BME Design-Fall 2022 - Joshua Varghese
Complete Notebook

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Joshua Varghese

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Team contact Information

Joshua Varghese - Sep 14, 2022, 10:30 PM CDT

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Project description

Joshua Varghese - Sep 14, 2022, 10:38 PM CDT

Course Number:

BME 200/300

Project Name:

REDUCING WHOLE-BODY VIBRATIONS ON NEONATAL TRANSPORT

Short Name:

Neonatal Transport Unit

Project description/problem statement:

Critically ill neonates as a result of birth defects or other disorders require transport to neonatal intensive care units (NICU) where specialized medical professionals and equipment increase their chances of survival. Transport in ambulances or helicopters, while necessary, induces physiological stressors which adversely affect the health of the neonates. In particular, whole body vibration (WBV) and excessive sound levels can induce head bleeds, leading to subsequent neurodevelopmental impairment or death. Minimizing the effects of mechanical vibrations and rotational and translational motion could improve outcomes during transport. The current transport incubator has ventilators, monitoring equipment, and temperature control mechanisms, but no control of the physical stressors aforementioned. The client, Dr. Ryan McAdams, has tasked the team with developing a novel transport bed to minimize these issues. The new bed must ensure the safety and security of the neonate while maintaining the functions of current incubators.

About the client:

Dr. Ryan McAdams is the Neonatology Division Chief at UW Hospitals. He has spent the last 24 years working within neonatal transport medicine and 10 of those years were spent conducting transpacific neonatal aeromedical transports as a part of the Air Force. Dr. Josh Gollub is a fellow for Dr. McAdams and will be a main contact for the team since Dr. McAdams must balance many responsibilities as chief of neonatology. Dr. Gollub is in his first year as a Neonatal Perinatal Medicine fellow and has previously designed the bobbing owl head transport bed concept.

2022/9/12- Initial Team Meeting

Joseph Byrne - Sep 12, 2022, 5:29 PM CDT

Title: Initial Team Meeting

Date: 9/12/2022

Content by: Team

Present: Team

Goals: To go over the project, client, and initial assignments to be completed.

Content:

- Meeting with Dr. McAdams Friday at 1
- Reschedule meeting with Dr. Williams
    - After 1 on Friday?
- Questions for Dr. Williams
    - Lab Archives expectations?
        - Individual vs group meeting notes, etc
    - Meeting schedule/deadlines
    - Getting feedback on deliverables
    - Would you like to be cc'd on correspondence with our advisor?
- Questions for Dr. McAdams
    - What motivated you to start this project? What failures did you observe in current systems/devices?
    - When can we see the current transport system so that we can see exactly what we need to modify/include?
    - What exactly should we be modifying? Incubator, platform, cart, etc?
    - Are we creating the product for ground transport or air?
        - How do both of those differ?
    - How do we measure patient stability?
    - Could you elaborate on the bobbing owl concept and how you were hoping for this to be incorporated into the design?
    - What kind of materials should we be using?
        - PDS specs, etc.
    - Do you have any existing prototypes that we would be building upon?
    - How would you recommend testing be done, and what types of testing would you like to see done on the device?
        - Both testing in terms of vibration/sound levels and stress levels/biological variables related to the neonate's condition
    - How strict is the 500$ budget?
    - Can we ride in the helicopter?
    - What quantitative specs do you have, if any, that you would like us to aim for?

- Tasks to complete this week
    - Research general background information relating to the project
    - Add questions to Client Meeting Questions
    - Fill out the progress report by Thursday

Conclusions/action items:

This initial team meeting was scheduled to further meet each other, go over any questions or concerns, and address what needs to be done in the next week or two. The team needs to meet with the client to discuss initial goals, expectations, and questions. In the next week, each member should complete background research, think of questions for the client, and fill out their sections of the progress report.

2022/9/19 - Team Meeting

NEHA KULKARNI - Sep 19, 2022, 4:27 PM CDT

Title: Initial Team Meeting

Date: 9/19/2022

Content by: Team

Present: Team

Goals: To go over what we need to do to complete our PDS and Progress Report, and coordinate setting up a visit to the NICU.

Content:

- Email Dr. McAdams and Josh about NICU visit
- Meet with Heidi at some point next week
- Designated sections for the PDS:
  - Joey – Function, Client Requirements, 1 standard
  - Josh – Physical and Operation Characteristics (a-e), 1 competition
  - Julia - Physical and Operation Characteristics (f-k), 1 competition
  - Sydney - Physical and Operation Characteristics (L), 2 standards
  - Neha – Product Characteristics (a&b), Miscellaneous (b), 1 standard
  - Greta – Miscellaneous (c), 1 standard, 1 competition
- By Thursday: fill in PDS
  - Update progress report with contributions
  - Research as needed, document research in lab archives
- Look up standards on ISO, ASTM
- Customer bullet point on PDS
  - General
  - If hospital were to purchase it, what would they want to see
  - Ex. easily integrated into existing incubators regardless of model
- For in-text citations, leave initials in brackets and comment citation from initials
  - Get Zotero figured out
- PDS should have bullet points but full sentences
  - Function section is a full paragraph

Conclusions/action items:

This team meeting was scheduled to divide sections of the PDS for individual team members to complete, and to touch base about a NICU visit in the near future. The team now needs to fill in their respective sections of the PDS and facilitate communication about the potential NICU visit.

2022/09/28 - Team Design Brainstorm

NEHA KULKARNI - Sep 30, 2022, 2:30 PM CDT

Title: 09/28/2022 Team Design Brainstorm

Date: 09/28/2022

Content by: Team

Present: Team

Goals: Brainstorm design ideas and combine them to produce the design matrix.

Content:

9/28

- Meeting with Heidi Kamrath Friday at 3
- Neha's design
    - Shock absorbing tray corner liners
        - Line corners of inner tray with shock absorbing material
        - Allow for hinges/latches that can rock the baby still
        - Make sure liners are removable/un-latchable
        - Use woodpecker as model for material
            - Silicone gel inner layer
            - aluminum
            - Foam
            - Stainless steel outer layer
- Greta's design
    - Use mountain bike suspension as idea
    - Fluid and spring suspension system so that base tray moves but inner tray does not
- Josh's design
    - Design 1
        - Head and torso restraint
    - Design 2
        - Mattress modification
        - Rubber strips and foam strips under mattress
    - Design 3
        - Damper
        - Metal plate with viscous liquid
        - 1 cm thick
        - Damper controls speed of vibration

        - Goes under inner tray
        - Modeled after inside of gas tanker
            - Plates have holes in them that allows liquid to pass through but controls rate of liquid passing through
- Sydney’s designs
    - Places to alter
    - Mat between incubator box and sled
        - Some sort of shock absorbing material
    - Magnets
        - Ratio of magnets that are repelling and magnets that are contracting
        - Suspend through the repulsion forces in magnet
        - Similar to hover train
- Joey’s designs
    - Shocks similar to car shocks
        - Under incubator
        - Along all axes
    - Uh oh
        - Piston with electrical component (sensors and arduino)
        - Vertical component has sensor to read vibrational movement
        - Arduino receives input from sensor, applies opposing force to piston
        - Worry about active component: delay in opposing force
- Julia’s design
    - springs/shock absorbers under incubator
    - Limit shaking of equipment to implicitly reduce incubator shaking
        - Between sled and gurney
- Final thoughts
    - Head restraints – include in presentation
    - Magnet idea
    - Damper-based
        - With hinged joints
    - Mat

Conclusions/action items: Complete the design matrix and refine these designs with more research.

2022/09/30 - Meeting with Dr. Kamrath

NEHA KULKARNI - Oct 11, 2022, 11:28 AM CDT

Title: 09/30/2022 Meeting with Dr. Kamrath

Date: 09/30/2022

Content by: Team

Present: Team, Dr. Heidi Kamrath

Goals: Get context for neonatal transport systems outside of UW Health and get feedback on our design

Content:

9/30 Dr. Kamrath Meeting

Goal: Get opinions on designs and get ideas about biggest issues in transport

- Would the magnet design be compatible with different stretcher types?
    - Wouldn't be necessarily on stretcher.
    - Would be placed on sled
- International Biomed types are widely distributed, but sleds sometimes change with aircraft and ambulance upgrades
    - Make design compatible with changes
- How would magnets interfere with other equipment on the transport unit?
    - Dr. Kamrath could reach out to equipment expert
    - Monitors would probably not be affected by equipment
- Make sure we consider how much everything would weigh
    - Especially with air transport
- Mat idea seems cheapest for institutions
    - Think about flammability
        - Must be non-flammable material
- Restraint system
    - Dr. Kamrath uses five-point restraint system like UW
    - Not FAA recommended
    - We would implement head restraint in addition to any design we implement
    - Modifications to restraint system
        - Additional blankets to cushion/pad and take up extra space in incubator
        - Blankets are rolled and around baby like a nest
    - If this could be a stabilizing and noise-reducing effect
- Consider noise reduction of designs
    - Would strengthen design if it could

    - Perhaps include within head restraint system
- Easiest to implement is foam layer
- Most questions about magnet layer
- Most issues are with loading system
    - Anything with a hinge point experiences more tear
- 400-500 transports per year
    - Average of 2 per day – but highly variable
- Do neonates move a lot?
    - More healthy infants more active
        - Turning head, bringing arms/legs up, dislodge equipment potentially
    - Some are sedated
- Most modifications to system occur when equipment is changed, but overall no overhaul of system to address vibrations
    - Using the system as created
- Main issues with transport in general
    - Extra stimulation from motion sometimes requires giving baby more sedation
    - Accessibility to baby
    - Don’t have all the medications that team would normally have in NICU
    - Dislodgement of devices
- Be mindful of temperature control of anything going into isolette

Conclusions/action items: When fabricating and refining our designs, keep in mind Dr. Kamrath's recommendations. Especially, consider weight and temperature.

2022/10/06 - Preliminary Presentation Rehearsal

Joshua Varghese - Oct 12, 2022, 12:17 AM CDT

Title: 2022/10/06 - Preliminary Presentation Rehearsal

Date: 10/06/2022

Content by: Team

Present: Team

Goals: To finalize the preliminary presentation and rehearse it together as a team

Content:

The team met at 5:30 in E hall room 3355 in order to practice the presentation in the very room we would be presenting in the next day. We were able to setup the desktop computer, move around obstacles from the front of the room, and use the projector screen to do a full run through of the presentation. We emphasized movements and transitions so that they would appear smooth and strengthen the professionalism of the presentation. Since our client, Dr. Gollub will be present for the actual presentation, we are even more encouraged to do everything we can to make sure it goes well.

Conclusions/action items: The team has noted where improvements can be made overnight. Small details were changed to the presentation and 2 complete run throughs were done so that the flow of the preesntation could be well developed

2022/10/20 - Ambulance Testing Prep

NEHA KULKARNI - Oct 26, 2022, 10:37 PM CDT

Title: 2022/10/06 - Ambulance Testing Prep

Date: 10/20/2022

Content by: Team

Present: Team

Goals: To plan and prepare for gathering baseline measurements from the ambulance ride.

Content:

- Friday ambulance ride
    - Two in incubator
    - Two on deck
    - Two on floor
- Get a mannequin?
    - Sydney will try to get one from her job
- MATLAB app settings
    - Stream to Log
    - 100.0 Hz
    - Record
        - Acceleration
        - Orientation
        - Angular Velocity
        - Position
- Data analysis
    - PSD?
    - Spectrogram
    - Figures

Conclusions/action items: The team will follow this plan to ensure testing goes smoothly on Friday and that all data is stored and collected correctly.

2022/10/26 - Initial Testing Data Analysis and Design Modification

NEHA KULKARNI - Oct 26, 2022, 10:41 PM CDT

Title: 2022/10/06 - Initial Testing Data Analysis and Design Modification

Date: 10/26/2022

Content by: Team

Present: Team

Goals: To analyze our testing data in Matlab and rework our design based on new findings from our ambulance ride on Friday.

Content:

- Plans to make head restraint
  - Make or buy?
  - Respiratory therapist said they don't use the head restraint bc it's too thick. We could fabricate a head restraint with a thinner strap to test with
    - This could be better to put together for Show and Tell next Friday
- Modifications to current design:
  - Damper with ball and socket joints in front two corners
  - Side dampers towards the front of tray
- Measurements
  - 9.82 mm margin between inner and outer tray on either side
- Modifications to fabrication plan
  - Due to size restraints, cut tube in half crosswise for side pieces and diagonally for corner pieces
    - Tube will half the height, open-faced on one side
  - Stacked layers instead of concentric
    - Foam, foil, gel, foil
    - Make sure layer in contact with inner tray (open side) is foil
- Baseline measurement data
  - Loaded into Matlab
  - Y direction experienced the most vibration
  - Neha: put event log in spreadsheet to correlate

Conclusions/action items: The team will create a new fabrication plan based on the design modifications and continue to run analysis in Matlab to correlate vibrational data with events during the ride.

2022/11/03 - Preparation for Show and Tell

Joshua Varghese - Dec 14, 2022, 6:53 PM CST

Title: 2022/11/03 - Preparation for Show and Tell

Date: 11/3/2022

Content by: Team

Present: Team

Goals: To prepare content for the show and tell this upcoming Friday

Content:

- We decided to fabricate a temporary sled design to help our classmates visualize the inner and outer tray of the incubator
- We are hoping to use the following outline to seek suggestions for our design:
-

  We are the Neonatal Transport group and we are tasked with reducing the vibrations felt by neonates when they are being transported within an incubator either in an ambulance or by helicopter.

  So far, we have created a SolidWorks model of our prototype which shows the dimensioning and layers that we hope to include in the damper.

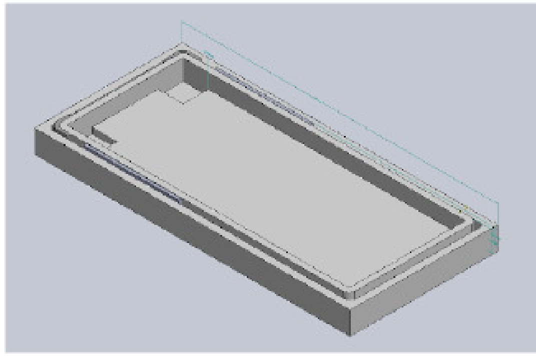
  Current design/progress:
  - Four-layered damper with layers outward of aluminum, silicone gel, aluminum, foam, and stainless steel
    - L-shape in front corners and open-faced rectangle on side between the inner and outer tray
    - Elimination of damper in back corners due to constraint of cylinder rod and track that allow movement of the tray
  - Currently waiting on materials to arrive, but the team plans to fabricate the design by cutting the stainless steel using a band saw or diamond saw blade, and cutting the other components to the correct dimensions using an exact-o knife.

  Baseline measurement collection:
  - Matlab app: recorded acceleration, orientation, angular velocity, and position
    - Plotted normalized acceleration at 6 locations within the ambulance

  Call to action ideas:
  - Best ways to work with the space constraints of the isolette?
  - Based upon the initial description, do individuals feel that the design would reduce vibrations in all directions (x, y, z) or just some of them?
    - Concerns about whether the design will limit vertical vibrations but limitations beneath the tray prevented the implementation of foam below the mat
  - Fabrication recommendations for such a small scale?

Conclusions/action items: The team practice the elevator pitch in order to be ready for Friday

Joshua Varghese - Dec 14, 2022, 6:53 PM CST



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Show_and_Tell_Slides.pptx (832 kB)

2022/11/12 - Fabrication Part 1

Joshua Varghese - Dec 14, 2022, 7:04 PM CST

Title: 2022/11/03 - Preparation for Show and Tell

Date: 11/3/2022

Content by: Team

Present: Team

Goals: To prepare begin the fabricating steps

Content:

- The majority of the materials have arrived, so this week was spent fabricating the prototype in the TEAMLab.
- We are still missing the silicone, which we hope to receive soon.
- Joshua and Julia went to the Makerspace to use the waterjet to cut the sheet metal into the appropriate dimensions
- We plan to continue fabrication next week as well as getting a head start on the final deliverables as that wraps up.

- 

Conclusions/action items: We will continue to do more of the team lab work next week

2022/11/19 - Fabrication Part 2

Joshua Varghese - Dec 14, 2022, 7:14 PM CST

Title: 2022/11/19 - Fabrication Part 2

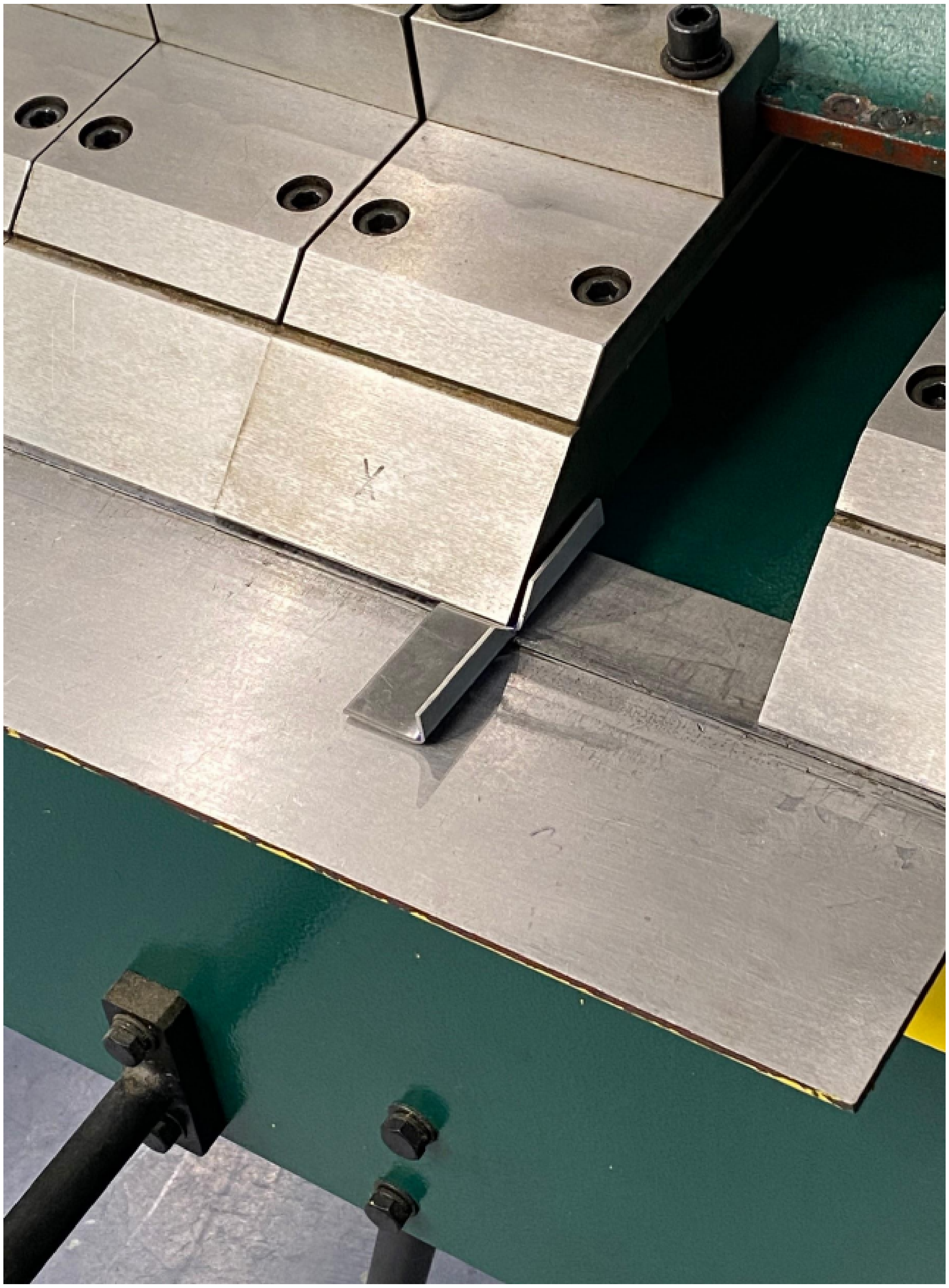
Date: 11/19/2022

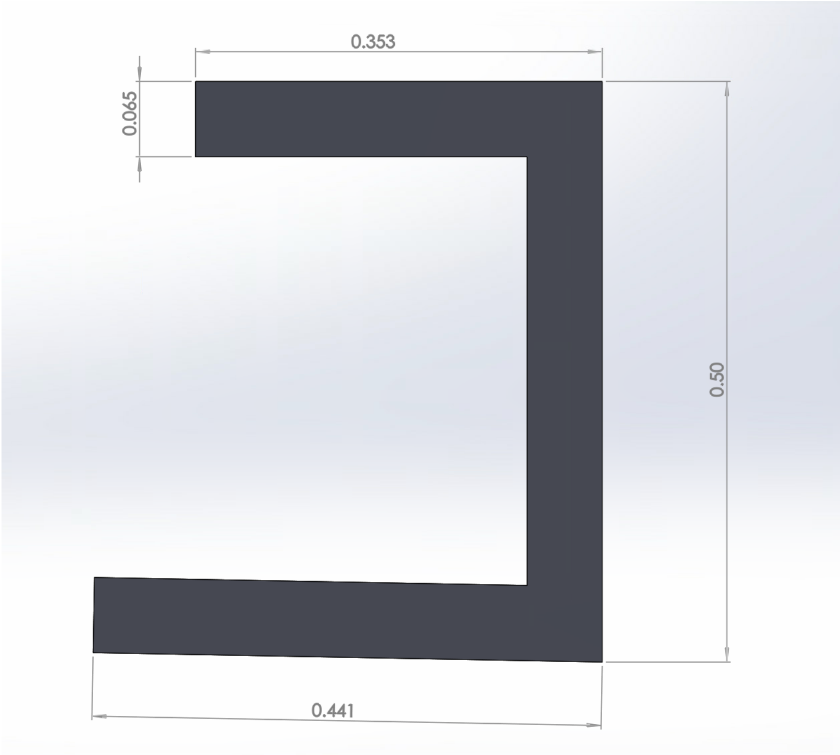
Content by: Team

Present: Team

Goals: To complete the next steps of the fabrication process

Content:

- Joshua and Greta made an appointment with the TEAMLab to mill the metal rod and bend the sheet metal
- Joshua used the sheet metal bender to apply the 2 bends needed to form the corner shape
- 
- Greta used the mill to shave down one side of the square rod and then shorten the other side to match with the slant of the inner tray.

- 

Conclusions/action items: The team will continue to put the fabricated pieces together

2022/12/2 - Fabrication Part 3

Title: 2022/12/2 - Fabrication Part 3

Date: 12/2/2022

Content by: Team

Present: Team

Goals: To complete the final steps of the fabrication process

Content:

- We used this final meeting to glue together the individual layers and prepare our final design
- We ran into an unintended situation where the spray adhesive was difficult to control and got over a significant amount of the prototype so we used nail polish rem
-
-
- 
- 
-

Conclusions/action items: The team will organize a time to meet with MedFlight and conduct the second round of testing

2022/12/08 - Preparation for Poster Presentation

Joshua Varghese - Dec 14, 2022, 8:14 PM CST

Title: 2022/12/08 - Preparation for Poster Presentation

Date: 12/8/2022

Content by: Team

Present: Team

Goals: To prepare content for the poster presentation tomorrow

Content:

- We met as a team to go over our individual scripts with each other to ensure that all of the important information was covered and not repetitive
- We were a bit over time during our rehearsals but we identified that some of the background information could be shortened
- There were a lot of "um"s that will need to be fixed with practice
- I have attached the poster to this entry

Conclusions/action items: The team will continue to practice their portions of the final poster over night to make sure it is memorized

Joshua Varghese - Dec 14, 2022, 8:14 PM CST

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Text_Slash_Final_Poster.pptx (12 MB)

2022/9/16- Initial Client Meeting

NEHA KULKARNI - Sep 18, 2022, 4:06 PM CDT

Title: Initial Client Meeting

Date: 9/16/2022

Content by: Team

Present: Team

Goals: To introduce ourselves to Dr. McAdams and Dr. Gollub, learn more about the inspiration and background for this project, and develop a plan for our collaboration throughout the semester.

