prior art is from someone else. The grace period then does not exist. Public disclosure of an invention can be publishing it in a journal, discussing it at a conference or presentation, a non-confidential seminar within the department, defending an open thesis, etc. Patentability requires that the invention is eligible, useful, enabled, described, novel, and non-obvious. The process at WARF specifically is that first, the inventor needs to disclose the invention. Then, the Disclosure Committee will meet monthly to discuss the new disclosures. After this, the patent filling and application process is completed. Then there's marketing where they reach out to companies. Finally, there's licensing where they negotiate terms with external third parties.

Conclusions/action items:

Our design could have IP because we're coming up with a new training mannequin. This means that the process of creating the mannequin can be protected. The device itself can undergo the patenting process. We've also had presentations which can be used as prior art and the grace period would have started last semester.

2023/4/6 MTS Testing

TANISHKA SHETH - May 02, 2023, 3:36 PM CDT

Title: MTS Testing

Date: 4/6/2023

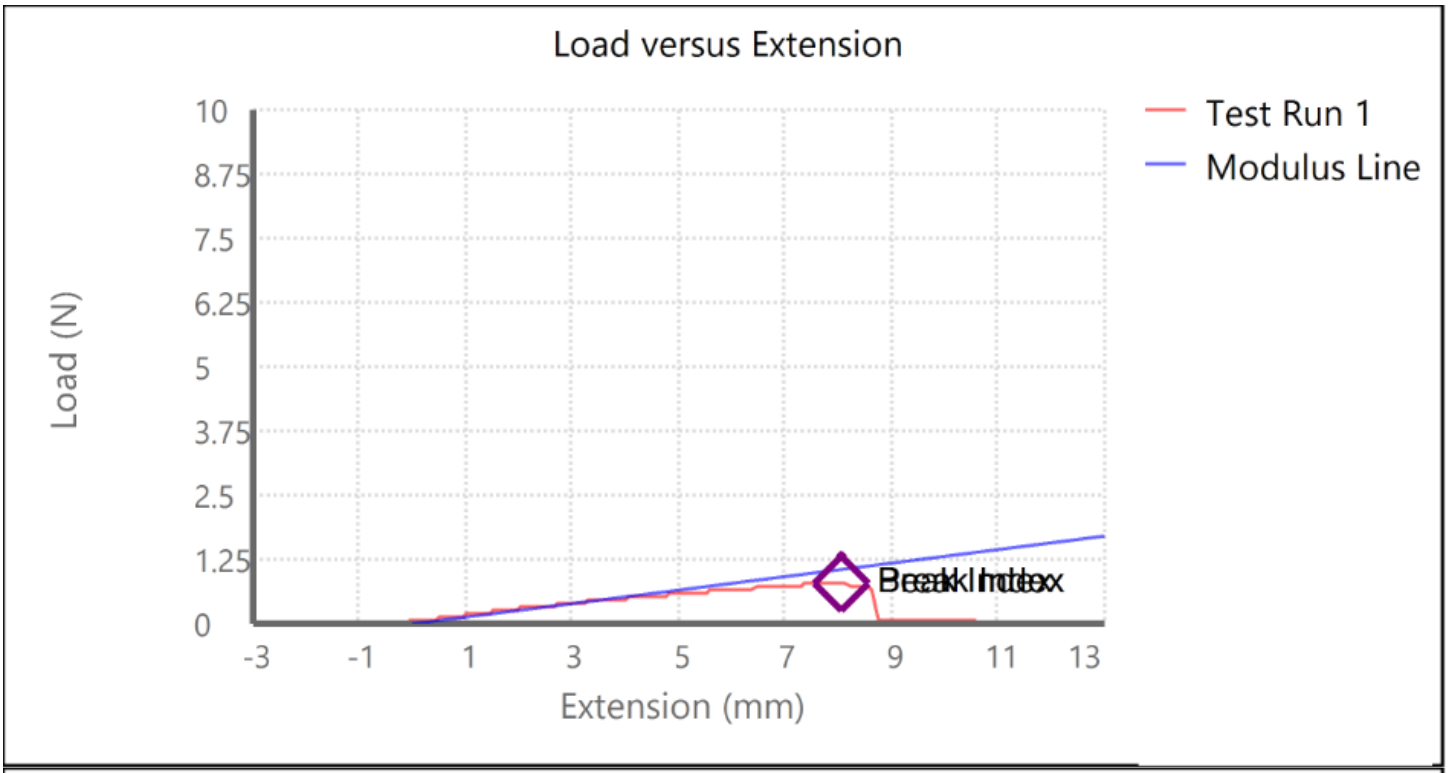
Content by: Tanishka

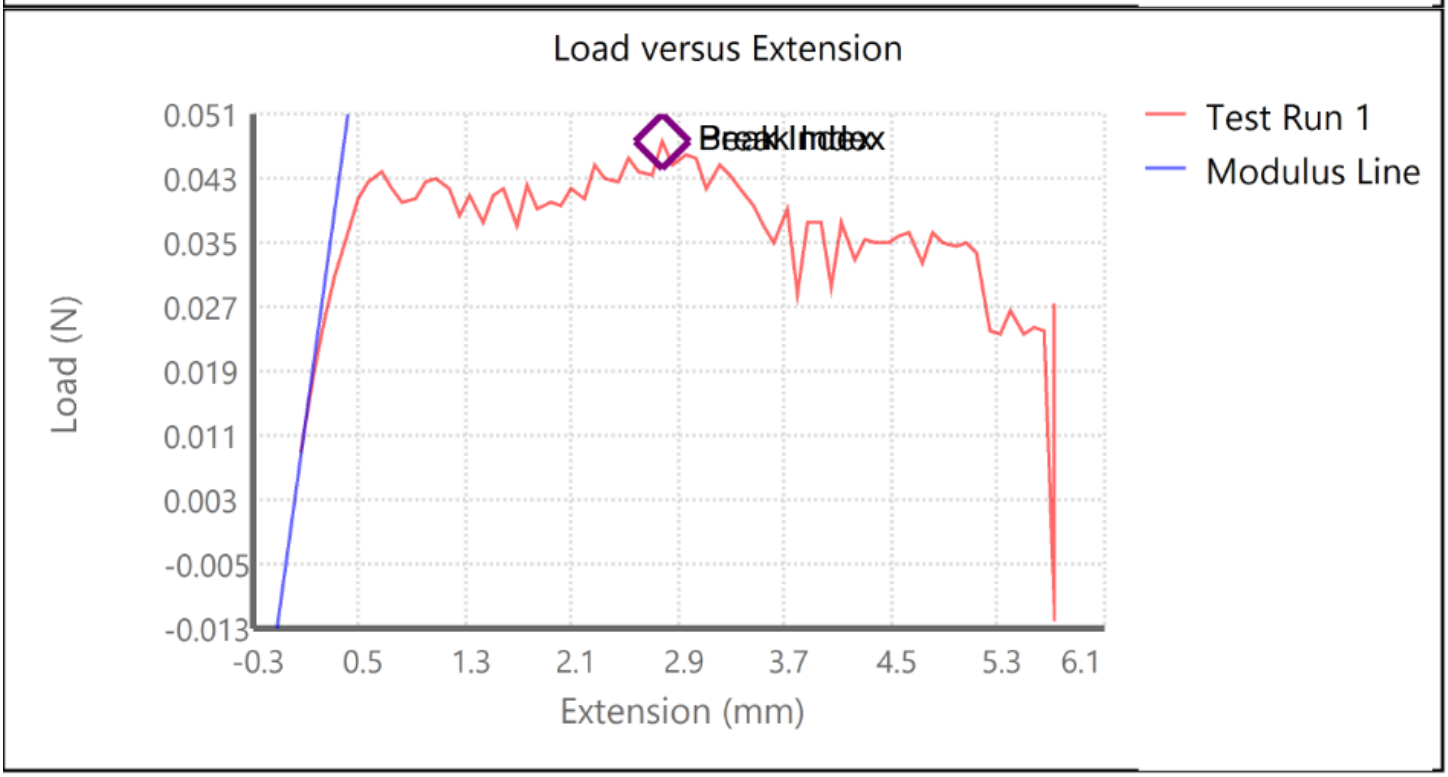
Present: Tanishka, Sophia, Abbie

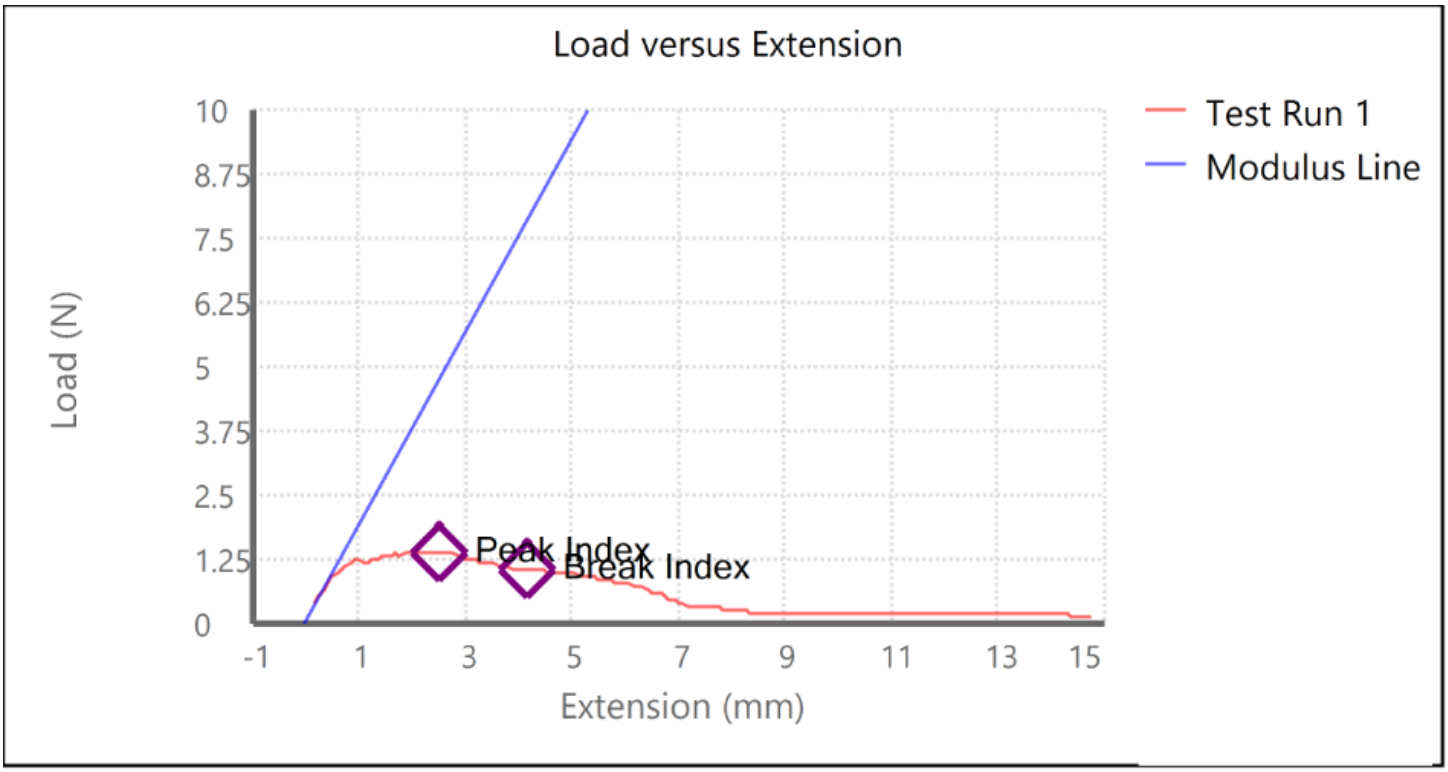
Goals: Test the samples with PDMS coated on top of ballistics gel. Determine if the formulation is sufficient for prototyping.

Content:

The tensile testing gave us very inconsistent results. The PDMS detached while the MTS machine was extending further and that resulted in subpar results.


Load versus Extension
Load (N)
10
8.75
7.5
6.25
5
3.75
2.5
1.25
0
-3
-1
1
3
5
7
9
11
13
Extension (mm)
Test Run 1
Modulus Line
Break Index


Load versus Extension
Load (N)
0.051
0.043
0.035
0.027
0.019
0.011
0.003
-0.005
-0.013
-0.3
0.5
1.3
2.1
2.9
3.7
4.5
5.3
6.1
Extension (mm)
Test Run 1
Modulus Line
Break Index



Conclusions/action items:

Figure out why the PDMS is peeling off of the sample. Additionally, why are we seeing weird texture issues and how to resolve those.

2023/4/16 MTS Testing Part 2

TANISHKA SHETH - May 02, 2023, 3:41 PM CDT

Title: MTS Testing 2

Date: 4/16/23

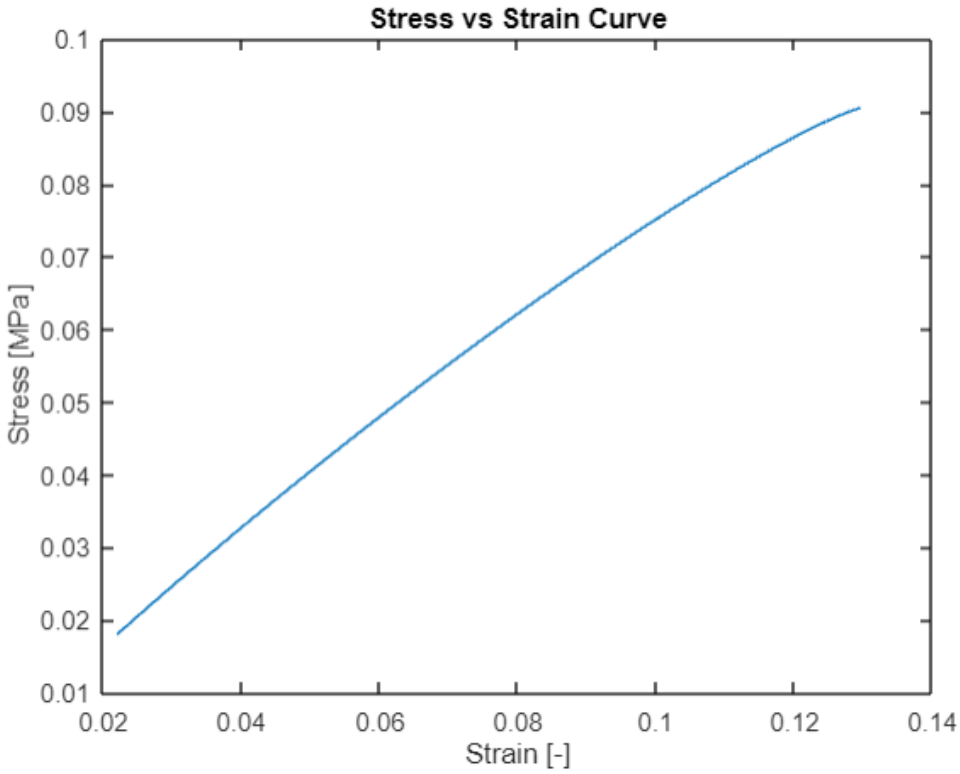
Content by: Tanishka

Present: Tanishka, Sophia

Goals: Turn the data from tensile testing of ballistics gel into stress strain curves

Content:

We used the MatLab code that was used in BME315 to turn data from the MTS machine into a stress stain curve. Our results showed that the average Young's Modulus from our 6 test runs was 727.85 kPa.



Conclusions/action items:

Create poster with our results and compare to values we were supposed to have for realistic skin.

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:

2022/9/15 Client Meeting 1

TANISHKA SHETH - Sep 15, 2022, 3:19 PM CDT

Title: Client Meeting 1

Date: 9/15/2022

Content by: Tanishka Sheth

Present: Team + Dr.Elgin

Goals: Understand what the client expects from us and ask any/all clarifying questions

Content:

- What progress was made on the prototype last semester and what resources about its development can we have access to?
    - Additionally, could we see the prototype?
        - He has a prototype + sheet with specs + mold that was used to make it
- What aspects of this model should we try to make true-to-life? AKA, what functions of the model are most essential?
    - Size is okay, skin and texture could be improved
    - Size could even be smaller if possible
    - Nice to put a breathing tube, synthetic umbilical cord, vital signs, etc
- What budget are we aiming for with this model?
    - No specific number but under a few thousand
        - He has grant money, money not an issue right now
- What dimensions should the model be?
    - Length not as important but ~1 foot
    - 400-500 grams
- How durable should the model be?
    - May only last 6 months- year but would be easily reproducible
- How often can we expect the model to be used?
    - 3-5 years are the products at market
    - Should be low cost but reproducible
- Should the model be easily sanitized?
    - Take cord out clean w q-tip
- What kind of electronic components should be included in the mannequin?
    - He will follow up on this question later
- What are current methods for practicing resuscitation techniques on premature infants?
    - Many places don’t resuscitate for extremely premature infants
    - Current methods are flawed and not of good quality
- How would you recommend testing to be done?

    - What kinds of testing do you require to be done?
        - Base has to handle bag and mask so pressure testing
        - Tolerant of umbilical cord insertion etc.
- Is there a weight/size restriction on the mannequin?
    - 400-500 grams approximately
    - Some extra weight is okay, especially with potential new tech
- What kind of conditions does this mannequin need to be able to withstand?
    - Survive breathing tube pressure
    - Fill expand lungs
    - Umbilical cord area
- What are some differences between adult skin texture versus 22-23 week premature baby's skin?
    - Texture and feel is very important to him
    - Skin is very gelatinous
    - Very wet and almost sticky
    - Skin can tear easily
- What are the breathing tube dimensions we will be using?
    - 2.0- 2.5 mm diameter
- How often would you like to meet with the group?
    - What days/times work the best for you?
        - Every other week meetings
        - At least one in person meeting to see the physical mannequin (soon)
- We have found some new born anatomical texts; however, these may not as accurately show premature babies. Do you have any suggestions for articles or texts?
    - No
- Make a lot of prototypes prior to deadline

Conclusions/action items:

We were able to get a better understanding of what the client required out of the model. Additionally we were able to see the prototype that was previously created by prior groups. These gave us better insight into what further research

2022/10/21 Client Meeting 2

TANISHKA SHETH - Dec 13, 2022, 8:08 PM CST

Title: Client Meeting 2

Date: 10/21/2022

Content by: Tanishka

Present: Team + Dr.Elgin

Goals: Discuss purchasing requests and client's opinion on how we should move forward with scanning a competing design

Content:

We will be receiving the funding information via email.

Client is okay with us scanning Premature Anne and creating a scaled down prototype version.

Conclusions/action items:

We will set up a meeting time to scan Premature Anne.

2022/9/16 Advisor Meeting 1

TANISHKA SHETH - Sep 16, 2022, 1:16 PM CDT

Title: Advisor Meeting 1

Date: 9/16/2022

Content by: Tanishka

Present: All + Dr.Skala

Goals: Understand expectations and what our upcoming deadlines are

Content:

-Weekly notebook checks

-PDS due next week

Conclusions/action items:

We discussed our expectations for each of the different assignments. We are also going to start working on the PDS for next week.

2022/9/23 Advisor Meeting 2

TANISHKA SHETH - Oct 09, 2022, 5:06 PM CDT

Title: Advisor Meeting 2

Date: 9/23/2022

Content by: Tanishka

Present: All

Goals: Discuss next steps

Content:

Discussed with advisor about potentially going in to see a NICU. Also discussed that it would be best to reach out to client and create a drop off time to receive the prior group's work. It might be best to rely on client's input than find external research if it is a very sparsely researched topic.

Conclusions/action items:

Connect with client to try and receive the prior group's model and information.

2022/10/14 Advisor Meeting 3

TANISHKA SHETH - Dec 13, 2022, 8:14 PM CST

Title: Advisor Meeting 3

Date: 10/14/2022

Content by: Tanishka

Present: All + Dr.Skala

Goals: Check in and discuss what we've prepared for preliminary presentations

Content:

No major issues. Progress looks good and we should continue working and starting to look into purchasing.

Conclusions/action items:

Begin coming up with prototyping plan.

2022/10/21 Advisor Meeting 4

TANISHKA SHETH - Dec 13, 2022, 8:17 PM CST

Title: Advisor Meeting 4

Date: 10/21/2022

Content by: Tanishka

Present: Team + Dr.Skala

Goals: Discuss whether 3D scanning is an acceptable way to come up with our mold/model

Content:

Dr.Skala will check in with Dr.P about ensuring that we are not breaking patent laws by scanning and printing based on an existing model.

Confirmed with Dr. Skala that we will be meeting with client to discuss funding.

Conclusions/action items:

Meet with Dr.Elgin and figure out how to purchase things.

2022/11/18 Advisor Meeting 5

TANISHKA SHETH - Dec 13, 2022, 8:19 PM CST

Title: Advisor Meeting 5

Date: 11/18/2022

Content by: Tanishka

Present: Team + Dr.Skala

Goals: Check in and discuss what we are getting done prior to Thanksgiving break

Content:

Told her about how mold will be printed and Dr.Skala was impressed and happy. She is hoping we can get a prototype by the first week of December so it's testable prior to presentations.

Discussed how we are creating samples of the skin to be tested. Dr.Skala is asking Dr.P about MTS testing.

Conclusions/action items:

Pick up the mold once it's printed. Wait to hear back about MTS testing samples of the materials.

2022/12/2 Advisor Meeting 6

TANISHKA SHETH - Dec 13, 2022, 8:20 PM CST

Title: Advisor Meeting 6

Date: 12/2/2022

Content by: Tanishka

Present: Team + Skala

Goals: Update Dr.Skala about how our testing is going

Content:

Showed Dr.Skala the mold that we'd picked up and she was impressed. Updated her on the fact that we've MTS testing samples of the materials.

Conclusions/action items:

Start creating final deliverables.

12/13/2022 Previous Group's Final Presentation

LOUKIA AGOUDEMOS - Dec 13, 2022, 10:26 PM CST

Title: Previous Group's Final Presentation & Project Overview

Date: 12/13/2022

Content by: Previous Design Group

Present: N/A

Goals: Show the previous group's design process for their neonatal mannequin model.

Content:

Please see the attached file for the previous group's work.

Conclusions/action items:

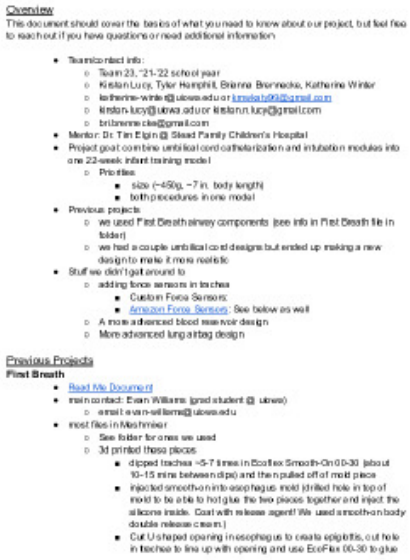
With regard to the design project, this information could be used in conjunction with our final design for the next design group, pulling the strengths of both design groups into one!