Content:

- Goal: introductions, background information, set expectations
- Dr. McAdams' background
  - In Madison for six years, previously at Seattle Children's hospital
  - Research on brain injury, lung injury
  - Device development for low-resource settings
  - Previous Air Force experience
    - With ground transport and flight transport
- Josh Gollub background
  - Neonatologist
  - Research in limiting handling of babies and improving outcomes
  - Improving outcomes for neonates with transport
- Next meeting(s):
  - videos/photos about neonatology
    - Size of patients
    - Equipment
  - Go to NICU at some point
    - Meriter
    - Get measurements, photos, videos, other specs
  - Get into a rig/transport
- Babies being transported are in incubators
  - Many have life-threatening conditions
  - Forces during transport impact baby
    - Many are not quantified
    - True impact of forces cannot be determined
      - Some of this is in literature
- Hope: develop proof of concept
  - Approval process is rigorous, time consuming
    - Consider safety, testing, cost, marketing
- Goal: get a lot of firsthand experience in medical realm with babies
  - Josh and Dr. McAdams will provide education and mentorship
- Goal: present at pediatric research conference
  - Maybe: turn into a publication
  - Maybe: get product on marketplace
- Communication and availability
  - Work collaboratively
  - Be responsive, communicate often
  - Text/call Josh 314-

        - Less availability in person in September (on service in NICU)
        - In October/November, more in-person availability to work as a team
            - In whatever capacity we need for testing, design, medical knowledge, access to materials
    - During service, less/different availability
    - Frequent meetings (weekly check-ins)
        - Hopefully on site
        - Every other week definitely
        - Weekly zoom meetings at least
    - Progress reports
        - Include questions for client
- Use transport team as a resource
    - Present designs to them, defend designs to them
    - Get their input
- Goal: keep baby from moving, but allow some mobility so baby is not absorbing all forces
    - Use mannequins with sensors to test – we would make these
    - Use sensors in transport to test
- Find scope of project
    - What forces can we address?
    - How much stress can we mitigate?
- Bobbing owl head concept
    - Some component of bed allows ranges of motion
    - Movement allowed so that baby doesn't feel force
        - What is the effect of this movement?
    - Rocking motion absorbs energy, not baby's body is basic principle
- We decide the scope of what we are going to modify
    - Consider cost
    - Add onto existing equipment
    - Don't want to come up with whole new line of incubators
    - How can we modify an existing incubator?
        - Insert that can be locked in place?
    - Ideally this product can exist in conjunction with existing equipment
- Budget is flexible
    - Start with constraints, more if needed
    - Further modifications will take more money
    - Start with developing best design, then consider cost
- Create list of what we don't know
    - Find literature about it
- Transport unit is at American Family Children's Hospital
- Focus on ground transport for this project
    - More common
    - Easier to test
- Transport times vary a lot
    - More recently, if a ground transport takes more than an hour they will switch to air
    - Most times are ideally around an hour, could get up to 3-4 in some cases
- Forces to measure
    - Vibration, gravitational, rotational, sound
    - Measure mannequin, rig, ambulance?

Conclusions/action items:

This initial client meeting was scheduled to acquaint ourselves with the client and with the project. Dr. McAdams advised us on how to get started with our project, and we are hoping to get some initial measurements and specifications on a planned visit to the Meriter NICU. We have planned to check in with Dr. McAdams and Dr. Gollub at least every other week on our progress.

2022/9/23- Meeting with Dr. Gollub at Meriter NICU

NEHA KULKARNI - Oct 12, 2022, 2:13 PM CDT

Title: Meeting with MedFlight for Measurement Collection

Date: 9/23/2022

Content by: Team

Present: Team

Goals: To see the Meriter NICU and understand the context of neonatal care and transport.

Content:

- Meriter NICU meeting with Dr. Gollub
- Neonates are incredibly small, fragile
- Can be as small as 700 g
- Equipment in use is also incredibly small
- Incubator capabilities
- Temperature control
    - Radiation heat for larger babies or direct heat for smaller babies
- Ports for nurses/doctors to reach in
- Oxygen
- Light
- Camera for parents to watch
- Transport incubator
- For use *within* hospital
- Baby born downstairs, placed in transport incubator, wheeled to elevator, up to NICU
- No radiation heat capabilities, but still temp controlled
- Transports are done at AFCH, not Meriter
- Babies are not born at AFCH, but rather at Meriter
- So if a baby is known to be born prematurely it will be born at Meriter so it can directly be treated upstairs at NICU
- Lots of twin units since twins are more likely to be born prematurely

Conclusions/action items: The team will keep this context in mind and make sure that any prototype is compatible with use in a NICU setting.

2022/9/26- Meeting with MedFlight for Measurement Collection

Joshua Varghese - Oct 12, 2022, 2:16 PM CDT

Title: Meeting with MedFlight for Measurement Collection

Date: 9/26/2022

Content by: Team

Present: Team

Goals: To see the transport isolette used to transport critically ill neonates and collect measurements of the system.

Content:

- The team received a tour of the MedFlight ambulance and helicopter that are used for transports.
- The team was able to discuss the current issues with several member of the MedFlight team who are able to provide a firsthand perspective on the issue.

Measurements collected:

Box dimensions

28.5L

10.5H

16W

Wheel diameter

4 inches

Wheel thickness

7/8inch

Tray

25.25L

1.25H

11W

Monitor Box

30.25L

9.75H

18.375W

Helicopter interior clearance

35.75 height

32 width

Conclusions/action items:

The team will continue to look into the design specifications for the International Biomed Voyager model that the hospital uses. We will also prepare our first design sketches and create a design matrix to determine our final design for the project.

2022/12/09 - Client Meeting at Poster Presentation

Joshua Varghese - Dec 13, 2022, 10:22 PM CST

Title: 2022/12/09 - Client Meeting at Poster Presentation

Date: 12/9/2022

Content by: Team

Present: Team

Goals: To hear feedback from Dr. McAdams regarding our progress this semester

Content:

Dr. McAdams was happy with the progress we have made so far and is keen on continuing this project. He presented the following ideas to further pursue next semester:

1. He suggested making an accelerometer system to collect and store data for a long period without the team needing to be present
2. He suggested find a computer modeling system to test the combination of different material options for a damper so that we can spend the money necessary to purchase the best materials.
3. He suggested working towards a published paper in which we can present the whole challenge of vibration amplification within the isolette.

Conclusions/action items:

We will need to schedule an additional meeting with Dr. Gollub to present our final findings and hear his feedback since he was unable to attend the poster presentation.

2022/09/16 - Initial Advisor Meeting

NEHA KULKARNI - Sep 18, 2022, 4:08 PM CDT

Title: Initial Advisor Meeting

Date: 09/16/2022

Content by: Team

Present: Team

Goals: Introduce ourselves to our advisor and receive guidance on moving forward with the initial phase of our project, and set expectations about our work going forward.

Content:

9/16 advisor meeting

- Questions for Dr. Williams
  - Lab Archives expectations?
    - Individual vs group meeting notes, etc - do what makes sense
    - Changing labarchives - using the notebook as a discussion driver
    - participation/labarchives grade
    - No final notebook grade! Maybe
    - Can do collective client/advisor/team meeting notes - specify contributions from individual members
  - Meeting schedule/deadlines
    - Fridays 1-1:30
  - Getting feedback on deliverables
    - Yes, will give us feedback
    - Can read drafts if given enough time - ideal time would be Thursday alongside progress report
  - Would you like to be cc'd on correspondence with our client?
    - Yes!
    - And with Dr. Kamrath as well
  - Measuring devices
    - Ask dr p to borrow the light sensor in green or blue room
    - Download an app for accelerometer and gyroscope
    - Get a microphone and use an app for sound
  - Should we use the same email chain with you?
    - Doesn't matter
    - As long as the communicator sends it or someone else copies everyone
  - Thoughts on proof of concept

        - Course requires some form of prototype
        - Specify client requirements in the PDS - keep Dr. Williams informed on details we gather and some requirements may be able to be modified
    - Relevant codes/standards:
        - Look into transport protocols so we don’t waste time with non-applicable solutions
        - Look into existing market products so we don’t infringe copyright
        - Look more into nature’s solutions

Next week

- Meet in 3355 at 1pm
- Draft of the pds is due

Conclusions/action items:

2022/09/23 - Advisor Meeting

NEHA KULKARNI - Sep 23, 2022, 5:21 PM CDT

Title: 09/23/2022 Advisor Meeting

Date: 09/23/2022

Content by: Neha Kulkarni

Present: Team

Goals: Check in about project progress and get any advice for developing designs

Content:

- Good job on report
    - Make sure to put team name in file name
- Notebooks
    - Spot check every few weeks
    - Grade in canvas for spot checks
    - Read report, cross check with notebook
    - Not graded on number of entries
        - Number of entries should make sense, make things easy to find
    - For group part of notebook, make sure there's an entry for every meeting
        - For group meetings, client meetings, advisor meetings
- Progress Report
    - Split up portions of PDS
    - Going to collect measurements today at Meriter
    - Struggle: without knowing exactly what we need to modify, PDS is hard to make specific at this time
        - We will change it as we move forward and get a more refined design idea
- PDS
    - Continue to revisit as design progresses
    - Competing designs
        - Passive vs active vibration receivers
            - Passive does not respond to changes
            - Active is more electronics-based, responds to changes
                - Battery powered preferred due to standards/practices
- General recommendations
    - Materials need to be sterilizable, non-corrosive
        - Need to exist in all different environments during transport
        - Narrow number of plastics that could be worked with easily at TEAM lab

        - Know materials we will have to make it out of eventually, but can prototype with a preliminary material
        - Make sure that prototype design that can be manufactured with medical grade material
    - Why are hospital instruments white/gray?
        - Provide contrast to things that would make them dirty
        - Avoid red, black, brown
        - Clear also is helpful
- Goals
    - Create preliminary designs by next week
        - preliminary design presentations in two weeks
    - Next week can be hand-drawn sketches, for preliminary design sketches turn them into digital
    - For design matrix, three in matrix is good but if we have six submit them somewhere for feedback
        - Put six designs in progress report for sure

Conclusions/action items: After our visit to the NICU, we will begin developing design sketches to evaluate using our matrix. We will take into consideration Dr. Williams's recommendations about materials and electronics.

2022/09/30 - Advisor Meeting

NEHA KULKARNI - Sep 30, 2022, 2:32 PM CDT

Title: 09/30/2022 Advisor Meeting

Date: 09/30/2022

Content by: Team

Present: Team

Goals: Get ready to craft Preliminary Design Presentation and receive feedback on the design matrix.

Content:

- Next Friday: Preliminary Design Presentations
    - Same room as usual in E Hall (3355)
    - 1:20
    - Send slides the night before
        - If want feedback, send by Wednesday night at the latest
    - Feel free to use own laptop
        - Have backup tech plan
    - 15 min slot
        - Plan for 10-12 min presentation
        - Few minutes for questions
    - Practice together as group
        - Make sure we're under time
        - Make sure content delivery makes sense
        - Smooth transitions
    - Invite clients
        - Include directions to E Hall, room
        - Zoom accommodations available if needed, but not preferred
- Design matrix feedback
    - Could do a sensitivity analysis to see how the matrix is sensitive to category weightage
    - Could swap two category weights to see how the scores are changed drastically
    - Don't want one factor dominating the others unless the client has a very specific requirement
    - Include head restraint addition in presentation
    - Include where cross section is coming from in sketches
- Talk to client about procurement payment processes
    - Want this in place right after presentation
    - Set up Shop at UW account access for us?
        - If Dr. McAdams has an account, this would be the best way

- UW Credit Card would also be a way to buy
    - Shipping could be a logistic issue this way
- Make it easy for them
- Last resort: buy things ourselves and get reimbursed

Conclusions/action items: Begin working on Preliminary Design Presentation. Contact client about procurement and invite them to presentation.

2022/10/14 - Advisor Meeting

NEHA KULKARNI - Dec 12, 2022, 9:39 PM CST

Title: 10/14/2022 Advisor Meeting

Date: 10/14/2022

Content by: Team

Present: Team

Goals: Check in about presentation feedback and moving forward with fabrication

Content:

- 10/14 Advisor Meeting

Presentation feedback

- Will be posted to canvas page
- Well-prepared
- Designs were clear
- Decision explanation was good
- Good figures
- Some slides were too busy/too many labels
    - Zoom in on what's important for audience to know what they should be looking at
- Design 3
    - What part of drawing is the actual design feature?
    - label/inset/zoom in

Plan for coming week

- Waiting to hear back about how to buy materials
    - Clarify ordering process soon since things are going out of stock
- Trying to get time scheduled for driving around in ambulance for baseline measurements
    - Will probably happen either Monday or Friday, Friday preferred

Invention Disclosure Report for WARF

- Fill out form
- Doesn't have to be perfect
- Include team, client
- Though we may still be at the beginning of designing/refining, still a good idea to get a walk through of the process

Julia and Neha should get green permits soon

- We need it for 201 anyway

Meet with Dr. Nimunkar about sensors/Arduino

- MATLab app might be easier for initial measurements
    - Concern: mass of phone will dampen vibration
- Arduino will be better for final measurements
- Could 3-D print mannequin with areas for sensors (bonus idea for a later semester)

Expect grades in canvas soon

Conclusions: The team will begin to move forward with planning testing and fabrication while coordinating material ordering.

2022/10/21 - Advisor Meeting

NEHA KULKARNI - Oct 26, 2022, 10:43 PM CDT

Title: 10/21/2022 Advisor Meeting

Date: 10/21/2022

Content by: Team

Present: Team

Goals: Check in about materials ordering and grades.

Content:

- Grades are in Canvas
    - Look for comments
    - Figure labels
        - Slides were wordy
        - Instead of bullet points try to say things
        - Some figures had too many labels within them
            - Too much going on in the figure itself

- Show and Tell
- Come in with questions you want answered, specifics you want feedback on
- Deadline to get something put together to show
- Dr. Williams will be there to check in, but mostly moderate
- For this week, view Intellectual Property lecture/considerations
    - Might be early for this project
- Next Friday meeting is virtual
    - Include data in progress report so we can go over it
- MATLab data analysis
    - Meet at ECB on Wednesdays if we need extra help from Dr. Williams
    - Virtual session is also possible with screen sharing
    - Could also send Dr. Williams code if needed

Conclusions/action items: Continue gathering initial data and as materials come in, make progress on fabrication.

2022/10/28 - Advisor Meeting

NEHA KULKARNI - Dec 12, 2022, 9:41 PM CST

Title: 10/28/2022 Advisor Meeting

Date: 10/28/2022

Content by: Team

Present: Team

Goals: Plan for Show and Tell and get advice on data analysis from testing.

Content:

- Show and Tell next Friday
  - 3355 E Hall
  - Half will stay with prototype, half will go around to other teams, then flip
    - Allows for everyone to give and get feedback
  - Don't have a presentation
    - Can have computer to show data
- Recap of past week
  - Ambulance test on Friday
    - Route with various turns, road types, 40 min total
    - 3 people in the ambulance with 6 phones used as sensors
    - Neha took notes about times when potholes, turns, etc occurred
      - These notes will be correlated with data
  - Modifications to design
    - Back corners can't have corner dampers
    - Keep two front dampers, use side dampers
    - Modifications to fabrication plan
      - Cut tube in half so it can fit
- What to bring to Show and Tell?
  - If nothing shows up, create detailed SolidWorks model or get help with data analysis
- Data analysis
  - Phones didn't seem to be time synchronized – delay in ripples
    - Verify if that's real
  - Green is chest cavity, got started last
  - Signal processing toolbox will be helpful
    - Try FFT to get basic spectral density calculation
      - Will be helpful, especially because we're not getting 0 baseline
      - FFT will normalize automatically

  - Normalize scales on graphs too
  - Spectral density will give us frequencies that are most prevalent
    - This would be helpful in guiding our design
    - What frequencies are we able to damp out?
  - Y direction has greatest variance in magnitude, which could show more vibrations
  - Could group floor, sled, mannequin measurements together
  - It is important to note which components experience the most vibration, so we can tweak the design to damp the vibration more in one direction

Conclusions/action items: The team will begin data analysis and work on something to present at show and tell depending on what materials arrive.

2022/11/21 - Advisor Meeting

NEHA KULKARNI - Dec 12, 2022, 9:47 PM CST

Title: 11/21/2022 Advisor Meeting

Date: `11/21/2022

Content by: Team

Present: Team

Goals: Update on fabrication progress, and come up with a testing plan.

Content:

- Fabrication progress
    - Waiting on silicone
    - Once that arrives we can finish up
- Testing plan
    - Hopefully early next week we can do an ambulance run
    - Meet with Dr. Williams afterwards to get help analyzing data
        - Most likely on Monday of the following week, so no need for Friday meeting

Conclusions/action items: The team will plan a test run while we wait for the silicone.

2022/12/5 - Advisor Meeting

NEHA KULKARNI - Dec 12, 2022, 9:57 PM CST

Title: 12/5/2022 Advisor Meeting

Date: `12/5/2022

Content by: Team

Present: Team

Goals: Get ready for poster presentations and get advice on wrapping up data analysis

Content:

- Poster logistics
    - Schedule is up on BME website
    - We are poster 31 at 1:20
    - Printing on wednesday at college library
        - Make a reservation to guarantee a time to print
    - Send to Dr. Williams for feedback as soon as we're done
    - Everyone should be at poster at given presentation time
    - Upload poster to website under deliverables
    - Invite clients
- Testing analysis
    - High frequency power seems to be dampened
    - Dampening can spread out the power, we may be seeing some of that
        - Not quite as high of peaks but more spread out
            - This is good
            - Rather have lower power across more frequencies instead of higher power at one
    - 20 is still a high frequency to have
    - Figure out what these frequencies should be based on materials
    - Most of dampening in our case comes down to material and the construction
        - Mass
        - Thickness
        - Elasticity
        - May be helpful to play around with these more, look into these
    - Metals as dampeners act like springs
    - Polymers have viscoelastic properties, like shock absorbers
    - From material properties, there should be basic equation to find spring model/capacitor model
        - K constant for spring

            - C constant for polymer
            - From these, calculate frequency response
        - Statistical analysis
            - T Test is not appropriate
                - We only have one trial, don't know variability
            - Repeated measures experiment
                - Think about each minute of the ride as an experiment
                - Would give an idea of variance
            - Hone in on areas of interest
                - Cut it into smaller chunks
            - Could do a bin of every hertz, account for statistical cost
                - Then we're looking for ranges that are statistically significantly different
                - Ex. everything from 10-23 is significant
                    - Hopefully this lines up with what we wanted
        - Should we focus on power/Hz or acc vs. time?
            - Frequency will be cleaner and more straightforward
        - Do the analysis, then for bin of frequencies that looks to be different, then plot histogram at power of frequency at each of time bins
            - This should be normally distributed
            - You can start with the assumption that it is normally distributed
- Solidworks
    - Join layer parts and then do a cut
        - This should cut everything at the same time
    - Could also click on exposed cut edge, and change that face and constrain it in x direction
        - Scale part in one direction
    - Unlink parts
        - Made then within the model a new entity

Conclusions/action items: The team will prepare the poster and continue data analysis.

2022/12/07 SolidWorks Models of Final Design

SYDNEY THERIEN - Dec 07, 2022, 3:45 PM CST

Title: SolidWorks Models of Final Design

Date: 2022/12/07

Content by: Sydney Therien

Present: Team

Goals: To model the final device as-fabricated in SolidWorks for visualization after the final tinfoil layer has been added.

Content:

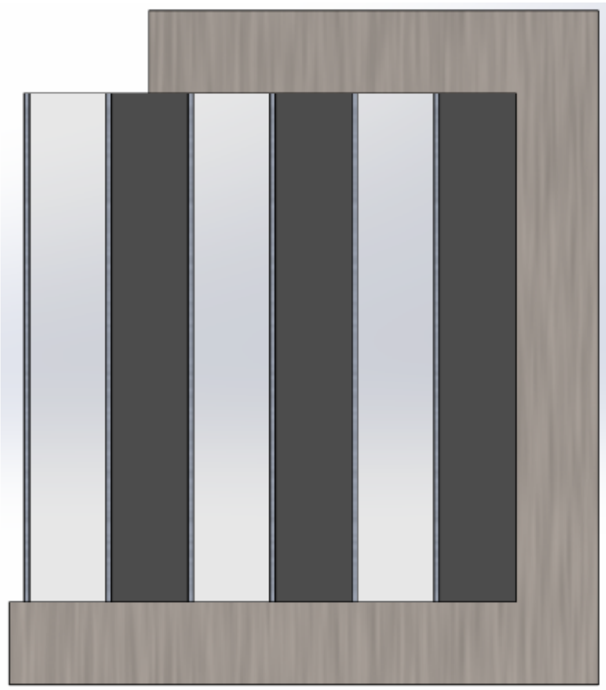


Figure 1: A cross-sectional sideview of the side damper.

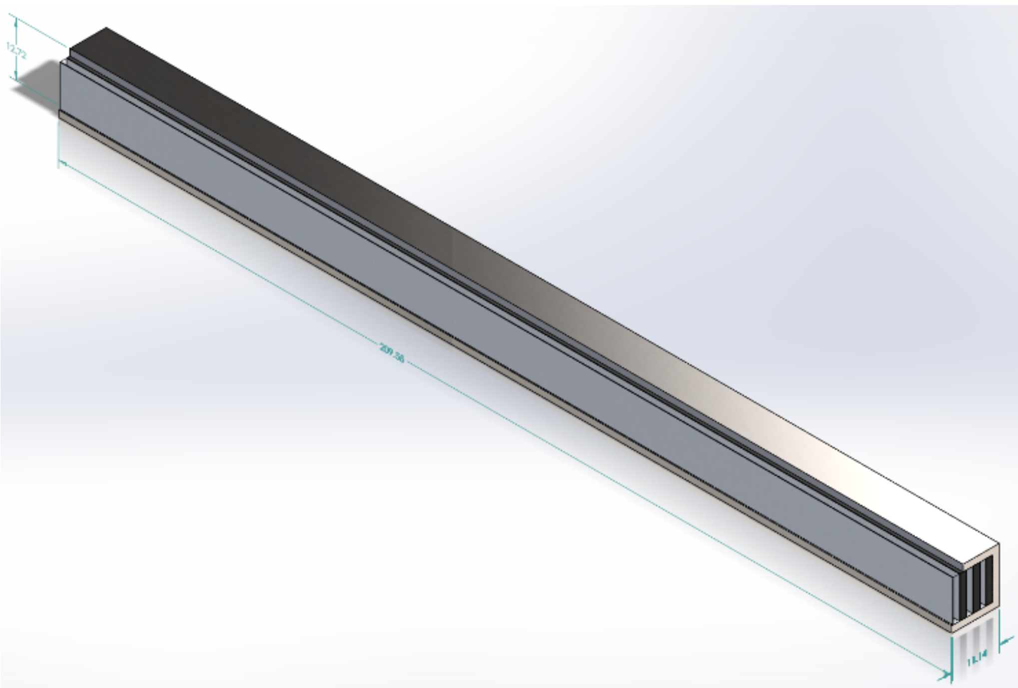


Figure 2: A trimetric view of the side damper. Dimensions are in mm.

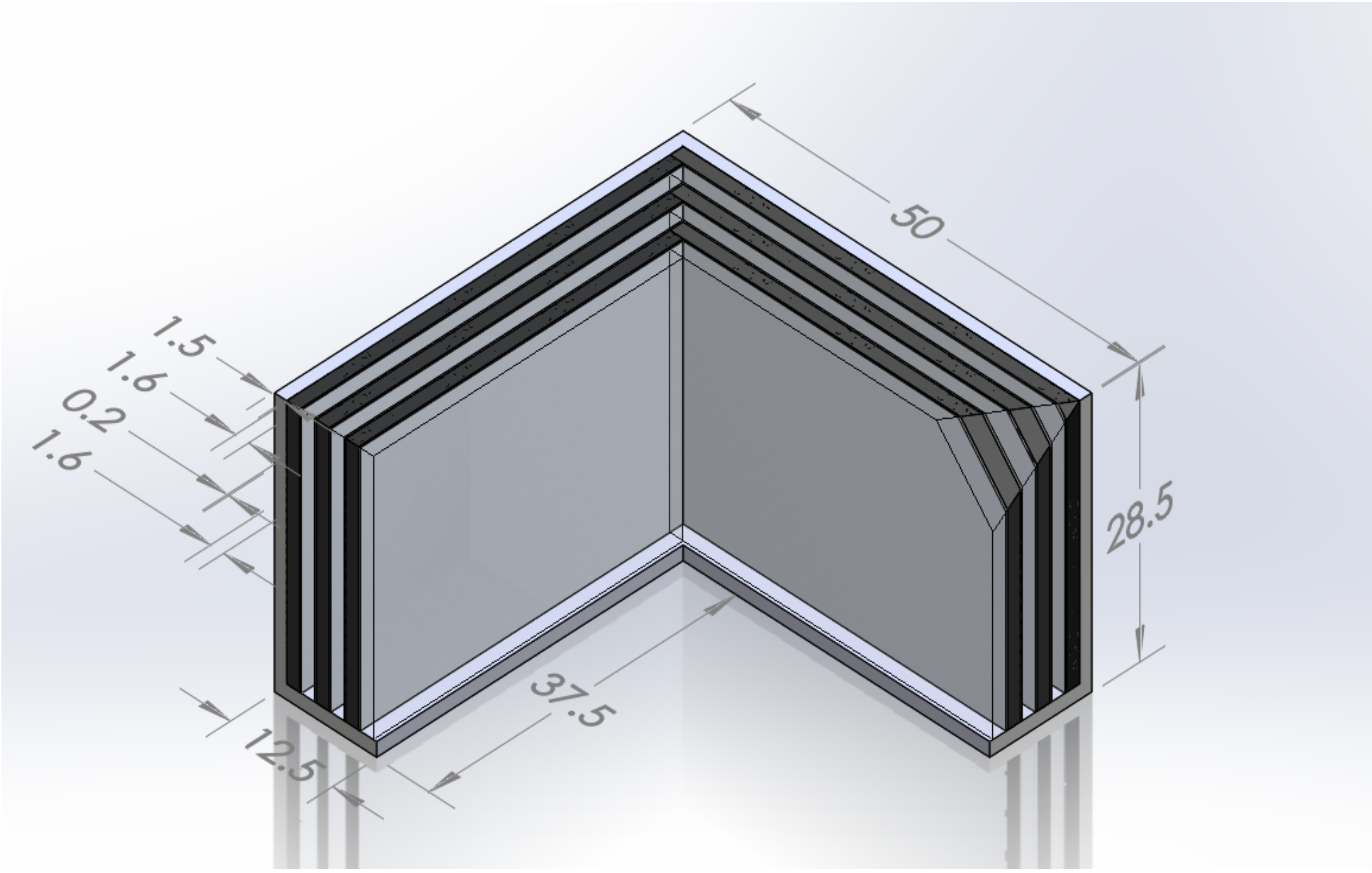


Figure 3: A trimetric view of the corner damper with a cutaway view on the upper right corner to better visualize the layers. Dimensions are in mm.

Conclusions/action items:

- add these images to the poster and final report

2022/12/14 Damper Placement in Isolette

GRETA SCHEIDT - Dec 14, 2022, 8:24 AM CST

Title: Damper Placement in Isolette

Date: 12/14/22

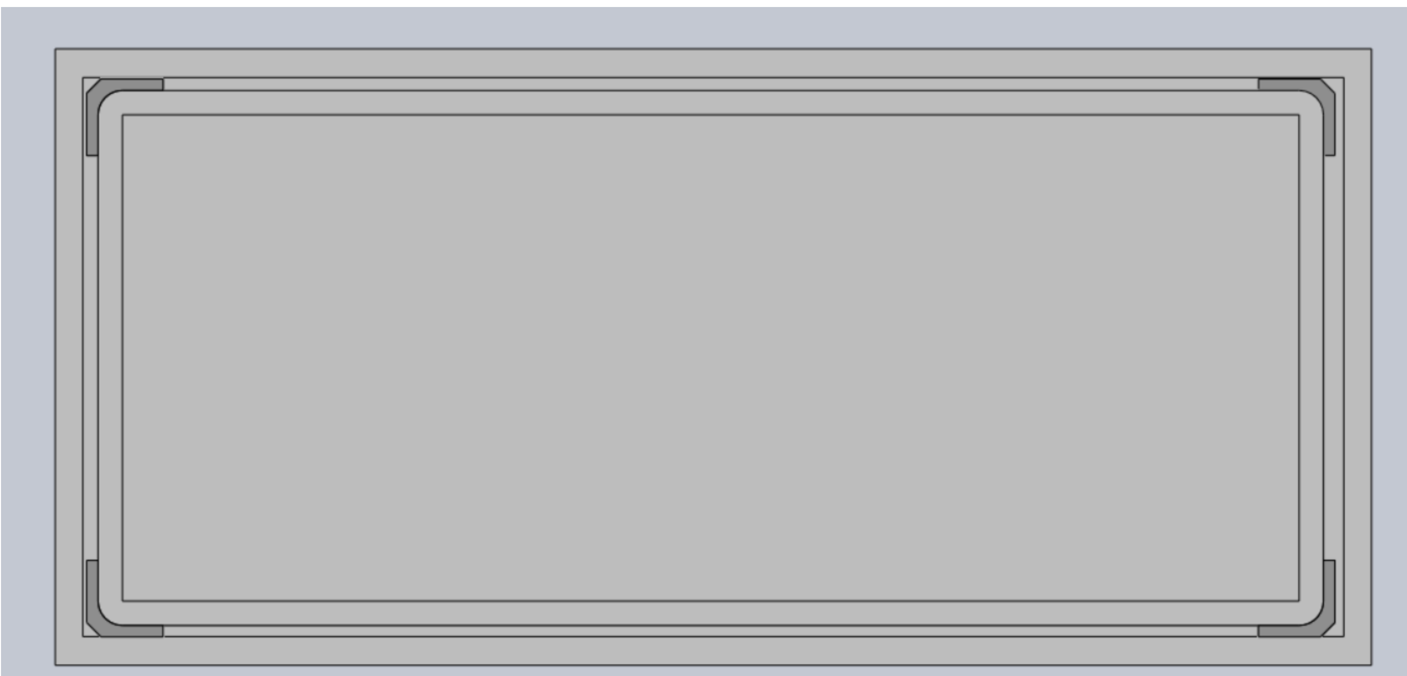
Content by: Greta Scheidt

Present: Team

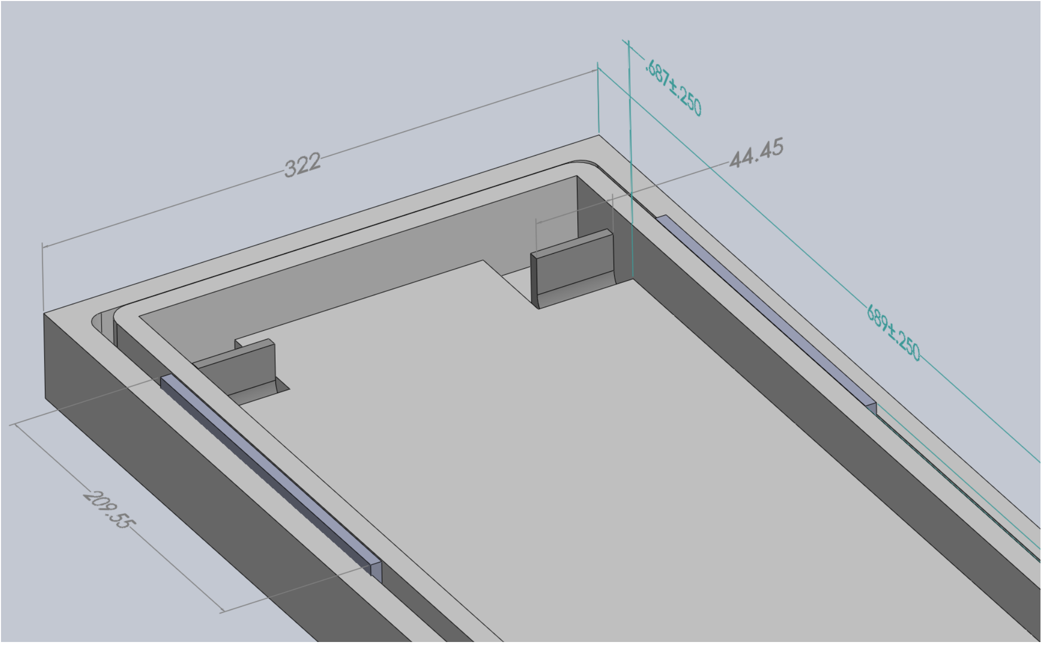
Goals: Create a dimensioned Solidworks drawing that showcases the modifications that were made to damper placement over the course of the project.

Content:

The initial plan for the L-shaped corner dampers was to place them between the inner and outer trays of the isolette in the corners, such that the damper would wrap around the corner of the inner tray. This plan is shown below.



However, due to space constraints that were identified during the testing process, the dampers were turned and placed in a different orientation. The dampers were placed through the holes in the base of the inner tray near the corners. One side of the L-shape was placed beneath the inner tray with the stainless steel side resting against the outer tray and the outermost silicone gel layer resting against the bottom of the inner tray. The other side of the L stuck straight up through the hole, which ended up reducing some sliding of the mattress during transport. The damper placement used can be seen below.



Conclusions/action items: The team should continue to evaluate whether the dampers will be placed in this orientation in future testing, or if a reduction of layers should be completed to ensure that the damper can fit as originally intended in the corners of the tray. There is some benefit to having damping material both below the tray and around the sides, however the dampers do occlude some of the space in the inner tray in this orientation.

2022/10/08 - Materials Brainstorm

NEHA KULKARNI - Oct 11, 2022, 11:33 AM CDT

Title: Materials Brainstorm

Date: 10/10/08

Content by: Neha Kulkarni

Present: Neha Kulkarni

Goals: Research material options for our design and come up with a tentative fabrication plan.

Content:

- Stainless steel
    - Grainger stainless steel sheets https://www.grainger.com/category/raw-materials/stainless-steel/stainless-steel-sheets-plates/standard-stainless-steel-sheets-plates?categoryIndex=1
    - Grainger stainless steel foil: https://www.grainger.com/category/raw-materials/stainless-steel/stainless-steel-foil?categoryIndex=6
    - Grainger stainless steel rectangular tubes: https://www.grainger.com/category/raw-materials/stainless-steel/stainless-steel-tubes/rectangular-stainless-steel-tubes?categoryIndex=2
    -
- Aluminum
    - Grainger aluminum sheet: https://www.grainger.com/category/raw-materials/aluminum/aluminum-sheets-plates/standard-aluminum-sheets-plates?categoryIndex=1
    - Grainger aluminum foil: https://www.grainger.com/category/raw-materials/aluminum/aluminum-foil?categoryIndex=6
    - Grainger aluminum tube: https://www.grainger.com/category/raw-materials/aluminum/aluminum-tubes/rectangular-aluminum-tubes?categoryIndex=2
- Foam
    - Couldn't find foam but did find neoprene elastomer on grainger which is used for sound and mechanical vibration absorption
    - https://www.grainger.com/product/AIRLOC-Vibration-Isolation-Pad-Sheets-3ECL9
- Silicone gel sheet
    - Medical grade silicone sheet: https://www.grainger.com/search/raw-materials/rubber/rubber-sheets-strips-rolls/silicone-high-temperature-rubber?filters=webParentSkuKey&searchQuery=silicone&webParentSkuKey=WP13435109&sst=4&tv_optin=true
- Ball and socket joint/pin joint
    - Coiled spring pin: https://www.grainger.com/category/fasteners/pins/spring-pins?categoryIndex=9
    - Cap nut
    - https://www.grainger.com/category/fasteners/nuts/cap-nuts?categoryIndex=3

Based on available materials, possible modifications:

1. Lose layers due to size constraints

    1. Could fill a stainless steel tube with the foam and/or silicone, rather than nesting an aluminum layer within a stainless steel layer

2. Ball and socket as modeled currently might have to be fabricated. Coiled spring pin provides a good alternative since it is capable of adapting to various forces

I tProposed fabrication plan (concentric layers):

1. Outer layer: stainless steel tube
    1. Removes need for welding and any errors that could cause
2. Next layer in:
    1. Neoprene elastomer
3. Innermost layer:
    1. Silicone gel

** This proposed plan removes the aluminum layer due to size constraints.

Proposed fabrication plan (stacked layers):

1. Outer layer: stainless steel tube
2. Multilayered pattern within tube
    1. Neoprene
    2. Aluminum foil (or sheet if we can get it thin enough)
    3. Silicone gel
    4. Repeat these layers as many times as can fit in tube

Conclusions/action items: Concentric layers are the preferred configuration. Due to stocking issues, some materials may need to be sourced from other accredited vendors. We will continue to research available options to put together a final fabrication plan.

2022/12/12 Materials and Expenses Spreadsheet

GRETA SCHEIDT - Dec 12, 2022, 8:57 PM CST

Title: Materials and Expenses Spreadsheet

Date: 12/12/22

Content by: Team

Present: Team

Goals: The goal of the expenses spreadsheet is to create a reference to all materials ordered over the course of the semester and ensure that the total cost of all items stays under the budget outlined by the client.

Content:

Item	Description	Manufacturer	Part Number	Date	QTY	Cost Each	Total	Link
Component 1: Dampers								
Stainless Steel Rectangular Tube	To be used as the outer housing for the dampers.	Grainger	786G80		1	$22.80	$22.80	Stainless Steel Rectangular Tube
Stainless Steel Sheet	"Caps" that will be welded to the open ends of the rectangular tube	Grainger	796XW3		1	$64.99	$64.99	Stainless Steel Sheet
Vibration-Dampening Pad	Component of the damper inside the rectangular tube	McMaster-Carr	5940K57		1	$51.24	$51.24	Vibration-Damping Pad
Reynolds Wrap Aluminum Foil	Component of the damper inside the rectangular tube	Reynolds (from Target)	N/A		1	$6.29	$6.29	Aluminum Foil
Matte Non-Reinforced Silicone Sheeting	Component of damper inside the rectangular tube	Specialty ManufacturingInc. (SMI)	N/A		1	$26.00	$26.00	Silicone Sheeting
Component 2: Attached Roller								
Stainless Steel Coiled Spring Pin	Attached between the cap nut and damper to reduce vibrational forces	Grainger	41LZ72		1	$22.32	$22.32	Spring Pin
Cap Nut	Attached the cap nut and butting against the incubator tray to allow movement.	Grainger	6NY12		1	$14.64	$14.64	Cap Nut
Component 3: Adhesive								
3M Series 27 Spray Adhesive	Used to attach various components together	3M (from Grainger)	6KWY1		1	$13.68	$13.68	Spray Adhesive
						TOTAL:	**$221.96**	

Conclusions/action items: Place this table in the appendix of the final report as a reference to all materials purchased and used over the course of the semester.

2022/11/10 Steel Fabrication Plan

GRETA SCHEIDT - Nov 10, 2022, 4:15 PM CST

Title: Steel Component of Damper Fabrication Plan

Date: 11/10/22

Content by: Greta Scheidt

Present: Greta Scheidt, Joey Byrne

Goals: Determine the feasibility and methods of stainless steel fabrication for use in the side and corner dampers.

Content:

Fabrication plan based upon TEAMLab design consultation with Jay Bowe

Corners:

1. Water jet to cut sheet to desired length for corner dampers

1. Sheets will then be bent to form L-shape to be used in corners
    1. Sheet will be easier to bend than tube (no easy way to bend metal with 3 walls)
2. Jay will help to bend material into L-shape

Side dampers:

1. Use drop saw to cut tube close to desired length
2. Square ends using a mill
3. Use mill to remove one side by milling down the thickness of the wall
    1. Place tube in vise on parallels with face you are removing barely sticking out the top of the vise (enough that the end mill doesn't hit the vise)

General Notes:

- Dimensions of steel are well within constraints of TEAMLab machinery
- Use quick clamps to hold everything together in the TEAMLab when applying adhesive
- Speeds on mill are different for stainless steel than aluminum (use RPM calculator on TEAMLab website to determine speed)
- No recommendations on a way to decrease the thickness of the foam or gel, may be able to keep thickness since we are doing stacked layers instead of concentric. Otherwise, we may need to remove a layer

Conclusions/action items: Develop more detailed fabrication plan and dimensioned sketch for use in fabrication. Dimension corner steel using Water Jet and set up time with Jay to complete the rest of steel fabrication.

2022/11/14 Steel Housing Fabrication Side Dampers

GRETA SCHEIDT - Nov 29, 2022, 4:35 PM CST

Title: Steel Housing Fabrication Fabrication Side Dampers

Date: 11/14/22

Content by: Greta Scheidt

Present: Greta Scheidt

Goals: Modify rectangular steel tube to fit the dimensions needed for the design

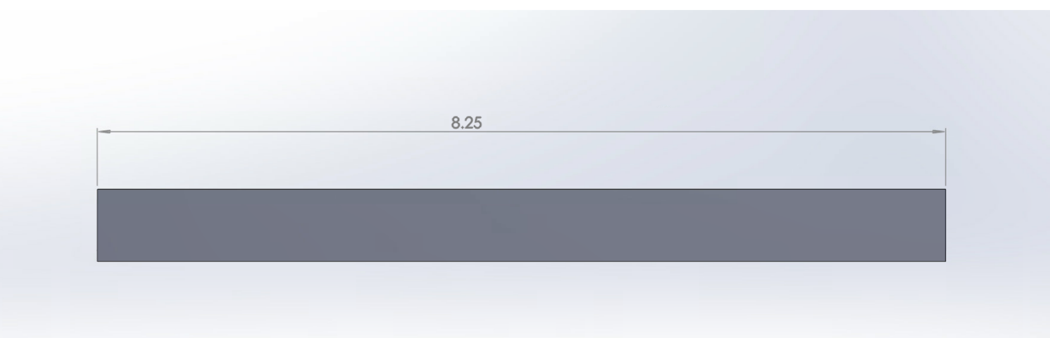
Content:

Procedure used to create the steel housing for two side dampers.

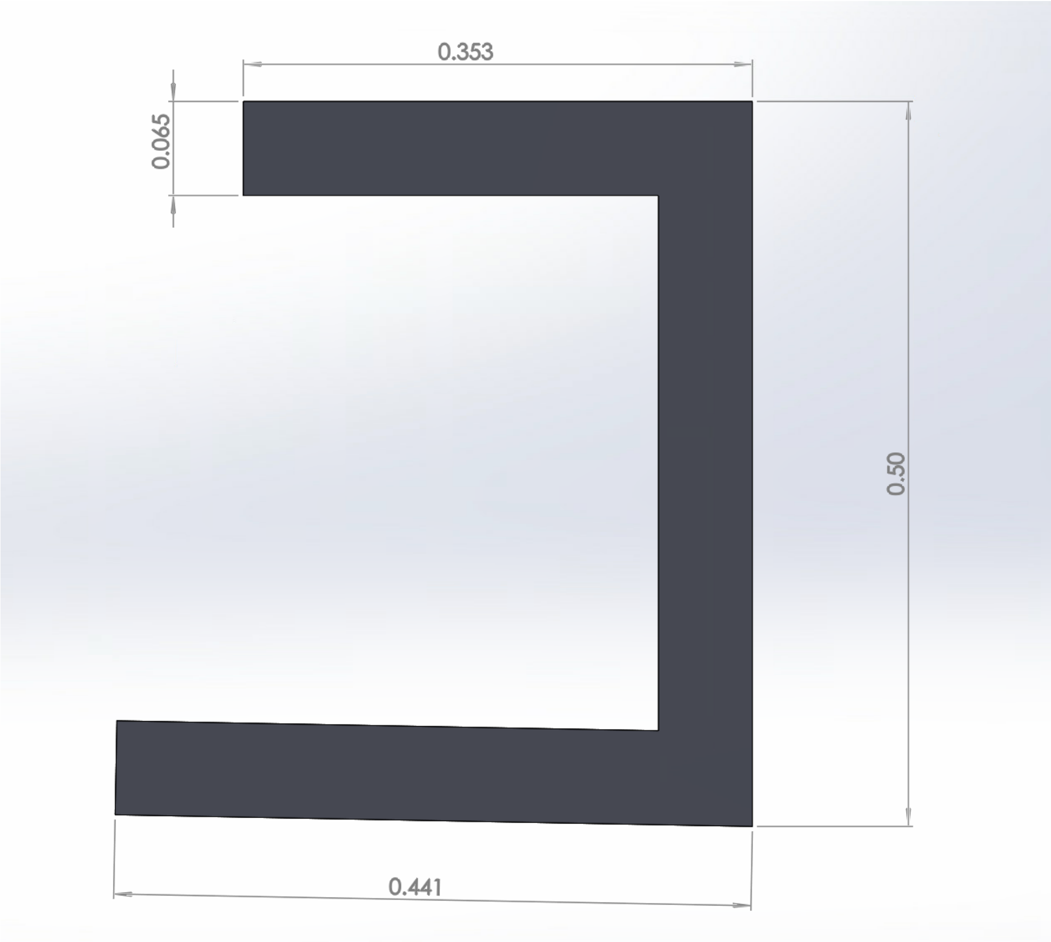
1. Use drop saw to cut tube close to desired length (8.25 inches with a tolerance of 0.25 inches)
2. Square ends using a mill.
3. Use mill to remove one side by milling down the thickness of the wall (0.065 inches)
    1. Place tube in vise on parallels with face you are removing barely sticking out the top of the vise (enough that the end mill doesn't hit the vise)
    2. Run mill at an RPM of 153 and complete two passes of 0.03"
4. After removing 1 side, shorten upper wall by 0.09 inches
    1. Inner tray wall is at a moderate slant, shortening the top wall will allow the pieces to be flush with one another

Dimensions of part:

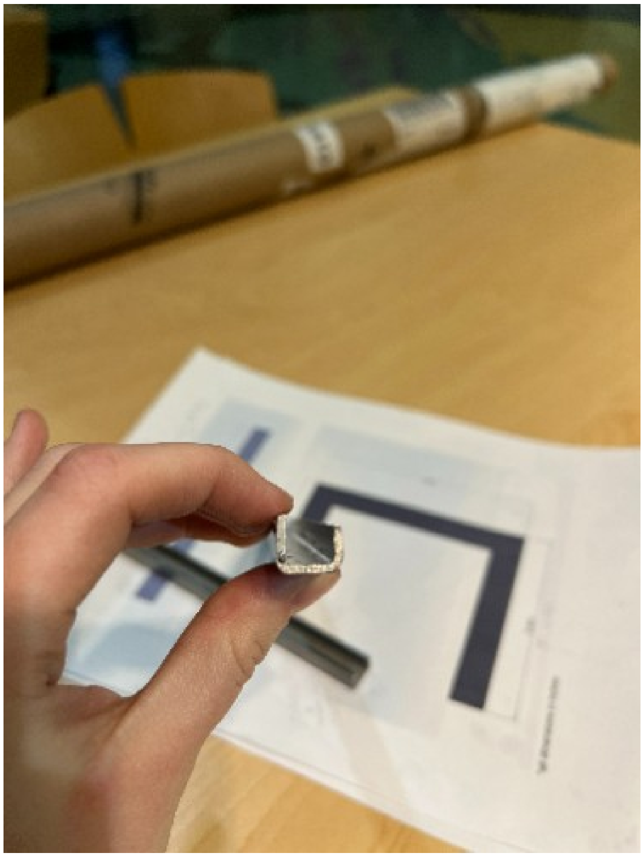
Right side view:



Front view:



Images of completed part:



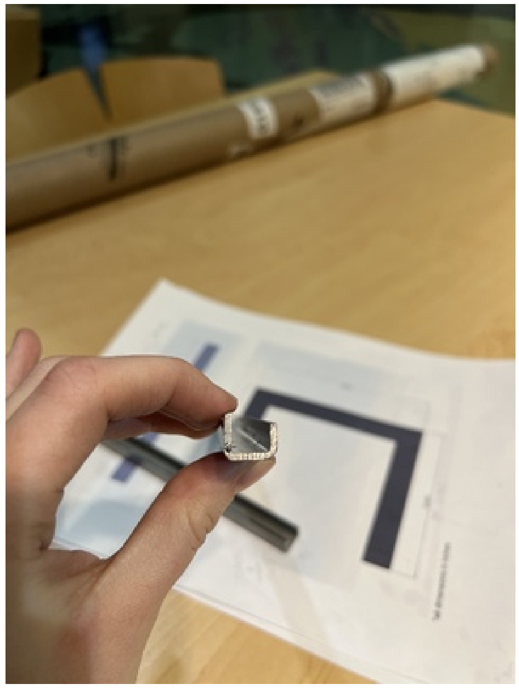
Conclusions/action items: After this step, the foam mat was cut to desired length and thickness to fit inside of the corner and side damper steel housings. The next steps are to cut the aluminum foil and silicon sheet to desired dimensions and then use the adhesive spray to glue all components together. After this step is finished, the design will be tested by repeating the accelerometer data collection set-up with the same ambulance route.