LOUKIA AGOUDEMOS - Dec 13, 2022, 10:23 PM CST

Download

Final_Presentation_Micro_Mike.pdf (10.5 MB)

LOUKIA AGOUDEMOS - Dec 13, 2022, 10:26 PM CST



Overview

This document should cover the basics of what you need to know about our project, but feel free to reach out if you have questions or need additional information

- Team/contact info:
  - Team 23, '21-22 school year
  - Kristen Lucy, Tyler Hamphill, Brianne Brennecke, Katherine Winter
  - katherine-winter@uiowa.edu or kmwinter90@gmail.com
  - kristen-lucy@uiowa.edu or kristen.n.lucy@gmail.com
  - briannemcke@gmail.com
- Mentor: Dr. Tim Elgin @ Stead Family Children's Hospital
- Project goal: combine umbilical cord catheterization and intubation modules into one 22-week infant training model
  - Priorities:
    - size (~450g, ~7 in. body length)
    - both procedures in one model
- Previous projects:
  - we used First Breath airway components (see info in First Breath file in folder)
  - we had a couple umbilical cord designs but ended up making a new design to make it more realistic
- Stuff we didn't get around to
  - adding force sensors in trachea
    - Custom Force Sensors:
    - Amazon Force Sensors: See below as well
  - A more advanced blood reservoir design
  - More advanced lung airbag design

Previous Projects

First Breath

- Read Me Document
- main contact: Evan Williams (grad student @ uiowa)
  - email: evan-williams@uiowa.edu
- most files in Mashmixer
  - See folder for ones we used
  - 3d printed these pieces
    - dipped trachea ~5-7 times in Ecoflex Smooth-On 00-30 (about 10-15 mins between dips) and then pulled off of mold piece
    - injected smooth-on into esophagus mold (drilled hole in top of mold to be able to hot glue the two pieces together and inject the silicone inside. Coat with release agent! We used smooth-on body double release cream.)
    - Cut U-shaped opening in esophagus to create epiglottis, cut hole in trachea to line up with opening and use EcoFlex 00-30 to glue

Download

Neonatal_Prior_Info.pdf (2.53 MB)

2022/12/11 - Cost Chart

CLAIRE KRAMAR - Dec 11, 2022, 8:26 PM CST

Title: Cost Chart

Date: 12/11/2022

Content by: Claire Kramar

Present: self

Goals: document the expenses of creating our prototype

Content:

Item	Description	Manufacturer	Part Number	Date	QTY	Cost Each	Total	Link
Skin								
Slyguard Silicone Elastomer	Needed to make the layer of skir	WPI		11/4/2022	1	$286.00	$286.00	https://www.wpiinc.com/sylg18
Agar Agar Powder	Needed to make the protective s	The Seaweed Solution		11/4/2022	1	$14.99	$14.99	https://www.amazon.com/Agar-
Petri Dishes	Needed to work on differnt conc	LabAider		11/13/202	1	$14.98	$14.98	https://www.amazon.com/Steril
3D Printing								
Mold	Needed mold in order to make r	Makerspace		11/22/202	1	$123.00	$123.00	
							$0.00	
						TOTAL:	**$438.97**	

Conclusions/action items: We stayed within the budget our client gave us.

2022/12/11 - Methods

CLAIRE KRAMAR - Dec 11, 2022, 8:29 PM CST

Title: Methods

Date: 12/11/2022

Content by: Claire Kramar

Goals: describe the fabrication of our prototype

Content:

The first step in building the prototype was to 3D scan Premature Anne at the MakerSpace. Then, the file was processed and sent to the team. From there, the members modified the files using a combination of SolidWorks, MeshMixer, and Blender to remove the limbs from the scan, slice it in half, and then extrude a box so that the scan became the negative space. The team 3D printed the mold at the MakerSpace. Meanwhile, the team began to test skin materials to use for the prototype. It was determined that the Sylgard would suffice for the design, but the Agar was too wet to be used in the mannequin. The next prototyping step was to pour the Sylgard into the mold and cure it. Afterwards, a balloon mechanism was inserted to simulate a breathing mechanism, and the two halves of the molds were glued together. The balloon mechanism consisted of a tube that was able to fit the required 2mm intubation tube, a balloon, and a rubber band connecting the two such that no air could escape.

Conclusions/action items: We completed a prototype that satisfied some of our initial design criteria. We discussed many ways to improve the design in the future.

12/13/2022 - Previous Group's Fabrication Protocol

LOUKIA AGOUDEMOS - Dec 13, 2022, 10:28 PM CST

Title: Previous Group's Ecoflex Protocol

Date: 12/13/2022

Content by: Previous Design Group

Present: N/A

Goals: Show the previous group's testing protocol for pouring mold using eco flex to show a comparison of our Sylgard curing protocol.

Content:

Outer shell
Materials needed:
1. smooth-on body double release cream
2. PLA print of half baby (right and left)
3. Internal mouth and throat mold (left and right)
4. Internal abdominal cavity mold (left and right)
5. Ecoflex 00-30
6. Flesh-colored Silc Pig coloring
7. Metal wire
8. Hot glue gun
9. Ruler
- Lightly coat the external walls of the mouth and abdominal cavity molds with release cream
- Cut 6 metal wires the width of the shell mold
- Using a hot glue gun, secure 2 metal wires parallel to the top surface of to each of the mouth molds spacing them evenly (this will allow the molds to be suspended in the ecoflex without touching the bottom of the shell mold)
- Warning: if internal molds touch the external body mold there will be a hole in the shell

- Following the same process, glue the remaining 4 wires (2 per mold) to the internal abdominal cavity mold
- Once the glue is set, start to place the right side internal molds in the right side external mold (do the same for the left)
- Preceding with caution, use the ruler to make sure all internal components are lined up properly
- Note: we glued the right mouth and abdominal cavity components together, measured and repeated this process for the left (this helped eliminate some of the placement errors)

- Once all parts are lined up properly, secure the wires to the external mold using hot glue
- Use hot glue or a popsicle stick to fill a space for the umbilical cord between the internal abdomen mold and outer shell mold
- Mix 180g each part A and part B of Ecoflex 00-30 pigmented with “flesh” Silc Pig and pour slowly into the external molds
- Allow models to sit at least 24 hours before removing molds
- Halves will be glued together with more Ecoflex 00-30 once all internal components are properly installed

Airway
Materials needed:
1. 3D printed trachea
2. 3D printed esophagus (should be 2 parts that fit together)
3. 4 mm tubing (the same type used for u.cord)
4. Infant CPR bags
5. Heat gun
6. Hot glue gun

7. Metal wire
8. Pliers
9. Sharpie marker
10. Ecoflex 00-30
11. Silc pig skin coloring
12. 50 mL syringe
13. smooth-on body double release cream

Trachea:

- Using bright yellow colored Ecoflex 00-30, dip the 3D printed trachea 5-7 times waiting 15 minutes between each dip
- Wait a full 24 hours after the last dip before removing the trachea from the mold.

Esophagus:

- Drill a hole into the top of the mold (use a drill bit large enough for the 50 mL syringe to fit into
- Coat both internal walls of the mold with smooth-on body double release cream
- Hot glue the two halves of the esophagus mold together and allow 5 minutes for it to set
- While glue sets, mix together 10 mL Ecoflex 00-30 colored red
- Using a syringe, inject Ecoflex 00-30 into the hole in the top of the esophagus mold, tap or flick the mold to release air bubbles
- Wait at least 24 hours to remove the esophagus from the mold

Lung Bag:

- Using the infant CPR bag, draw a wishbone shape on the bag (2 rectangles ~2”x1” connected by a long/skinny rectangle ~0.5”x4.
- Cut about a 5” section of wire and bend it into a triangle with a 0.5” long handle on the top (needs to be held by the pliers).

- Using the pliers, hold the metal triangle so that the bottom is in front of the heat gun. Hold for 30-60 seconds. (wire must be hot enough to melt and fuse the plastic bag together).
- Once hot, press the wire firmly against the bag following the outline you have drawn.
- Repeat the 2 steps above until the wishbone is completely sealed at all edges
- Cut about 1mm outside of the line along with the wishbone shape and then cut the wishbone in half along the long/skinny rectangle.
- You now have 2 lung bags.

Assemble airway:

Materials needed:

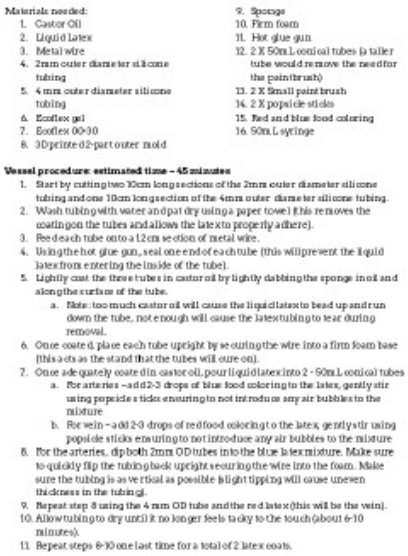
1. Esophagus
2. Trachea
3. Ecoflex 00-30
4. 4 mm tubing
5. Lung bag
6. 4 popsicle sticks
7. Small rubber bands

- Start by cutting a “u” shaped flap into the ridge of the esophagus (|_|)
- Cut a hole in the trachea that lines up with the cut in the esophagus, this should simulate the epiglottis leading to the trachea
- Using an intubation tube, see that the placement is correct and apply Ecoflex 00-30 to adhere the trachea to the esophagus. Hold the trachea and esophagus together with small rubber bands and popsicle sticks
- Once dry (about 24 hours later), insert the 4mm tubing into the bottom hole of the trachea and attach the lung bag to the other end with hot glue

Additionally, please see attached for the group's umbilical cord fabrication process.

Conclusions/action items:

This may be a useful resource for groups who attempt to do this project in the future and consider this group's streamlined, but the complex process for pouring the mold as opposed to our process.



Materials needed:

1. Castor Oil
2. Liquid Latex
3. Metal wire
4. 2mm outer diameter silicone tubing
5. 4 mm outer diameter silicone tubing
6. Ecoflex gel
7. Ecoflex 00-30
8. 3D printed 2-part outer mold
9. Sponge
10. Firm foam
11. Hot glue gun
12. 2 X 50mL conical tubes (a taller tube would remove the need for the paintbrush)
13. 2 X Small paint brush
14. 2 X popsicle sticks
15. Red and blue food coloring
16. 50mL syringe

Vessel procedure: estimated time – 45 minutes

1. Start by cutting two 10cm long sections of the 2mm outer diameter silicone tubing and one 10cm long section of the 4mm outer diameter silicone tubing.
2. Wash tubing with water and pat dry using a paper towel (this removes the coating on the tubes and allows the latex to properly adhere).
3. Feed each tube onto a 12 cm section of metal wire.
4. Using the hot glue gun, seal one end of each tube (this will prevent the liquid latex from entering the inside of the tube).
5. Lightly coat the three tubes in castor oil by lightly dabbing the sponge in oil and along the surface of the tube.
    a. Note: too much castor oil will cause the liquid latex to bead up and run down the tube, not enough will cause the latex tubing to tear during removal.
6. Once coated, place each tube upright by securing the wire into a firm foam base (this acts as the stand that the tubes will cure on).
7. Once adequately coated in castor oil, pour liquid latex into 2 - 50mL conical tubes
    a. For arteries – add 2-3 drops of blue food coloring to the latex, gently stir using popsicle sticks ensuring to not introduce any air bubbles to the mixture
    b. For vein – add 2-3 drops of red food coloring to the latex, gently stir using popsicle sticks ensuring to not introduce any air bubbles to the mixture
8. For the arteries, dip both 2mm OD tubes into the blue latex mixture. Make sure to quickly flip the tubing back upright securing the wire into the foam. Make sure the tubing is as vertical as possible (slight tipping will cause uneven thickness in the tubing).
9. Repeat step 8 using the 4 mm OD tube and the red latex (this will be the vein).
10. Allow tubing to dry until it no longer feels tacky to the touch (about 6-10 minutes).
11. Repeat steps 8-10 one last time for a total of 2 latex coats.

Download

UCord_Protocol.pdf (31.1 kB)

12/02/2022 Agar Hydrogel Compression Testing Protocol

LOUKIA AGOUDEMOS - Dec 13, 2022, 8:40 PM CST

Title: Agar Hydrogel Compression Testing Protocol

Date: 12/02/2022

Content by: Loukia Agoudemos

Present: Tanishka Sheth, Sophia Finn

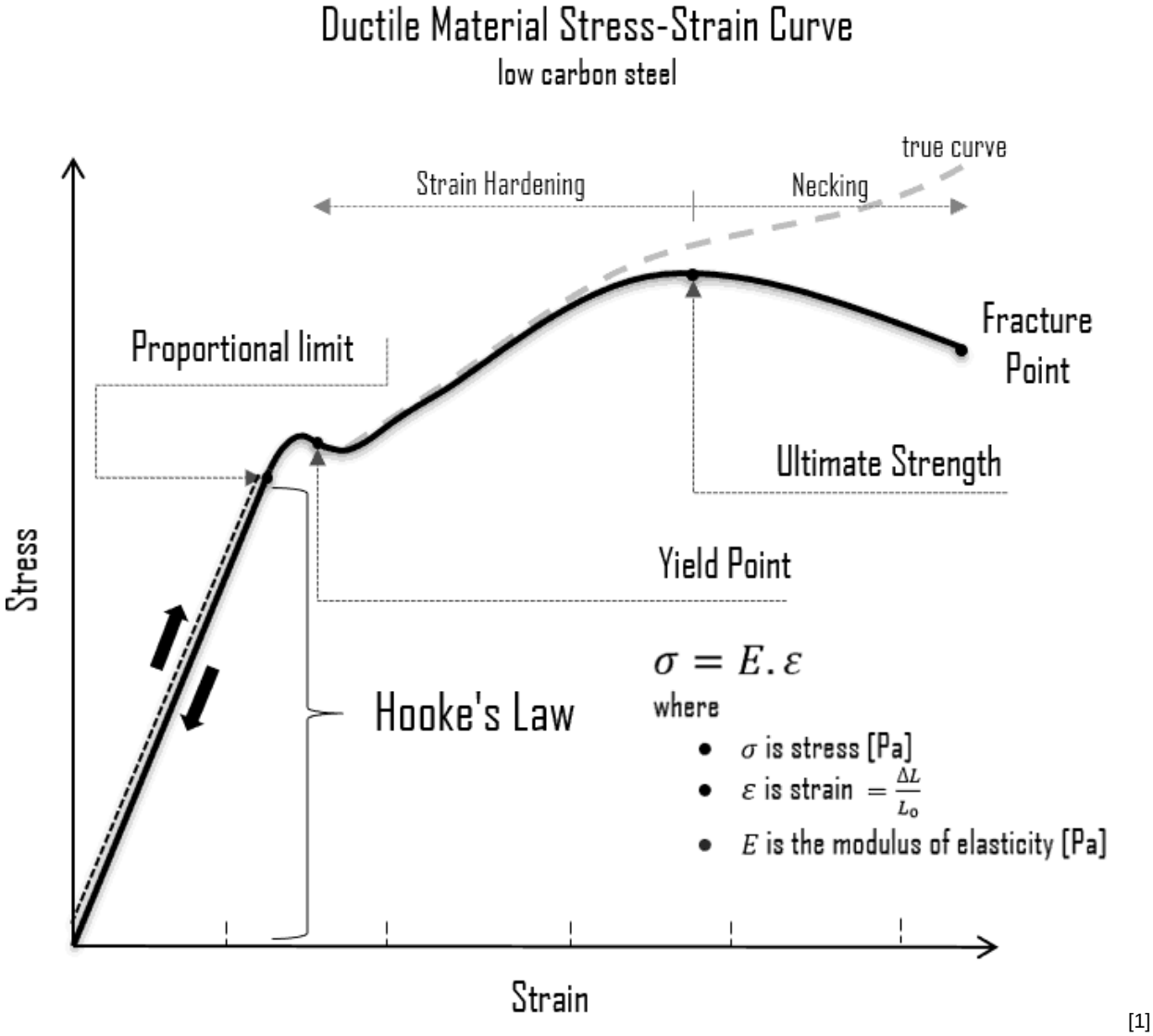
Goals: Describe the testing protocol used for MTS compression testing on our agar hydrogel so testing could be repeated in the future.

Content:

Compression testing is a mechanical test to characterize the mechanical properties of the desired material. This involves applying vertical load over time, measuring the displacement of the material, and creating a stress-strain curve from this data until mechanical failure. This makes it easy to characterize the elastic modulus of the agar hydrogel and the greatest load it can hold before failure.

The protocol is as follows:

1. Select 3 samples of agar hydrogel of appropriate thickness and area for use on the MTS machine in ECB, and do your best to ensure that the sample is as uniform as possible within the sample and among the other sample.
2. Equip appropriate compression testing plate heads onto the MTS testing loads.
3. Power up the MTS machine and open the MTS software. Open a new test.
4. For each sample, conduct the following...
    1. Measure and record the length, width, and thickness of the agar sample.
    2. Put this information in the appropriate text-entry prompts in the MTS software for your new test.
    3. Place the sample centered on the compression plates.
    4. Double-check that everything is looking right before you run the test.
    5. Unlock the machine and select run test.
    6. Collect compression testing data until failure-- should look like a sudden dip in displacement.
    7. Stop the machine and take picture of a sample where you believe failure to be located.
5. Use data analysis to identify elastic modulus and failure load following this example.
    1. Elastic Modulus and Ultimate Strength --Yield point does not apply to the elastic material.



[1]

Citation:

[1]"What is Modulus of Elasticity – Elastic Modulus - Definition," Material Properties, Jul. 31, 2020. [Online]. Available: https://material-properties.org/what-is-modulus-of-elasticity-elastic-modulus-definition/. [Accessed: Dec. 13, 2022]

Conclusions/action items: Use this testing protocol to conduct any future compression testing on hydrogel samples to identify the most appropriate hydrogel choice for the composite skin model. Compression testing can be conducted on elastomer and any other material used in the mannequin.

12/02/2022 Agar Hydrogel Compression Testing Data & Results

LOUKIA AGOUDEMOS - Dec 13, 2022, 8:29 PM CST

Title: Agar Hydrogel Compression Testing Data & Results

Date: 12/02/2022

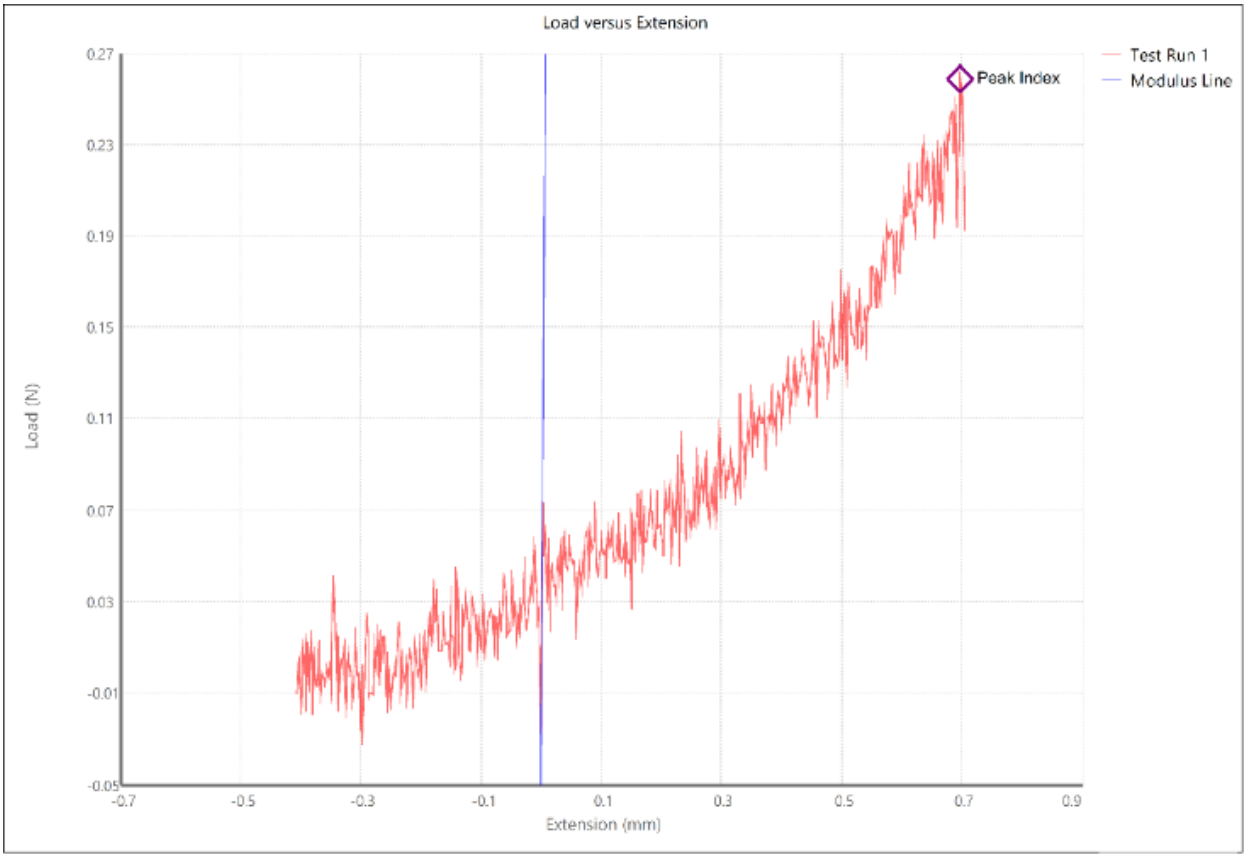
Content by: Loukia Agoudemos

Present: Tanishka Sheth, Sophia Finn

Goals: Present data in an effective way for agar hydrogel MTS compression testing.

Content:

Graphic Data:

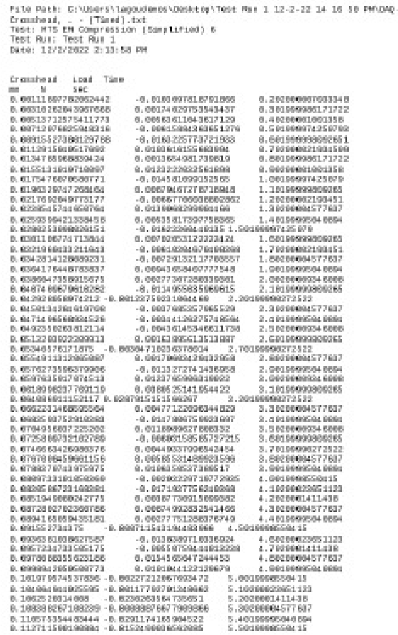


Calculations: Agar withstood maximum of 0.25 N on average of 3 trials, Young's Modulus of 360 kPa (.25N/.69mm) where .69 mm was the average of 3 trials

Conclusions/action items:

Based on our calculations, our agar hydrogel is within industry standards and its mechanical properties could be used in the mannequin prototype, given that the elastic modulus of the hydrogel in the application does not need to be very high. Further testing of the mechanical properties must be conducted to understand whether or not our choice of materials is appropriate for use in the mannequin.

LOUKIA AGOUDEMOS - Dec 13, 2022, 5:05 PM CST


File Path: C:\Users\lagoudemos\Desktop\Test Run 1 12-2-22 14 16 50 PM\DAQ- Crosshead, . - (Timed).txt
Test: MTS EM Compression (Simplified) 6
Test Run: Test Run 1
Date: 12/2/2022 2:13:58 PM

Crosshead Load Time
mm N sec

[illegible]

Download

DAQ-_Crosshead_-_Timed_.txt (29 kB) Raw data from MTS machine.

2022/9/16 Team Meeting 1

TANISHKA SHETH - Sep 16, 2022, 1:39 PM CDT

Title: Team Meeting 1

Date: 9/16/2022

Content by: Tanishka

Present: All

Goals: Discuss our prior research findings and begin coming up with ideas for what our mannequin will need to include

Content:

-Discussed that we want to include electronic components that show the pressure and how hard we're pushing down

-Start looking into other mannequins that exist and try to tear them apart to see what's inside

-Discussed getting access to CPR dummies

-Get access to MATC to see the labor and delivery area

Conclusions/action items:

-Start working on the PDS

-Start reaching out to Dr. Elgin and others to try and get a CPR dummy and get access to MATC

2022/9/23 Team Meeting 2

CLAIRE KRAMAR - Dec 11, 2022, 8:34 PM CST

Title: Team Meeting 2

Date: 9/23/2022

Content by: Claire Kramar

Present: whole team

Goals: continue getting to know the team, assign research roles

Content:

We discussed the PDS and determined who was going to study which topic.

Conclusions/action items: The next course of action is to research the topics decided on and work on the PDS.

2022/09/30 Team Meeting 3

CLAIRE KRAMAR - Dec 13, 2022, 3:56 PM CST

Title: Team Meeting 3

Date: 09/30/2022

Content by: Claire Kramar

Present: whole team

Goals: split team into 3 subgroups to narrow research

Content:

3D mold and limbs: Tanishka and Claire

Intubation and Chest Cavity: Sophia and Sai

Skin: Loukia and Lael

Conclusions/action items: The number of things we want to accomplish this semester is high, so we thought splitting up the work to focus our research and efforts would be beneficial.

2022/10/07 Team Meeting 4

CLAIRE KRAMAR - Dec 13, 2022, 4:00 PM CST

Title: Team Meeting 4 - Preliminary Presentaion

Date: 10/07/2022

Content by: Claire Kramar

Present: whole team

Goals: give our preliminary presentation to advisor and other groups in our room

Content:

Link to presentation slides: https://bmedesign.engr.wisc.edu/projects/f22/neonatal_mannequin/file/view/4330c155-3efb-44d4-8329-9a051fec9a64/Neonatal_Mannequin_Poster_Presentation.pdf

Conclusions/action items: Our presentation went well. Our next course of action is to continue researching and begin to prototype our design.

2022/10/14 Team Meeting 5

CLAIRE KRAMAR - Dec 13, 2022, 4:21 PM CST

Title: Team Meeting 5

Date: 10/14/2022

Content by: Claire Kramar

Present: whole team

Goals: decide on final design from our preliminary design

Content:

We are prioritizing 3 main aspects of the mannequin: realistic skin, intubation and a chest cavity, and limbs for IV insertion.

Conclusions/action items: The next steps are to continue researching in their specific topics and find materials to buy for prototyping.

2022/10/21 Team Meeting 6

CLAIRE KRAMAR - Dec 13, 2022, 4:23 PM CST

Title: Team Meeting 6

Date: 10/21/2022

Content by: Claire Kramar

Present: whole team

Goals: receive and discuss feedback from preliminary deliverables

Content:

Overall, we were happy with our scores on our preliminary deliverables. We did not receive much constructive criticism and are excited to continue with our ideas.

Conclusions/action items: continue working on our prototype

2022/10/28 Team Meeting 7

CLAIRE KRAMAR - Dec 13, 2022, 4:18 PM CST

Title: Team Meeting 7

Date: 10/28/2022

Content by: Claire Kramar

Present: whole team

Goals: finalize mold for 3D printing

Content:

Modifying the 3D scan has been our biggest road block. We have not been able to extrude a box from the surface to make the scan the negative space, forming the mold.

Conclusions/action items: We have tried problem-solving as a team, so the next course of action would be to find someone who has more expertise in 3D modeling to help us solve our problem.

2022/11/04 Team Meeting 8

CLAIRE KRAMAR - Dec 13, 2022, 4:14 PM CST

Title: Team Meeting 8 - Show and Tell

Date: 11/04/2022

Content by: Claire Kramar

Present: whole team

Goals: get feedback from peer groups

Content:

The most valuable feedback we received was about our 3D modeling. Some groups suggested we try using Blender or Meshmixer to modify the 3D scan.

Conclusions/action items: Our next course of action is to take the feedback and act on it, especially with the mold.

2022/11/18 Team Meeting 9

CLAIRE KRAMAR - Dec 13, 2022, 4:15 PM CST

Title: Team Meeting 9

Date: 11/18/2022

Content by: Claire Kramar

Present: whole team

Goals: make a gameplan for how to finish final deliverables in the given time

Content:

We determined we needed to meet that weekend in order to test the skin in a timely manner. The mold was also finalized and 3D printing began at the MakerSpace.

Conclusions/action items: We next need to test the skin, pick up the mold, and pour the skin into the mold to build the prototype.

2022/11/20 Team Meeting 10

CLAIRE KRAMAR - Dec 13, 2022, 4:09 PM CST

Title: Team Meeting 10

Date: 11/20/2022

Content by: Claire Kramar

Present: Claire, Sai, Sophia, Tanishka

Goals: cook sample of skin materials

Content:

We cooked the Sylgard in different quantities for different amounts of times to see what worked. We also made the Agar from the Agar powder and determined that it was very wet, too wet to adhere to any other skin material.

Conclusions/action items: We decided not to use the Agar due to the amount of water it retained. The Sylgard seemed to work well. The next course of action is to test the skin and pour it into the mold.

2022/12/02 Team Meeting 11

CLAIRE KRAMAR - Dec 13, 2022, 4:11 PM CST

Title: Team Meeting 11

Date: 12/02/2022

Content by: Claire Kramar

Present: whole team

Goals: build our prototype and test skin

Content:

Some members of the team used the MTS machine to complete tensile and compression testing for the skin. Other members worked on curing the test samples of Sylgard and experimenting with the pigment. The other members worked on the poster presentation.

Conclusions/action items: The skin would not cure with the pigment in it, so we had to drop the idea of using a pigment to make the baby look more realistic. The sample was also not degassed fully, potentially leading to incorrect testing results.

2022/11/11 Tong Lecture: How to Evolve an Entrepreneurial Mindset

TANISHKA SHETH - Nov 11, 2022, 12:35 PM CST

Title: Tong Lecture

Date: 11/11/2022

Content by: Tanishka

Present: All

Goals: Learn about entrepreneurship and how to apply that in the future

Content:

- >50% of 18-24 year-olds want to start their own business
- Entrepreneurial Mindset:
  - engineers play a critical role by addressing problems and creating solutions
  - this role requires collaboration, leadership, technical skills, curiosity, connecting knowledge, and value creation
  - EM in common with habitual entrepreneurs
    - passionately seek new opportunities
    - pursue opportunities with discipline
    - pursue only the best opportunities
    - focus on execution
    - engage in energies of everyone in their domain
- 2/3 of students believed entrepreneurship education would broaden career prospects, while only 1/2 of faculty believed entrepreneurship education is valuable

Conclusions/action items:

I will now look into entrepreneurial opportunities at the university

2022/09/14 Normal Development of the Lung and Premature Birth

TANISHKA SHETH - Sep 14, 2022, 9:21 PM CDT

Title: Normal Development of the Lung and Premature Birth

Date: 9/14/2022

Content by: Tanishka Sheth

Present: Tanishka Sheth

Goals: Understand chest structure in premature infants to try and understand how our mannequin should start to look

Content:

L. J. Smith, K. O. McKay, P. P. van Asperen, H. Selvadurai, and D. A. Fitzgerald, “Normal development of the lung and premature birth,” *Paediatric Respiratory Reviews*, 25-Jan-2010. [Online]. Available: https://www.sciencedirect.com/science/article/abs/pii/S1526054209001006?via%3Dihub. [Accessed: 14-Sep-2022].

-Lung development is still within saccular period in infants born between 24-32 weeks

-In adults, the chest wall will spring outward which will reduce the extent of lung collapse

-In newborns the ribs are so compliant that significant collapse of alveoli occurs

-Infants will have difficulty breathing and often go into RDS and increase morbidity

Conclusions/action items:

There is a notable lack of research regarding infants born at 22-23 weeks of gestation, thus research is proving to be difficult. However, looking into typical premature infants is aiding in my understanding of what characteristics need to be included in the mannequin.

2022/9/29 Survival Among Infants Born at 22-23 Weeks

TANISHKA SHETH - Oct 09, 2022, 5:01 PM CDT

Title: Survival Among Infants Born at 22 or 23 Weeks' Gestation Following Active Prenatal and Postnatal Care

Date: 9/29/2022

Content by: Tanishka

Present: Tanishka

Goals: Better understand the survival odds for infants born at 22-23 weeks of gestation since this is what the project focuses on.

Content:

> Mehler K;Oberthuer A;Keller T;Becker I;Valter M;Roth B;Kribs A; "Survival among infants born at 22 or 23 weeks' gestation following active prenatal and postnatal care," *JAMA pediatrics*, 23-May-2016. [Online]. Available: https://pubmed.ncbi.nlm.nih.gov/27214875/. [Accessed: 29-Sep-2022].

The survival rates for neonates born at 22-23 weeks of gestation is fairly low (1 in 4 survives without severe complications). However, there is some variability depending on the neonatology unit. This can be something that can be aided with the use of simulation mannequins. The article stresses that future research should be done regarding the environment in the hospital and delivery management services.

Conclusions/action items:

This article better explains how our project is necessary. Though it was conducted in Germany, the information remains relevant and reflects what we were told by the client. Knowing this, we can move on to best define what components within the mannequin are most necessary to include.

TANISHKA SHETH - Oct 09, 2022, 4:54 PM CDT

Survival Among Infants Born at 22 or 23 Weeks' Gestation Following Active Prenatal and Postnatal Care

Download

jamapediatrics_mehler_2016_oi_160015.pdf (187 kB)

2022/10/25 IV Access in Neonates

TANISHKA SHETH - Dec 13, 2022, 7:44 PM CST

Title: IV Access Points in Neonates

Date: 10/25/2022

Content by: Tanishka

Present: Tanishka

Goals: Determine what IV access points are necessary so we can choose which to include within the prototype

Content:

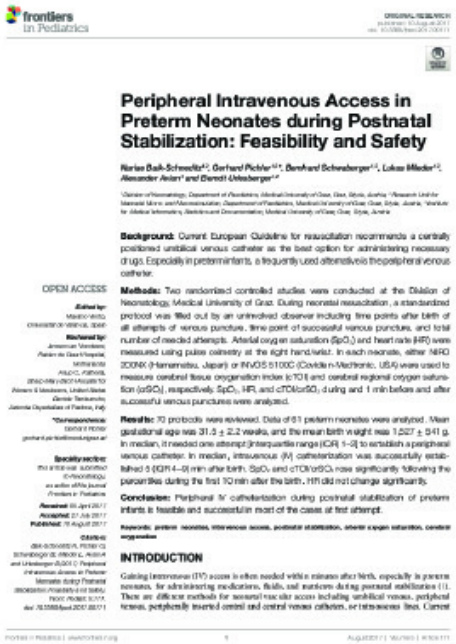
> N. Baik-Schneditz, G. Pichler, B. Schwaberger, L. Mileder, A. Avian, and B. Urlesberger, "Peripheral intravenous access in preterm neonates during postnatal stabilization: Feasibility and safety," *Frontiers in Pediatrics*, vol. 5, 2017.

In terms of IV access, typically during resuscitation the IV is inserted peripherally. This means on the back of hands or feet. Ideally we would include this kind of access to the neonatal model we are creating.

Conclusions/action items:

Brainstorm how to include (attachment, printing) limbs to a potential prototype.

TANISHKA SHETH - Dec 13, 2022, 7:41 PM CST



frontiers in Pediatrics

Peripheral Intravenous Access in Preterm Neonates during Postnatal Stabilization: Feasibility and Safety

OPEN ACCESS

INTRODUCTION

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fped-05-00171.pdf (116 kB)

2022/9/22 CPR Mannequin

TANISHKA SHETH - Sep 22, 2022, 9:05 PM CDT

Title: CPR Mannequins

Date: 9/22/22

Content by: Tanishka

Present: Tanishka

Goals: Understand how the lights and electronics work in cpr mannequins to determine if it's viable in our project

Content:

When students are practicing CPR compressions on a Prestan® child Manikin, not only will they see when they have reached and are maintaining the minimum recommended speed of 100 cpm, they will also see when they reach the upper limit of 120 cpm. Light indicators are as follows:

-a red light indicates fewer than 60 compressions per minute
-a yellow light illuminates when the rate is 60 to fewer than 80 compressions per minute
-a single green light comes on when the student is administering 80 to fewer than 100 compressions per minute
-two green lights let students know that they have reached 100 compressions-119 per minute, and stay on to help students maintain that rate
-two green lights and a flashing yellow light indicates the student has reached 120 + compressions per minute and needs to slow down

-two green lights and a flashing yellow light indicates the student has reached 120 + compressions per minute and needs to slow down

Conclusions/action items:

Including a rate monitor for the resuscitation mannequin of a neonatal infant would be useful feedback. As far as training models go I could continue to look into pressure sensors and some kind of arduino code, similar to heart rate monitors from BME 310. Further, I will continue looking through other cpr dummies to see what kind of sensors they use to generate this feedback

2022/10/5 LED Specifications

TANISHKA SHETH - Oct 09, 2022, 4:50 PM CDT

Title: 5mm LED Specifications

Date: 10/5/2022

Content by: Tanishka

Present: Tanishka

Goals: Determine if the 5mm LED would be acceptable for my design idea

Content:

“5mm LED technical specifications and power characteristics,” *Make*, 20-Aug-2022. [Online]. Available: https://www.make-it.ca/5mm-led-specifications/#:~:text=The%205mm%20LED%20can%20be,common%20size%20of%20LED%20available. [Accessed: 05-Oct-2022].

A Super Bright 5mm LED is exceptionally bright with a wide beam angle, so they’re suitable for use in your projects, illuminations, headlamps, spotlights, car lighting, and models. The 5mm LED can be used anywhere where you need low power, high-intensity reliable light, or indication. They go quickly into a breadboard and will add that extra zing to your project.

The 5mm T1 3/4 LED is the most common size of LED available

Conclusions/action items:

These LEDs might be too large, but can work for the initial prototype. Next steps would be to determine whether this design will be the final design and if there are any other light components that would be more feasible.

2022/10/18 Ethics

TANISHKA SHETH - Dec 13, 2022, 7:58 PM CST

Title: Ethical Considerations for mannequin creation

Date: 10/18/2022

Content by: Tanishka

Present: Tanishka

Goals: Determine what ethical considerations we should be aware of when creating the prototype.

Content:

> “Covid 19 essentials,” *Guidelines for AHA Manikins | CPR Savers & First Aid Supply*. [Online]. Available: https://cpr-savers.com/aha-manikin-guideline. [Accessed: 18-Oct-2022].

American Heart Association requires an instrumented directive feedback device that provides audio or visual feedback on the rate and depth of compressions during CPR training. This is not directly relevant to the mannequin that we are creating but it's something to keep in mind if we want to put it in market.

Conclusions/action items:

Look into what kind of feedback we can provide within a potential prototype whether it's electronic or visual like a chest rising and falling

2022/10/10 Specifications for Neonatal Resuscitation Devices

TANISHKA SHETH - Dec 13, 2022, 8:04 PM CST

Title: WHO Technical specifications of Neonatal Resuscitation Devices

Date: 10/10/2022

Content by: Tanishka

Present: Tanishka

Goals: Understand what the WHO requires for resuscitation devices

Content:

WHO technical specifications for neonatal resuscitation devices. Geneva, Switzerland: World Health Organization, 2016.

There are different types of suction machines that can be used when it comes to resuscitation of neonates. As a result we would need to make sure that what we choose for our materials for the design are able to withstand them.

Conclusions/action items:

Look into what will be able to withstand the forces that are applied when undergoing resuscitation .

TANISHKA SHETH - Dec 13, 2022, 8:04 PM CST

Download

9789241510264_eng.pdf (2.03 MB)

2022/10/5 Design Idea

TANISHKA SHETH - Oct 09, 2022, 4:45 PM CDT

Title: Individual Design Idea

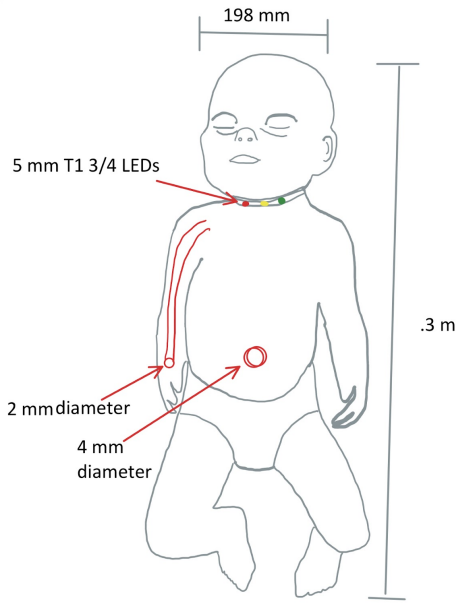
Date: 10/5/2022

Content by: Tanishka

Present: Tanishka

Goals: Develop a viable design idea for the design matrix and final presentation.

Content:



Components:

LEDs connected to chest cavity

Green=proper resuscitation

Yellow=approaching incorrect technique

Red=improper resuscitation

Allows insertion of 2mm IV line

Silicone skin material

Umbilical line insertion

Conclusions/action items:

Compare to other design ideas on matrix and determine best idea.

2022/11/4 Show and Tell

TANISHKA SHETH - Dec 13, 2022, 7:18 PM CST

Title: Show and Tell

Date: 11/4/2022

Content by: Tanishka

Present: All

Goals: Come up with ideas to create our mold

Content:

A member from the other neonatal group told us that using Meshmixer might be a good idea. I will download and attempt to use this to come up with our mold from the 3D scan.

Conclusions/action items:

Creating the mold is proving to be a big issue especially using Solidworks, so I will visit the Makerspace and try to figure that out.

2022/11/11 Makerspace Visit

TANISHKA SHETH - Dec 13, 2022, 7:20 PM CST

Title: Makerspace Visit

Date: 11/11/2022

Content by: Tanishka

Present: Claire

Goals: Visit the Makerspace and ask for guidance with using Blender and Meshmixer

Content:

The Makerspace was able to help create one of the halves, but not the other. I will attempt to create the other half in my own time. File attached.

Conclusions/action items:

Continue working on second half of the mold.

TANISHKA SHETH - Dec 13, 2022, 7:23 PM CST

Download

BackofNeonate_1_.stl (2 MB)

2022/11/18 3D Mold of Neonate

TANISHKA SHETH - Dec 13, 2022, 7:15 PM CST

Title: 3D Mold of Neonate

Date: 11/18/2022

Content by: Tanishka

Present: Claire

Goals: Include files of the neonate that I created by using Blender and Meshmixer

Content:

Attachments included below

Conclusions/action items:

These files will be printed at the Makerspace using a nylon, heat resistant material so that we can cure Sylgard layers in it

TANISHKA SHETH - Dec 13, 2022, 7:13 PM CST

Download

neonateback_2_.stl (11.6 MB)

TANISHKA SHETH - Dec 13, 2022, 7:13 PM CST

Download

neonatefront_2_.stl (12.6 MB)

2022/11/20 Sylgard Curing Protocol

TANISHKA SHETH - Dec 13, 2022, 7:09 PM CST

Title: Curing of Sylgard

Date: 11/20/2022

Content by: Tanishka

Present: Sophia, Sai, Claire

Goals: Document how we created the Sylgard 184 samples

Content:

1. Combine base and curing agent at a 10:1 ratio
2. Spread a layer of about 1mm onto an oven safe tray
3. Allow to cure in the oven at 280 degrees F
4. Remove and allow to cool
5. Remove the material from the tray and place in petri dish
6. Repeat for multiple samples

Conclusions/action items:

This can be used to create smaller samples for when we are MTS testing. This will be a good indication of whether or not Sylgard 184 will be sufficient material.

2022/12/2 MTS Testing Data

TANISHKA SHETH - Dec 13, 2022, 7:49 PM CST

Title: MTS Testing of Elastomer and Hydrogel

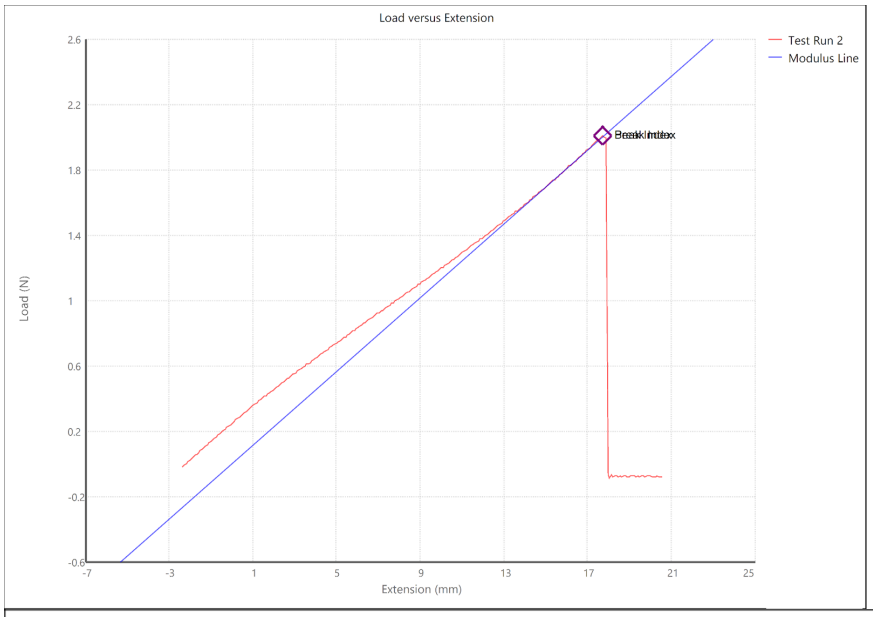
Date: 12/2/2022

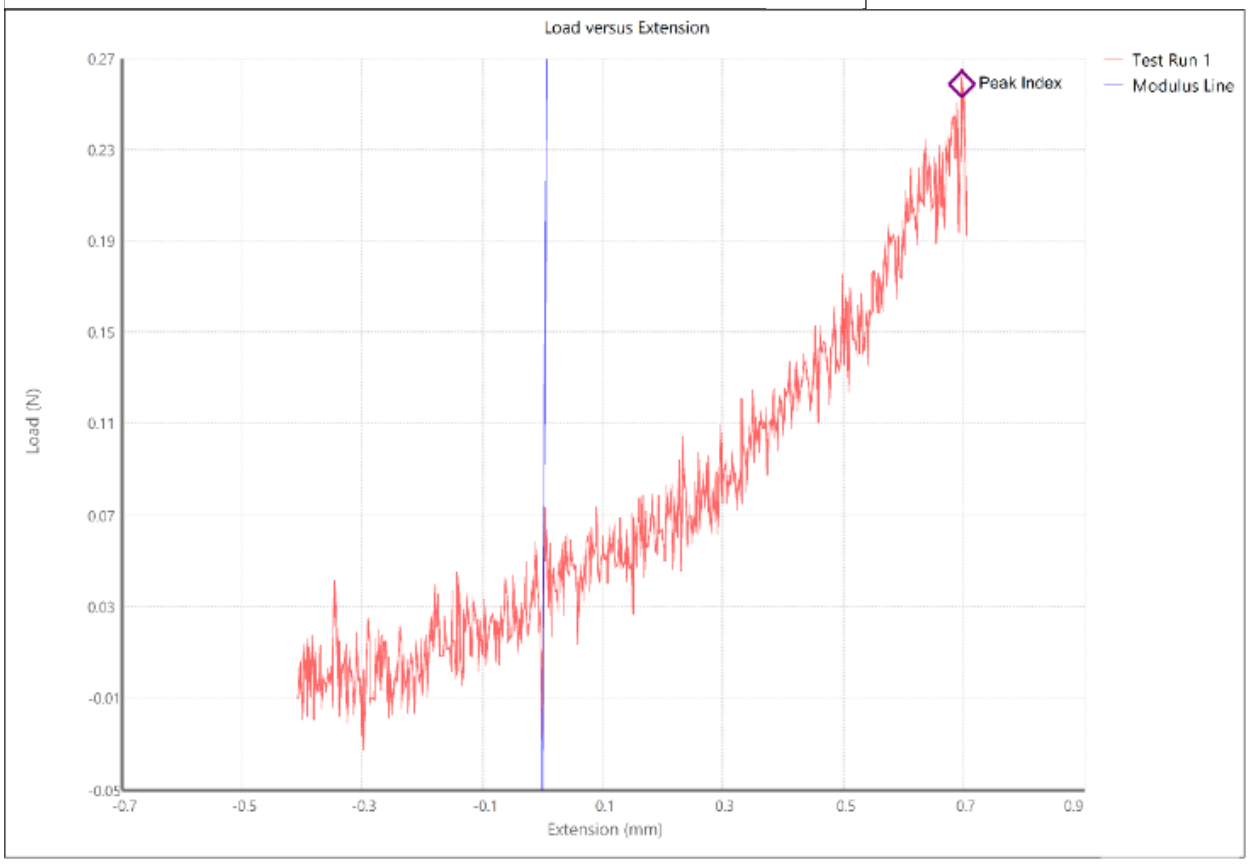
Content by: Tanishka

Present: All

Goals: Perform testing for chosen elastomer and hydrogel and determining whether the values that are collected fall within industry standards

Content:





Conclusions/action items:

Sylgard :Withstood maximum of 2.0 N on average (average taken of 3 trials), Young's Modulus of .11 MPa (2N/18mm) where 18mm was the average of 3 trials as well

Agar: Withstood maximum of 0.25 N on average of 3 trials, Young's Modulus of 360 kPa (.25N/.69mm) where .69 mm was the average of 3 trials

I will now determine whether these values fall within industry standards by consulting literature that pertains to these specific materials.