GRETA SCHEIDT - Nov 29, 2022, 4:35 PM CST

Download

Steel_Component_Side_Damper.SLDPRT (66.2 kB)

GRETA SCHEIDT - Nov 29, 2022, 4:35 PM CST



Download

Side_view_Steel.jpg (3.03 MB)

GRETA SCHEIDT - Nov 29, 2022, 4:35 PM CST

Download

Top_View_Steel.jpg (3.53 MB)

2022/12/8 Prototype Fabrication Protocol

GRETA SCHEIDT - Dec 14, 2022, 11:44 AM CST

Title: Damper Prototype Fabrication Protocol

Date: 12/8/22

Content by: Greta Scheidt

Present: All of team

Goals: Provide a step-by-step guide to building the prototype from start to finish.

Content:

Side dampers (x2):

1. Measure and cut the stainless steel tube to 8.25 in long using a drop saw.
2. Square ends using a mill.
3. Use a mill to remove one side by milling down the thickness of the wall (0.065 inches) using a ⅝" colette and end mill.
    1. To do this, place the tube in a vise on parallels with the face you are removing sticking out of the vise just enough that the end mill doesn't hit the vise.
    2. Run the mill at an RPM of 153 and complete two passes, taking off 0.03" each time.
4. After removing one side, shorten one of the exposed remaining walls by 0.09 inches. Creating a slanted edge will allow the damper to sit flush with the outside of the inner tray in the isolette.
5. Cut foam to 8.25 x 0.375 x 0.0625 inch pieces. Cut length and width using a breaker and cut thickness using an X-acto knife.
6. Cut gel to 8.25 x 0.375 x 0.06 inch pieces using scissors.
7. Cut foil to 8.25 x 0.375 inch pieces using scissors.
8. Spray tube with adhesive and place foam piece in bottom of tube. Apply even pressure on the layer for 10-15 seconds.
9. Spray foam with adhesive and place aluminum foil piece on top. Apply even pressure on the layer for 10-15 seconds.
10. Spray foil with adhesive and place gel piece on top. Apply even pressure on the layer for 10-15 seconds.
11. Spray gel with adhesive and place additional foil layer on top. Apply even pressure on the layer for 10-15 seconds.
12. Repeat steps 6-8 three times or until a silicone gel layer is flush with the top of the tube.
13. Tinsnip any overhanging edges.
14. Cover the exposed edge with aluminum foil to seal layers.

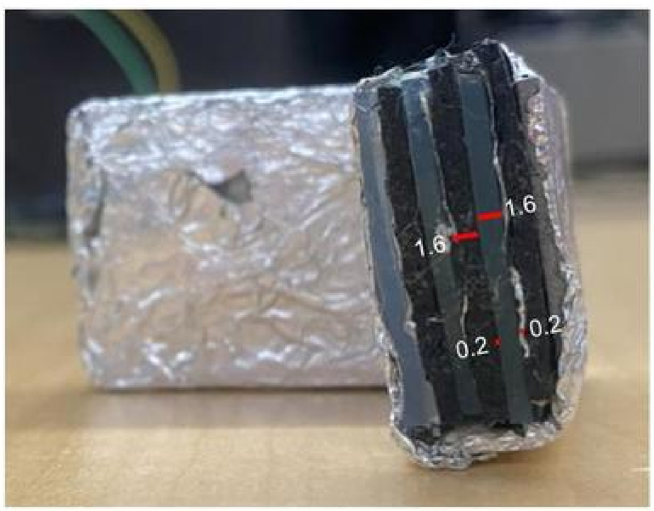
Corner dampers (x2):

1. Measure and cut the stainless steel sheet to 3.4 in long using a water jet.
2. Bend sheet in the center and to create a bottom edge using a sheet metal bending break.
3. Cut foam to 1.2 x 0.375 x 0.0625 inch pieces using a breaker and an X-acto knife.
4. Cut gel to 1.2 x 0.375 x 0.06 inch pieces using scissors.
5. Cut foil to 1.2 x 0.375 inch pieces using scissors.

6. Spray housing with adhesive and place foam against the side of the stainless steel housing. Apply even pressure on the layer for 10-15 seconds.
7. Spray foam with adhesive and place aluminum foil on top. Apply even pressure on the layer for 10-15 seconds.
8. Spray foil with adhesive and place gel piece on top. Apply even pressure on the layer for 10-15 seconds.
9. Spray gel with adhesive and place additional foil layer on top. Apply even pressure on the layer for 10-15 seconds.
10. Repeat steps 6-8 three times or until a silicon gel layer is flush with the bottom edge of the stainless steel housing.
11. Tinsip any overhanging edges.
12. Cover any exposed edges with aluminum foil to seal layers.

Conclusions/action items: Transfer this formal protocol to the appendix of the final report. Steel fabrication went smoothly with the tools available in the TEAM Lab and Makerspace, however there were some limitations to the level of precision we could achieve in fabricating the other layers. Future work should include modifying dimensions of layers to increase fabrication feasibility or exploring additional fabrication methods

GRETA SCHEIDT - Dec 14, 2022, 6:35 PM CST



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Corner_Cutout_Dimensioned.jpg (26.2 kB)

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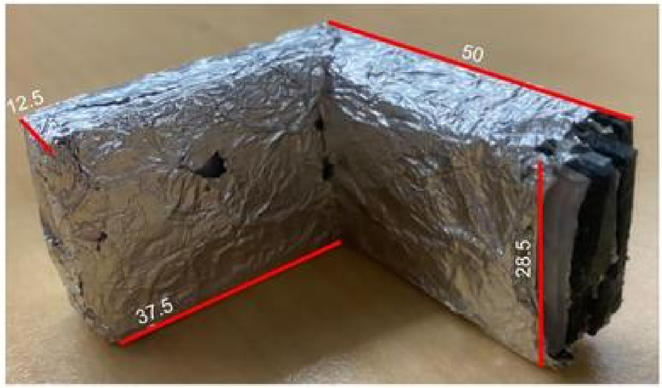

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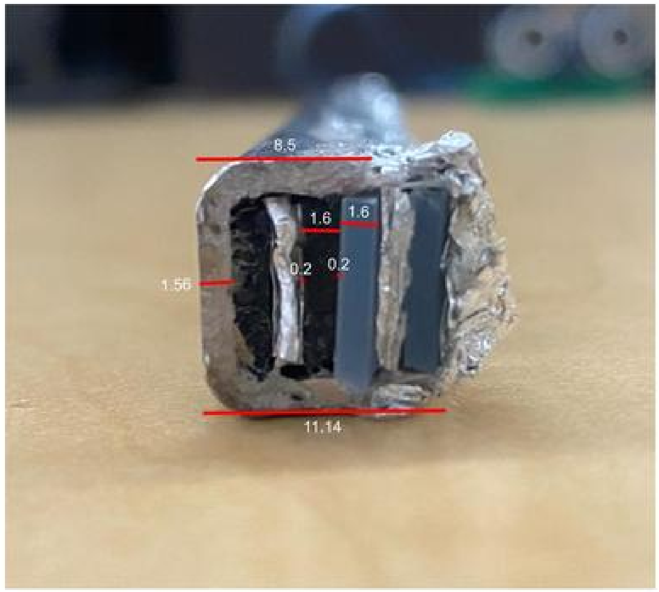

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Side_Cutaway_Dimensioned.jpg (45.6 kB)

2022/10/28 Testing Protocol for Collecting Vibrational Data

GRETA SCHEIDT - Oct 28, 2022, 12:09 PM CDT

Title: Testing Protocol for Measuring Vibration

Date: 10-28-22

Content by: Greta Scheidt

Present: Greta Scheidt

Goals: Formally outline the protocol used for collecting baseline vibrational data, so that the same procedure can be repeated with the inclusion of the manufactured device.

Content:

Vibration is quantified using accelerometer/gyroscope data collected in the Matlab app from six different locations during ambulance movement. The steps of setting up and completing data collection are outlined below.

1. Start by setting up the inside of the International Biomed Voyager isolette as would be done in a typical transport. Place the mannequin on its back with lateral cushions on either side of its head and legs. Secure five-point restraint straps across the shoulders and over the legs.
2. Load transport set-up into the ambulance.
3. Open up Matlab app on all six devices and adjust sensor settings to reflect these parameters:
    1. Stream to Log
    2. Set sample rate to 100.0 Hz
    3. Turn on acceleration, orientation, angular velocity, and position sensors (all sensors except magnetic field)
    4. Ensure device is connected to Matlab drive
4. Secure devices to the six locations described below using tape and ensure that the device is screen side up with the top of the phone oriented in the direction of the front of the sled.
    1. Phone 1 is placed on the mannequin's forehead
    2. Phone 2 is placed in the chest cavity of the mannequin.
    3. Phone 3 is placed on top of the middle of the sled deck directly behind the isolette.
    4. Phone 4 is placed on top of the back of the sled deck.
    5. Phone 5 is placed on the ambulance floor directly in front of the stretcher.
    6. Phone 6 is placed on the ambulance floor directly behind the stretcher.
5. Take photos of the positioning of all devices for reference.
6. Once all devices have been secured, start data collection on all devices (limit time between start of the devices).
7. Complete the testing route as outlined below (takes approximately 30 minutes) and ensure data continues to be logged throughout the duration of the route.

Highland → Speedway

Speedway → Mineral Point

Mineral Point → Whitney Way (left turn)

Whitney → Beltine/ US Highway 12

Exit on S Park Street

Park → University (left turn)

University → Campus Drive

Campus Drive → Highland

Back to AFCH

1. One individual should sit up front in the ambulance to direct the driver and record measurements related to changes in speed, road disruptions, harsh breaks/turns, etc.

2. Individuals seated in the back of the ambulance should make note of visual observations related to vibrational movement of the mannequin, isolette, or overall transport set-up during transport.

8. After completion of the route, stop data collection on phones 5 and 6, title data logs and click save. Allow the other four devices to continue data collection for removal of the transport set-up from the ambulance.

9. After the transport set-up is back on the ground, stop data collection on phones 1-4, title each data log and click save.

Conclusions/action items: This procedure allowed a lot of data to be obtained related to changes in position of different components during transport. This procedure will be repeated with the addition of our experimental device in the transport set-up to analyze whether the device is able to reduce the amplitude of vibration recorded during transport. It is especially important that the same route be followed to minimized differences in road conditions during data collection. A separate protocol should be written to outline analysis of the data collected.

2022/09/28 - PDS

NEHA KULKARNI - Sep 28, 2022, 3:02 PM CDT

Title: Product Design Specifications

Date: 09/28/2022

Content by: Team

Present: Team

Goals: Outline the specifications for our product to guide our design process.

Content:

THE UNIVERSITY of WISCONSIN MADISON

Product Design Specifications: Neonatal Transport Unit

September 23, 2022

BME 300/200

Clients: Dr. Ryan McAdams and Dr. Joshua Gollub

Advisor: Dr. Justin WIlliams

Team Members:

Team Leader: Joshua Varghese

Communicator: Sydney Therien

BWIG: Neha Kulkarni

BWIG: Julia Salita

BPAG: Joey Byrne

BSAC: Greta Scheidt

Function:

Critically ill neonates as a result of birth defects or other disorders require transport to neonatal intensive care units (NICU). The quality of that transport heavily influences survival or morbidity [1]. Transport in ambulances or helicopters, while necessary, induces physiological stressors including vibration, translational inertia forces, and rotational inertia moments [2]. These environmental exposures are associated with intraventricular hemorrhage (IVH) in transferred neonates, leading to subsequent neurodevelopmental impairment or death [3]. The current transport incubator has ventilators, monitoring equipment, and temperature control mechanisms, but no control of the physical stressors aforementioned. The natural frequencies of the incubator (12-16 Hz) accentuates the ambulance's natural frequencies (2.5-15 Hz), resulting in amplified vibration felt by the neonate [4]. The proposed device will oppose the mechanical forces transmitted through the transport vehicle or undergo purposeful motion which acts to absorb such forces. The device will improve neonatal transport outcomes by mitigating the effects of vibration and motion, improving the safety of the critical neonate, and simplifying the required care by the medical transport team.

Client Requirements:

1. The device must minimize vibrational forces such that a critical neonate does not sustain injury.
2. The device must minimize translational and rotational forces enough to prevent injury to critical neonates.
3. The device must mitigate sound levels experienced by the neonate in order to eliminate stress and injury (maximum accepted level of 45 dB) [5].
4. The device must either attach to current incubators or include all the associated functions including ventilators, monitoring equipment, and temperature control mechanisms.
5. The device must be small enough to fit within a standard ambulance and allow the movement of the transport team.

Design Requirements:

1. Physical and Operational Characteristics:

a. Performance Requirements:

- The product must decrease the amount of whole-body vibrations to be below 0.87 m/s^2 as recommended by the ACGIH for the exposure of adults [2].
- The product should be capable of reducing the volume of excessive sound levels to be below 45 decibels in order to prevent permanent hearing damage while riding in the transport vehicle [6] .
- The product should allow the infant to maintain proper vital signs in a range appropriate for its size, age, and condition:
  - A heart rate between 100 and 160 beats per minute [7].
  - A respiratory rate between 30 and 60 breaths per minute [7].
  - Blood pressure of no less than 30mmHg systolic [8].
  - An oxygen saturation level between 85 and 95% [9].

b. Safety:

- The transport bed must allow for continuous treatment and should not disrupt the incubator, mechanical ventilator, or monitoring equipment.
- The device should be sterilizable and resistant to degradation that can be caused by common sterilization chemicals such as ethylene oxide [10].
- The device must not have any sharp edges or long cords that the neonate could interact with.

c. Accuracy and Reliability:

- The device should require no maintenance during its lifetime, but should be easy to remove or replace if any malfunctions occur.
- The device should be functional for neonates ranging from 0.66 to 12 pounds [11].

d. Life in Service:

- The service life of a device should allow for 5,000 lifetime transports, or an estimated 5 years of operation, assuming that all ideal practices and operating conditions are followed.

e. Shelf Life:

- The device should last for a minimum of 7 years if any electrical components are involved in the design or a minimum of 12 years if no electrical components are included [12].

f. Operating Environment:

- The operating environment of the device will be ground transport using an ambulance with an incubator [13].

g. Ergonomics:

- The device should have a simple screen interface to control any electrical components.
- The entire device will be designed such that it causes no interference to ambulance personnel when installed and functional.

h. Size:

- The device should be able to fit inside the Voyager transport incubator by International Biomedical, which has dimensions of 53cm H x 48cm W x 99cm L [14].
    - The device could also be created to fit inside the ambulance under the incubator.

i. Weight:

- The device should be no more than 10lb which is equivalent to 5% of the incubator's weight when empty [15].

k. Materials:

- The materials should be safe to use in a medical environment and be in compliance with all federal EMS regulations. [13].

l. Aesthetics, Appearance, and Finish:

- The device should be entirely white or gray to make it easy to identify when cleaning is required [16].
- The device should be distinguishable enough from the incubator that it is not a challenge to locate and remove.
- Aesthetics should not impede the functionality of the device.

2. Product Characteristics:

a. Quantity:

- One functional prototype should be developed by the end of the semester.
- Once refined, the prototype will be mass produced for the general market.

b. Target Product Cost:

- The device will cost no more than $500 to fabricate and test.

3. Miscellaneous:

a. Standards and Specifications :

- The device must be compatible with a sterilization process in accordance with ISO 14937 [17].
- The product will be a Class II medical device according to FDA standards due to moving components that pose some risk to the patient and measurement capabilities [18].
  - FDA approval will be required for commercial use of the device.
- The device must comply with ISO 2631 which sets acceptable frequencies of whole body vibration, established to minimize health risk and discomfort [19].
  - Specifies that for health and comfort, vibrations should not exceed 0.5-80Hz.
  - Specifies that for patients that are motion sick, vibrations should not exceed 0.1-0.5Hz.
- IEC 60601-2-20 sets standards for the basic safety and essential performance of neonatal transport incubators [20]. This standard has been recognized by the FDA under Sec. 880.5410.

b. Customer:

- The target customer for our product is a hospital; specifically, the department within the hospital that manages neonatal transport and/or a Neonatal Intensive Care Unit (NICU).
- The device should be easily compatible with the equipment already used by the hospital, including incubators, transport carts, ambulances, and any accessory equipment used to treat patients during transport.

c. Patient-Related Concerns:

- The device should not pose additional risks to the patient during transport.
- Thorough testing must be completed to ensure the device does not decrease comfortability for the patient.

d. Competition:

- One category of competing designs involves the use of passive vibration isolation systems such as the use of a quasi-zero-stiffness (QZS) isolator placed beneath the infant compartment. This design has a high ability to attenuate low frequency vibrations [21].
- Magnetorheological (MR) dampers address variations in the international roughness index and the curve radius of roads in order to reduce vibrations within the vehicle. The pneumatic suspension system can be toggled between a compliant and stiff setting while the MR damper has an adjustable continuous range of viscosities that allow it to work in tandem with the pneumatic suspensions to reduce vibrations [22].
- A plate mounted to the incubator and another to the stretcher with a gap in between. Between the parallel plates springs are attached, “preferably gas springs, with a range and a damping effect” [23]. The spring reduces vibrations transmitted to the infant during transport.

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Conclusions/action items: As of 09/28/2022, these specifications are subject to change as the team conducts more research and consults with the client more. The team will use these specifications to guide the development and refining of designs.

Poster Presentation Poster PDF

JULIA SALITA - Dec 09, 2022, 2:43 PM CST

Title: Poster presentation poster

Date: 12/9/2022

Content by: Team

Present: Team

Goals: create a visual aid to assist in explaining the process and results of out design progress

Content:

JULIA SALITA - Dec 09, 2022, 2:34 PM CST

Download

Text_Slash_Final_Poster.pptx.pdf (4.05 MB)

2022/09/15: Impact of Sounds and Vibrations on Physiological Stability

Joshua Varghese - Sep 15, 2022, 9:10 PM CDT

Title: 2022/09/15: Impact of Sounds and Vibrations on Physiological Stability

Date: 9/15/22

Source Link: https://www.thieme-connect.com/products/ejournals/abstract/10.1055/s-0038-1668171

Citation: V. Bailey et al., "Modern Neonatal Transport: Sound and Vibration Levels and Their Impact on Physiological Stability," Am J Perinatol, vol. 36, no. 4, pp. 352–359, Mar. 2019, doi: 10.1055/s-0038-1668171.

Content by: Joshua Varghese

Present: N/A

Content:

The purpose of this experiment was to measure sound and vibration in rotary wing air transport (RWAT) and ground ambulance transport (GAT). The measurements were compared to current recommendations, and correlated with physiological stability measures in transported neonates.

The study participants included infants ≤ 7 days of age transported over an 8-month period. Infants with neurologic conditions were excluded. Sound and vibration was continuously measured during transport. Transport Risk Index of Physiologic Stability (TRIPS) scores were calculated from vital signs as a proxy for physiological stability.

For the final results,118 newborns were enrolled, of whom 109 were analyzed: 67 in RWAT and 42 in GAT. Peak sound levels ranged from 80.4 to 86.4 dBA in RWAT and from 70.3 to 71.6 dBA in GAT. Whole-body vibration ranged from 1.68 to 5.09 m/s2 in RWAT and from 1.82 to 3.96 m/s2 in GAT. Interval TRIPS scores for each infant were not significantly different despite excessive sound and vibration.

Conclusions/action items:

This study measures sound and vibration during neonatal transport in modern air and ground vehicles and evaluates their impact on physiological stability. Noise levels during neonatal transport exceed published recommendations for both RWAT and GAT and are higher in RWAT. Transported infants are exposed to vibration levels exceeding acceptable adult standards. Despite excessive noise and vibration, levels of physiological stability remained stable after transport in both RWAT and GAT groups.

2022/09/15: Reducing the Pyro-Shock of a MEMS IMU

Joshua Varghese - Sep 15, 2022, 10:04 PM CDT

Title: 2022/09/15: Reducing the Pyro-Shock of a MEMS IMU

Date: 9/15/22

Source Link: https://www.mdpi.com/1424-8220/22/13/5037/htm

Citation: K. Ryu, B. Park, H. Lee, K. Han, and S. Lee, “A Study on the Design of Isolator and the Mounting Method for Reducing the Pyro-Shock of a MEMS IMU,” Sensors, vol. 22, no. 13, Art. no. 13, Jan. 2022, doi: 10.3390/s22135037.

Content by: Joshua Varghese

Present: N/A

Content:

An Inertial Measurement Unit combines three accelerometers and gyroscopes to produce a specific force and angular rate in three-dimensions The accelerometer measures the linear acceleration of an object relative to an inertial reference frame. The developed MEMS IMU consists of a vibratory gyroscope, a resonant accelerometer, digital board, and isolator.

Components:

1. Vibratory Gyroscope: When the resonance frequency of the structure is applied by the driving electrode, the structure reciprocates constantly in the drive direction (x-axis). When rotation (z-axis) is applied to an inertial mass body that is undergoing linear vibration, the Coriolis force is generated in the direction (y-axis) perpendicular to the vibration axis (x-axis) and the rotation axis (z-axis). The Coriolis force causes micro-vibrations in the sensing direction (y-axis), which have a frequency that is equal to the driving frequency and a magnitude that is proportional to the rotational input. The magnitude that is proportional to the rotation input is sensed by the sensing electrode (parallel plate electrode), and the change in the capacitance is detected to measure the applied angular velocity.
2. Resonant Accelerometer: Designed with a double-ended tuning fork (DTF) structure with resonators. A resonant accelerometer consists of an inertial mass and a string that structurally supports it. The accelerometer is driven by resonating the DTF strings using electrostatic force. When an acceleration is applied from the outside, the inertial mass body moves due to the inertial force. The applied acceleration can be detected by differentiating the amount of frequency change between them. This difference type of detection technique has the advantage of eliminating common error factors depending on the temperature of the accelerometer and increasing sensitivity.

The best design: In Case #4, a metal washer was added between the two PEEK washers at the fastening part. Case #4 had the best reduction performance among the all-mounting methods especially at 5 kHz or higher, which is estimated to be the pyro-shock frequency band. From this result, inserting two different types of washers in order of PEEK-metal-PEEK was found to be the most effective method.

Conclusions/action items:

This experiment tested four different mounting options for reducing the experienced vibrations. Adding a metal washer between the fastening portions had the best results when trying to limit shock frequencies.

2022/09/21: Whole-body vibration in neonatal transport

Joshua Varghese - Sep 21, 2022, 9:07 PM CDT

Title: 2022/09/21: Whole-body vibration in neonatal transport

Date: 9/21/22

Source Link: **https://www-clinicalkey-com.ezproxy.library.wisc.edu/#!/content/playContent/1-s2.0-S0378378220302139?returnurl=null&referrer=null**

Citation:

"Whole-body vibration in neonatal transport: a review of current knowledge and future research challenges - ClinicalKey." https://www-clinicalkey-com.ezproxy.library.wisc.edu/#!/content/playContent/1-s2.0-S0378378220302139?returnurl=null&referrer=null (accessed Sep. 21, 2022).