2022/12/6 Sylgard Industry Standard Data

TANISHKA SHETH - Dec 13, 2022, 6:37 PM CST

Title: Sylgard 184 Tensile Testing Industy Standard

Date: 12/6/2022

Content by: Tanishka

Present: N/A

Goals: Determine what the industry standard values are for tensile testing of Sylgard 184

Content:

I. D. Johnston, D. K. McCluskey, C. K. Tan, and M. C. Tracey, “Mechanical characterization of bulk Sylgard 184 for microfluidics and microengineering,” *Journal of Micromechanics and Microengineering*, vol. 24, no. 3, p. 035017, 2014.

Sylgard 184 elastomer should have a Young’s modulus of 1.32-2.97 MPa

Conclusions/action items:

Based on these values, it can be determined that the testing data that we collected Sylgard 184 MTS testing does not fall within industry standards and needs to be improved on for future prototypes.

2022/12/7 Agar Industry Standard Data

TANISHKA SHETH - Dec 13, 2022, 6:42 PM CST

Title: Agar Industry Standard Data

Date: 12/7/2022

Content by: Tanishka

Present: Tanishka

Goals: Determine whether or not the agar testing data that we had collected fell within industry standards

Content:

V. T. Nayar, J. D. Weiland, C. S. Nelson, and A. M. Hodge, “Elastic and viscoelastic characterization of agar,” *Journal of the Mechanical Behavior of Biomedical Materials*, vol. 7, pp. 60–68, May 2011.

Agar should have a Young’s modulus of ~30 kPa-700 kPa

Conclusions/action items:

Based on these values, we can determine that the agar values we got fall within the values that are defined by industry. This can be a valuable addition to our prototype.

2022/09/13 - Neonate Chest Cavity

Sophia Finn - Sep 14, 2022, 1:31 AM CDT

Title: Neonate Chest Cavity

Date: 9/14/2022

Content by: Sophia Finn

Present: Sophia Finn

Goals: To establish a solid foundation of knowledge for this project by researching the anatomy and complexities of the neonate chest cavity.

Content:

The loss in lung development that occurs in premature infants results in higher rates of morbidity and higher rates of lung disease (which may continue to affect them into adulthood). (1)

There are 5 stages of lung development.

- (26-6 weeks) Embryonic phase

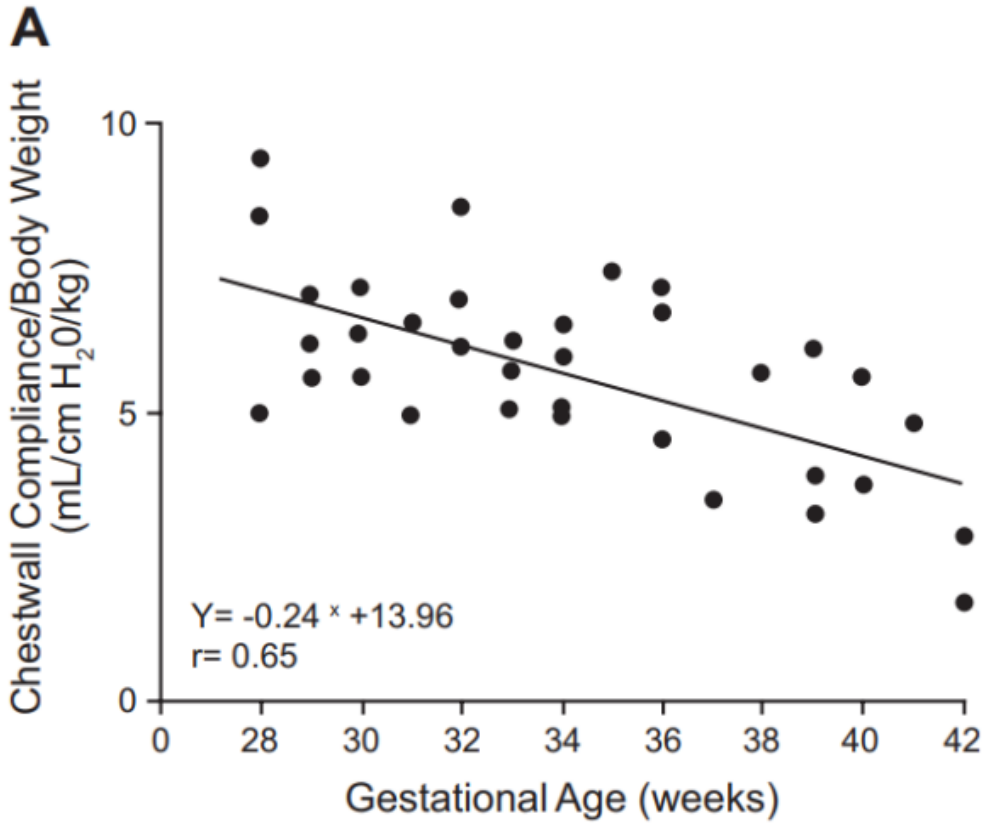
- (6-16 weeks) Pseudoglandular: Bronchial branching is formed by the end of this phase.

- (16-28 weeks) Canalicular: Conducting airways and terminal bronchioles form. Gas exchange basis is thus formed.

- (28-36 weeks) Saccular: Number of saccules increases, making alveoli more effective at gas exchange. Alveoli walls become more compact than walls of alveoli. The alveoli are not uniformly present until the end of this phase.

- (36 - term) Alveolar: Double capillary structure is reduced to single capillary structure by maturity in the alveoli. Blood vessels that are in the epithelium of alveoli and grow into air spaces fully mature (these are responsible for more gas exchange). The epithelium and interstitium walls thin out, and the capillary network matures and becomes a single capillary network.

Prematurely born infants tend to have less elasticity in their lungs, and therefore have trouble maintaining stable gas exchange and reduced functional residual capacity (FRC). This results in low lung volumes and "rapid desaturation" (1). .



Tethering:

Elastic components in the alveoli walls that surround bronchi are tethered to one another and transfers tension from the "pleural surface" (membrane that covers the lungs) to individual bronchi. The tethering process is decreased in efficiency in prematurely born infants, as the elastic network that promotes it is not fully matured. This causes alveoli units to be more prone to collapse and makes the airway more difficult to open.

Citations:

1) Colin, A. A., McEvoy, C., & Castile, R. G. (2010). *Respiratory Morbidity and Lung Function in Preterm Infants of 32 to 36 Weeks' Gestational Age. PEDIATRICS, 126(1), 115–128.* doi:10.1542/peds.2009-1381

Conclusions/action items:

I think that we should consider at least the terms learnt in this research when writing the background for this project and when discussing the project's significance. We could also try to demonstrate concepts such as tethering in our model.

2022/10/12 - Physiology of how intubation works

Sophia Finn - Dec 14, 2022, 5:36 PM CST

Title: Physiology of how intubation works.

Date: 10/12/2022

Content by: Sophia Finn

Present: Sophia Finn

Goals: To understand the mechanics and theory behind why intubation works.

Content:

The tube inserted into a patient during intubation is called an “endotracheal tube (ET)”. It is placed into the trachea through either the mouth or nose. If it is through the mouth, this is called an endotracheal intubation. If it is through the nose, this is called a nasotracheal intubation. It is typically easier to perform the endotracheal intubation.

If the health care provider, however, needs to access the mouth or if there is an obstruction there, a nasotracheal intubation is performed.

The ET is connected to a ventilator, which circulates air through the lungs.

Intubation may be performed easily and not cause any symptoms in the patient. However, it may also cause symptoms such as a sore throat or damage to the soft tissues of the throat.

Once the tube is placed in the trachea, a small balloon inflates at the end of it to create a seal that prevents air from moving outside of it. The part of the tube extending out of the mouth is taped down

Intubating children usually requires a smaller ET. Intubating infants is difficult because the proportion of the tongue size to the windpipe size is larger, and the respiratory organs are less flexible. Nasal intubation is usually opted for in this scenario.

Sources:

https://www.verywellhealth.com/what-is-intubation-and-why-is-it-done-3157102#:~:text=Intubation%20is%20the%20process%20of%20inserting%20a%20tube,pushes%20air%20in%20and%20out%20of%20the%20lungs.

Conclusions/action items:

We may have other aspects we should incorporate into our design now that we know the tube needs to be inflated on one end and taped down on the other. It is also good to know that it is actually the size of the tongue that strongly differentiates infant intubation from other age groups.

2022/10/27 - Neonatal Intubation

Title: Neonatal Intubation

Date: 10/27/2022

Content by: Sophia Finn

Present: Sophia Finn

Goals: I want to know more about the biology of what makes neonatal intubation more challenging than the intubation of other age groups.

Content:

Health professionals have, over time, received fewer opportunities to proactive neonatal intubation. This is because of the reduction in recommendations for which intuba
of the advance of non-invasive respiratory support measures.

However, the need for the intubation of neonates is still very real. Some studies report a less than <23% success rate for first-time neonatal intubations. These inexperien
recommended time frame.

Is it not rare not an intubation to not even be attempted for a neonate who may benefit from it. This is because, due to their physiology, they may be too physiologically un

There are theories that neonates may benefit morel due to these circumstances, from high-flow therapy through the nose. Some professionals suggest that it may also be
to execute.

Sources:

https://www.nejm.org/doi/full/10.1056/NEJMoa2116735#:~:text=An%20intubation%20attempt%20was%20defined%20as%20the%20insertion,attempt%20was%20made%

Conclusions/action items:

We should include these challenges of neonatal intubation in our deliverables. We should also look into how we can replicate nasal intubation, should this prove to be the

2022/09/24 - Intubation Mannikin Model

Sophia Finn - Sep 24, 2022, 7:14 PM CDT

Title: Intubation Mannikin Model

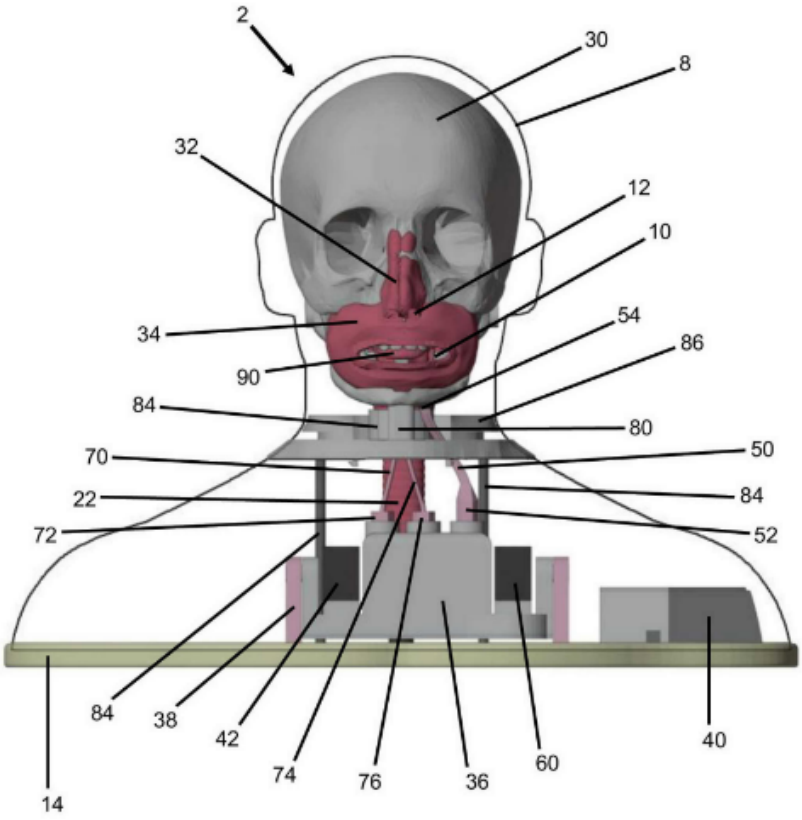
Date: 2022/09/24

Content by: Sophia Finn

Present: Sophia Finn

Goals: I would like to understand what current methods are on the market for mimicking intubation in training models. By doing this, I hope to become more educated on what existing mechanisms and design methods there are for accurately simulating the intubation process.

Content:



A gearbox is used to simulate the natural rotation of the head and neck. Internal organs are represented with hard plastic and silicone materials. The organs mimicked in the thorax should be attached to a baseplate. A tongue is included in the mouth and is made to move accurate to the adult human tongue using a "rack and pinion mechanism". A servo motor is used for the gearbox, which uses a rechargeable, 12-volt battery. A left and right vocal chord is included.

The skin is able to mimic color and texture. It is made with a silicone cast with a mold. The vocal cords are also made with a silicone cast.

Sources:

AU2021103415A4 - Training Model for Upper Airway Intubation - Google Patents (see the patent imbedded in this page)

Conclusions/action items:

This patent, while helpful, is made to mimic an adult being intubated. Therefore, my next steps should include research on how this gets scaled down for an infant. I think that we should seriously consider silicone casts to mimic various tissues in our model.

2022/09/28 - Neonatal Skin Prototypes

Sophia Finn - Oct 12, 2022, 8:34 AM CDT

Title: 2022/09/28 - Neonatal Skin Prototypes

Date: 2022/09/28

Content by: Sophia Finn

Present: Sophia Finn

Goals: To find and detail possibilities for the neonatal protype skin material.

Content:

An efficient model for the skin of mammals needs to fit certain criteria of elasticity in addition to being able to withhold moisture. A hydrogel is able to offer the additional helpfulness of microfluidic channels. A large variety of fluids may be fed through these channels. Common elastomers used in combination with hydrogels include “polydimethylsiloxane Sylgard 184, polyurethane, latex, VHB and Ecoflex.” (1)

Water soluble tape can be used to print onto hydrogels using Ag ink. The elastomers used in combination with hydrogels can be very thin, in this paper, being 30 μm. (2)

References:

Skin-inspired hydrogel-elastomer hybrids with robust interfaces and functional microstructures - PubMed (nih.gov)
Ultrastretchable Conductor Fabricated on Skin-Like Hydrogel-Elastomer Hybrid Substrates for Skin Electronics - PubMed (nih.gov)

Conclusions/action items:

This research gives us information on how to print onto hydrogels, which may be useful for aesthetic purposes, and provides us with various materials that we may use and test for the elastomer. It also gives us a potential thickness to test for the elastomer.

2022/10/07 - Electronics Materials

Sophia Finn - Oct 12, 2022, 8:45 AM CDT

Title: Electronics Materials

Date: 2022/10/07

Content by: Sophia Finn

Present: Sophia Finn

Goals: The purpose of this research is to find online solutions that may inform our problem solving when pertaining to the pressure sensor and LED system we would like to use in our device.

Content:

The arduino does have a compatible pressure sensor. This is the MPL3115A2 digital pressure sensor from SparkFun. Sample code for the pressure sensor given by the product website is:

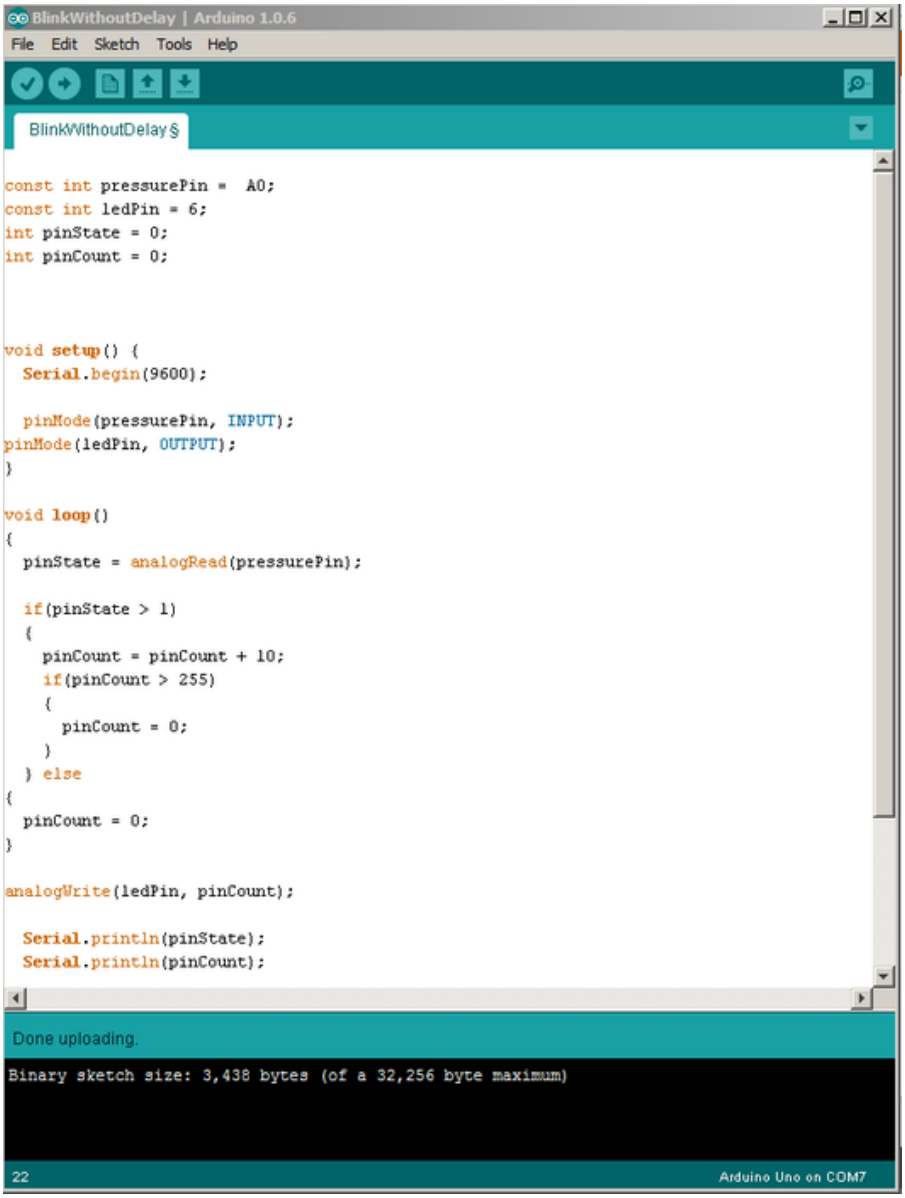
```
#include <Wire.h> // so we can use I2C communication
#define MYALTITUDE 262 //define altitude at your location to
calculate mean sea level pressure in meters
// Register addresses
const int SENSORADDRESS = 0x60; // MPL3115A1 address from the
datasheet
#define SENSOR_CONTROL_REG_1 0x26
#define SENSOR_DR_STATUS 0x00 // Address of DataReady status
register
#define SENSOR_OUT_P_MSB 0x01 // Starting address of Pressure
Data registers
float baroAltitudeCorrectionFactor = 1/(pow(1-
MYALTITUDE/44330.77,5.255877));
byte I2Cdata[5] = {0,0,0,0,0}; //buffer for sensor data
void setup(){
Wire.begin(); // join i2c bus
Serial.begin(9600); // start serial for output at 9600 baud
Serial.println("Setup");
I2C_Write(SENSOR_CONTROL_REG_1, 0b00000000); // put in standby
mode
// these upper bits of the control register
// can only be changed while in standby
I2C_Write(SENSOR_CONTROL_REG_1, 0b00111000); // set oversampling
to 128
Serial.println("Done.");
}
void loop(){
float temperature, pressure, baroPressure;
Read_Sensor_Data();
temperature = Calc_Temperature();
pressure = Calc_Pressure();
baroPressure = pressure * baroAltitudeCorrectionFactor;
Serial.print("Absolute pressure: ");
Serial.print(pressure); // in Pascal
Serial.print(" Pa, Barometer: ");
Serial.print(baroPressure); // in Pascal
Serial.print(" Pa, Temperature: ");
Serial.print(temperature); // in degrees C
Serial.println(" C");
delay(1000);
}
// Read the pressure and temperature readings from the sensor
void Read_Sensor_Data(){
// request a single measurement from the sensor
```

```
I2C_Write(SENSOR_CONTROL_REG_1, 0b00111010); //bit 1 is one shot
mode
// Wait for measurement to complete.
// One-shot bit will clear when it is done.
// Rread the current (sensor control) register
// repeat until sensor clears OST bit
do {
Wire.requestFrom(SENSORADDRESS,1);
} while ((Wire.read() & 0b00000010) != 0);
I2C_ReadData(); //reads registers from the sensor
}
// This function assembles the pressure reading
// from the values in the read buffer
// The two lowest bits are fractional so divide by 4
float Calc_Pressure(){
unsigned long m_pressure = I2Cdata[0];
unsigned long c_pressure = I2Cdata[1];
float l_pressure = (float)(I2Cdata[2]>>4)/4;
return((float)(m_pressure<<10 | c_pressure<<2)+l_pressure);
}
// This function assembles the temperature reading
// from the values in the read buffer
float Calc_Temperature(){
int m_temp;
float l_temp;
m_temp = I2Cdata[3]; //temperature in whole degrees C
l_temp = (float)(I2Cdata[4]>>4)/16.0; //fractional portion of
temperature
return((float)(m_temp + l_temp));
}
// Read Barometer and Temperature data (5 bytes)
void I2C_ReadData(){
byte readUnsuccessful;
do {
byte i=0;
byte dataStatus = 0;
Wire.beginTransmission(SENSORADDRESS);
Wire.write(SENSOR_OUT_P_MSB);
Wire.endTransmission(false);
// read 5 bytes. 3 for pressure, 2 for temperature.
Wire.requestFrom(SENSORADDRESS,5);
while(Wire.available()) I2Cdata[i++] = Wire.read();
// in some modes it is possible for the sensor
// to update the pressure reading
// while we were in the middle of reading it,
// in which case our copy is garbage
// (parts of two different readings)
// We can check bits in the DR (data ready)
// register to see if this happened.
Wire.beginTransmission(SENSORADDRESS);
Wire.write(SENSOR_DR_STATUS);
Wire.endTransmission(false);
Wire.requestFrom(SENSORADDRESS,1); //read 5 bytes. 3 for
pressure, 2 for temperature.
dataStatus = Wire.read();
readUnsuccessful = (dataStatus & 0x60) != 0;
// This will be unsuccessful if overwrite happened
// while we were reading the pressure or temp data.
// So keep reading until we get a successful clean read
} while (readUnsuccessful);
}
// This function writes one byte over I2C
void I2C_Write(byte regAddr, byte value){
```

```
Wire.beginTransmission(SENSORADDRESS);
Wire.write(regAddr);
Wire.write(value);
Wire.endTransmission(true);
}
(1)
```

This may be assembles into an LED circuit if need be. This can be accomplished as in one example, which uses a 547 and a 10k Ohm resistor, 5 wires, an Arduino, and a breadboard in conjunction with the pressure sensor and LED. Here is the circuitry:

And here is the code given:



References

Digital Pressure Sensor– Arduino Workshop - Arduino Project Hub
https://www.instructables.com/Arduino-Pressure-Switch-to-LED/

Conclusions/action items:

These two sources may help us have a jumping off point from which we can begin our electronics setup. I believe that we should work to adapt the code and circuitry given in order to fit our pressure needs and to fit three LEDs as opposed to one for the green, yellow, and red light system we are proposing.

2022/10/20 - Sylgard 184 Properties

Sophia Finn - Dec 14, 2022, 5:37 PM CST

Title: Sylgard 184 Properties.

Date: 10/20/2022

Content by: Sophia Finn

Present: Sophia Finn

Goals: I would like to understand the reasons that Sylgard 184 seems to be the industry standard when it comes to replicating the properties of human skin texture in simple models.

Content:

The uses of Sylgard are as widespread as a “silicone encapsulant”. Some convenience is prodded by Sylgard 184 in terms of heat capacity, as objects that are not able to withstand heat can cure in Sylgard 184 even at room temperature.

Sylgard is also able to capture more detail than its competitors. It has a low viscosity and is therefore able to fill small details in mold and in objects that need to be encapsulates. However, the Sylgard 184 collusion should be made sure to have no gas bubbles within it. It may cure the gas inside the solution quickly.

If you do wish to cure the Sylgard elastomer at a quicker pace, the solution functions at a temperature range of -49 F to 392 F. This means that Sylgard is also more compatible with electronics, which will often give off heat.

Sylgard is also useful because it is clear. It allows the engineer to see errors through the cured solution and plan repairs.

Sources:

Sylgard 184 by DOW is the Top Choice for a Transparent, Silicone Encapsulant. Read Why: (gluespec.com)

Conclusions/action items:

I strongly think that we should consider Sylgard 184 as the material we will use for the skin. It seems to mimic human tissue well and is compatible if we or any future teams want to add electronic components.

2022/11/02 - Tissue engineering applications of agar

Title: Tissue engineering applications of agar.

Date: 11/02/2022

Content by: Sophia Finn

Present: Sophia Finn

Goals: This entry attempts to find other instances where agar has been used to mimic human tissue in order to learn from their applications.

Content:

Agar was used in this study along with keratin as a scaffold. The structure was very porous, and the materials were interconnection with one another. The pores ranges f

It was also very hydrophilic, meaning it was good at retaining water. Its water retention capacity was recorded at 160 +/- 7.89%.

It was found to have antimicrobial properties. The researchers concluded that this agar and keratin scaffold could be used in tissues engineering to regenerate skin or hea

Sources:

https://www.sciencedirect.com/science/article/abs/pii/S0141813015004869#:~:text=The%20porous%20scaffold%20was%20fabricated%20from%20a%20binary,Fourier%
ray%20diffractometer%20study.

Conclusion/action items:

We should look into using gar in our design. We might also borrow the idea of putting it into a scaffold.

2022/11/07 - Nylon Mold Possibility

Sophia Finn - Dec 14, 2022, 5:39 PM CST

Title: Nylon Mold Possibility

Date: 11/07/2022

Content by: Sophia Finn

Present: Sophia Finn

Goals: I would like to know more about the properties of nylon in order to make an informed decision about whether or not it should be used to 3D print our mold.

Content:

Nylon is in a class of plastics called the “semicrystalline thermoplastics”. It is easy to 3D print with because it tends to absorb moisture. Materials printed with nylon tend to be tougher and resistant to abrasion.

It is an ideal material if you are making a product that needs to withstand a large load. It also is very resistant to organic solvents. However, there are downsides to using nylon. Because it is so good at absorbing moisture, it may even absorb it after printing, cause it to become defected.

For optimal sturdiness, a wall thickness of at leats 1.5 mm should be used.

Sources:

All About Nylon 3D Printing Filament: Materials, Properties, Definition | Xometry

Conclusion/ action items.

I do like that nylon is so sturdy, but I am skeptical of using it knowing that it can be easily damaged by moisture. We can’t use this and agar, which is very moist. The team will have to pick one or the other.

2022/11/18 - Curing PDMS

Sophia Finn - Dec 14, 2022, 5:40 PM CST

Title: Curing PDMS

Date: 11/18/2022

Content by: Sophia Finn

Present: Sophia Finn

Goals: I want to figure out how the properties of PDMS change with different curing conditions, so that we may select the conditions best for us.

Content:

At low temperatures, the mechanical strength of cured PDMS remains fairly high and does not fluctuate with heating time. However, at higher temperatures, PDMS loses mechanical strength. This is because thermal decomposition begins to occur at 200$_{o}$ F and caps out at 310$_{o}$ F (1).

Another study selected PDMS as an in vitro model for blood vessels because of its properties. This is both because it is a biocompatible material and because it is very elastic. They used it in a 10:1 ratio to achieve this hyperelastic effect.

Sources:

1. Influences of heating temperature on mechanical properties of polydimethylsiloxane - ScienceDirect
2. Biomechanical analysis of PDMS channels using different hyperelastic numerical constitutive models - ScienceDirect

Conclusion/ action items.

It look like we should stick with curing the PDMS at a low temperature, for however long it needs to take to solidify, and we should do this ina 10:1 ratio between the solution and the curing agent.

2022/11/22 - How to make a mold

Sophia Finn - Dec 14, 2022, 5:41 PM CST

Title: How to make a mold

Date: 11/22/2022

Content by: Sophia Finn

Present: Sophia Finn

Goals: I would like to understand the established ways of making a mold for PDMS to fit into.

Content:

Apparently, there are already charts out there that outline how to best achieve your desired PDMS properties.

No.	Base/Curing agent ratio by weight	Curing temperature	Curing time	Performance
1	10:1	80°C	1.5h	Soft
2	10:1	100°C	1h	Medium
3	10:1	120°C	1h	Hard
4	5:1	120°C	1h	Hardest

The main problem with curing PDMS in a mold seems to be that, depending on the materiel usd, the PDMS may bond too much to it and become difficult to remove. In other applications, like encapsulants, there are also instances where PDMS doesn't bond enough. It seems that the rougher the surface, the more difficult it will be for the PDMS to bond to the object it is being cured on top of.

Sources:

Optimal protocol for moulding PDMS with a PDMS master – Chips and Tips (rsc.org)

Conclusion/ action items.

I believe that we should experiment with the different given ratios for various PDMS samples. This way, we can see which ratio "performance" will yield the optimal texture.

2022/11/30 - PDMS troubleshooting

Sophia Finn - Dec 14, 2022, 5:42 PM CST

Title: PDMS troubleshooting

Date: 11/30/2022

Content by: Sophia Finn

Present: Sophia Finn

Goals: I would like to understand why the PDMS solution seems to cure unevenly.

Content:

There are a few reasons why the PDMS may not cure correctly. Contamination, especially with organic substances, might prevent the PDMS from being activated correctly.

The PDMS will adhere to the surface it is cured on if the surface is very hydrophilic or is wet. This creates an “irreversible seal”.

The PDMS may not cure correctly as well if the environment it is in is too warm or is humid.

Sources:

PDMS Bonding - Harrick Plasma

Conclusion/ action items.

I think it may be our nylon mold that is the problem. Even though we have not elected to use the gar, the nylon is probably hydrophilic enough to force deformations in the PDMs to occur.

2022/12/05 - Ethical Questions

Sophia Finn - Dec 14, 2022, 5:44 PM CST

Title: Ethical Questions

Date: 12/05/2022

Content by: Sophia Finn

Present: Sophia Finn

Goals: I would like to take a step back and look more at the ethical and safety concerns that relate to our project.

Content:

There is a shocking lack of training that medical professionals get before they must perform their first intubation. This si partially because the use of the deceased to practice intubations on has been outlawed. Therefore, it falls on expensive and scarce intubation manikins to provide accurate models for medical professionals ion training to practice on.

A large fear when it comes to intubation is how it may injure the patient. Many say that they are uncomfortable with the idea of being intubated due to fears that it may damage their throats or teeth. It is an invasive procedure that caused some people surveyed about it to feel “upset”.

Sources:

[Ethical dilemmas when teaching intubation techniques--what does the population think?] - PubMed (nih.gov)

Conclusion/ action items.

If we were to address ethical concerns, I think it would be that these manikins really need to be accurate. It looks like people are uncomfortable with the idea of such a physical and invasive produce being performed by a fairly untrained professional Mannikins in the future should also work to train medical professionals to perform this without causing other discomforts.

2022/11/11 Tong Lecture Series

Sophia Finn - Dec 14, 2022, 5:45 PM CST

Title: Tong Lecture Series

Date: 11/11/2022

Content by: Sophia Finn

Present: BME Class

Goals: To listen to an experienced speaker talk to us about how entrepreneurship applies to us,

Content:

Engineers also have a place in the business world. It is not something that is just reserved for business majors. This is a relatively novel idea. In fact, a lot of engineers who work in academic do not believe that learning business skills is useful to our careers. However, the current generation of college students seems to widely express the idea that they would like to get involved with business endeavors.

The skills we use as engineering are applicable to business. Business is, at its core, a way to sell solutions. Engineers are taught about how to methodically and creatively solve problems. By adding on an entrepreneurial side of learning, we can pick up other skills, such as leadership and how to spot areas for business opportunities.

Although a lot of engineering programs in the country have already incorporated some business element to their education, UW-Madison hasn't done so as much.

Conclusions/action items:

I think it would be nice to look into how other engineers are becoming educated in the world of business.

09/13/22 Newborn Anatomy_Vilensky & Suárez-Quian

LOUKIA AGOUDEMOS - Oct 11, 2022, 10:13 PM CDT

Title: Notes/ Main Points on Newborn Anatomy Article

Date: 09/13/2022

Content by: Loukia Agoudemos

Present: Loukia

Goals: Conduct research on some good anatomical texts for newborn anatomy

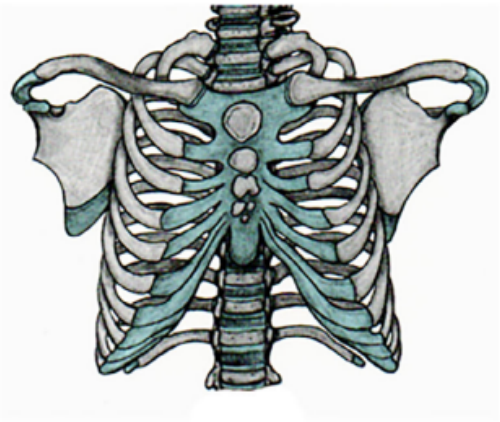
Content:

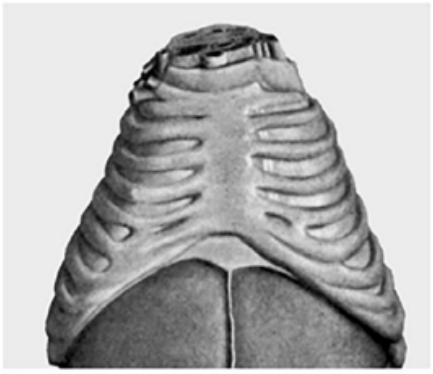
Citation:

J. A. Vilensky and C. A. Suárez-Quian, “Newborn anatomy,” Clinical Anatomy, vol. 35, no. 1, pp. 15–18, 2022, doi: 10.1002/ca.23774. [Online]. Available: https://onlinelibrary.wiley.com/doi/10.1002/ca.23774. [Accessed: Sep. 22, 2022]

Read through Newborn Anatomy by Vilensky & Suarez. The main points I derived from this document are that there are two largely used anatomy texts (Anatomy of the Newborn: An Atlas (1969) & and Functional Anatomy of the Newborn (1973)) on infant anatomy that we should reference when completing the design. Additionally, I found an image showing the shape of the thoracic cavity and how different it looks from the adult anatomy.

FIGURE 3 The shape of the thoracic cage in the newborn is much more cone-shaped than cylindrical-shaped as in the adult. Crelin's depiction is that of the adult form whereas the image from Scammon correctly shows the form in a newborn





For full texts with my annotations, please see the attached below.

Citation: From what is read in this article, more research must be conducted on premature baby anatomy specifically to understand the nuance of what we would need to capture with our mannequin. While these texts would serve as useful for anatomical references that we would scale

VIEWPOINT

CLINICAL ANATOMY WILEY

Newborn anatomy

Joel A. Vilensky[1] | Carlos A. Suárez-Quian[2]

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Abstract

Newborn anatomy, despite being distinctly different than adult anatomy, does not constitute a major component of a typical medical school course in gross anatomy. Accordingly, there is a perception that other than the well-known late 20th-century atlas and small textbook by Edmund Crelin on newborn anatomy, there is almost no information available for anatomists and clinicians to refer to on normal infant anatomy. This perception, as verbalized by Crelin in his books, is not correct. There is an amazing wealth of accurate descriptive and pictorial information on infant anatomy available from late 19th- and early 20th-century sources. One of these sources is a comprehensive 200-page chapter on pediatric anatomy by Richard Scammon that was published in 1930 and that is freely available. Because of some inconsistencies and inaccuracies we have identified in the Crelin works, we suggest that any anatomist or clinician who wishes to learn and teach about infant anatomy refer to Scammon's chapter before using any text or image from the Crelin books.

KEYWORDS
infant anatomy, newborn anatomy, pediatric anatomy

The number of physician office visits for infants in the months that of any other age group (https://www.cdc.gov/nchs/products/databriefs/db301.htm), yet in medical gross anatomy courses, we teach most newborn anatomy, which differs substantially from adult anatomy. For instance, aside from the classic examples of fetal circulation, the anatomy of the fontanelles, and an underdeveloped mastoid process in the newborn and its associated risk of fatal mastoiditis with [illegible] delivery, we are hard-pressed to think of other anatomical areas addressed that pertain to infant anatomy in the modern medical school curriculum. We likely teach salient content pertaining to newborn anatomy because we do not have newborn cadavers, and, additionally, there is an apparent dearth of anatomical images and text on newborn anatomy. Definitely take a look into these

This dearth was recognized approximately 50 years ago by Edmund S. Crelin (1923–2004), who published (1) *Anatomy of the Newborn: An Atlas* (1969), and (2), *Functional Anatomy of the Newborn* (1973), which is still available from Yale University Press.

Both books readily appear in a Google search of "newborn anatomy," and thus may still be considered authoritative sources. The Crelin atlas contains 292 plates initially drawn by Crelin; the drawings are based on the dissection of 10 male and 6 female newborn cadavers between eight-and-one-half and nine-and-one-half months gestation. The small well-illustrated Crelin textbook (except for three sections on the head, 87 p.p.) consists of 49 short descriptions of anatomical structures. In the preface to this textbook, Crelin notes that he "could not find a single publication containing the functional anatomical information I needed on the newborn infant," (p. xi). Similarly, in the preface to the atlas, Crelin states, "After much searching, I found only limited descriptions of certain structures or body regions of the newborn scattered throughout some adult anatomy and surgical texts." (p. vii). And this view as the availability of information on the newborn remains the common perception. Even within the 2015 special *Clinical Anatomy* issue devoted to pediatric anatomy, there is very little information presented on the normal anatomy of the infant.

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viewpoint_Newborn_Anatomy.pdf (1.19 MB)

09/21/22 Premature Birth Anatomy and Symptoms from the Mayo Clinic

LOUKIA AGOUDEMOS - Sep 21, 2022, 9:46 PM CDT

Title: Premature Birth Anatomy and Symptoms from the Mayo Clinic

Date: 09/21/22

Content by: Loukia Agoudemos

Present: Loukia Agoudemos

Goals: Understand some anatomical and physiological differences in premature infant anatomy in comparison to that of term babies.

Content:

Citation: [1]“Premature birth - Symptoms and causes,” Mayo Clinic. [Online]. Available: https://www.mayoclinic.org/diseases-conditions/premature-birth/symptoms-causes/syc-20376730. [Accessed: Sep. 22, 2022]

- 25 weeks and under is an extremely preterm birth in comparison to the typical 37-week pregnancy. Our project will be covering this extreme.
- Symptoms include
  - Small size with a disproportionately large head
  - sharper-looking, less rounded features because of a lack of fat storage
  - lanugo (fine soft hair) all over the body
  - low body temperature
  - labored breathing and respiratory distress
  - Lack of reflexes

Dimensions For Premature Males

Gestational Age	Weight	Length	Head Circumference
24 weeks	1 lb., 6.9 oz.	12.1 in (31 cm)	8.7 in (22 cm)

Dimensions For Premature Females

Gestational Age	Weight	Length	Head Circumference
24 weeks	1 lb., 5.2 oz.	12.6 in (32 cm)	8.3 in (21 cm)

Conclusions/action items:

With these things considered, we are conducting a project with extremely preterm babies. Some differences our team may consider are dimensions, but also the physical effects of how being this preterm may affect their physiology, such as more labored, faster-paced breathing, and how they are colder to the touch.

LOUKIA AGOUDEMOS - Sep 21, 2022, 9:48 PM CDT

Download

Web_capture_21-9-2022_21471_www.mayoclinic.org.jpeg (1.82 MB)

11/02/2022 - Agar Hydrogels

LOUKIA AGOUDEMOS - Nov 02, 2022, 8:29 PM CDT

Title: Agar Hydrogels

Date: 11/02/2022

Content by: Loukia Agoudemos

Present: Loukia Agoudemos

Goals: Identify some relevant properties and information about the selected hydrogels we will be formulating from Agar.

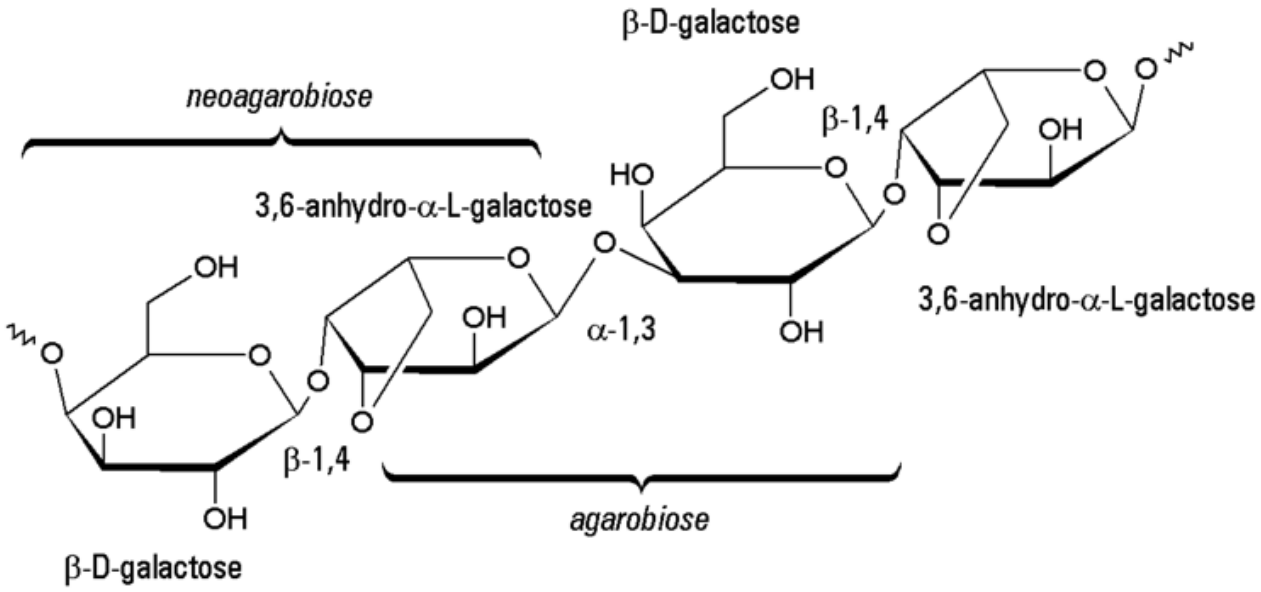
Content:

Cite:

[1]S. User, “About agar agar.” [Online]. Available: https://agar.com/en/about-agar-agar. [Accessed: Nov. 03, 2022]

- Agar is a hydrocolloid (a substance that forms a gel when exposed to water) sourced from red seaweed

Chemical Structure



- Compatible with other proteins!

Conclusions/action items: We can use the chemical structure of this polysaccharide on the poster presentation and the final report, and share that it is a natural source, which is relatively sustainable.

11/09/2022 Agar Hydrogel Research

LOUKIA AGOUDEMOS - Nov 10, 2022, 12:16 AM CST

Title: Agar Hydrogel Research

Date: 11/09/2022

Content by: Loukia Agoudemos

Present: Loukia Agoudemos

Goals: Taking a look at a different perspective of agar gel use, where it is understood and used most commonly--in culinary!

Content:

Citation:
[1]“FS 004| Guide to Agar Gels | Stella Culinary.” [Online]. Available: https://stellaculinary.com/cooking-videos/food-science-101/fs-004-guide-agar-gels. [Accessed: Nov. 10, 2022]

I like the pitfalls the most in this article, explaining the ways agar could underperform such as, leaking liquid and dehydrating, proper pH ranges, and losing moisture. They also provided some fixes we could troubleshoot with in case we are seeing issues.

Conclusions/action items: Using common knowledge from culinary experts who work with agar hydrogels to be able to troubleshoot some issues we may experience with agar hydrogel fabrication.

09/21/2022 - Quality Management of Medical Devices Standard

LOUKIA AGOUDEMOS - Sep 22, 2022, 9:06 PM CDT

Title: Quality Management of Medical Devices Standard

Date: 09/21/2022

Content by: Loukia Agoudemos

Present: Loukia Agoudemos

Goals: Understand by official medical device standards provided by the ISO, that there is an obligation for the manufacturers and designers of the medical device to provide quality management and correspondence for their medical devices.

Content:

Citation:

14:00-17:00, “ISO 13485:2016,” ISO. [Online]. Available: https://www.iso.org/cms/render/live/en/sites/isoorg/contents/data/standard/05/97/59752.html. [Accessed: Sep. 23, 2022]

ISO 13485:2016(en)

- Creators of the device must manage the quality of their device by
  - needs for quality management
  - risk-based assessment of their device
  - create sufficient documentation for the regulation and use of their device (ex quality manual, policy manual, procedures required by the ISO)
  - Have a customer focus on establishing and developing a quality project.
  - And more...
- Please see the link for the article for additional regulations regarding the quality management of this device.

Conclusions/action items: Understand that if this device is to be manufactured, the organization that produces this device will have to ensure quality manufacturing via the above-described practices. Medical devices are, above all else, for the benefit of the customer and patient, and should be manufactured and designed as such.

09/22/2022 - Risk Management of Medical Devices

LOUKIA AGOUDEMOS - Sep 23, 2022, 12:38 PM CDT

Title: Risk Management of Medical Devices

Date: 09/22/2022

Content by: Loukia Agoudemos

Present: Loukia Agoudemos

Goals: To understand the standard for risk management of medical devices, and to apply it to our design.

Content:

Citation:

14:00-17:00, “ISO 14971:2019,” ISO. [Online]. Available: https://www.iso.org/cms/render/live/en/sites/isoorg/contents/data/standard/07/27/72704.html. [Accessed: Sep. 23, 2022]

ISO 14971

This standard states that risk management and design with risk considerations must be taken to account. This involves risk evaluation and the implementation of risk control by the design team.

Conclusions/action items: The implementation of risk control for the mannequin design would promote the safety of the clients and users of our device, and mitigate risks associated with using a device of this caliber. Even though the device may seem unassuming, there is always a chance someone can get hurt with incorrect usage.

09/29/2022 - Skin Models

LOUKIA AGOUDEMOS - Sep 30, 2022, 12:54 PM CDT

Title: Skin Models

Date: 09/29/2022

Content by: Loukia Agoudemos

Present: Loukia Agoudemos

Goals: To find various models of human skin for use on our neonatal mannequin.

Content:

Citation: A. K. Dąbrowska et al., “Materials used to simulate physical properties of human skin,” Skin Res Technol, vol. 22, no. 1, pp. 3–14, 2016, doi: 10.1111/srt.12235. [Online]. Available: https://onlinelibrary.wiley.com/doi/10.1111/srt.12235. [Accessed: Sep. 29, 2022]

- Cell Culture models
  - The properties are varying and not very close to real skin
  - Difficult for storage and handling
  - Expensive
- Skin Overview, 3 layers with an epidermis (20-150 um), dermis (1-4 mm) and hypodermis (fat layer)
- Combinations are the best
  - Liquid Suspensions
    - Lipid solutions (best for optical properties)--may not be helpful in this project
  - Gelatinous Substances** study this one
    - Polymer
      - **Gelatine**
        - Dry gelatine can be stored
        - Not an accurate model alone--combine a second layer made of a different material simulating the epidermis
      - ****Agar**
        - not very stable--low contact to light contact
        - limited lifetime
        - similar to skin models
        - Synthesis is easy
      - **Polyvinyl alcohol gels**
        - used in medical applications--hydrogel
        - similar properties to human skin
  - Elastomers
    - rubber-like polymers
      - **Silicones**
        - widely used
        - durable over long periods of time and can be molded
      - **Polyurethanes**
        - often used for training
  - Resins
    - Epoxy resins
      - Mixed with plasticizers and diluents
  - Metals
    -
  - textiles (nano and micro fillers)
    - Stimulates sweat distribution
  - Albumen
  - Engineered models

Good Picture to reference:

 Details are in the caption following the image

Conclusions/action items: For this project we may want to focus our research on gelatinous substances and elastomers for the skin we design for our mannequin. These materials are cheap, and best mimic the surface and mechanical properties.