Content by: Joshua Varghese

Present: N/A

Content:

1. Preterm newborns have a limited ability to coordinate autonomic and self-regulatory responses to deal with stress from external perturbations until 32 to 34 weeks postmenstrual age.
2. Shock refers to singular distinct acceleration versus time profiles that are typically of short duration and potentially high amplitude.
3. Vibration refers to sustained rhythmic (harmonic) acceleration versus time profiles that can occur at a single frequency, multiple distinct frequencies, or over a broad range of frequencies.
4. The translational motion occurs in the longitudinal (x axis – directed along the length of the incubator), lateral (y axis – directed from side to side), and vertical (z axis - directed perpendicular to the infant tray surface) directions.
5. Rotational motion includes roll (rotation about the x axis), pitch (rotation about the y axis), and yaw (rotation about the z axis), and are more pronounced in air transport
6. Only 10% of preterm infants (< 31 weeks) requiring transport in the first hours of life developed severe IVH (intraventricular hemorrhage) and there was no evidence of evolving severe IVH post transfer implicating the need for larger studies to further this information
7. As per ACGIH recommendations from 2018, workers/adults should not be exposed to a daily exposure >0.87 m/s^2
8. The estimated natural frequencies of the ambulance were around 2.5 Hz and 15 Hz, while the natural frequency of the incubator system without any mattress was 12–16 Hz
9. Using a gel mattress shifts the natural frequency of the system to 8–10 Hz which may reduce resonance
10. The systems natural frequency can also be altered by the weight of the infant. When using a 2 kg manikin with a gel mattress, the system had a natural frequency of 8–10 Hz, whereas replacing the manikin with a 300 g manikin changed the natural frequency to 15 Hz [38] suggesting that the hazards of vibration may be more significant in very low birth weight infants.
11. the mattress system amplified vibration magnitude by factors of 2–3 for a foam mattress and 1–2 for a gel mattress
12. Prehn et al. also reported that the combination of an air mattress with a gel mattress on top significantly decreased vibration

13. Their findings had poor generalizability due to the use of an airport runway instead of real-life driving and road conditions. Thinner wheels having a width of 1 in. on the stretcher were found to be inferior to thicker 1.4 in. rubber wheels

Conclusions/action items:

This article is a review of the situation in neonatal transport according to articles published before December 30th, 2019.

2022/10/03: Canadian Review on Neonatal Transport Systems

Joshua Varghese - Oct 03, 2022, 6:10 PM CDT

Title: 2022/10/03: Canadian Review on Neonatal Transport Systems

Date: 9/10/03

Source Link: **https://curve.carleton.ca/405aa798-1f34-43e9-95c3-d8bdc0f9efe4**

Citation:

F. Darwaish, "Investigating Vibration Levels in Neonatal Patient Transport," Master of Applied Science, Carleton University, Ottawa, Ontario, 2020. doi: 10.22215/etd/2020-14398.

Content by: Joshua Varghese

Present: N/A

Content:

1. The indication that the damped natural frequency of the neonate inside the incubator is at a similar frequency to that of the overall NPTS on the stretcher is an important finding that must be considered when developing a solution.
2. During the shaker table tests, the custom mattresses demonstrated better performance than the currently used Geo-MatrixTM mattress. These mattresses decrease the peak amplitude by a factor of 2-4 during random vibration testing
3. The head restraint (HR) harness is shown to be effective in reducing the vibrations experienced by the neonate in all test types, and for most mattress types. The HR decreased the peak amplitude by a factor of 1.7-3.3 during random vibration testing
4. The effect of transport on neonates has been examined in several studies, and an increase in mortality and morbidity rates of neonates following transport has been observed [12]. These negative effects of exposure to transport may be the result of the immaturity of the central nervous system in addition to the transport being in the highest risk period for physiological instability for the neonate
5. There is currently no standard for safe levels of vibration exposure for neonates. In the absence of appropriate standards, the standards established for vibration exposure for adults, such as the standard developed by the International Standards Organisation (ISO 2631-1) [18], are often applied to neonates [19]. The standard presents a health guidance caution zone for different exposure durations, and comfort levels that reflect the adult perception of vibration [18]. Safe levels of vibration for neonates are expected to be lower than those of adults.
6. They found that the mattress type and the weight of the manikin could influence the natural frequency. For example, when using a 2 kg manikin with a gel mattress, measured vibrations peaked in the frequency of 8-10 Hz. Replacing the manikin with a 300 g manikin caused the peak to shift to 15 Hz, which aligns with the damped natural frequency of the ambulance (2.5 Hz and 15 Hz). Their results suggest that neonates with lower weights could have a higher risk of vibration exposure.
7. They implemented modifications to the incubator tray by placing a foam restraint between the tray and the underlying track, and a foam pad beneath the tray. They found a decrease of vibrations measured at the neonate after modifications by performing one-way analysis of variance
8. They also experimented with different mattress types, including gel, foam, and air, and found that the gel mattress provided the least measured vibration. It was also shown that the use of different mattresses could

shift the natural frequency measurement of the incubator system away from the natural frequency of the ambulance. As a result, this could reduce resonance

9. An air-spring-based vibration isolation system was suggested by Bailey et al. [24] that fits between the incubator and the stretcher platform, and its isolator frequency can be controlled by changing the pneumatic pressure of the air-spring isolators
10. A study by Prehn et al. (2015) [25] focused on the use of different materials including polyurethane washers and anti-vibration pads to isolate the incubator. The vibration isolators were placed under the incubator's wheels but were deemed ineffective in reducing vibrations.
11. Repeatability examined on the stretcher suggests that the damped natural frequency of the neonate inside the incubator is similar to the damped natural frequency of the overall NPTS on the stretcher
12. The Geo-matrix mattress showed the highest amplification when compared to other mattresses, while the custom mattresses developed by Airtech Canada resulted in lowering the measured amplification. The HR harness lowered the vibrations when compared to the 5-point harness type. The PSD vibration measurements obtained were analysed to study the interplay between the different layers of the equipment. Ratios were created to see the highest amplifications occurring. The highest ratios were between the stretcher and the Power-LOAD®, and between the manikin's head and the incubator. These ratios provide information on where interventions should take place when designing mitigation strategies.
13. The custom mattresses developed by Airtech Canada showed a reduction in PSD amplitude at the manikin's head when compared to the Geo-matrixTM mattress currently in use. The 50 mm and 70 mm mattresses were the ones that were extensively tested. For example, during the random tests, the 70 mm mattress showed a
14. reduction by 2 to 4 times when compared to the Geo-matrixTM mattress. The head restraint harness type showed a reduction in PSD peak amplitude for all experiment types for most mattress types. For random tests, the HR has shown a reduction by 1.7 to 3.3 times when compared to the standard 5-point harness. The adoption of one of these mattresses and the head restraint inside the transport incubators is strongly suggested.

Conclusions/action items:

This was the most thorough article I have found related to our topic. This article concluded that a head restraint system was superior to a 5-point harness system and that a custom 70mm mattress was most effective compared to some of the mel mattresses advertised for neonatal transport.

2022/10/10: Power Spectral Density #1

Joshua Varghese - Oct 11, 2022, 11:56 PM CDT

Title: 2022/10/10: Power Spectral Density #1

Date: 10/10/22

Source Link: https://www.sciencedirect.com/science/article/pii/B9780121726515500105

Citation:

S. L. Miller and D. Childers, “10 - Power Spectral Density,” in *Probability and Random Processes*, S. L. Miller and D. Childers, Eds. Burlington: Academic Press, 2004, pp. 369–411. doi: 10.1016/B978-012172651-5/50010-5.

Content by: Joshua Varghese

Present: N/A

Content:

To start with, for a random process $X(t)$, define a truncated version of the random process as

$$X_{to}(t) = \begin{cases} X(t) & |t| \leq t_o \\ 0 & |t| > t_o \end{cases}. \tag{10.4}$$

The energy of this random process is

$$E_{Xto} = \int_{-to}^{to} X^2(t)dt = \int_{-\infty}^{\infty} X_{to}^2(t)dt, \tag{10.5}$$

and hence the time averaged power is

$$P_{Xto} = \frac{1}{2t_o}\int_{-\infty}^{\infty} X_{to}^2(t)dt = \frac{1}{2t_o}\int_{-\infty}^{\infty} |X_{to}^2(f)|^2 df. \tag{10.6}$$

$$\overline{P_{Xto}} = E[P_{Xto}] = \frac{1}{2t_o} \int_{-\infty}^{\infty} E[|X_{to}(f)|^2] df. \tag{10.7}$$

The power in the (untruncated) random process $X(t)$ is then found by passing to the limit as $t_o \to \infty$,

$$\overline{P_X} = \underset{t_o \to \infty}{\text{limit}} \frac{1}{2t_o} \int_{-\infty}^{\infty} E\left[|X_{to}(f)|\right] df = \int_{-\infty}^{\infty} \underset{\text{t}_o \to \infty}{\text{limit}} \frac{E[|X_{to}(f)|]}{2t_o} df. \tag{10.8}$$

Define $Sxx(f)$ to be the integrand in Equation 10.8. That is, let

$$S_{XX}(f) = \underset{t_o \to \infty}{\text{limit}} \frac{E[|X_{to}(f)|]}{2t_o}. \tag{10.9}$$

Then, the average power in the process can be expressed as

$$\overline{p_X} = \int_{-\infty}^{\infty} S_{XX}(f) df. \tag{10.10}$$

Conclusions/action items:

The purpose of this article is to organize a list of equations that would be useful for our testing protocols. Since the Power Spectral Density seems like a valuable quanitifer of the level of whole body vibrations, it is important to be aware of how the we can analyze the data collected using accelerometers.

2022/10/10: Power Spectral Density #2

Joshua Varghese - Oct 12, 2022, 12:11 AM CDT

Title: 2022/10/10: Power Spectral Density #2

Date: 10/10/22

Source Link: **https://resources.pcb.cadence.com/blog/2020-power-spectrum-vs-power-spectral-density-what-are-you-measuring**

Citation:

“Power Spectrum vs. Power Spectral Density: What Are You Measuring?” https://resources.pcb.cadence.com/blog/2020-power-spectrum-vs-power-spectral-density-what-are-you-measuring (accessed Oct. 12, 2022).

Content by: Joshua Varghese

Present: N/A

Content:

1. Power spectrum and power spectral density describe how the intensity of a time-varying signal is distributed in the frequency domain.

2. Power spectrum and power spectral density are agnostic to the type of signal that is used to generate an intensity distribution in the frequency domain. Such a signal could be a broadband noise measurement, a harmonic analog signal, or a wideband signal of any type. Measurements are always gathered in the time domain, after which they can be converted to the frequency domain for further analysis.
3. The units of your time-domain signal are V, then the units of power spectral density are V2/Hz, and the units for the bandlimited power spectrum are V2. Power spectral densities in electronics may be written in W/Hz or dBm/Hz. Note that the use of a square unit in electronics is quite important as electrical power is proportional to V2 or I2.
4. Continuous and discrete signals are treated differently in terms of the mathematics, although the mathematical manipulations in continuous or discrete time are analogous. The power spectral density S for a continuous or discrete signal in the time-domain x(t) is:

Continuous

$$S(f) = \left| \int_0^\infty x(t) e^{-i2\pi f t} dt \right|^2$$

Discrete

$$S(f) = \frac{1}{N} \left| \sum_{n=1}^{N} x_n(t = n\Delta t) e^{-i2\pi f n\Delta t} \Delta t \right|^2$$

5. Calculating a power spectrum vs. power spectral density for electronic systems with noise requires the right PCB design and analysis software. The design tools in Allegro PCB Designer from Cadence integrate with a full suite of analysis tools and allow you to layout powerful electronic systems. These tools are ideal for designing and simulating all aspects of your board’s functionality and signal behavior.

Conclusions/action items:

The purpose of this article is to gather a better understanding of the fundamental definition of the power spectral density and how to manipulate its relevant equations.

2022/09/21: Floating Patient Support System

Joshua Varghese - Sep 21, 2022, 7:30 PM CDT

Title: 2022/09/21: Floating Patient Support System

Date: 9/21/22

Source Link: https://patentimages.storage.googleapis.com/f3/65/d3/3e72d3fb0018bc/WO2014145253A1.pdf

Citation:

P. SABOTA and R. AGHILI, "Infant care transport device with shock and vibration system," WO2014145253A1, Sep. 18, 2014 Accessed: Sep. 21, 2022. [Online]. Available: https://patents.google.com/patent/WO2014145253A1/es

Content by: Joshua Varghese

Present: N/A

Content:

1. Includes a set of z axis dampers incorporated into the main structure, a similar set of dampers for x and y axes, and the addition of a floating patient support system that allows the patient system to move in the axis of vibration instead of being rigidly mounted to the frame as in current systems.
2. The side of the infant care device system includes a ventilator system, a user interface, and a monitor
3. A z-axis damper could be implemented by using springs, air bladders, bellows, elastomeric materials, magneto-rheological, piezoelectric, or other electronically controlled variable damper systems as well as viscous or fluidic type dampers or other art known techniques to absorb these shocks.

Conclusions/action items:

This is a patent for an infant care transport device with shock and vibration system. This design utilizes multiple damping systems that create a floating patient support system that allows the infant care device to move in various axes of motion instead of being rigidly mounted to the frame.

2022/09/21: Magnetorheological Dampers

Joshua Varghese - Sep 21, 2022, 8:35 PM CDT

Title: 2022/09/21: Magnetorheological Dampers

Date: 9/21/22

Source Link: https://www.researchgate.net/publication/303849282_A_semi-active_vehicle_suspension_based_on_pneumatic_springs_and_magnetorheological_dampers

Citation:

A. L. Morales, A. J. Nieto, J. M. Chicharro, and P. Pintado, "A semi-active vehicle suspension based on pneumatic springs and magnetorheological dampers," *Journal of Vibration and Control*, vol. 24, Jun. 2016, doi: 10.1177/1077546316653004.

Content by: Joshua Varghese

Present: N/A

Content:

1. The transfer function of a pneumatic suspension comprising an air–spring, auxiliary tank and several connecting pipes, can be modified simply by routing the air flow through the desired pipe.
2. Pneumatic systems have several advantages such as limited influence of sprung mass on natural frequency and the fact that the modification of its stiffness is quite straightforward
3. A high restriction (low Cr) tends to isolate the air–spring from the reservoir increasing the resonance frequency. The upper limit corresponds toa totally closed connecting pipe (Cr= 0). Conversely, a low restriction (high Cr) decreases the resonance frequency, where the lower limit corresponds to a configuration in which air–spring and reservoir pressures coincide at all times (Cr=∞), and behaves like an air–spring with the com-pounded air volume (spring and reservoir). Intermediate restriction coefficients yield intermediate resonance frequencies and, generally, higher damping. The increase in damping is due to the fact that, when the flow is not highly restricted nor freely allowed, viscous dissipation mechanisms become dominant
4. The MR/Pneumatic suspension described in this paper is based on:
    1. a pneumatic suspension with two adaptive configurations (compliant and stiff) in order to toggle between two different stiffnesses
    2. MR dampers with an adjustable continuous range of viscosities which can be used as a semi-active device
5.

Conclusions/action items:

This is a design for a suspension comprising a pneumatics system capable of controlling the suspension damping. This paper also contains a lot of equations that may be useful for calculating the effect of a variety of directional variables.

2022/09/28: Head Restraint

Joshua Varghese - Oct 03, 2022, 6:15 PM CDT

Title: 2022/09/28: Head Restraint

Date: 9/29/22

Content by: Joshua Varghese

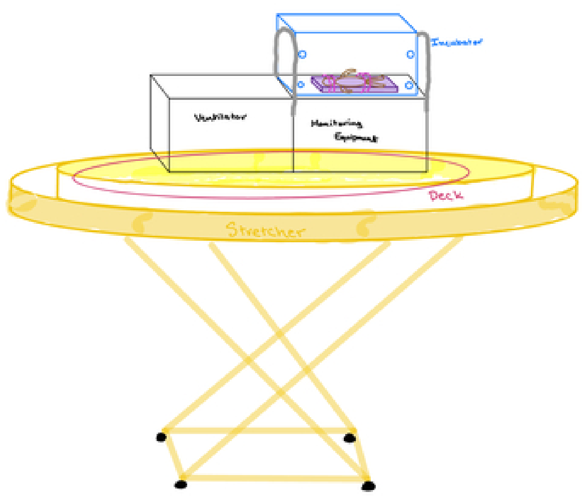
Present: N/A

Content:

Conclusions/action items:

This design improves on the existing 5-point restraint system. The head-restraint system will be placed across the body. For the smallest babies, 2 restraints will be used. One on the head and another on the torso. For larger neonates, a third restraint will be placed across the legs.

Joshua Varghese - Oct 03, 2022, 6:18 PM CDT



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2022/09/28: Damper

Joshua Varghese - Oct 03, 2022, 6:17 PM CDT

Title: 2022/09/28: Damper

Date: 9/28/22

Content by: Joshua Varghese

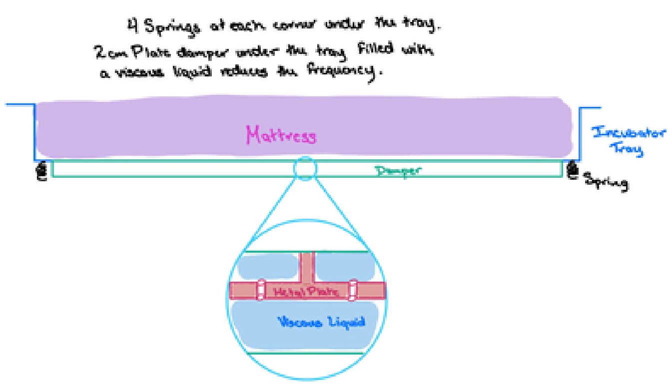
Present: N/A

Content:

Conclusions/action items:

This design Has 4 springs at each corner and are positioned to hold the inner tray up at its resting position. A 2cm plate damper is placed under the tray and filled with a viscous liquid which will reduce the frequency at which the plate can move up and down. This will allow for a slow vertical motion instead of a rapid felling which will reduce the intensity of any vibrations.

Joshua Varghese - Oct 03, 2022, 6:18 PM CDT



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D99D8B9C-D35B-4B01-9652-12A5249C0F69.jpg (200 kB)

2022/09/28: Rubber Inner Tray

Joshua Varghese - Oct 03, 2022, 6:15 PM CDT

Title: 2022/09/28: Rubber Inner Tray

Date: 9/28/22

Content by: Joshua Varghese

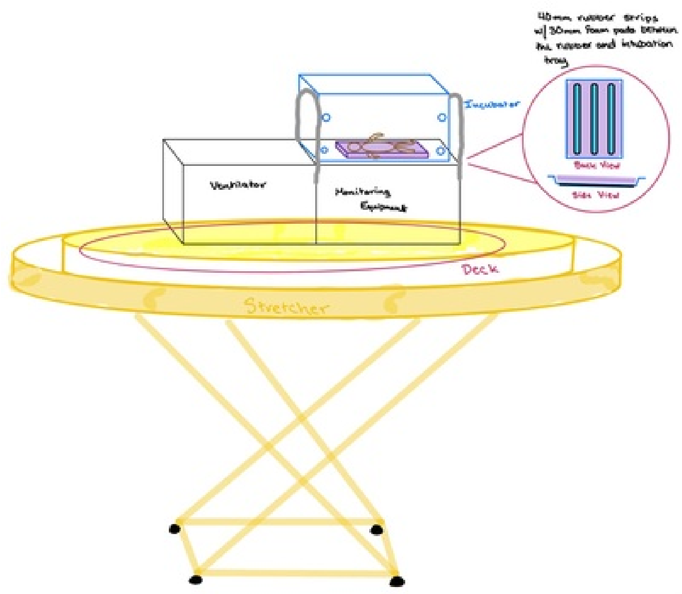
Present: N/A

Content:

Conclusions/action items:

This design has 40mm rubber strips placed under the inner tray with+h 30mm foam pads between the rubber and inner tray. I research study that I found concluded that a 70mm addition of foam was enough to reduce the effect of physical vibrations by 36%.

Joshua Varghese - Oct 03, 2022, 6:18 PM CDT



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B164E823-C9BE-47C0-9338-FE8463494AF1.jpg (153 kB)

2022/09/28: Foam Layering

Joshua Varghese - Oct 03, 2022, 6:16 PM CDT

Title: 2022/09/28: Rubber Inner Tray

Date: 9/28/22

Content by: Joshua Varghese and Sydney Therein

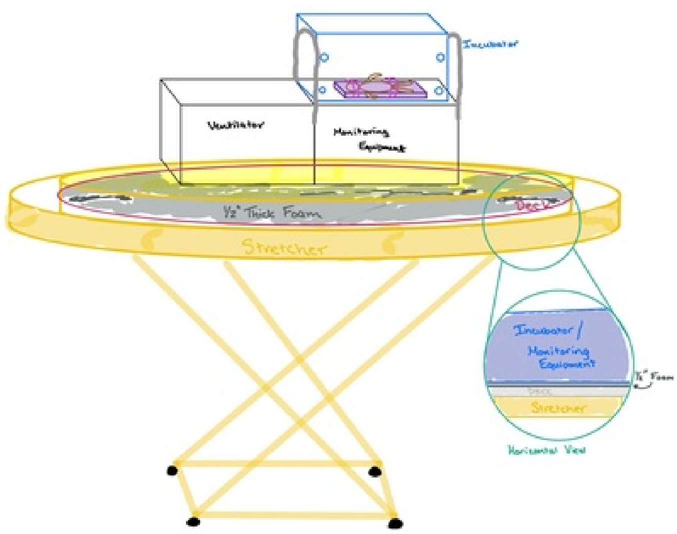
Present: N/A

Content:

Conclusions/action items:

This is Sydney's original design which I illustrated for use in the design matrix. The design simply adds a 1/2 inch thick foam mat underneath the entirety of the deck. This layering of foam should be enough to reduce vibrations by nearly 36%.

Joshua Varghese - Oct 03, 2022, 6:18 PM CDT



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F9764D45-7CA1-43C5-9427-5CD6CC399327.jpg (156 kB)

2022/10/05: 3D of foam Mat Design

Joshua Varghese - Oct 11, 2022, 11:49 PM CDT

Title: 2022/10/05: 3D of foam Mat Design

Date: 9/28/22

Content by: Joshua Varghese

Present: N/A

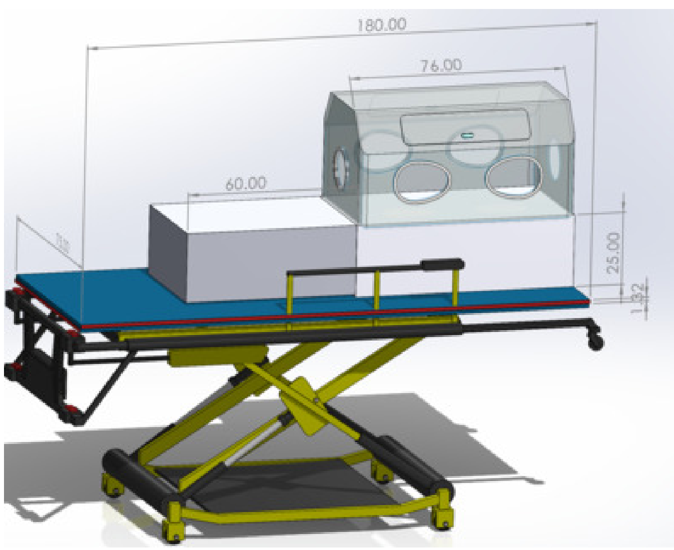
Content:

The screenshots and solidworks assemblies attached to this entry are labeled in units of centimeters.

Conclusions/action items:

The purpose of this 3D design was so that we would have a clean and legible model to present in the preliminary presentation and preliminary report. I spent about 4 hours working on this solidworks file. I tried to use existing parts and assemblies already in grabCAD, but resizing and joining different parts together proved to be a huge learning experience.