10/06/2022 Realistic Chest Cavity With Intubation Design Idea

LOUKIA AGOUDEMOS - Oct 06, 2022, 9:09 AM CDT

Title: Realistic Chest Cavity With Intubation Design Idea

Date: 10/06/2022

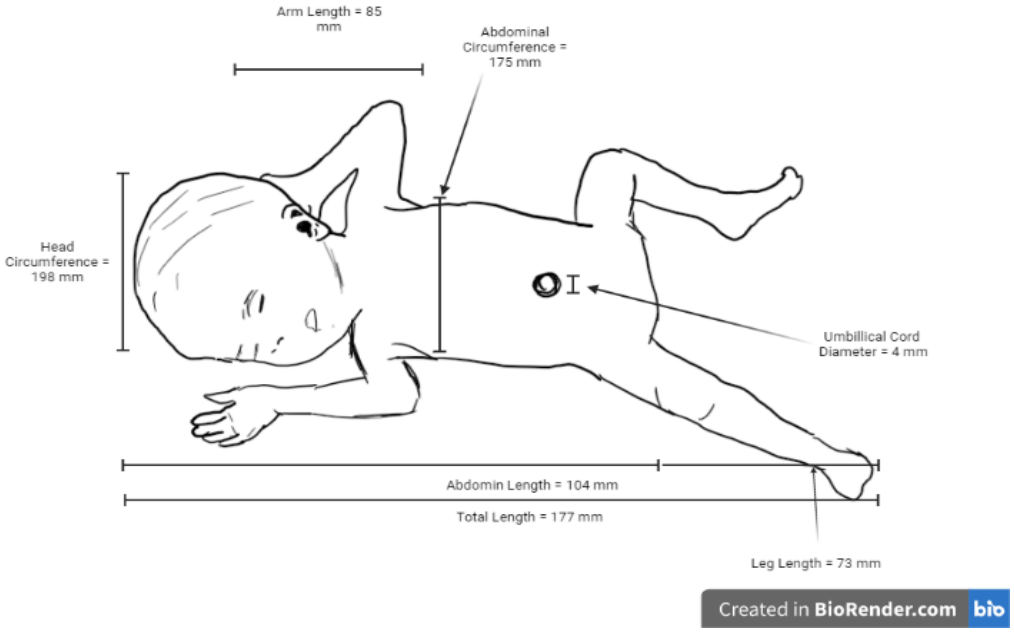
Content by: Loukia Agoudemos

Present: Loukia Agoudemos

Goals: Come up with an idea for the design idea for a realistic and usable 22-24 week neonatal mannequin.

Content:

1. Skin: a gelatinous and elastomer polymer composite skin model
2. Electronics: Electronics that mimic the labored breathing of a neonatal infant, light signal if intubation is done incorrectly (pressure sensor)
3. Physical features: lanugo (fine hairs on an infant on skin), accurate shading and aesthetics through airbrushing, movable limbs (ball and stick joints), vein-like cables throughout the body, and IV insertion holes)



Conclusions/action items: We will evaluate this design with a design matrix based on client criteria and what our group believes will be most accomplishable within the span of the semester.

10/06/22 Painting Ideas

LOUKIA AGOUDEMOS - Oct 11, 2022, 5:59 PM CDT

Title: Painting Ideas

Date: 10/06/22

Content by: Loukia Agoudemos

Present: Loukia Agoudemos

Goals: Gather resources for making realistic-looking mannequins.

Content:

In conducting my research I have found a very interesting resource about making very life-like infant mannequins. There is a whole community of people who make "reborn" dolls which as very accurate baby dolls with intricate painting and detail work. This may be a good resource to make the painting and more art-centric parts of this project more convenient/

How To Make A Reborn Doll For Beginners (Video Tutorial) (littlereborns.com)

Conclusions/action items: When it comes to the airbrushing and coloring part of this project, perhaps refer to the reborn community for assistance in making this mannequin very lifelike.

10/11/2022 Composite Skin Model That Does Not Dehydrate

LOUKIA AGOUDEMOS - Oct 11, 2022, 6:38 PM CDT

Title: Composite Skin Model That Does Not Dehydrate

Date: 10/11/2022

Content by: Loukia Agoudemos

Present: Loukia Agoudemos

Goals: Find a formulation for the composite polymer skin idea that we want to employ with our mannequin that does not dehydrate.

Content:

The first article I found was the following.

Citation:
"Tough new hydrogel hybrid doesn't dry out," MIT News | Massachusetts Institute of Technology. [Online]. Available: https://news.mit.edu/2016/tough-hydrogel-hybrid-artificial-skin-0627. [Accessed: Oct. 11, 2022]

This article highlights a research group that developed a hydrogel that does exactly what I detailed in the preliminary presentation. I want a hydrogel that is able to synthesize with elastomers on the outside to make it anti-dehydrating and to make it more durable for clinical use. Backtracking from this article, I found the research group's paper in Nature and will look through the document to find the synthesis of their hydrogel.

Citation:
H. Yuk, T. Zhang, G. A. Parada, X. Liu, and X. Zhao, "Skin-inspired hydrogel–elastomer hybrids with robust interfaces and functional microstructures," Nat Commun, vol. 7, no. 1, p. 12028, Jun. 2016, doi: 10.1038/ncomms12028. [Online]. Available: https://www.nature.com/articles/ncomms12028. [Accessed: Oct. 11, 2022]

Looking through this article, we find that the formulation the team wants to most closely mimic is that of the group's anti-dehydration coating text.

- The exact methods of the process are detailed in the article, however, there are some big ideas we want to capture.
- Using a thin layer of ecoflex on the outer layers of the model
- treating that with a benzophenone solution.
- Create hybrid with PAAm-alginate hydrogel pre-gel solution
- UV irradiation to crosslink together.

While this formulation may be our group's best bet, I do have some concerns as to how we will make it form on either side or if it all mixes together. There is a method for making it on either side however If it is the latter, it makes the skin synthesis process a lot easier. Perhaps there is a way we can swap the molds and then make it so we can coat the other side.

Conclusions/action items: Conduct more research on how to make this synthesis and ask more hydrogel experts to make the synthesis possible.

LOUKIA AGOUDEMOS - Oct 11, 2022, 6:38 PM CDT

nature COMMUNICATIONS

ARTICLE

Received 5 Feb 2016 | Accepted 29 May 2016 | Published 27 Jun 2016 OPEN

Skin-inspired hydrogel–elastomer hybrids with robust interfaces and functional microstructures

Hyunwoo Yuk[1], Teng Zhang[2], German Alberto Parada[1,3], Xinyue Liu[2] & Xuanhe Zhao[1,4]

Inspired by many natural skins, soft hybrids integrating the merits of elastomers and hydrogels have potential applications in diverse areas including stretchable and bio-integrated electronics, microfluidics, tissue engineering, soft robotics and biomedical devices. However, existing hydrogel–elastomer hybrids have limitations such as weak interfacial bonding, low robustness and difficulties in patterning microstructures. Here, we report a simple yet versatile method to assemble hydrogels and elastomers into hybrids with extremely robust interfaces (interfacial toughness over 1,000 J m^{-2}) and functional microstructures such as microfluidic channels and electrical circuits. The proposed method is generally applicable to various types of tough hydrogels and diverse commonly used elastomers including polydimethylsiloxane Sylgard 184, polyurethanes Tetra-, VHB and Ecoflex. We further demonstrate applications enabled by the robust and microstructured hydrogel–elastomer hybrids including anti-dehydration hydrogel–elastomer hybrids, stretchable and reactive hydrogel–elastomer microfluidics, and stretchable hydrogel circuit boards patterned on elastomer.

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NATURE COMMUNICATIONS | DOI: 10.1038/ncomms12028 ARTICLE

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10/27/2022 Looking for a Cheap Hydrogel

LOUKIA AGOUDEMOS - Oct 27, 2022, 10:15 AM CDT

Title: Looking for a Cheap Hydrogel

Date: 10/27/2022

Content by: Loukia Agoudemos

Present: Loukia Agoudemos

Goals: Finding a formulation for a relatively cheap hydrogel in comparison to a PEGDA or collagen gel.

Content:

May 14, 2022 | Can anyone please suggest a cheap hydrogel brand available to buy for 3D cell culture? | ResearchGate Looked at this forum post to find a relatively cheap hydrogel recipes.

Found:

- Sodium Alginate with a cost-effective cross linker (sodium alginate and calcium chloride make beads. --sodium alginate would be best; however I do not want to go with calcium chloride as out cross linker as I want the gels to be really soft.
- Other example given was tissue labs hydrogel products! MATRIXPEC HYDROGELS | TissueLabs-- could use their gelma, if we were to go this route, we would probably additionally need a risky or expensive crosslinker.
- Agar-agar after in water*** another great option

Conclusions/action items:

To make a cost-effective hydrogel, ideally, we would make a gel out of sodium alginate or agar. All of these options would be cost effective and readily available for purchase or making!

notes 09/16/22

LOUKIA AGOUDEMOS - Sep 16, 2022, 1:51 PM CDT

- Talk to Tim about a baby CPR -- asking about purchasing about cpr dummy or one that you want one replicated scaled down
    - Ask about potentially touring his facility
- Talk to MATC about touring their area
- Talk to Dr. Skala about anyone she would know about baby models
- Talk to Ashley

2022/09/12-Premature Infant Physiology

CLAIRE KRAMAR - Sep 12, 2022, 8:46 PM CDT

Title: Premature Infant Physiology

Date: 09/12/2022

Content by: Claire Kramar

Content:

-neonates have smaller oral cavities and a large, flat tongue with limited lateral movement => could cause airflow obstruction

-neonates, especially premature, have fewer alveoli => are at risk of collapsing

Conclusions/action items: This source was generally unhelpful in determining the anatomy and physiology of a 22-23 week premature infant but helped me gain insight on how and why premature infants are at such a high risk of health complications, especially those related to the heart and lungs

Citation (MLA): Saikia, Diganta, and Bandana Mahanta. “Cardiovascular and respiratory physiology in children.” *Indian journal of anaesthesia* vol. 63,9 (2019): 690-697. doi:10.4103/ija.IJA_490_19

2022/09/21-Development at Each Week of Pregnancy

CLAIRE KRAMAR - Sep 21, 2022, 7:55 PM CDT

Title: Development of Infant at Each Week of Pregnancy

Date: 09/21/2022

Content by: Claire Kramar

Present: self

Goals: discover what has developed by the age of 22-23 weeks and what was supposed to still be developed in the womb that will now have to be developed outside of the womb

Content:

(pictures below)

-lungs are fully formed at 24 weeks, but the baby is not ready to breathe outside of the womb yet

-skin looks less wrinkly at 25 weeks, so at 22-23 weeks the baby's skin will still be very wrinkly

-baby's brain, liver, and lungs are still developing and growing up until 38 weeks of pregnancy

Conclusions/action items:

According to this website, at 22-23 weeks, the premature infant should be structurally the same as a full-term newborn, just with less developed lungs, brain, and liver, and with all dimensions sized down to about 5-8 inches and weighing about a pound.

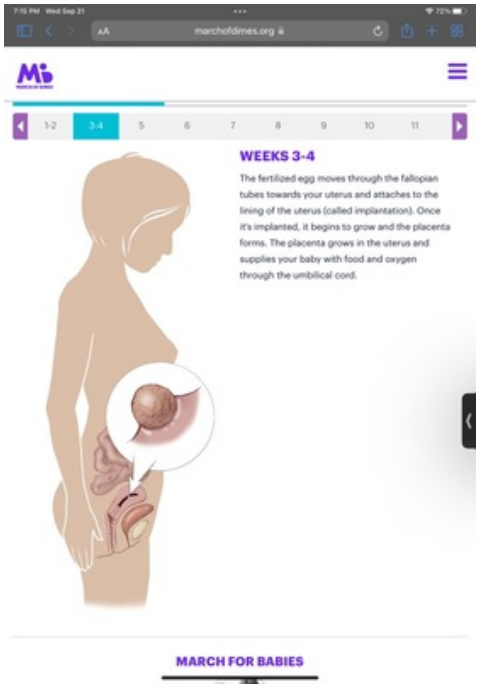
Website: https://www.marchofdimes.org/pregnancy/week-by-week.aspx#38

CLAIRE KRAMAR - Sep 21, 2022, 7:19 PM CDT

Download

Weeks_1-2.jpg (28.8 kB)

CLAIRE KRAMAR - Sep 21, 2022, 7:22 PM CDT



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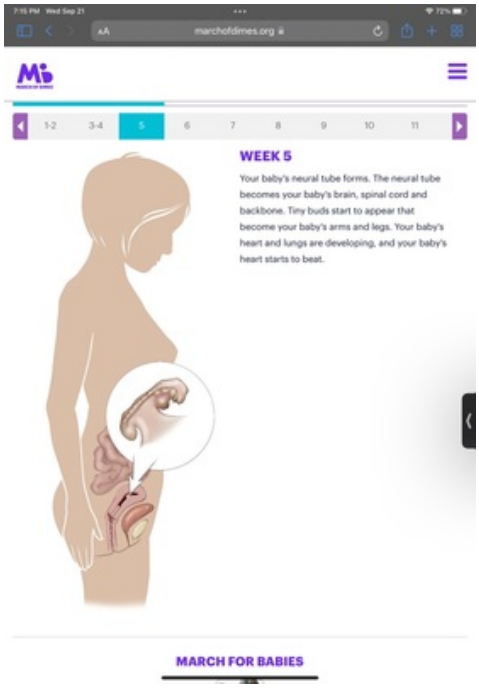
Weeks_3-4.jpg (76 kB)

CLAIRE KRAMAR - Sep 21, 2022, 7:22 PM CDT



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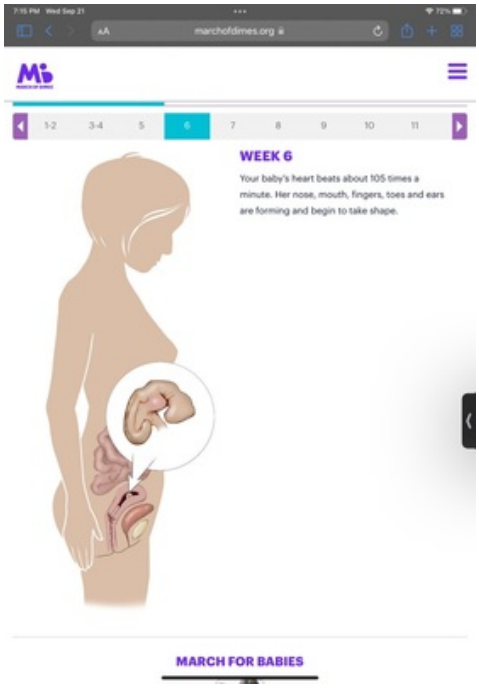
Week_5.jpg (71.5 kB)

CLAIRE KRAMAR - Sep 21, 2022, 7:23 PM CDT



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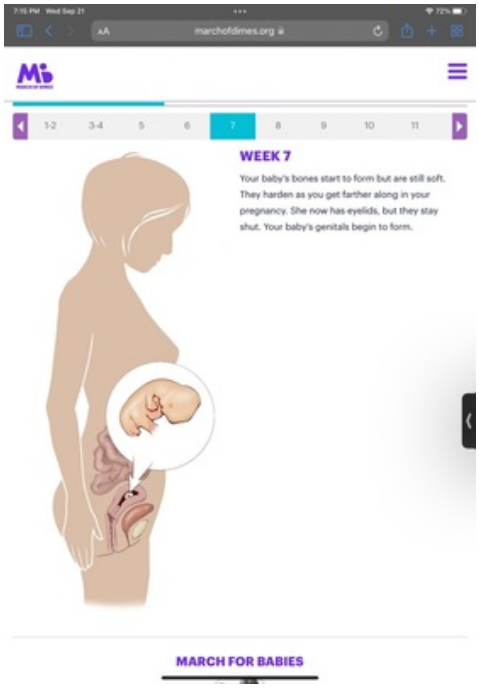
CLAIRE KRAMAR - Sep 21, 2022, 7:23 PM CDT



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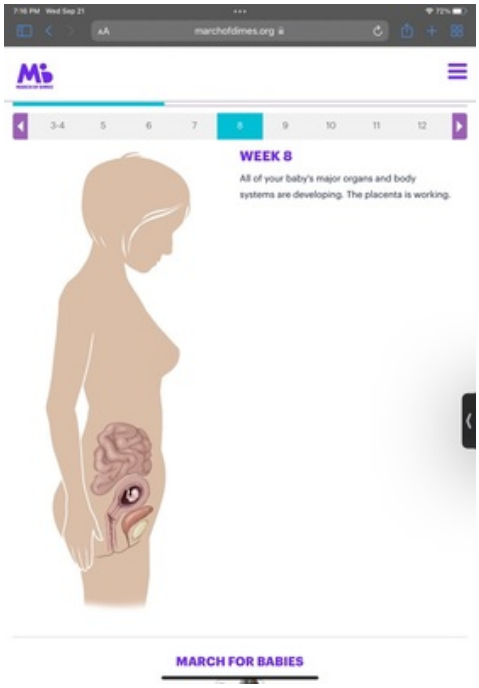

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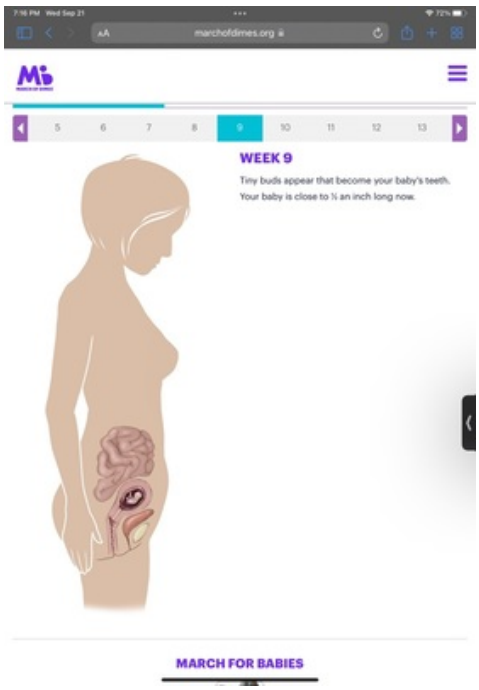
CLAIRE KRAMAR - Sep 21, 2022, 7:24 PM CDT



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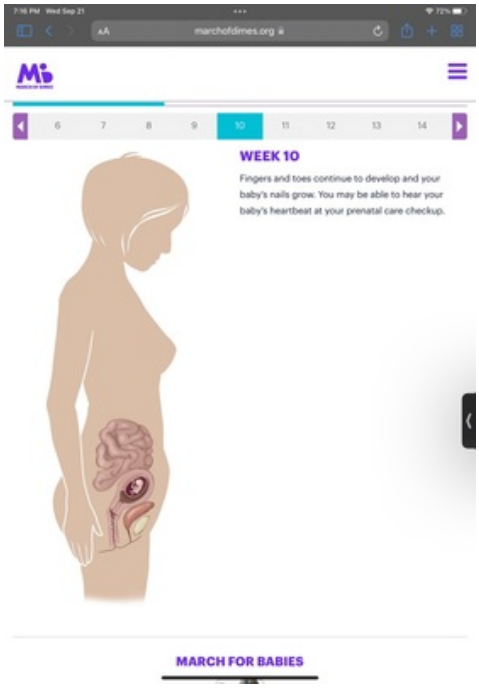

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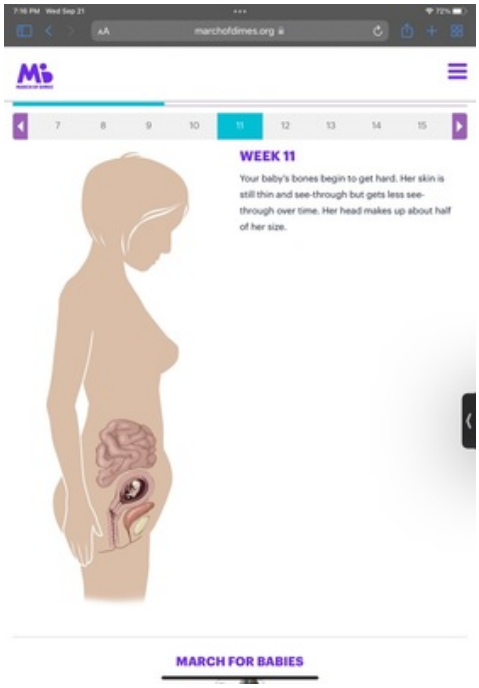

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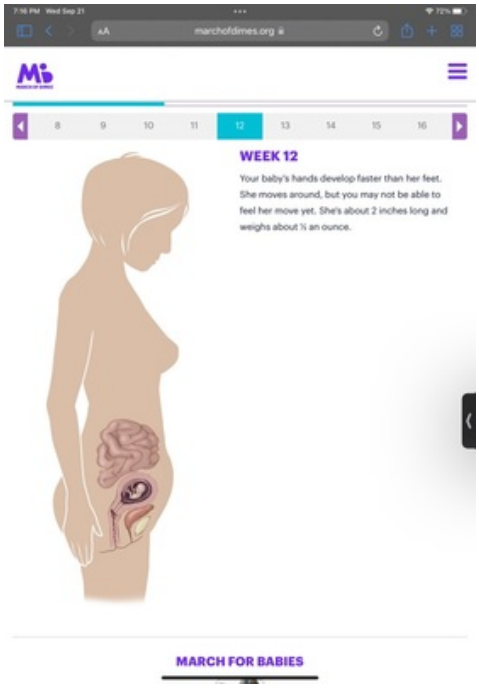

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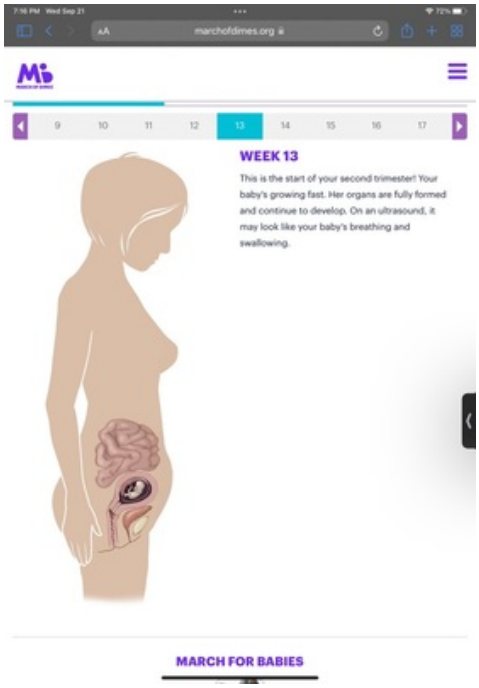
CLAIRE KRAMAR - Sep 21, 2022, 7:25 PM CDT



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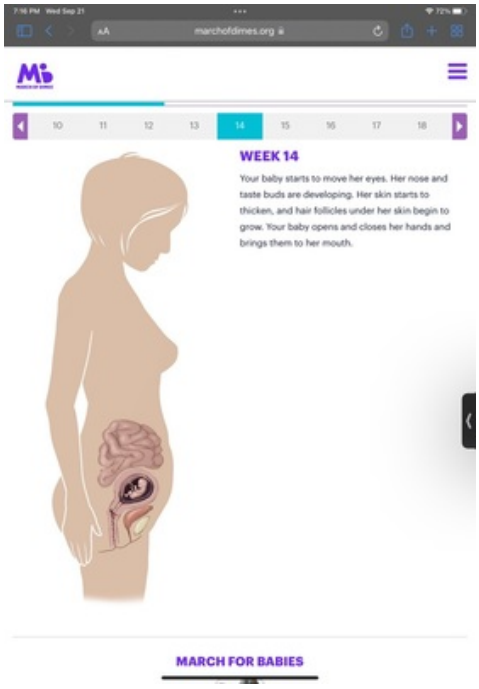

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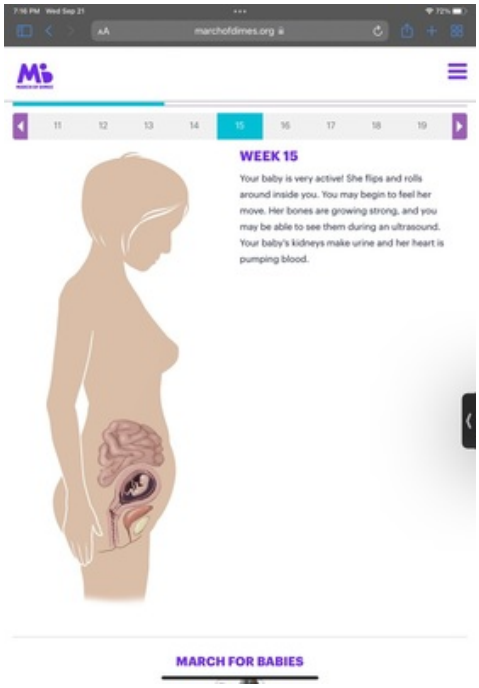

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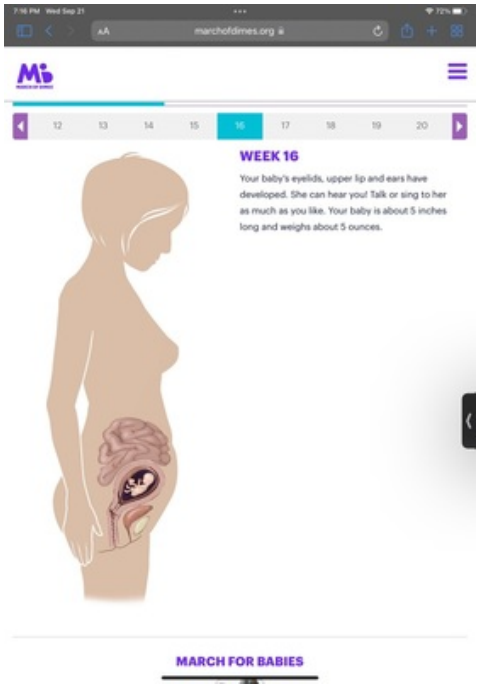
CLAIRE KRAMAR - Sep 21, 2022, 7:26 PM CDT



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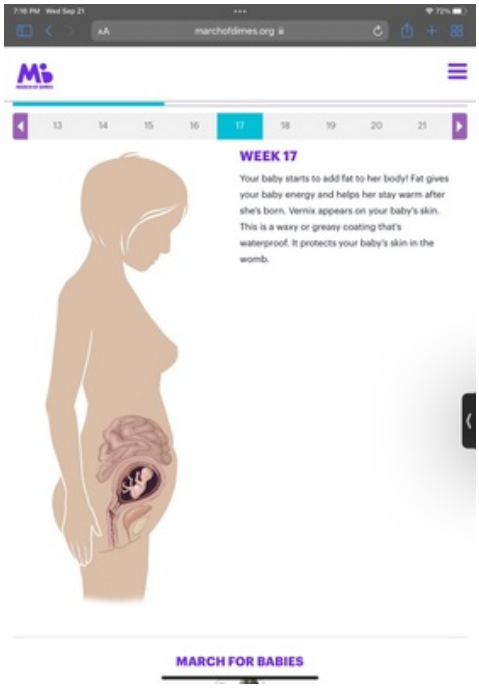

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CLAIRE KRAMAR - Sep 21, 2022, 7:26 PM CDT

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CLAIRE KRAMAR - Sep 21, 2022, 7:26 PM CDT

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CLAIRE KRAMAR - Sep 21, 2022, 7:27 PM CDT

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CLAIRE KRAMAR - Sep 21, 2022, 7:27 PM CDT

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CLAIRE KRAMAR - Sep 21, 2022, 7:27 PM CDT

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CLAIRE KRAMAR - Sep 21, 2022, 7:28 PM CDT

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CLAIRE KRAMAR - Sep 21, 2022, 7:28 PM CDT

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CLAIRE KRAMAR - Sep 21, 2022, 7:28 PM CDT

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Week_25.jpg (75.3 kB)

CLAIRE KRAMAR - Sep 21, 2022, 7:29 PM CDT

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Week_26.jpg (69.8 kB)

CLAIRE KRAMAR - Sep 21, 2022, 7:29 PM CDT

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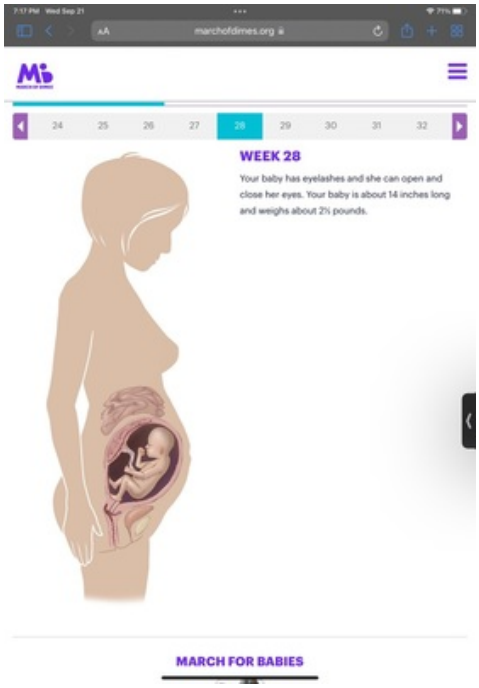
Week_27.jpg (61.8 kB)

CLAIRE KRAMAR - Sep 21, 2022, 7:29 PM CDT



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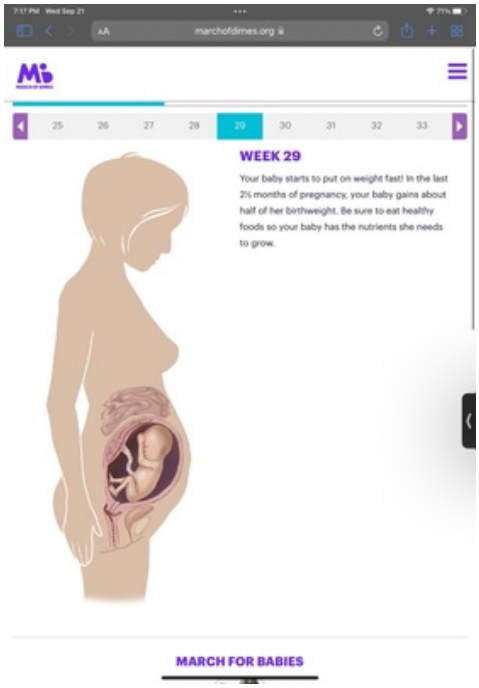

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CLAIRE KRAMAR - Sep 21, 2022, 7:29 PM CDT

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Week_30.jpg (64.7 kB)

CLAIRE KRAMAR - Sep 21, 2022, 7:30 PM CDT

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Week_31.jpg (62 kB)

CLAIRE KRAMAR - Sep 21, 2022, 7:30 PM CDT

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Week_32.jpg (65.4 kB)

CLAIRE KRAMAR - Sep 21, 2022, 7:30 PM CDT

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Week_33.jpg (64 kB)

CLAIRE KRAMAR - Sep 21, 2022, 7:31 PM CDT

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Week_34.jpg (71.3 kB)

CLAIRE KRAMAR - Sep 21, 2022, 7:31 PM CDT

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Week_35.jpg (77.9 kB)

CLAIRE KRAMAR - Sep 21, 2022, 7:31 PM CDT

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Week_36.jpg (74.3 kB)

CLAIRE KRAMAR - Sep 21, 2022, 7:31 PM CDT

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Week_37.jpg (73.8 kB)

CLAIRE KRAMAR - Sep 21, 2022, 7:32 PM CDT

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Week_38.jpg (71.4 kB)

CLAIRE KRAMAR - Sep 21, 2022, 7:32 PM CDT

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Week_39.jpg (70.3 kB)

CLAIRE KRAMAR - Sep 21, 2022, 7:32 PM CDT

Download

Week_40.jpg (75.2 kB)

2022/10/10-Resuscitation of Extremely Premature Infants

CLAIRE KRAMAR - Oct 10, 2022, 6:01 PM CDT

Title: Resuscitation of Extremely Premature Infants

Date: 10/10/2022

Content by: Claire Kramar

Present: self

Goals: determine the age at which doctor's start attempting to resuscitate extremely premature babies and gather statistics on their survival rates

Content:

-survival rates at certain gestational ages:

- 25 weeks: 59% - 86%
- 24 weeks: 31% - 78%
- 23 weeks: 1% - 64%
- 22 weeks: <10%

-factors to consider in resuscitation decision:

- survival rate statistics
- parents preference
- doctor's preference
- risk of permanent disabilities and diminished quality of life

-decisions truly vary from case to case

Conclusions/action items: There is not a set age that doctors will not attempt resuscitation at if the infant is born before that age, but each individual case creates a tricky ethical dilemma, impacted by many factors.

Citation (IEEE): A. Cavolo, B. Dierckx de Casterlé, G. Naulaers, and C. Gastmans, “Physicians’ Attitudes on Resuscitation of Extremely Premature Infants: A Systematic Review,” *Pediatrics*, vol. 143, no. 6, p. e20183972, Jun. 2019, doi: 10.1542/peds.2018-3972.

2022/09/20-Competing Laerdal Premature Mannequin

CLAIRE KRAMAR - Sep 29, 2022, 3:39 PM CDT

Title: Competing Design (Laerdal Premature Anne Task Trainer Manikin)

Date: 09/20/2022

Content by: Claire Kramar

Present: self

Goals: see what premature mannequins are available on the market and find out what functions they can perform

Content:

Premature Anne is advertised to be:

- realistically proportional to a 25-week premature infant
- anatomically accurate and allows for placement of ET tube
- provides realistic training experience
- align with objectives of NRP course curriculum
- highly mobile

Conclusions/action items: This mannequin is very close to what we are trying to create, just a couple weeks too big. We may also want to add some sort of electronics to check for vital signs and for sure add lungs that rise and fall. I believe this mannequin is the closest competing design to what we are trying to make.

Citation: https://www.aedsuperstore.com/laerdal-290-00050-290-00150-premature-anne-task-trainer-manikin.html?select2=1&gclid=CjwKCAjwyaWZBhBGEiwACslQo_4mzYyYMkp3m8MMYu1RJJtFztHRCXsqZo_ZSNmZgXn9AB5K-Iq8RBoCxIYQAvD_BwE

"Premature Anne," *Laerdal Medical*. https://laerdal.com/us/products/simulation-training/obstetrics-pediatrics/premature-anne/ (accessed Sep. 23, 2022).

2022/09/29-Competing Universal Medical C.H.A.R.L.I.E. Design

CLAIRE KRAMAR - Sep 29, 2022, 3:39 PM CDT

Title: Competing Universal Medical C.H.A.R.L.I.E. Design

Date: 09/29/2022

Content by: Claire Kramar

Present: self

Goals: evaluate the competing design and get inspiration for our own design

Content:

Charlie is advertised to contain these features:

- Airway, breathing, intubation, and ventilation
- Birth anomalies
- Chest tube placement
- CPR
- ECG simulation
- Gastrointestinal (GI) tube
- Interchangeable genitalia
- Intraosseous infusion
- IV hand and foot
- Observation and measurement
- Palpable manual pulse points in 7 locations
- Patent umbilicus with venous and arterial access
- PICC site in arm
- Urinary catheterization

-besides this description, I can find few pictures, videos, or reviews about Charlie

-intended age of mannequin is unknown, probably bigger than what we would want

-comes with iv bag, needles, umbilicus, blood, etc.

Conclusions/action items: A lot of the features included in Charlie are ones we will want to consider adding, such as the IV hand and foot, the intubation areas, airway and breathing mechanisms, etc. We may also want to include a design that is sold with extra features, such as the IV, blood bag, etc.

Citation: “CPR Simulators | CPR Training Manikin.” https://www.universalmedicalinc.com/all-products/education/anatomical-models/medical-training-models/cpr-simulators.html (accessed Sep. 23, 2022)

2022/09/29-Competing Trucorp TruBaby X Design

CLAIRE KRAMAR - Sep 29, 2022, 3:47 PM CDT

Title: Competing Trucorp TruBaby Design

Date: 09/29/2022

Content by: Claire Kramar

Present: self

Goals: evaluate this competing design and gain inspiration for our own design

Content:

Advertised Features:

- Realistic & durable AirSim X airway with a 5-year warranty
- Realistic movement including head tilt, chin lift & jaw thrust
- Interchangeable head in case of repairs
- Realistic rib structures including xiphoid process & clavicle
- Palpable landmarks in the 2nd intercostal space midclavicular line & 5th intercostal space mid-axillary line
- Palpable vertebrae landmarks
- Lumbar puncture can be practiced at L3-L4 & L4-L5 spine locations
- Proximal tibia interosseous needle insertion site
- Contains tibial tuberosity anatomy & patella anatomy
- Realistic anatomy to practice inserting catheter tube to extract urine
- Option for interchangeable male and female genitalia
- Fully enclosed fluid management system giving realistic blood flashback & flow
- Allows needle cannulation at various locations in hand, arm & foot with realistic blood flashback
- Realistic look & feel of tissues
- Lifelike responsiveness during procedure training
- Set-up time is less than 5 minutes

-mannequin appears large and unrealistic compared to a 22-23 week premature baby, but the simplicity of this design may be more feasible for our team to create in one semester

-highlights chest rise and fall, multiple IV insertion areas, and intubation techniques

-has life-like blood coming out of the mannequin

Conclusions/action items: This design seems like a more realistic goal for our team to accomplish, but the size and skin could be much improved.

Citation: “TruBaby X | Infant CPR Manikin | Pediatric Manikin,” *Trucorp*. https://trucorp.com/product/trubabyx/ (accessed Sep. 23, 2022).

2022/11/10-3D Scans of Mannequin

CLAIRE KRAMAR - Nov 10, 2022, 10:50 AM CST

Title: 3D Scans of Mannequin

Date: 11/10/2022

Content by: Claire Kramar

Present: individual

Goals: 3D scan Laerdal's Premature Anne

Content:

attachments below

Conclusions/action items: The model, due to its lack of rigidity, did not scan as well as we had hoped.

CLAIRE KRAMAR - Nov 10, 2022, 10:49 AM CST

Download

Neonatal_Mannequinn_Whole_2_.stl (5.64 MB)

CLAIRE KRAMAR - Nov 10, 2022, 10:50 AM CST

Download

Neonatal_Mannequinn_NoZipper_1_.stl (5.54 MB)

2022/11/18 - 3D Molds

CLAIRE KRAMAR - Nov 18, 2022, 1:29 PM CST

Title: 3D Molds

Date: 11/18/2022

Content by: Claire Kramar

Present: self

Goals: create molds

Content:

files attached below

Conclusions/action items:

Making the mold was our biggest road block so far. Now that we got it figured out, we need to print the mold and create the chest cavity.

CLAIRE KRAMAR - Nov 18, 2022, 1:28 PM CST

Download

FrontofNeonate_1_.stl (2.24 MB)

CLAIRE KRAMAR - Nov 18, 2022, 1:28 PM CST

Download

BackofNeonate_1_.stl (2 MB)

9/11/2022 Neonatal Pulmonary Physiology

Lael Warren - Sep 11, 2022, 8:44 PM CDT

Title: Neonatal Pulmonary Physiology Article

Date: 09/11/2022

Content by: Lael Warren

Present: N/a

Goals: Learn more about the development of the lungs in a fetus.

Content: Details how the lungs grow inside the chest cavity from conception to approximately 8 years of age. It also details why assisted ventilation might be needed in a neonatal patient. Finally, details how complications with pulmonary development cause premature birth and some complications that arise with premature birth.

Neonatal Pulmonary Physiology

Conclusions/action items: The development of the chest cavity is important for many reasons, one of them being the growth and development of the lungs. Complications with this can cause serious health issues and could cause health professionals to have to step in and take serious action to sustain life.

9/20/2022 Skin Physiology of the Neonate and Infant: Clinical Implications

Lael Warren - Sep 20, 2022, 10:26 AM CDT

Title: Skin Physiology of the Neonate and Infant: Clinical Applications

Date: 09/20/2022

Content by: Lael Warren

Present: n/a

Goals: To better understand the skin physiology of the neonate and how it differs from infants and adults.

Content: This article details how the skin of a neonatal baby differs from the skin of a infant or a child and adult. Big take aways listed in the table below.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4593874/

Table 1.

Structural and functional differences between infant and adult skin

	Infant	*Adult*	*Reference*
Structural differences			
Epidermal thickness	Thinner	Thicker	9
	No significant differences		8
Cell attachments and epidermal cellularity	Less	More	3
Dermoepidermal junction	Flat	Undulating	3
Lipids	Less	More	14
Melanin	Less	More	17
Functional differences			
Sweat	Less	More	21,22
Water content	Higher	Lower	15,24
Natural moisturizing factor concentration	Lower	Higher	2
pH	Higher	Lower	29–31
TEWL	Lower	Higher	59
	Higher	Lower	2
	No significant differences		23,28

Conclusions/action items: Find a way to replicate the skin of a neonatal baby in a synthetic form for our doll.

9/27/2022 CPR Mannequin

Lael Warren - Sep 27, 2022, 8:03 PM CDT

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

Title: Real-Time Visual Feedback Device Improves Quality Of Chest Compressions: A Manikin Study

Date: 09/27/2022

Content by: Lael Warren

Present: n/a

Goals: To learn how CPR mannequins help improve compressions.

Content: **https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7468227/**

This article details how being able to practice compressions and take vitals on mannequins was able to improve health care professional's abilities in the field. This is a good reason why being able to do CPR and take vital signs should be included in our baby doll mannequin.

Conclusions/action items:

10/5/2022 Intubation in Neonates

Lael Warren - Oct 05, 2022, 3:08 PM CDT

Title: Two Complications of Tracheal Intubation in a Neonate: **Gastric Perforation and Lung Collapse**

Date: 10/05/2022

Content by: Lael Warren

Present: n/a

Goals: Understand why correct intubation is needed

Content:

This article describes why correct intubation in neonates is important and how incorrect intubation can damage the lungs and chest cavity. It describes proper techniques and improper techniques of intubation.

https://pubs.asahq.org/anesthesiology/article/115/4/858/12851/Two-Complications-of-Tracheal-Intubation-in-a

Conclusions/action items: Start looking into how to improve intubation on current mannequin.

2022/11/20- Competing Lung Design

Lael Warren - Dec 14, 2022, 11:51 AM CST

Title: Competing Lung Design

Date: 11/20/2022

Content by: Lael Warren

Present: N/A

Goals: Look at competing lung designs of other neonatal mannequins

Content:

https://www.redcross.org/store/baby-anne-airways-24-pack/130-10150.html?cgid=manikins-and-lung-bags#start=29&cgid=manikins-and-lung-bags

Lungs that are used in many of the baby mannequins are small rectangular and made of plastic. They connect to a tube that would be inserted through the mouth.

Conclusions/action items: Find or make something similar

12/1/2022 Red Cross Inflatable Infant Lungs

Lael Warren - Dec 01, 2022, 9:32 PM CST

Title: Inflatable Lungs

Date: 12/1/2022

Content by: Lael Warren

Present: NA

Goals: Find lungs for infant mannequin

Content:

https://www.redcross.org/store/training-supplies/manikins-and-lung-bags

Contains different inflatable lung sizes for infants to adults that we could use for our mannequin.

Conclusions/action items: Do more research

9/15/2022-Resuscitation of extremely preterm infants - controversies and current evidence

SAIVARSHINI RISHI - Sep 16, 2022, 1:22 PM CDT

Title: "Resuscitation of Extremely Preterm Infants - Controversies and Current Evidence

Date: 9/15/22

Content by: Saivarshini Rishi

Present: NA

Goals: My goal is to learn about key factors to keep in mind during resuscitation for premature infants and their effects.

Content:

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4857228/

- Important biological processes after infant born
    - Getting a certain residual capacity
    - Gas exchange
    - Adapting to oxygen-dependent metabolism
    - Making sure body temperature in appropriate range
- 22-23 week premature infants especially have difficulties in those processes compared to non-premature infants
- Actions by nurses/doctors to aid premature infants in these processes must be done with extreme care as there is also the risk of organ damage due to inflammatory and oxidative cascades
- Neonatal resuscitation reduces the risk of death
- Antenatal corticosteroids aid in the rapid development of the lungs, especially useful for premature infants
    - Not much research for 22-26 week infants regarding their effects on reducing risk of morbidity and mortality
    - For infants less than 26 weeks, it is shown that steroids decrease occurrence of intra ventricular hemorrhage
    - Corticosteroids can be used for infants from 23 weeks and above but for 22 weeks or below there is not enough evidence/data
- Delaying umbilical cord clamping can help premature infants
    - Blood supply continues to the heart helps left ventricular output which allows for continued blood flow throughout the body
    - Reduces the need for transfusion
    - Improves circulatory stability
    - Reduced intra ventricular hemorrhage
    - Reduces risk of necrotising enterocolitis
    - Not as much information regarding benefits of delaying umbilical cord clamping for extremely premature infants
    - Time after which umbilical cord clamping must be delayed by is controversial
- Hemoglobin levels greater than 12 g/dL reduces mortality/morbidity rates for premature infatns less than 32 weeks
- Maintaining normal temperature range
    - Lack of enough amount of brown adipose tissue for premature infants resulting in not able to maintain normal temp range

    - Losing heat due to
        - Evaporation of amniotic fluid
        - Conduction of heat from body to cooler surfaces
        - Convection (due to cooler environment)
        - Radiation (due to cooler environment)
    - Higher risk of hypothermia
    - Essential to increase ambient temp of the room to minimum 26 degrees celsius
- ventiliatory/respiratory support
    - Higher cases of bronchopulmonary dysplasia for premature infants
    - Premature infants have “noncompliant” chest wall and immature lungs
    - Suggested to use positive and expiratory pressure (PEEP) in intermittent positive pressure ventilation (IPPV) or continuous positive airway pressure (CPAP)
    - CPAP improves pulmonary hemodynamics
        - Majority of the NRP/NLS resuscitation guidelines support CPAP
        - Studies looking into CPAP effects didn’t include infants less than 23 weeks and just 1 for infants at 24 weeks
        - 50% of infants at 24 weeks can be stabilized with CPAP but most infants less tha 24 weeks used intubation
        - But even with CPAP for extremely premature infants, BPD or death rates are high (from 41-64%) at 36 weeks postmenstrual age
        - It is not recommended for CPAP to replace using positive pressure ventilation
- Oxygenation
    - Premature infants lack anti oxidative protection so at high risk of oxygen toxicity
    - Pulse oximetry required to be on right hand/arm to look at preductal oxygen levels and heart rate

Conclusions/action items: Preterm infants, especially periviable infants, are at a higher risk of morbidity/mortality due to respiratory related issues caused by their underdeveloped respiratory system and other biological systems. To lower these rates, various techniques must be used right after birth to ensure that the infant is able to adapt to their surroundings until the infant is able to undergo these biological processes on their own. These techniques include utilizing corticosteroids, delayed umbilical cord clamping, maintaining proper temperature levels in the room and for the infant and providing proper ventilatory/respiratory support.

Action items:

- continuing research on periviable infants after birth and resuscitation
- research on anatomy and physiology of periviable infant

9/22/22-Extremely Preterm Infant Skin Care

SAIVARSHINI RISHI - Sep 22, 2022, 3:02 AM CDT

Title: "Extremely Preterm Infant Skin Care"

Date: 9/22/22

Content by: Saivarshini Rishi

Present: NA

Goals: My goal is to learn about how the skin of a preterm infant is like and the extra precautions that must be taken to protect it.