Joshua Varghese - Oct 11, 2022, 11:49 PM CDT



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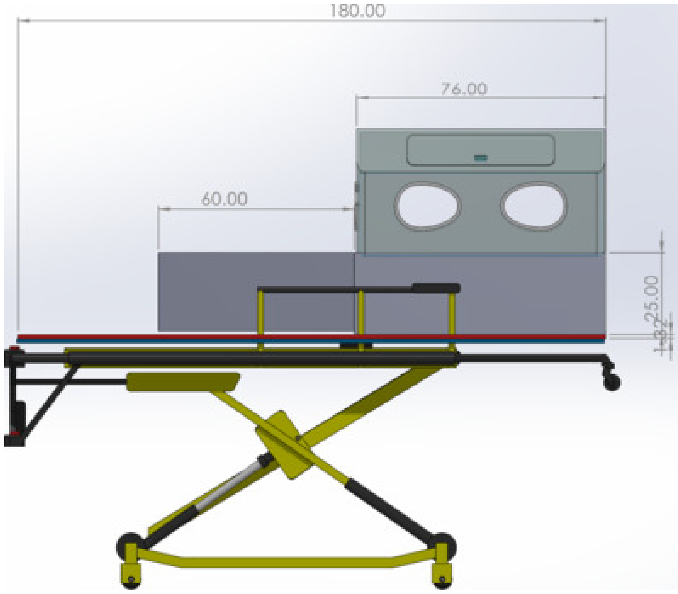
Screenshot_2022-10-05_234849.png (496 kB)

Joshua Varghese - Oct 11, 2022, 11:49 PM CDT



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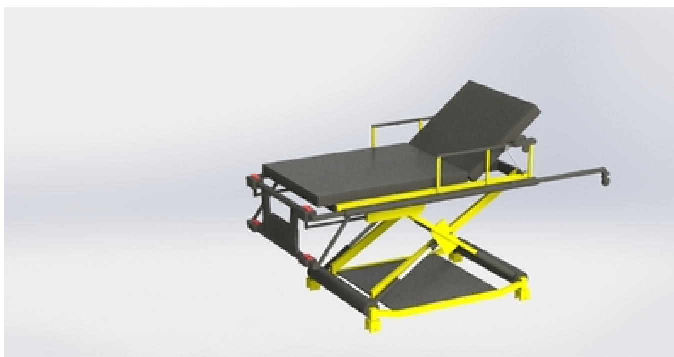
X_view_Screenshot.png (229 kB)

Joshua Varghese - Oct 11, 2022, 11:50 PM CDT



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123.JPG (486 kB)

Joshua Varghese - Oct 11, 2022, 11:50 PM CDT

DATA

Download

assem_2.SLDASM (371 kB)

Joshua Varghese - Oct 11, 2022, 11:50 PM CDT

DATA

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assem_2.SLDPRT (1.16 MB)

Joshua Varghese - Oct 11, 2022, 11:50 PM CDT

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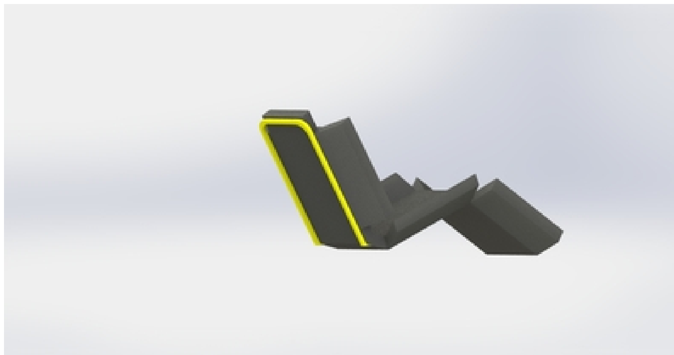
Baby_Incubator.SLDPRT (271 kB)

Joshua Varghese - Oct 11, 2022, 11:50 PM CDT



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bed_render.JPG (146 kB)

Joshua Varghese - Oct 11, 2022, 11:50 PM CDT

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bed.SLDPRT (165 kB)

Joshua Varghese - Oct 11, 2022, 11:50 PM CDT

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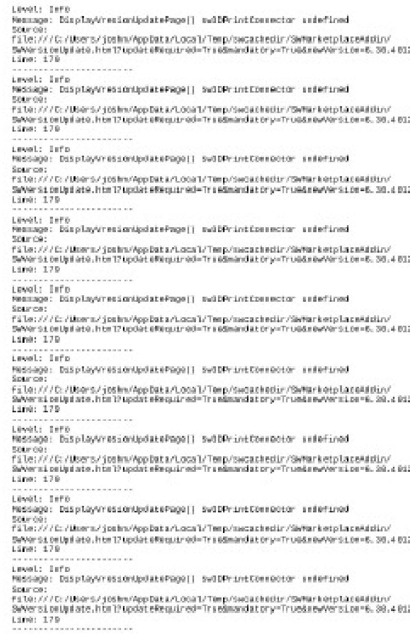
bolt.SLDPRT (95.7 kB)

Joshua Varghese - Oct 11, 2022, 11:50 PM CDT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SwVersionUpdate.htm?updateRequired=True&mandatory=True&newVersion=6.30.4012
Line: 179
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Level: Info
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console.log (12.2 kB)

Joshua Varghese - Oct 11, 2022, 11:50 PM CDT

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final_assem.SLDASM (324 kB)

Joshua Varghese - Oct 11, 2022, 11:50 PM CDT

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final_render_of_strecher.JPG (496 kB)

Joshua Varghese - Oct 11, 2022, 11:50 PM CDT

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Final_Assembly.SLDASM (427 kB)

Joshua Varghese - Oct 11, 2022, 11:50 PM CDT

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Foam_Mat.SLDPRT (64.8 kB)

Joshua Varghese - Oct 11, 2022, 11:50 PM CDT

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frame_render.JPG (506 kB)

Joshua Varghese - Oct 11, 2022, 11:50 PM CDT

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Monitor_Box_2.SLDPRT (92.9 kB)

Joshua Varghese - Oct 11, 2022, 11:50 PM CDT

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stretcher_frame_2.SLDPRT (1.23 MB)

Joshua Varghese - Oct 11, 2022, 11:50 PM CDT

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wheel.SLDPRT (70.4 kB)

2022/02/02: Training Documentation

Joshua Varghese - Feb 02, 2022, 4:34 PM CST

Title: 2022/02/02: Training Documentation

Date: 02/02/2022

Content by: Joshua Varghese

Present: N/A

Goals: To complete the required safety trainings for the class

Content:

The proof of completion is in an attachment below

Conclusions/action items:

I will need to complete my green permit in the coming week

Joshua Varghese - Feb 02, 2022, 4:34 PM CST

WISCONSIN
UNIVERSITY OF WISCONSIN-MADISON

This certifies that Joshua Varghese has completed training for the following course(s):

Course	Assignment	Completion	Expiration
2020-21 HIPAA Privacy & Security Training	HIPAA Quiz	5/14/2021	
Annual Macaque Safety Training	Basic Macaque Safety Training Quiz	5/10/2021	
Biosafety 102: Bloodborne Pathogens for Laboratory and Research	Biosafety 102: Bloodborne Pathogens Safety in Research Quiz 2021	5/25/2021	
Biosafety Required Training	Biosafety Required Training Quiz	5/10/2021	
Chemical Safety: The OSHA Lab Standard	Final Quiz	2/2/2022	
Risk Communication in Animal Facilities	Risk Communication in Animal Facilities Quiz	5/10/2021	
Safety for Personnel with Animal Contact	Animal Contact Personnel Quiz	5/10/2021	

Data Last Imported: 02/02/2022 04:20 PM

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Screenshot_2022-02-02_163020.jpg (365 kB)

2022/02/21: Training Documentation - Green Permit

Joshua Varghese - Feb 21, 2022, 6:04 PM CST

Title: 2022/02/21: Training Documentation - Green Permit

Date: 02/21/2022

Content by: Joshua Varghese

Present: N/A

Goals: To complete the required Green Permit trainings for the class

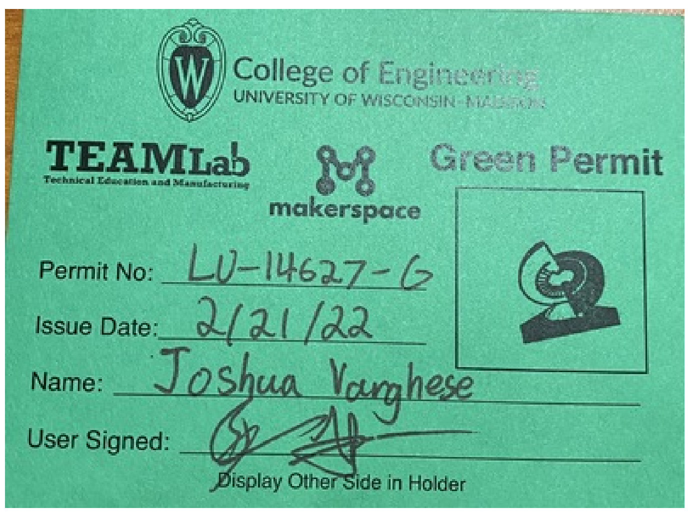
Content:

The proof of completion is in an attachment below

Conclusions/action items:

All trainings are now complete

Joshua Varghese - Feb 21, 2022, 6:04 PM CST



Download

IMG_9287.jpg (1.42 MB)

2022/11/03: Neonatal Data Preliminary

Joshua Varghese - Dec 12, 2022, 7:11 PM CST

Title: 2022/11/03: Neonatal Data Preliminary

Date: 11/03/22

Content by: Joshua Varghese

Present: N/A

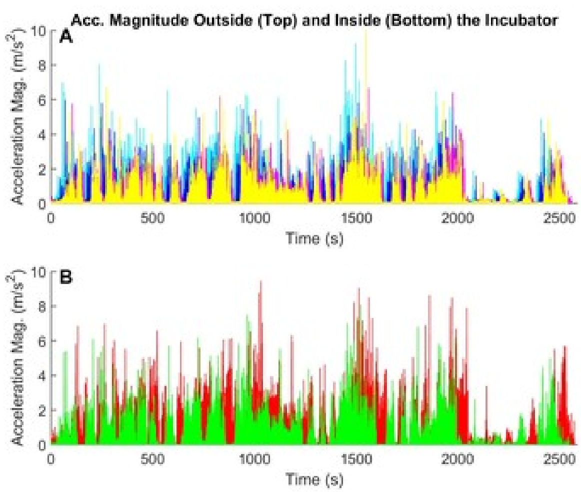
Content:

I have attached the data we collected from the preliminary testing ride as well as the preliminary test MATLAB code that allowed to visualize this data. The code includes plots for acceleration vs. time as well as a power vs. frequency derived from the Fourier transform. I have also included all of the plots I have made and will sort through the multitude of these in order to find a few that will be most relevant for our poster presentation and report.

Conclusions/action items:

I am hoping to reuse parts of this code in order to analyze the data that we will collect from the final testing run. Since this run will be relatively close to the final deliverable deadline, polishing this code will be extremely important in saving us time later in the semester.

Joshua Varghese - Dec 12, 2022, 7:08 PM CST



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Acc_Magnitude_OutsidevsInside.jpg (224 kB)

Joshua Varghese - Dec 12, 2022, 7:08 PM CST

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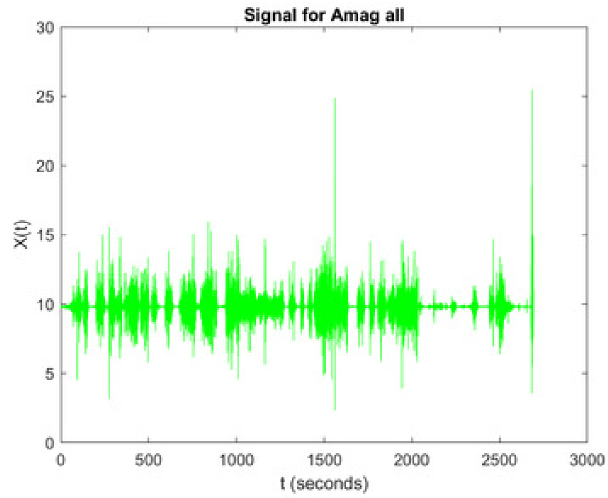
Amag_all_Signal.fig (27.2 MB)

Joshua Varghese - Dec 12, 2022, 7:08 PM CST



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Amag_all_Signal.png (45 kB)

Joshua Varghese - Dec 12, 2022, 7:08 PM CST

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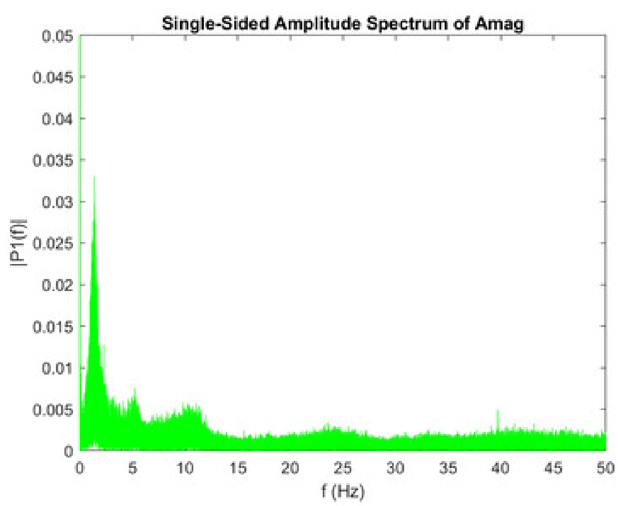
Amag_all_Spectrum.fig (3.87 MB)

Joshua Varghese - Dec 12, 2022, 7:08 PM CST



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Amag_all_Spectrum.png (51.2 kB)

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Download

Ax_all_Signal.fig (24.5 MB)

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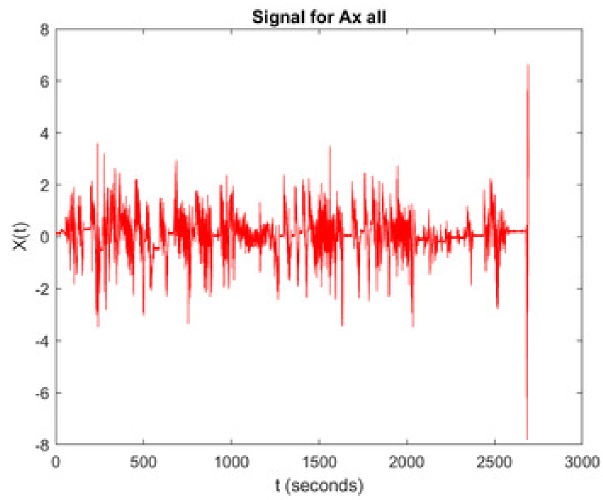

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Ax_all_Signal.png (47.4 kB)

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Download

Ax_all_Spectrum.fig (3.87 MB)

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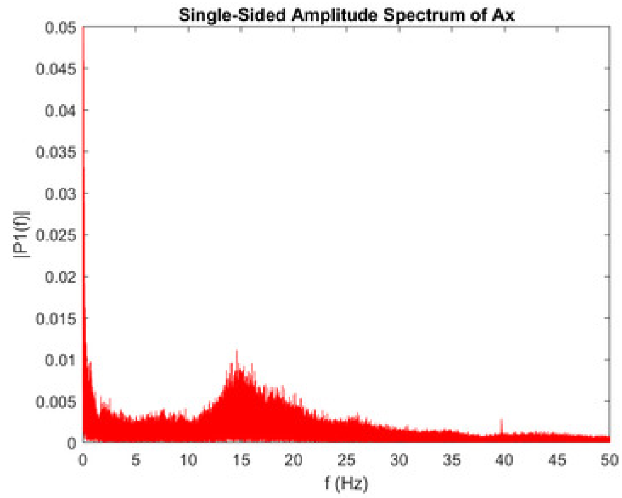

Download

Ax_all_Spectrum.png (50.6 kB)

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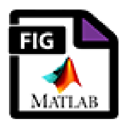

Download

Ay_all_Signal.fig (24.5 MB)

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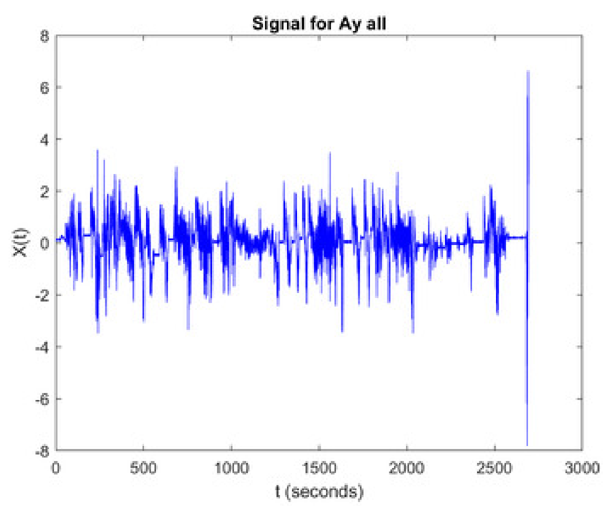

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Ay_all_Signal.png (47.4 kB)

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Ay_all_Spectrum.fig (3.87 MB)

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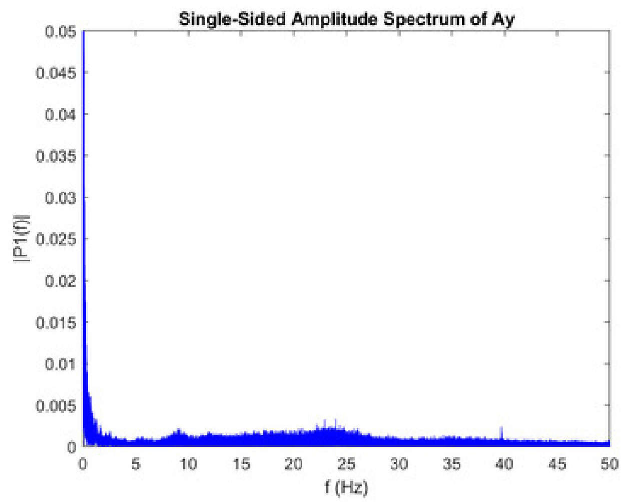

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Ay_all_Spectrum.png (48 kB)

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Az_all_Signal.fig (24.5 MB)

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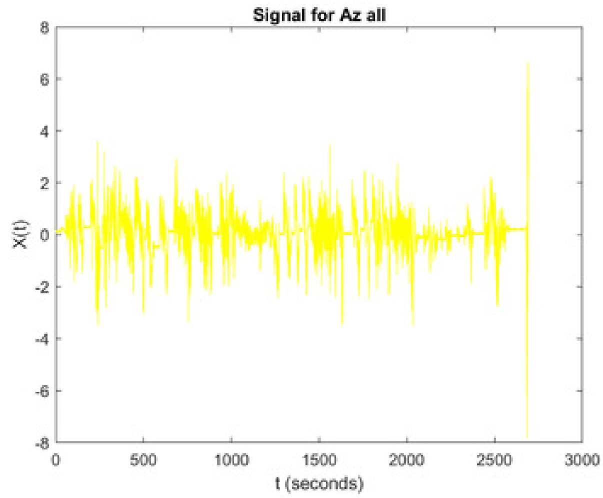

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Az_all_Signal.png (47 kB)

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Download

Az_all_Spectrum.fig (3.87 MB)

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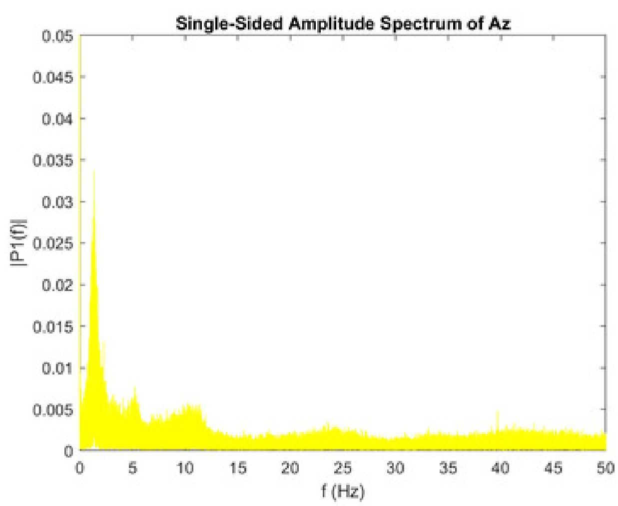

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Az_all_Spectrum.png (50.2 kB)

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Back_Floor.mat (17.8 MB)

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Back_Floorcomponents.mat (7.81 MB)

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Back_Sled.mat (35.8 MB)

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Download

Back_Sledcomponents.mat (7.86 MB)

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chest_cavity_preliminary_measurements.mat (17.3 MB)

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Download

chest_cavity_preliminary_measurementscomponents.mat (7.82 MB)

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front_floor.mat (17.2 MB)

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front_floorcomponents.mat (7.51 MB)

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Download

neonatal_fft_prelim.mlx (808 kB)

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```
clear;
clc;

% make a cell array of all data file names

DataNames = {'Neonate_Head (3)components.mat'...
             'chest_cavity_preliminary_measurementscomponents.mat'...
             'sled middlecomponents.mat'...
             'Back SledComponents.mat'...
             'front_floorcomponents.mat'...
             'Back Floorcomponents.mat'};
legendNames = {'Head'...
               'Chest'...
               'SledMid'...
               'SledBack'...
               'FloorFront'...
               'FloorBack'}; % legend name corresponds to DataName in same
location

colorCell = {'r','g', 'b', 'c', 'm', 'y'};

figure
% run through each data file and do something

for i = 1:numel(DataNames)
    load(DataNames{i})  %load the data from each file

    Ax_all = [];
    Ay_all = [];
    Az_all = [];
    Amag_all = [];
    Tm_all = [];

    for j = 1:5
    %plot information from each data set

        ax = Ax;
        ay = Ay;
        az = Az;
        amag = Amag;
        tm = t;

        Ax_all(:,j) = ax;
        Ay_all(:,j) = ay;
        Az_all(:,j) = az;
        Amag_all(:,j) = amag;
        Tm_all(:,j) = tm;

    end


    subplot(4,1,1)
        plot(Tm_all, Ax_all, colorCell{i})
        hold on
        title('Acceleration Components at Each Location in Ambulance')
        xlabel('Time (s)')
        ylabel('X Acceleration (m/s^2)')
        xlim([0,2600])

    subplot(4,1,2)
        plot(Tm_all, Ay_all,colorCell{i})
        hold on
        xlabel('Time (s)')
```

Download

NeonatalPlotAccel.m (2 kB)

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Neonate_Head_2_.mat (17.6 MB)

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Download

Neonate_Head_2_components.mat (8 MB)

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```
clear;
clc;

% make a cell array of all data file names

DataNames = {'NoMotionJoeycomponents.mat'...
            'nomotion_ADcomponents.mat'...
            'adam_nomotioncomponents.mat'...
            'nOmotion_gallagher (1)components.mat'...
            'nOMotionCondition_Sierra_Reschkecomponents.mat'};
legendNames = {'Joey'...
              'Addie'...
              'Adam'...
              'Lily'...
              'Sierra'}; % legend name corresponds to DataName in same location

colorCell = {'r','g', 'b', 'c', 'm'};

figure
% run through each data file and do something

for i = 1:numel(DataNames)
    load(DataNames{i}) %load the data from each file

    Ax_all = [];
    Ay_all = [];
    Az_all = [];
    Amag_all = [];
    Tm_all = [];

    for j = 1:5
    %plot information from each data set

        ax = Ax;
        ay = Ay;
        az = Az;
        amag = Amag;
        tm = t;

        Ax_all(:,j) = ax;
        Ay_all(:,j) = ay;
        Az_all(:,j) = az;
        Amag_all(:,j) = amag;
        Tm_all(:,j) = tm;

    end


    subplot(4,1,1)
        plot(Tm_all, Ax_all, colorCell{i})
        hold on
        title('No Motion Condition')
        xlabel('Time (s)')
        ylabel('X Acceleration (m/s^2)')
        xlim([0,10])

    subplot(4,1,2)
        plot(Tm_all, Ay_all,colorCell{i})
        hold on
        xlabel('Time (s)')
        ylabel('Y Acceleration (m/s^2)')
        xlim([0,10])
```

Download

PlotAccelerationComponents.m (1.87 kB)