Content:

https://journals-lww-com.ezproxy.library.wisc.edu/advancesinneonatalcare/FullText/2016/10001/Extremely_Preterm_Infant_Skin_Care__A.5.aspx

- Skin underdeveloped and weak barrier function
- In NICU it's important to take special care of the skin because can affect in long term due to chances of infection and allergen sensitization
- Gentle adhesives (ex: silicone tapes and hydrogel backed electrodes) can be used instead to decrease skin injuries caused by medical adhesives
- Stratum corneum = outermost skin layer
    - Made of keratinocytes and lipid
    - Made kind of like bricks and mature is from 10-20 layers
    - Serves as barrier
        - Does not allow for transepidermal water loss and evaporative hypothermia
        - Microbe protection
        - Allergen infiltration
        - Toxin absorption
    - Underdeveloped in extremely premature infants (less than 2-3 layers)
    - The drier environ causes accelerated skin maturation and more durable skin (visually) in 14 days
        - Accelerated skin maturation from 2-8 weeks
- Junction between dermis and epidermis layers underdeveloped
    - Layers connected by fibrils
    - fibril s weaker, fewer and more spaced out compared to mature skin
- Tissue edema
    - Caused by less collagen
    - Bond between epidermis and dermis weakened due to excess fluid collecting in between layers
    - Causes decreased elasticity of skin and higher chance of blistering from friction
- Skin acidification occurs at birth for all infants
    - Causes acid mantle (protection from invasive microorganisms)
    - Acid mantle formation is endogenous process that happens for all infants starting after delivery

    - Skin pH ranges from >6 to little over 7 after birth and after first week reduces to 5.5
    - 3 weeks later it drops more to 5
    - Alkaline products like soaps can cause increase in numbers of skin microbes and cause change in bacterial species present
        - Can also cause increase in transepidermal water loss affecting barrier function even more
    - Acidic skin surface causes barrier to function properly and prevents infection
- Medical adhesive related skin injuries
    - Contact dermatitis
    - Moisture maceration
    - Mechanical skin injury when separated epidermis and dermis
        - Tension blisters, tears and denudement due to epidermal stripping
        - Epidermal stripping most common type of MARSI
            - Due to bond between adhesive and epidermis stronger than that of epidermis and dermis
- Silicone tape and hydrogel adhesives are more gentle and can be used for nonlife lines and devices causing frequent rotation
    - Keep aggressive adhesives like silk, paper tapes and clear film dressings for critical tubes/lines (including endotracheal tubesand central lines)
- Anetoderma of prematurity: permanent atrophic patches of skin that look of different pigmentation and/or texture
    - Consequence of medical adhesives
    - Mostly ventrally located (places affected after long term use of medical adhesives/devices)
        - Ex: chest and abdomen due to electrodes
    - Lesions not seen right after certain skin injury and instead seen from several weeks to 5-10 months
    - Anetoderma of prematurity result of subclinical dermal injury caused by long term traction and pressure of device (ex: electrocardiographic monitoring patches and umbilical lines)
    - Mechanism not fully known
    - Higher chance of subclinical iatrogenic dermal injury is caused by focal hypoxemia and/or inflammatory response, affecting elasticity and development of dermis
    - To prevent this can make sure there is no traction on affixed lines and wires and decreasing prolonged pressure by preventing infants from lying on electrodes and to use low profile electrodes
    - Can also try to prevent electrodes from being used on cosmetically sensitive areas (ex: breast)
    - Can use hydrogel electrodes
- When infant/child sensitized to allergen, antibody circulates through bloodstream and goes to other parts of the body like nasal and lung mucosa
    - Increase in rate of TEWL causes increase in rate of allergen infiltration and sensitization to allergens (study in children with atopic dermatitis)
        - In AD there is intrinsic epidermal barrier weakness causing allergen penetration (can also lead to asthma)
- Due to premature infants' lower/almost absent barrier function, have to make sure things like diaper wipes and other products looked beforehand for things that could be allergens
    - Lesser ingredients the better

- When antiseptic needed to reduce risk of bloodstream infection before central line place it also increases risk of chemical dermatitis and/or absorption of toxins
- Skin emollients can make barrier function better (reduces TEWL) but can also increase the likelihood of infection from hospital
- Central line related blod s tream infections have 25% risk of mortality
    - Can affect neurodevelopment
    - Main risk factor is skin flora concentration at insertion site
    - Antisepsis required before central line inserted
- Chlorhexidine gloconate cleansing before central venous lines placed better choice as it reduces infection rates compared to iodine based solutions
    - CHG shouldn’t be used younger than 2 months due to less data
    - For preterm infants, alcohol can cause skin breakdown and significant contact dermatitis can occur with aqueous and alcohol CHG
- Chemical erosions or burns can occur for less than 26 weeks of age mostly on abdomen after umbilical line placement
- Preterm infants at highest risk for CHG absorption and chemical erosions in first two weeks
- Preterm infants also at high risk for too much iodine as alternate to CHG because of less renal clearance and not able to uptake iodine into thyroid
    - Uptaking iodine maturity at 36-40 weeks
    - High risk for transient hypothyroidism goiter and other neurodevelopment problems
- Using iodine or CHG products very carefully (like not allowing it to stay on skin surfaces and skin creases reduces risk of chem burns)
- Sterile water or saline can be used as extra precaution to remove the product and recommended
- Topical application of emollients has improved the skin condition but prophylactically applied topical emollients have caused higher chance of hospital acquired infection
- Should be careful in bathing for preterm infants
    - Acidication of skin after birth important and should make sure that that is not affected by cleansers
    - For first 2 weeks of extremely premature infants they should only be bathed with sterile water
    - Risk of hypothermia and worsening respiratory distress so should be careful
    - Only 2 to 3 times per week for premature infants when they show clinical stability

Conclusions/action items: This article discussed about the various characteristics of the skin in preterm infants and how those characteristics result in a higher risk for things like infections, burns, tears, etc. For example, the underdeveloped stratum corneum weakens the barrier function and increases the risk for things like infection and TEWL. Because of this, there must be extra precautions when doing actions directly involving the skin including when attaching electrodes which can cause anetoderma of prematurity. Gentler approaches and products are required to protect the skin as much as possible as these can have long term consequences/effects.

Action items:

- research more about the respiratory system of preterm infants
- work on the PDS document

9/29/22-"Plastics in Robots: A Degradation Study of a Humanoid Skin Mask Made of Soft Urethane Elastomer"

SAIVARSHINI RISHI - Oct 12, 2022, 12:05 AM CDT

Title: "Plastics in Robots: A Degradation Study of a Humanoid Skin Mask Made of Soft Urethane Elastomer"

Date: 9/29/22

Content by: Saivarshini Rishi

Present: NA

Goals: My goal is to learn about the different materials/chemicals in the mask of robot (particularly the robot used in the study) and what caused the damage of the mask in the long run.

Content:

https://heritagesciencejournal.springeropen.com/articles/10.1186/s40494-021-00636-8

- Polyurethane (PUR) conservation is difficult due to degradation
    - Polyurethane elastomers have risk of degrading right after they are produced
        - i.e. skin of robot SAYA
            - Tears, discoloration and stickiness occurred in 8 years
            - Discoloration due to material's instability most probably from degradation
            - Pigment white 6 or titanium dioxide found which increases photosensitivity of PUR substrates in UV light
            - ATR-FTIR spectroscopy revealed the PUR composition of the skin, phthalates used as plasticizers and also that the quinone chromophore formations in polymer due to photo oxidation have all caused the yellowing of the skin/mask
            - Made of methylene diphenyl diisocyanate PUR ether elastomer
            - Styrene acrylonitrile in mask could also cause the chemical instability of the skin mask
            - UV stabilizer and phthalates in higher concentration were found at surface compared to inside which resulted in stickiness
            - Degradation of mask due to MDI PUR ether and SAN light susceptibility and due to higher photochemical activity of anatase
- Since had to have facial expressions like in humans, the mask had to be deformable, soft and almost like real skin texture
    - Soft PUR or synthetic silicone rubber mostly used for humanoid skin masks
        - Made by mould technology
            - Production of human face mould
            - Injection of elastomer in mould
            - Release of skin and finish manufacture by trimming, painting and making up
- Polymerization of diisocyanate, polyester or polyether polyols and chain extenders makes PUR elastomers
    - Casting procedure: mix two low viscous liquid components (usually polyol mixture and isocyanate) in certain ratio and cure at room temperature
    - Plasticizer can be added in addition to achieve certain softness
    - Things like UV absorbers, antioxidants and pigments added in polyol at start of moulding

- Things made with PUR tend to degrade more compared to other plastic things
- Aging of PUR foams or PUR coatings related/due to ether or ester composition of polymer
- PUR ether polymers have higher sensitivity to oxidation causing discoloration and losing mechanical properties
- PUR ester polymers degradation through hydrolysis due to moisture, heat and light
- SAYA mask replaced
    - “Skin…transferred onto a new inert mannequin that was made of polypropylene…”
    - Actuators inside skull were able to control movements in the face through metal connections to the inner surface of skin mask
    - Velcros secured mask and skull
- Study looked at effectiveness of gluing stripes for stabilization of tears on new mannequin and stabilize/minimize more deformations
    - Goals: “...restabilize adhesion between the tears and connect the mask outward bent edges with the mannequin for keeping its original shape”
    - Made of Japanese paper
        - Make sure that the ripped long fibered paper would let there be smoother transition between edges
        - Make sure that the paper would give enough strength because of the Kozo fiber length
    - Adhesives had to be water soluble in order to prevent PUR exposure to harsh solvents
        - Would allow for flexibility and elasticity for longer period of time
        - Cellulose base adhesives tested
        - Synthetic polymer based adhesive (aqueous PUR dispersion that lacked free isocyanate groups) also was thought to be tested
- In one test, the paper strips embedded with adhesive solutions and dried
    - Adhesives didn’t delaminate so was able to keep original shape and flexibility was also maintained
- After cleaning PUR and PP surfaces with lightly damped polyurethane sponge, the adhesives were added in drops on paper strips and lightly pressed on testing surface with flat short haired brush
    - Then dried
    - After 7 days found that the paper’s flexibility with adhesives by controlling cracks that resulted from shrinkage/failure after manual tension test
- PUR elastomer sensitive to light
- Migration of plasticizers to surface causes stickiness that can occur in plastics like PVC
- In discoloration two parts observed in SAYA:
    - Pink color: carbon and oxygen present
    - yellow discoloration: other elements like magnesium, aluminum and silicon present
        - Shows that chance of aluminosilicates attach to sticky surface
- TiO_2 crystalline used for pigmentation
    - Might have influence on photo stability of different polymers
    - Anatase has photo sensitizing effect and could cause higher susceptibility of photo oxidation for elastomer
- PUR adhesives benefits
    - Good adhesion on different substrates
    - Toughness
    - Flexibility

    - Durability
    - Water resistant
- PUR forms hydrogen bonds and covalent bonds when hydrogen present
- The glue is like barrier against oxygen that slows yellow discoloration process
- Plasticizer migration caused the aging of mask and stickiness but plasticizer usage necessary to reproduce human skin
- In study two main degradation processes
    - Photo oxidation of MDI-PUR elastomer causing yellow discoloration and impacting physical/mechanical properties
        - Anatase form and SAN present
    - UV stabilizer and phthalates migrating to surface causing stickiness and dust particles to stick

Conclusions/action items: This article looks at a study of the skin of a robot called SAYA and analyzes what resulted in the degradation of the mask later on. The mask was made out of polyurethane which though has a stronger durability and waterproof, it can undergo oxidation or hydrolysis depending on whether you are using polyurethane ether polymers or polyurethane ester polymers respectively. Things like aluminosilicates attaching to the surface can cause stickiness of the mask over time which is something to keep in mind of during the project.

Action items:

- Continue to research about the skin

10/6/22- "Structural, physicochemical and biodegradable properties of composite plastics prepared with polyvinyl alcohol (PVA), OSA potato starch and gliadin"

SAIVARSHINI RISHI - Oct 11, 2022, 11:59 PM CDT

Title: "Structural, physicochemical and biodegradable properties of composite plastics prepared with polyvinyl alcohol (PVA), OSA potato starch and gliadin"

Date: 10/6/22

Content by: Saivarshini Rishi

Present: NA

Goals: My goal is to learn about the different components that make up composite plastics with PVA and the advantages/disadvantages of different ratios of them.

Content:

Structural, physicochemical and biodegradable properties of composite plastics prepared with polyvinyl alcohol (PVA), OSA potato starch and gliadin - ScienceDirect (wisc.edu)

- With octenyl succinic anhydride (OSA) esterified potato starch, gliadin and polyvinyl alcohol in solvent casting method allows for making ternary plastics
- Composite plastic's elastic modulus, water resistance and degradability larger compared to in pure PVA
- Adding OSA potato starch and gliadin helps with biodegradability of PVA plastics
- Polyvinyl alcohol
    - Linear polyhydroxy polymer
    - Strong polarity
    - In highly humid conditions, easier to cause plasticization with the water molecules
    - Mixing it with different biopolymers that have differing physical and chemical properties can make composite plastics which have good strength, flexibility and degradation rate
    - High light tranmittance
- Starch
    - Degradable composite
    - Has Free hydroxyl groups
    - Using native starch doesn't give a good water resistance and strength
    - OSA esterified starch better choice
        - Better thermoplasticity and hydrophobicity
    - Cheaper price
- PVA + potato starch base makes the water resistance better
    - PVA and starch not compatible so have to use other substances in addition
- Gliadin
    - Proline rich protein
    - Hydrophobic and hydrophilic regions
    - glycerol/water mixture part of plasticization process

    - Good water resistance
- OSA starch/gliadin ratio replacing PVA increasing causes rough/uneven surface of composite plastic
    - When ratio was 1/1 and PVA replacement ratio was 25% there was a uniform/smooth structure
        - Crack free
    - Higher compatibility of composite plastics causes better mechanical strength
- OSA starch and gliadin added led to bumps in images because of intermolecular accumulation
- OSA starch/gliadin ratio 3:1 with replacement ratio of PVA 75% resulted in darker areas on composite plastic surface
    - Three composites good compatibility
- With only OSA starch and PVA, there were bright and dark spots and there were bumps
    - Shows importance of gliadin
- Particular proportion of gliadin resulted in less roughness in composite plastic
- Composite plastics had less bumps in comparison to pure PVA plastic
- OSA starch + gliadin + PVA composite plastics decrease crystallization and increase smoothness
- Three components => less hydroxyl groups in composite plastics leading to more water resistance
- Light transmittance
    - Reflects resistance to light
    - Lower in composite plastics compared to in pure PVA after addition of OSA starch and gliadin
        - I.e. when ratio of the starch to gliadin was 3:1 and replacement ratio of PVA 25%, light transmittance lower in pure PVA compared to OSA starch but higher in other composite plastics
    - Increasing ratio of OSA starch/gliadin replaced PVA resulted in less light transmittance
        - Since PVA transparent and smooth and increases light transmittance
- Starch molecs can be hydrophilic because of presence of hydrophilic hydroxyl groups
    - OSA starch makes starch particles more hydrophobic
    - OSA starch and gliadin cause composite plastic interaction that leads to network structure
- Intermolecular hydrogen bonds between the OSA starch/gliadin/PVA and dense structure of composite plastics might cause more mechanical strength
- OSA starch can lead to more degradation
- Can change the proportions of the components depending on the specific requirements

Conclusions/action items: This article discussed about the analysis of plastics made of OSA potato starch, gliadin and polyvinyl alcohol and the different chemical characteristics of each component. Different ratios of the compounds resulted in differing observations of the plastic, thus affecting, light transmittance, pigmentation and texture. The lower OSA starch/gliadin ratio and replacement ratio of PVA resulted in a smoother plastic. For our project, we need to keep in mind if we are using OSA starch that using it might add on to the water proof aspect of the skin but also result on more degradation.

Action Items:

- Ask about 3D scanning solidworks design at the makerspace
- Look into fabrication techniques

10/21/22-“ Hydrogel: Preparation, characterization, and applications: A review”

SAIVARSHINI RISHI - Dec 14, 2022, 12:53 PM CST

Title: “ Hydrogel: Preparation, characterization, and applications: A review”

Date: 10/21/22

Content by: Saivarshini Rishi

Present: NA

Goals: My goal is to learn about hydrogels and the processes involved in the synthesis

Content:

https://www-sciencedirect-com.ezproxy.library.wisc.edu/science/article/pii/S2090123213000969

- Hydrogel products are hydrophilic
    - Group of polymeric materials
- Synthetic hydrogels have larger water absorption capacity compared to natural
    - Longer life also
    - Stronger gel strength
- Hydrogels are made of polymer networks
- “Water-swollen and cross-linked polymeric network”
- Monomers undergo rxn that produces the hydrogel
    - Polymerization
    - Parallel cross linking of multifunctional monomers
- Can hold a lot of water in the structure
    - Due to functional groups being hydrophilic
- it cannot dissolve when placed in water
    - Due to cross links in the network chains
- Flexibility
- Can be made from synthetic materials
- Withstand temperature fluctuations
- Usually Mass fraction of water that is held inside hydrogel > mass fraction of polymer
    - Occurs when hydrogel is “swollen”
- Water soluble synthetic polymers that are not cross linked => more swelling
- Polymeric composition classifications
    - Homopolymeric hydrogels
        - The polymer network comes from one certain type of monomer
        - Homopolymers may or may not have cross linking
    - Copolymeric hydrogels
        - Made of two or more varying monomers
            - Monomers have minimum 1 hydrophilic portion

        - Monomer arrangement possibilities
            - Random arrangmenet
            - Block arrangment
            - Alternating arrangement
    - Multipolymer interpenetrating polymeric hydrogel (IPN)
        - Synthesized from two independent cross linked polymer components that could be either synthetic, natural or both
        - semi-IPN hydrogel
            - One polymer component is cross linked while the other isn’t
- Configuration classification
    - Amorphous
    - Semicrystalline
    - Crystalline
- Type of cross linking classification
- Physical appearance classification
    - Matrix
    - Film
    - Microsphere
    - *depends on how polymerization occurs
- Network electrical charge classification
    - Nonionic
    - Ionic
    - Amphoteric electrolyte with acidic and basic portions
    - Zwitterionic with anionic and cationic portions of the monomers
- Natural polymers that are used when synthesizing hydrogel are
    - Proteins
        - Collagen
        - Gelatine
    - Polysaccharides
        - Starch
        - Alginate
        - Agarose
- Polymerization techniques produce synthetic polymers that are used when synthesizing hydrogel
- Volume collapse/phase transition: when hydrogel either retains or loses water capacity due to environmental factors
- Even hydrophobic monomers are used for synthesizing hydrogels for certain purposes
    - But mostly use hydrophilic monomers
- Synthetic polymers
    - Hydrophobic

        - Higher chemical strength compared to natural
            - Causes lower degradation rate
            - Durable
- Elastic structure
- Anything that causes cross linking in polymer will be able to synthesize hydrogel
- copolymerization/cross linking free radical polymericzations
    - Reaction of “hydrophilic monomers with multifunctional cross-linkers”
    - Popular way of hydrogel synthesis
- Methods of synthesizing hydrogel from cross linked linear polymers that are water soluble:
    - Chem rxn that links polymer chains
    - Ionizing radiation
        - =>main chain free radicals that “can recombine as cross-link junctinos”
    - Physical interactions
        - Entanglements
        - Electrostatics
        - Formation of crystallite
- Main parts in synthesizing hydrogels:
    - Monomer
    - Initiator
    - Cross linker
- Diluents (i.e. aqueous solutions like water) can control properties of hydrogel and also the heat of polymerization
- After the preparation has been completed, the hydrogel has to be washed so that there are not any impurities (i.e. nonreacted monomer, initators, cross linkers, waste products) present
- Most of the time monomers that are polar are used
- Possible methods of preparation:
    - Graft polymerizaiton
    - Cross linking polymerization
    - Networks formation of water soluble polymer
    - Radiation cross linking
- Most hydrogels are:
    - copolymers of acrylate and acrylic acid that are only lightly cross linked
    - Grafted starch acrylic acid polymers
    - Preparation includes:
        - Inverse suspension
        - Emulsion polymerization
        - Solution polymeriation
- Bulk polymerization:

    - =simplest way as it only has one monomer and monomer soluble initiators
    - Cross linking agent is only added in small quantity
    - Initiation of polymerization rxn occurs via radiation, ultraviolet or chemical catalysts
    - Due to large monomer concentration, the rate and degree of polymerization is also large
    - Rxn viscosity increases
        - Due to conversion causing heat during the rxn
        - Low conversions reduces viscosity
    - The polymerizationresults in polymer matrix that is:
        - Hard
        - glassy/transparent
        - Becomes soft and flexible when it is placed in water (retention of water also)
- Solution polymerization/cross-linking
    - ionic/neutral monomers added with multifunctional cross linking agent
    - (thermal) Initiation: UV irradiation or redox initiator system
    - Hydrogels washed using distilled water to remove reactants and other things
    - Formation of hydrogel occurs when when water in polymerization is higher than amount of water of swelling
    - Possible Solvents:
        - Water
        - Ethanol
        - Water ethanol mixture
        - Benzyl alcohol

Conclusions/action items: This article discussed the properties of hydrogels and the preparation of them. Understanding the chemical properties will help us synthesize them and utilize them in the skin of the mannequin.

Action items (at the time of the research): adding hydrogel to the skin and perfecting the texture

11/10/22-“Development of a Neonatal Thoracic Cavity Model and Preliminary Study”

SAIVARSHINI RISHI - Dec 02, 2022, 1:59 AM CST

Title: “Development of a Neonatal Thoracic Cavity Model and Preliminary Study"

Date: 11/10/22 (Lab Archives entry on 12/2/22)

Content by: Saivarshini Rishi

Present: NA

Goals: My goal is to learn about the different elements that can be added to a thoracic cavity model by examining the model in the study and learning about the different characteristics it had.

Content:

https://www.jstage.jst.go.jp/article/jscas/18/2/18_80/_pdf/-char/ja

https://www.jstage.jst.go.jp/article/jscas/18/2/18_80/_article/-char/ja/

- Modeling of neonatal thoracic cavity
    - For simulation of thoracoscopic repair for esophageal atresia
    - Making of ribcage of patient who is 13 days old
    - Esophagus model inside ribcage
        - Polyvinyl alcohol tube that is 8mm
        - Top part attached to force sensor
- Model will help pediatric surgeons practice
- 3D printed neonatal thoracic cavity model developed by Barsness et al.
    - For training for surgery
    - Also developed by Harada et al. for 1 year old patient
        - Included force sensor inside ribcage
- Surgical skill assessments used to find the validity of the models
- Construct validity
    - Type of objective validity
    - =looks at how much a test measures what it wants to measure
    - If there is statistically significant difference between beginners and experts utilizing a simulator shows that there is construct validity
- “Thoracoscopic repair of esophageal atresia” extremely hard to perform in neonates
    - Very intricate
    - Have to be careful especially since the esophageal wall is thin and fragile
- Using CT volume data was able to construct simplified model for patient who was 13 days old
    - Included posture of patient during surgery into model
- 3d printing of ribcage
    - Two materials
        - Polyamide nylon and glass beads used for rib bones

        - Thermoplastic elastomer used for base
            - Causes there to be more gap in between rib bones in port insertion
    - Synthetic elastomer sheet (10mm thickness) covered the ribcage
        - Allowed for three ports allowing insertion of endoscope, needle driver and forceps
        - Ports sutured into sheet
    - Elastic PVA tube for esophagus
        - Inside ribcage
        - On 3D printed heart
        - Wet
        - Length = 60mm
        - Outer diameter = 8mm
        - Inner diameter = 5mm
        - Highly resembled mechanical properties of esophagus
        - Higher stiffness compared to real esophagus

Conclusions/action items: In this article, it described a thoracic cavity model that they created, including the different elements they incorporated, materials and characteristics. Their model consisted of a 3D printed ribcage (made of polyamide nylon, glass beads, thermoplastic elastomer and synthetic elastomer sheet) and esophagus model (made of polyvinyl alcohol tube representing the esophagus). Their model was primarily used for replicating surgical procedures so they also included a force sensor and ports for inserting different tools. Though not all of these may apply to our project, definitely a lot of the materials they used could be used in our model too like the PVA (used in the esophagus) that was described as being wet and stiff.

Action items:

- work on prototype
- work on testing

2014/11/03-Template - Copy

SAIVARSHINI RISHI - Sep 15, 2022, 2:42 PM CDT

Title:

Date:

Content by:

Present:

Goals:

Content:

-

Conclusions/action items:

Team contact Information

Lael Warren - Sep 09, 2022, 2:20 PM CDT

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Project description

CLAIRE KRAMAR - Oct 10, 2022, 6:04 PM CDT

Course Number: BME 300

Project Name: Neonatal 22-23-Week Premature Infant Simulation Mannequin

Short Name: Premature Infant Mannequin

Project description/problem statement: There are currently no 22-23 week neonatal simulation mannequins on the market, though it is vital for medical professionals to practice the skills needed to resuscitate an infant at this age. As a result, it is critical to develop a simulation for medical personnel to practice their skills and ease the learning curve to learn in an environment that is less chaotic and high stakes than the first real event. This simulation mannequin must be able to be intubated, support central umbilical line placement, and include IV access. Including a chest cavity and rib structure that allows for additional training in thoracentesis and pericardiocentesis would be ideal.

About the client: Dr. Timothy Elgin, Neonatal Physician, working at UW Department of Pediatrics