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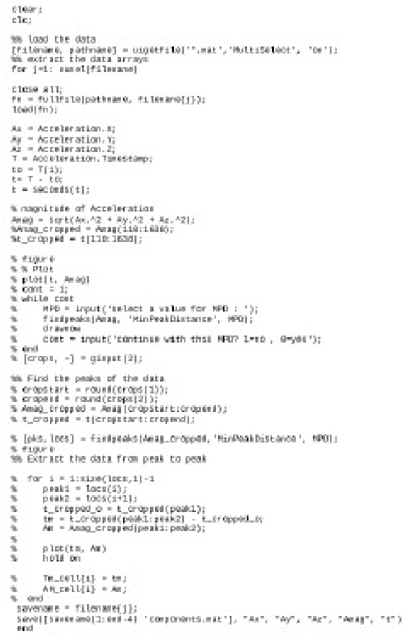

```
clear;
clc;

%% load the data
[filename, pathname] = uigetfile('*.mat','MultiSelect', 'on');
%% extract the data arrays
for j=1: numel(filename)

close all;
fn = fullfile(pathname, filename{j});
load(fn);

Ax = Acceleration.X;
Ay = Acceleration.Y;
Az = Acceleration.Z;
T = Acceleration.Timestamp;
to = T(1);
t= T - t0;
t = seconds(t);

% magnitude of Acceleration
Amag = sqrt(Ax.^2 + Ay.^2 + Az.^2);
%Amag_cropped = Amag(110:1630);
%t_cropped = t(110:1630);

% figure
% % Plot
% plot(t, Amag)
% cont = 1;
% while cont
%     MPD = input('select a value for MPD : ');
%     findpeaks(Amag, 'MinPeakDistance', MPD);
%     drawnow
%     cont = input('Continue with this MPD? 1=no , 0=yes');
% end
% [crops, ~] = ginput(2);

%% Find the peaks of the data
% cropstart = round(crops(1));
% cropend = round(crops(2));
% Amag_cropped = Amag(cropstart:cropend);
% t_cropped = t(cropstart:cropend);

% [pks, locs] = findpeaks(Amag_cropped,'MinPeakDistance', MPD);
% figure
%% Extract the data from peak to peak

%  for i = 1:size(locs,1)-1
%     peak1 = locs(i);
%     peak2 = locs(i+1);
%     t_cropped_o = t_cropped(peak1);
%     tm = t_cropped(peak1:peak2) - t_cropped_o;
%     Am = Amag_cropped(peak1:peak2);
%
%     plot(tm, Am)
%     hold on

%     Tm_cell{i} = tm;
%     Am_cell{i} = Am;
%  end
 savename = filename{j};
 save([savename(1:end-4) 'Components.mat'], "Ax", "Ay", "Az", "Amag", "t")
 end
```

Download

SaveAccelComponentsCode.m (1.47 kB)

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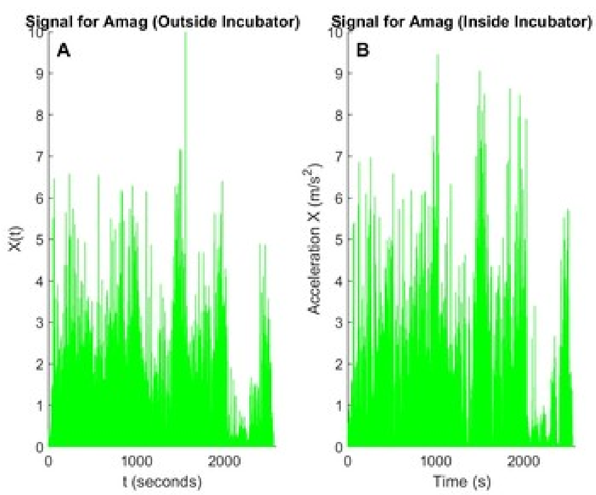

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Signal_for_Amag_OutsidevsInside.jpg (177 kB)

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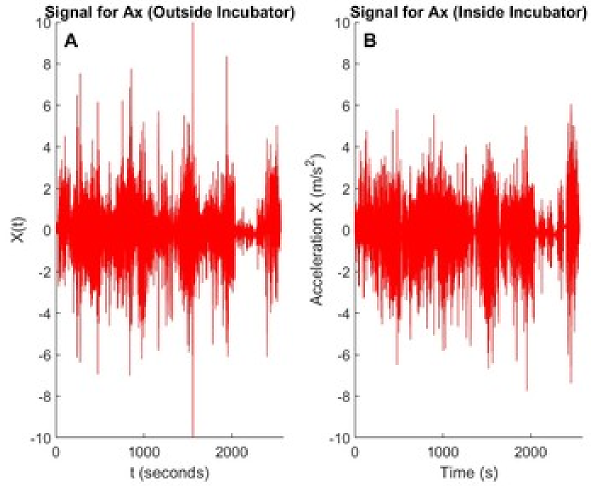

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Signal_for_Ax_OutsidevsInside.jpg (181 kB)

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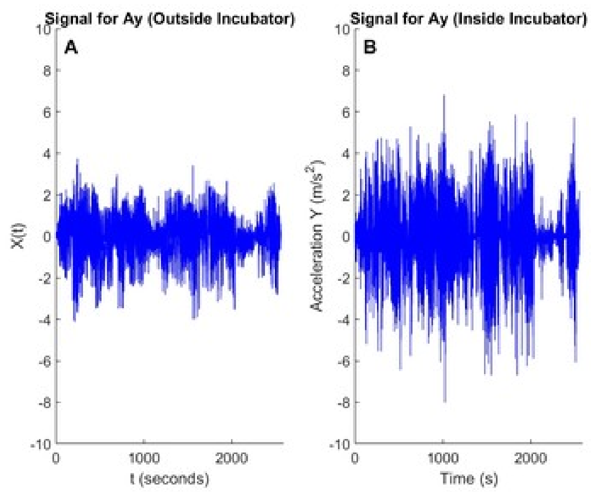

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Signal_for_Ay_OutsidevsInside.jpg (169 kB)

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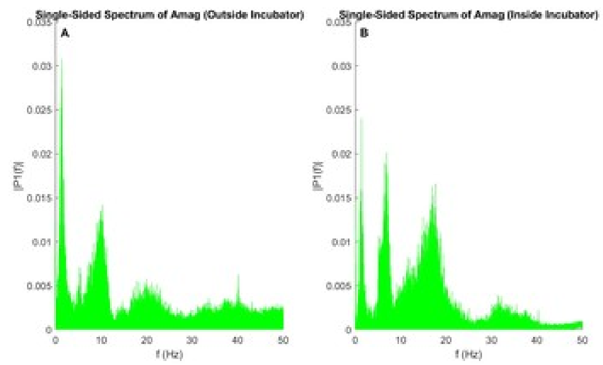

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Single_Sided_Amag_Spectrum_OutsidevsInside.jpg (177 kB)

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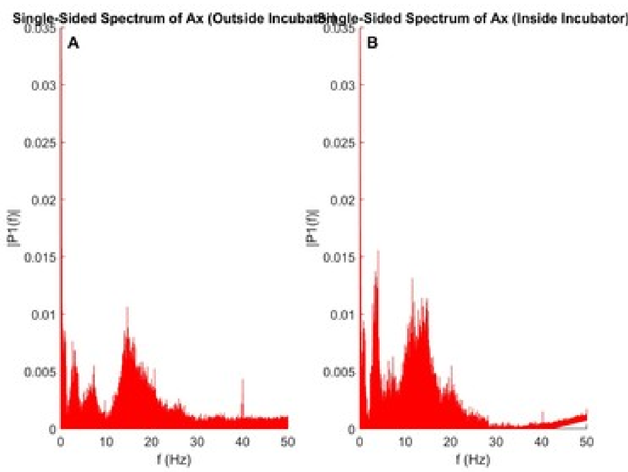

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Single_Sided_Ax_Spectrum_OutsidevsInside.jpg (141 kB)

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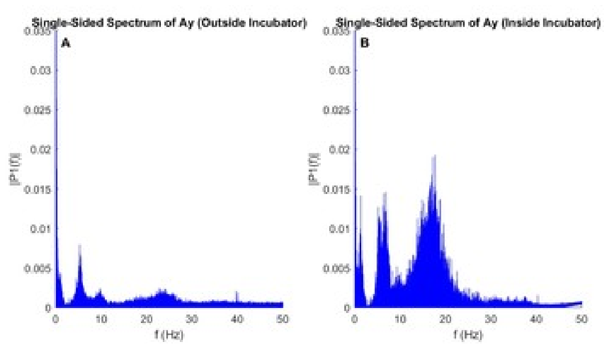

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Single_Sided_Ay_Spectrum_OutsidevsInside.jpg (149 kB)

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sled_middle.mat (17.1 MB)

Joshua Varghese - Dec 12, 2022, 7:10 PM CST

Download

sled_middlecomponents.mat (7.42 MB)

2022/12/03: Summary of Testing Results

Joshua Varghese - Dec 14, 2022, 8:19 PM CST

Title: 2022/12/03: Summary of Testing Results

Date: 12/03/22

Content by: Joshua Varghese

Present: N/A

Content:

I have attached the a presentation of the figures that were generated by the MATLAB code. I organized these figures so that I could present them during an advisor meeting and receive feedback from Dr. Williams.

Conclusions/action items:

I will need to use the feedback from Dr. Williams to further improve the figures.

Joshua Varghese - Dec 14, 2022, 8:19 PM CST

Download

Text_Slash_Final_Poster.pptx (12 MB)

2022/12/04: Neonatal Data Final

Joshua Varghese - Dec 12, 2022, 7:26 PM CST

Title: 2022/12/04: Neonatal Data Final

Date: 12/04/22

Content by: Joshua Varghese

Present: N/A

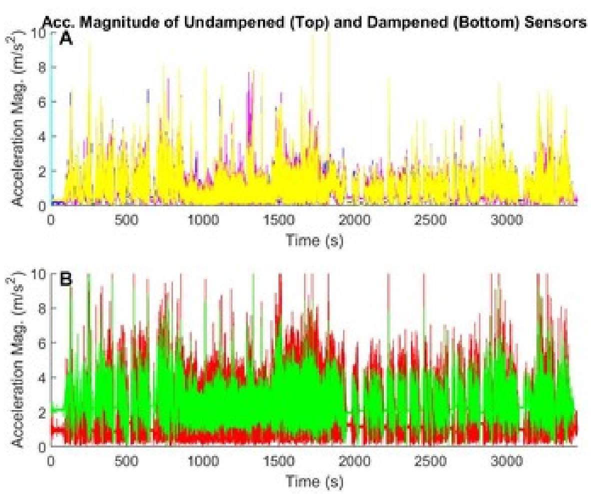
Content:

I have attached the data we collected from the final testing ride as well as the preliminary test MATLAB code that allowed to visualize this data. The code includes plots for acceleration vs. time as well as a power vs. frequency derived from the Fourier transform. I have also included all of the plots I have made and will sort through the multitude of these in order to find a few that will be most relevant for our poster presentation and report.

Conclusions/action items:

I will need to analyze the results and compare them to the preliminary testing in order to determine statistical significance

Joshua Varghese - Dec 12, 2022, 7:26 PM CST



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Acc_Magnitude_UndampenedvsDampened.jpg (270 kB)

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back_sled_final.mat (24.3 MB)

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BackFloor_Test2.mat (7.52 MB)

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chest_cavity_device_test_2.mat (8.13 MB)

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front_floor_final.mat (7.41 MB)

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middle_sled_test_2.mat (7.67 MB)

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neonatal_fft_final.mlx (1.13 MB)

Joshua Varghese - Dec 12, 2022, 7:26 PM CST

```
clear;
clc;

% make a cell array of all data file names

DataNames = {'Neonate_Head_FinalComponents.mat'...
             'chest_cavity_device_test_3components.mat'...
             'Middle_sled_test_2components.mat'...
             'back_sled_finalComponents.mat'...
             'front_floor_finalComponents.mat'...
             'BackFloor_Test2Components.mat'};
legendNames = {'Head'...
               'Chest'...
               'SledMid'...
               'SledBack'...
               'FloorFront'...
               'FloorBack'}; % legend name corresponds to DataName in same
location

colorCell = {'r', 'g', 'b', 'c', 'm', 'y'};

figure
% run through each data file and do something

for i = 1:numel(DataNames)
    load(DataNames{i})  %load the data from each file

    Ax_all = [];
    Ay_all = [];
    Az_all = [];
    Amag_all = [];
    Tm_all = [];

    for j = 1:5
    %plot information from each data set

        ax = Ax;
        ay = Ay;
        az = Az;
        amag = Amag;
        tm = t;

        Ax_all(:,j) = ax;
        Ay_all(:,j) = ay;
        Az_all(:,j) = az;
        Amag_all(:,j) = amag;
        Tm_all(:,j) = tm;

    end

    subplot(4,1,1)
        plot(Tm_all, Ax_all, colorCell{i})
        hold on
        title('Acceleration Components at Each Location in Ambulance')
        xlabel('Time (s)')
        ylabel('X Acceleration (m/s^2)')
        xlim([0,2600])

    subplot(4,1,2)
        plot(Tm_all, Ay_all,colorCell{i})
        hold on
        xlabel('Time (s)')
```

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NeonatalPlotAccel.m (2.02 kB)

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Neonate_Head_Final.mat (8.2 MB)

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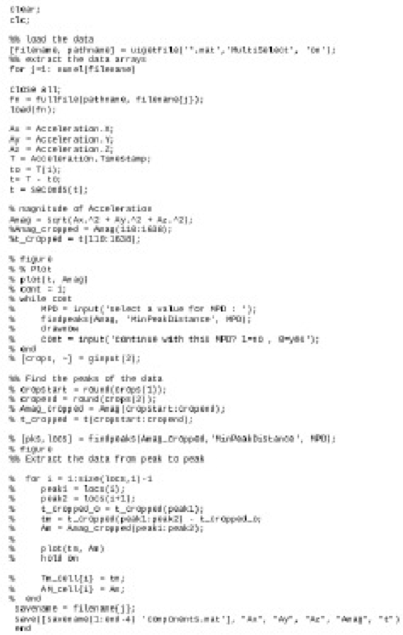

```
clear;
clc;

%% load the data
[filename, pathname] = uigetfile('*.mat','MultiSelect', 'on');
%% extract the data arrays
for j=1: numel(filename)

close all;
fn = fullfile(pathname, filename{j});
load(fn);

Ax = Acceleration.X;
Ay = Acceleration.Y;
Az = Acceleration.Z;
T = Acceleration.Timestamp;
to = T(1);
t= T - t0;
t = seconds(t);

% magnitude of Acceleration
Amag = sqrt(Ax.^2 + Ay.^2 + Az.^2);
%Amag_cropped = Amag(110:1638);
%t_cropped = t(110:1638);

% figure
% % Plot
% plot(t, Amag)
% cont = 1;
% while cont
%     MPD = input('select a value for MPD : ');
%     findpeaks(Amag, 'MinPeakDistance', MPD);
%     drawnow
%     cont = input('continue with this MPD? 1=no , 0=yes');
% end
% [crops, ~] = ginput(2);

%% Find the peaks of the data
% cropstart = round(crops(1));
% cropend = round(crops(2));
% Amag_cropped = Amag(cropstart:cropend);
% t_cropped = t(cropstart:cropend);

% [pks, locs] = findpeaks(Amag_cropped, 'MinPeakDistance', MPD);
% figure
%% Extract the data from peak to peak

%  for i = 1:size(locs,1)-1
%     peak1 = locs(i);
%     peak2 = locs(i+1);
%     t_cropped_0 = t_cropped(peak1);
%     tm = t_cropped(peak1:peak2) - t_cropped_0;
%     Am = Amag_cropped(peak1:peak2);
%
%     plot(tm, Am)
%     hold on

%     Tm_cell{i} = tm;
%     Am_cell{i} = Am;
%  end
 savename = filename{j};
 save([savename(1:end-4) 'Components.mat'], "Ax", "Ay", "Az", "Amag", "t")
 end
```

Download

SaveAccelComponentsCode.m (1.47 kB)

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sensorlog_accel_BackFloor_Test2.csv (14.6 MB)

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sensorlog_accel_chest_cavity_device_test_2.csv (14.9 MB)

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sensorlog_accel_front_floor_final.csv (14.4 MB)

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sensorlog_accel_middle_sled_test_2.csv (15.2 MB)

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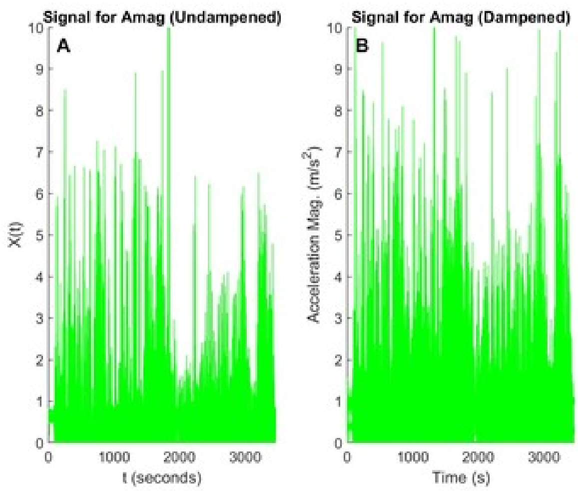
sensorlog_accel_Neonate_Head_Final.csv (15.2 MB)

Joshua Varghese - Dec 12, 2022, 7:27 PM CST



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Signal_for_Amag_UndampenedvsDampened.jpg (203 kB)

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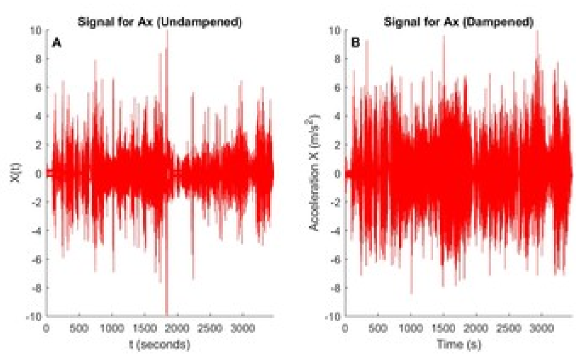

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Signal_for_Ax_UndampenedvsDampened.jpg (279 kB)

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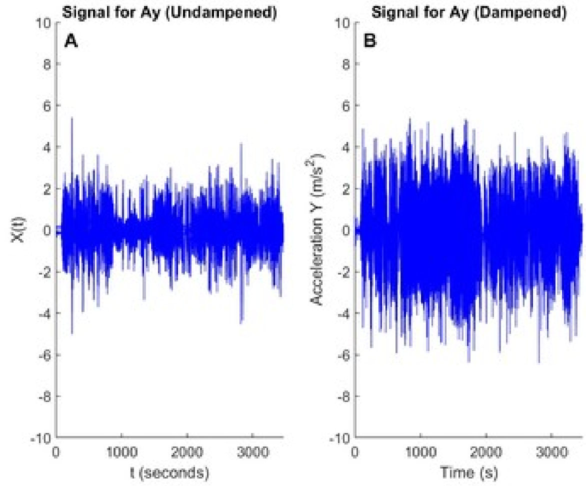

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Signal_for_Ay_UndampenedvsDampened.jpg (169 kB)

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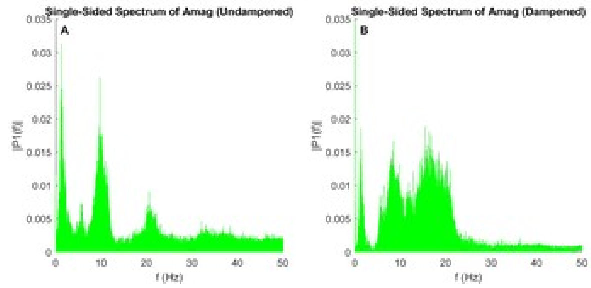

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Single_Sided_Amag_Spectrum_UndampenedvsDampened.jpg (154 kB)

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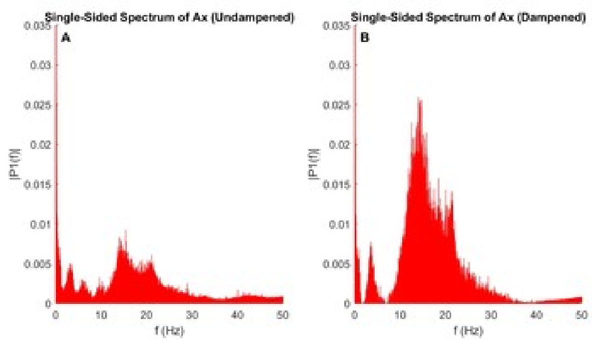

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Single_Sided_Ax_Spectrum_UndampenedvsDampened.jpg (149 kB)

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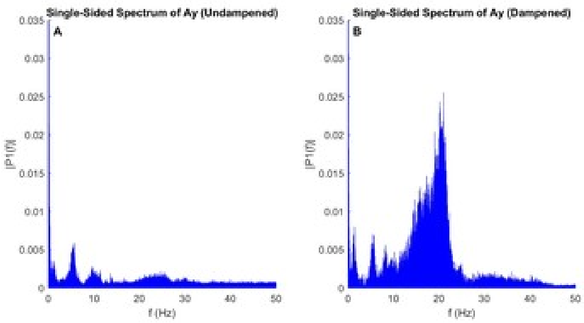


Download

Single_Sided_Ay_Spectrum_UndampenedvsDampened.jpg (151 kB)

2022/12/07: P-Values

Joshua Varghese - Dec 12, 2022, 8:07 PM CST

Title: 2022/12/07: P-Values

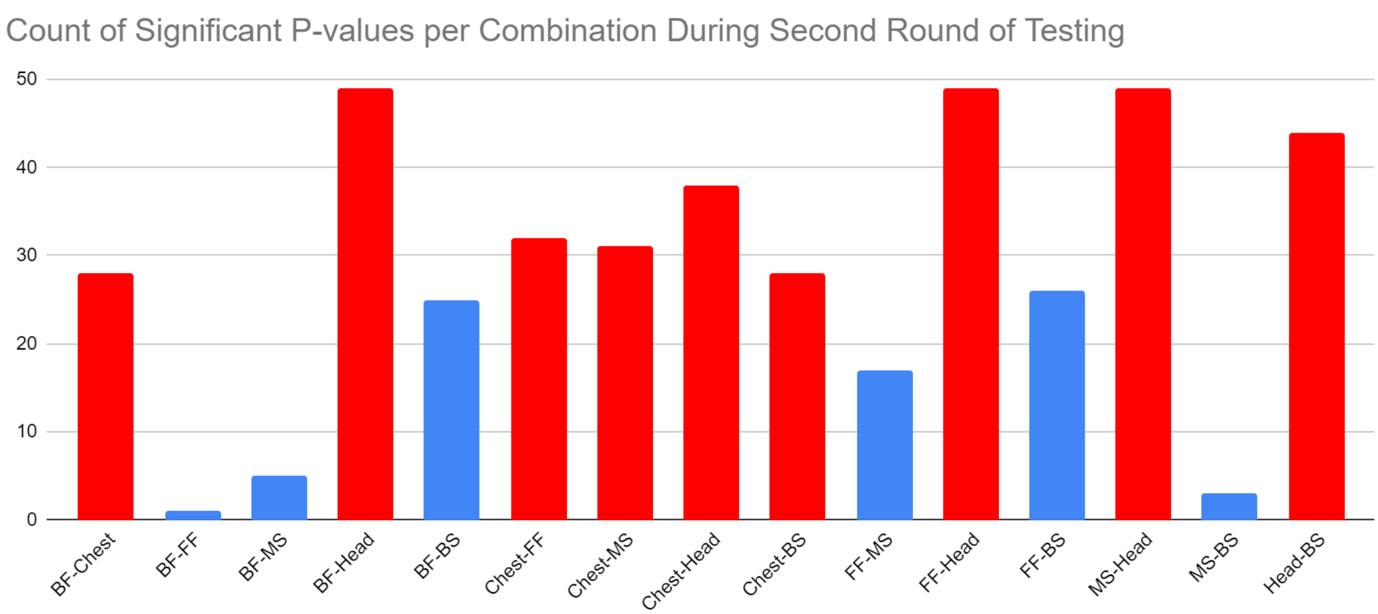
Date: 12/07/22

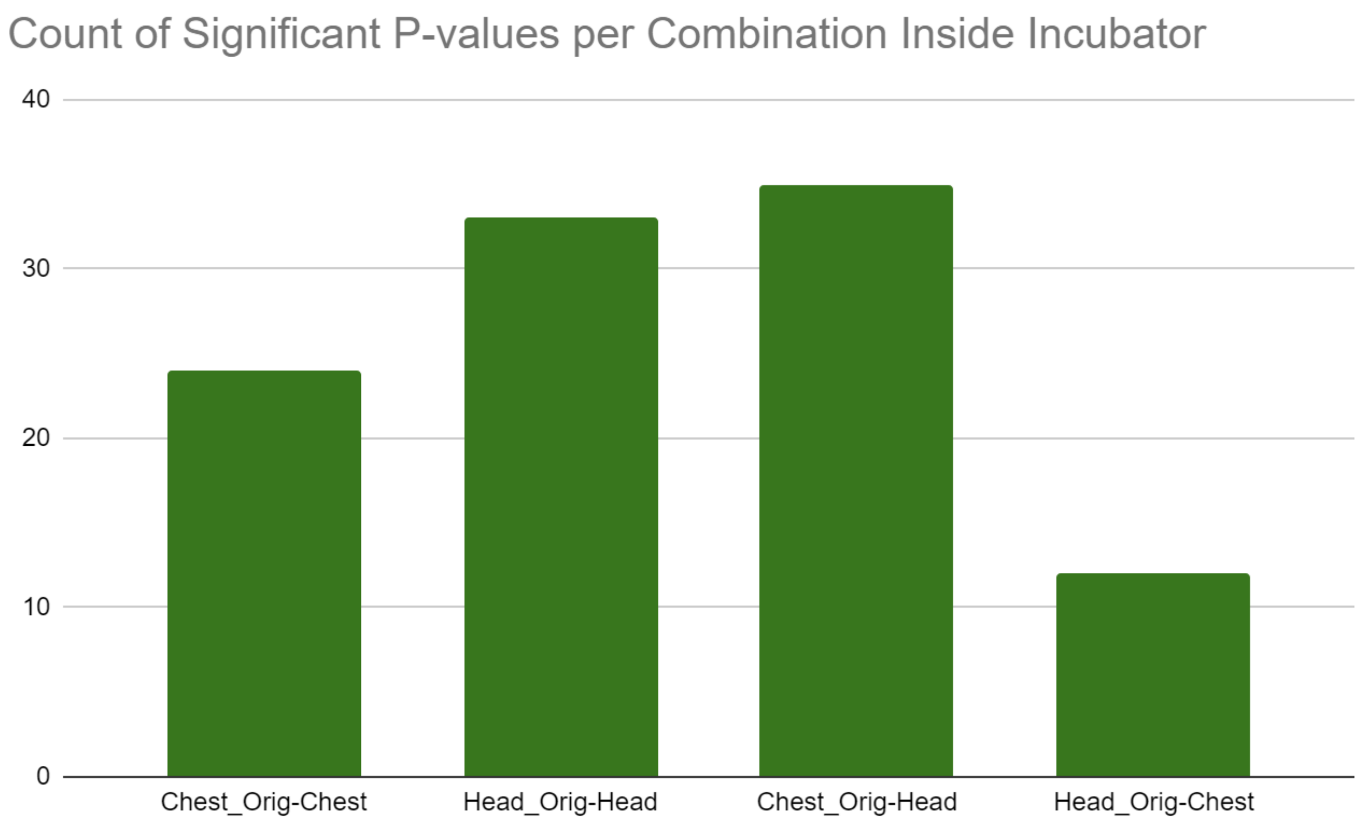
Content by: Joshua Varghese

Present: N/A

Content:

I have attached the a table with the p-values that I calculated using MATLAB. Since the table is too large to include in the final report on its own, I have also attached additional bar charts that summarize the number of significant p-values identified in the table.

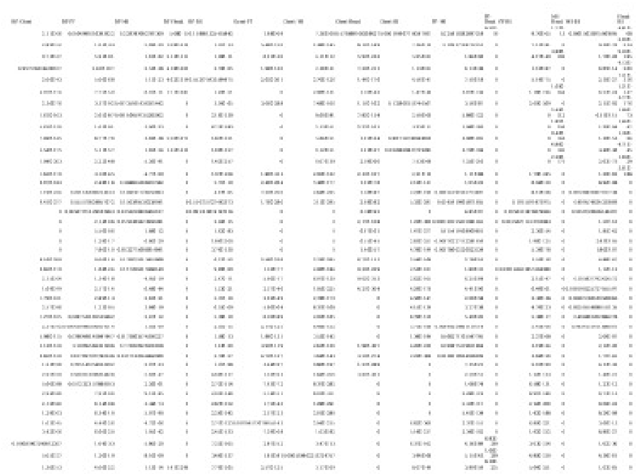




Conclusions/action items:

I will need to copy these charts into the final report and appendix of the final report.

Joshua Varghese - Dec 12, 2022, 8:07 PM CST



Download

p_value_matrix.xlsx (27.2 kB)

2022/09/18- Whole-Body Vibrations

Joseph Byrne - Oct 12, 2022, 1:18 PM CDT

Title: Neonate Body Response to Whole-Body Vibrations

Date: 9/19/2022 (Updated 10/12/2022)

Content by: Joseph Byrne

Present: Joseph Byrne

Goals: To understand how whole-body vibrations affect the health of neonates during medical transport.

Link: https://www.sciencedirect.com/science/article/pii/S0378378220302139

Citation: Goswami, I., Redpath, S., Langlois, R., Green, J., Lee, K. and Whyte, H., 2020. Whole-body vibration in neonatal transport: a review of current knowledge and future research challenges. *Early Human Development*, [online] 146, p.105051. Available at: <https://www.sciencedirect.com/science/article/pii/S0378378220302139> [Accessed 18 September 2022].

Content:

In adults, vibrations from transport have been found to cause increased blood pressure and heart rate, motion sickness, vomiting, and raised intracranial pressure. The vibration also has negative affects on cardiorespiratory function, the nervous system, electroencephalographic activity, and body temperature. Whole-body vibrations can induce brain injury, starting with cerebral vasoconstriction, increased free radicals, decreased nitric oxide, decreased cerebral blood flow, and repeated reperfusion injury.

While less studied, the affects of vibration on neonates can be expected to be more severe than in adults. It is associated with heart variability and increased stress. Vibrations and various forms of motion during transport have been associated with brain injury for neonates. Additionally, it is well known that neonates transported in ambulances have increased risks of intraventricular hemorrhage (IVH). One reason for this is that a neonate's central nervous system is undergoing organizational changes and has physiological instability. A neonate's ability to handle external stressors is very limited until 32-34 weeks. During transport, a neonate's cardiopulmonary, metabolic, and thermal homeostasis systems are very fragile and need support to be maintained. For this reason, safety and care of a neonate during transport are important for the neonate's survival.

Whole-body vibrations are also found to lead to Intraventricular Hemorrhage (IVH) through a cumulative process beginning with cerebral vasoconstriction, increased free radicals, decreased nitric oxide, decreased cerebral blood flow, and repeated reperfusion injury.

Conclusions/action items:

Whole-body vibrations can severely impact the health of neonates during medical transport. The vibrations can adversely affect the underdeveloped and unstable brains and homeostatic systems of neonates and lead to further injury or death.

2022/10/05- Preterm Birth Neonates

Joseph Byrne - Oct 05, 2022, 6:44 PM CDT

Title: Preterm Birth and Critically Ill Neonates

Date: 10/5/2022

Content by: Joseph Byrne

Present: Joseph Byrne

Goals: To understand how preterm babies often are in critical condition and need medical attention or transport.

Link: https://www.who.int/news-room/fact-sheets/detail/preterm-birth

Citation: World Health Organization. 2018. Preterm birth. [online] Available at: <https://www.who.int/news-room/fact-sheets/detail/preterm-birth> [Accessed 5 October 2022].

Content:

A preterm baby is defined as a baby which is born before 37 complete weeks of gestation. The World Health Organization records an estimated 15 million babies born preterm each year. Being born preterm is extremely dangerous and is the leading cause of death for children under the age of 5 years. The percentage of babies born preterm is 5-18%.

The World Health Organization further categorizes preterm babies into extremely preterm (<28 weeks gestation), very preterm (28-32 weeks gestation, and moderate to late preterm (32-37 weeks gestation). Causes of preterm birth includes multiple pregnancies, infections, diabetes, high blood pressure, genetic influence or early induction of labor.

Most preterm babies are found to be born in low-income countries or places with poor medical care. Due to this, most of them do not have chances of survival.

Conclusions/action items:

Preterm babies are the largest cause of critically ill neonates. Many of these babies will need transport to NICU units in which the quality of that transport directly impacts their chances on survival.

2022/10/12- Intraventricular Hemorrhage Related Biology

Joseph Byrne - Oct 12, 2022, 1:00 PM CDT

Title: Causes of Intraventricular Hemorrhage and Related Biology

Date: 10/12/2022

Content by: Joseph Byrne

Present: Joseph Byrne

Goals: To understand the biology of a neonate which makes it prone to Intraventricular Hemorrhage.

Content:

Note I used much of this information to write part of the background in the preliminary report and much of it is the same as a result:

Within the brain, neuronal-glial precursor cells make up a vascularized region called the germinal matrix. This region is particularly vulnerable for infants due to weaknesses in the blood-brain barrier in the first 48 hours of life. Moreover, premature infants struggle with cerebral autoregulation which is the ability of cerebral vessels to keep constant cerebral blood flow (CBF) regardless of changes in arterial blood pressure. The smooth muscle cells and pericytes responsible for minimizing variations of CBF are not fully developed. A fluctuating CBF is associated with pressure passivity in regards to cerebral circulation.

Conclusions/action items:

A neonates underdeveloped brain, specifically in the region of the germinal matrix, reveals why they are so susceptible to brain injury. This information should be used to gain understanding of why neonates sustain brain injury during transport.

2022/10/12- Brain Injury Statistics and Analysis

Joseph Byrne - Oct 12, 2022, 1:28 PM CDT

Title: Brain Injury Statistics and Analysis

Date: 10/12/2022

Content by: Joseph Byrne

Present: Joseph Byrne

Goals: To analyze studies to understand how brain injuries increase during neonatal transport.

Link: https://www.bmj.com/content/367/bmj.l5678

Citation: K. Helenius, N. Longford, L. Lehtonen, N. Modi, and C. Gale, “Association of early postnatal transfer and birth outside a tertiary hospital with mortality and severe brain injury in extremely preterm infants: observational cohort study with propensity score matching,” The BMJ, vol. 367, p. l5678, Oct. 2019, doi: 10.1136/bmj.l5678.

Content:

The effects of ex-utero transfer are well-documented in studies which conclude that transportation of a neonate significantly increases the odds of severe brain injury (odds ratio of 2.32) and significantly lower odds of survival without brain injury (odds ratio of 0.60). Several studies were analyzed in this report and all had similar findings. The results of one study are summarized in the table below:

Table 3 Comparison of outcomes between propensity score matched extremely preterm infants (<28 gestational weeks) born in England in 2008 to 2015, by hospital of birth and transfer status within 48 hours

Outcomes	No (%; 95% CI)			Effect size % (95% CI)			Odds ratio (95% CI); P value		
	Upward transfer	Non-tertiary care	Controls	Upward transfer *v* controls	Non-tertiary care *v* controls	Non-tertiary care *v* upward transfer	Upward transfer *v* controls	Non-tertiary care *v* controls	Non-tertiary care *v* upward transfer
Death before discharge (n=571)	140 (24.5; (20.9 to 28.1)	150 (26.3; 22.6 to 30.0)	120 (21.0; 17.6 to 24.4)	3.50 (−1.47 to 8.47)	5.25 (0.23 to 10.27)	1.75 (−3.40 to 6.90)	1.22 (0.92 to 1.61); 0.16	1.34 (1.02 to 1.77); 0.04	1.10 (0.84 to 1.44); 0.50
Severe brain injury (n=705)	194 (27.5; 24.2 to 30.9)	95 (13.5; 10.9 to 16.1)	99 (14.0; 11.4 to 16.7)	13.48 (9.22 to 17.74)	−0.56 (−4.24 to 3.12)	−14.04 (−18.28 to −9.80)	2.32 (1.78 to 3.06); <0.001	0.95 (0.70 to 1.30); 0.76	0.41 (0.31 to 0.53); <0.001
Survival without severe brain injury (n=593)	338 (57.0; 42.9 to 61.1)	382 (64.4; 60.5 to 68.4)	408 (68.8; 65.0 to 72.6)	11.80 (6.21 to 17.39)	−4.38 (1.11 to −9.87)	7.42 (1.75 to 13.09)	0.60 (0.47 to 0.76); <0.001	0.82 (0.64 to 1.05); 0.11	1.37 (1.09 to 1.73); 0.009

Upward transfer=infants born in hospitals with local neonatal units and transferred to tertiary hospitals within 48 hours of birth; non-tertiary care=infants born in hospitals with local neonatal units and not transferred within 48 hours of birth; controls=infants born in tertiary hospitals and not transferred within 48 hours of birth.

3 of 6

Conclusions/action items:

The study found statistical significance relating to an increase in brain injury and deaths for transported neonates. This information is significant for understanding the importance of quality neonatal transport.

2022/09/28- Vibration Attenuating Medical Platform

Joseph Byrne - Sep 28, 2022, 2:21 PM CDT

Title: Vibration Attenuating Medical Platform

Date: 9/28/2022

Content by: Joseph Byrne

Present: Joseph Byrne

Goals: To analyze a competing design that mitigates whole body vibrations and to identify its merits.

Link: https://scholarcommons.scu.edu/cgi/viewcontent.cgi?article=1083&context=mech_senior

Citation: Fisch, C., Friedman, N., Gambill, T., Harris, D. and Olais, K., 2018. Vibration Attenuating Medical Platform. [online] Santa Clara: Santa Clara University. Available at: <https://scholarcommons.scu.edu/cgi/viewcontent.cgi?article=1083&context=mech_senior> [Accessed 28 September 2022].

Content:

In the prospective design, a gurney is attached to a platform which is the top part of a box-like frame. An electronic control system measures the vibrations with accelerometers and other sensors and then sends that information to a microcontroller to be processed. The microcontroller then coordinates with a 12-inch stroke length piston (connected to the top platform) which outputs the exact force and pressure needed to attenuate the vibration.

Downfalls of the prospective device include lack of mitigation for translational or rotational motion. The piston only appears to move vertically which means only vibrations are mitigated by the design.

Conclusions/action items:

The Vibration Attenuating Medical Platform has a good design for attenuating vibrations, but lacks the ability to minimize the effects of translational or rotational motion. Some parts of the design could be reused or built upon this semester. For example, the accelerometer, sensors, and microcontroller system may be useful in determining the exact amount of force that we need to oppose.

2022/10/12- Quasi-Zero-Stiffness Isolator

Joseph Byrne - Oct 12, 2022, 1:19 PM CDT

Title: Quasi-Zero-Stiffness Isolators

Date: 10/12/2022

Content by: Joseph Byrne

Present: Joseph Byrne

Goals: To analyze a current method for reducing vibrations and determine its merits and downfalls.

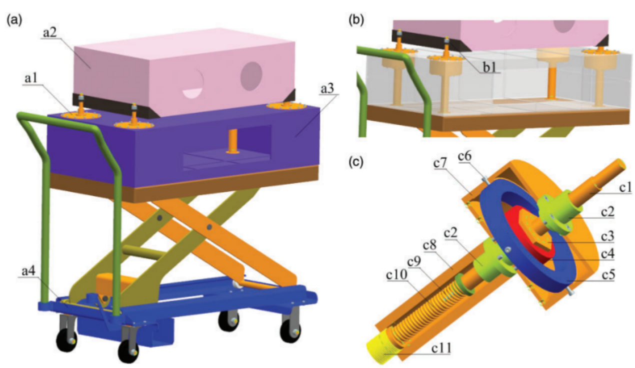
Link: https://journals.sagepub.com/doi/10.1177/1077546317703866

Citation: J. Zhou, K. Wang, D. Xu, H. Ouyang, and Y. Fu, “Vibration isolation in neonatal transport by using a quasi-zero-stiffness isolator,” J. Vib. Control, vol. 24, no. 15, pp. 3278–3291, Aug. 2018, doi: 10.1177/1077546317703866.

Content:

Note that I wrote this section of the preliminary report and much of the writing is similar as a result:

The Quasi-Zero-Stiffness (QZS) Isolator identifies and targets low-frequency components as the primary disturbing vibration. This product modifies the incubator control box directly below the incubator itself by adding four QZS Isolators in each corner of the housing. Each QZS Isolator has a pair of repelling ring permanent magnets that are connected in parallel to a coil spring. The inner ring magnet is fixed to a central rod while the outer ring magnet is fixed on the sleeve that surrounds the rod. This concentric system of ring magnets mitigates the effects of rotational and translational motion and keeps the isolators aligned vertically, allowing the coil spring to take on most of the weight. Finally, a viscous damper is added inside the coil spring to help reduce vibrations and forces in the vertical direction. Although the concept of QZS Isolators is well supported, the design involves substantial alterations to the current transport setup, has a complicated design, and lacks experimental testing to verify its ability to reduce whole body vibrations.



Conclusions/action items:

The QZS system uses magnets and springs to reduce vibrations felt by the neonate. The team should analyze its design to see what can be reused for built upon for our project.

2022/09/21- Vibrations Felt During Transport

Joseph Byrne - Sep 21, 2022, 10:04 PM CDT

Title: Neonate Body Response to Whole-Body Vibrations

Date: 9/21/2022

Content by: Joseph Byrne

Present: Joseph Byrne

Goals: To analyze how vibrations transfer from a transport vehicle to a neonate in an incubator.

Link: https://www.nature.com/articles/7200349

Citation: Gajendragadkar, G., Boyd, J., Potter, D., Mellen, B., Hahn, G. and Shenai, J., 1999. Mechanical Vibration in Neonatal Transport: A Randomized Study of Different Mattresses. Pediatric Research, [online] 45(4, Part 2 of 2), pp.198A-198A. Available at: <https://pubmed.ncbi.nlm.nih.gov/10920789/> [Accessed 20 September 2022].

Content:

A study was conducted to determine the vibration felt by a neonate in an ambulance during transport. The study tested multiple different mattresses, or materials, that a neonate could lay on to reduce the experienced vibrations. The various mattresses were no mattress, a foam mattress, a gel mattress, and a gel mattress on top of a foam mattress. To test these mattresses, 24 ambulance runs were made.

The study concluded that the natural frequencies of the ambulance were concentrated at 2.5 Hz and 15 Hz. The natural frequency (at the incubator base) of no mattress and the foam mattress was 12 Hz to 16 Hz. These frequencies accentuated with the natural frequencies of the ambulance to create an amplified vibration. The natural frequencies of the system with the gel mattress or the gel and foam mattress combination were 8 Hz to 10 Hz. Additionally, these mattress choices did not overlap with the frequencies from the ambulance and no accentuation occurred.

Ultimately, the study found that no combination completely attenuated the vibrations from the ambulance signifying a need for a more effective design.

Conclusions/action items:

The study looked at current incubators and mattress choices and concluded that none of them are sufficient to mitigate vibrations during transport. This data and knowledge that gel mattresses performed the best can be built upon for our design.

2022/12/14- Viscoelastic Properties of Steel

Joseph Byrne - Dec 14, 2022, 3:14 PM CST

Title: Viscoelastic Properties of Steel

Date: 12/14/2022

Content by: Joseph Byrne

Present: Joseph Byrne

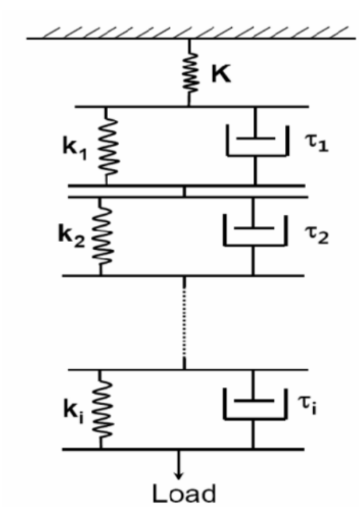
Goals: To understand the usage of steel as a viscoelastic material in our damper.

Link: https://link.springer.com/article/10.1007/s12206-018-0217-6

Citation: Avasthi, A. *et al.* (2013) "Ethics in medical research: General principles with special reference to psychiatry research," *Indian Journal of Psychiatry*, 55(1), pp. 86–91. Available at: https://doi.org/10.4103/0019-5545.105525.

Content:

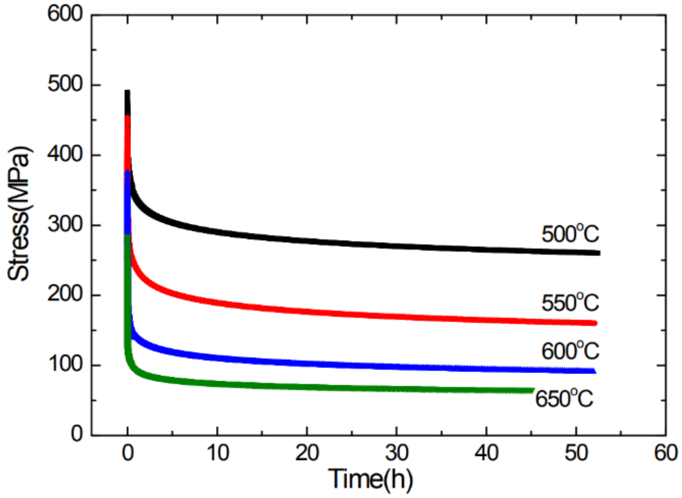
Stress-relaxation curves are often used to describe the viscoelasticity of a given material because they show how the material is able to relieve stress under constant strain. Similarly, spring-dashpot models can show the viscous and elastic components of a material which allow it to exhibit viscoelastic behavior. In the study for Grade 91 Steel, it was found that the metal behavior was described by a multi spring-dashpot system (shown below). This system features a spring in series with three consecutive sections of a spring and dashpot in parallel. In the model, springs deform rapidly (store energy by deformation) and are very elastic whereas the dashpots take longer to deform. Putting a spring and dashpot in parallel makes it so the spring can only deform as fast as the dashpot, reducing the elastic behavior of the material.



The typical equation to describe a spring-dashpot model is shown below. Sigma(e) is the elastic part of stress, sigma(a) is the anelastic part, e is the elastic strain, E is Young's modulus, e(a) is anelastic strain, a is the spring constant, t is time, and tau is the viscous constant in the dashpot. From these variables, it can be seen that viscoelasticity is highly related to stress and strain and also the elastic and viscous components of a material.

$$\sigma_e + \sigma_a = eE + \left[\frac{e_a}{a(1 - e^{-t/\tau})} \right]$$

In the study, stress-relaxation curves for grade 91 steel were obtained at different temperatures. As seen in the graph below, the material is able to relieve stress under constant strain. This is characteristic of viscoelastic materials. Note that the steel displayed more viscoelastic behavior as temperatures got higher.



Conclusions/action items:

Surprisingly, steel is a viscoelastic material that can be described by equations and known values. Since steel is included in our prototype, these properties should be included in explaining why steel was chosen and the calculations should be followed to determine the expected dampening from the material.

2022/09/21- IEC 60601-2-20

Joseph Byrne - Sep 21, 2022, 10:34 PM CDT

Title: IEC 60601-2-20: Code for Transport Incubator Safety and Performance

Date: 9/21/2022

Content by: Joseph Byrne

Present: Joseph Byrne

Goals: To identify a standard which affects the development of our device.

Link: https://webstore.iec.ch/publication/67567

Citation: "IEC 60601-2-20:2020 RLV | IEC Webstore." https://webstore.iec.ch/publication/67567 (accessed Sep. 21, 2022).

Content:

IEC 60601-2-20 is a code which sets standards for the basic safety and essential performance of neonatal transport incubators. The FDA has reviewed and recognized this standard under Sec. 880.5410.

Conclusions/action items:

The details of IEC 60601-2-20 need to be further researched to determine the applicability to our project.

2022/10/12- Neonatal Ethics

Joseph Byrne - Oct 12, 2022, 1:16 PM CDT

Title: Ethical Dilemmas in the Neonatal Intensive Care Unit

Date: 10/12/2022

Content by: Joseph Byrne

Present: Joseph Byrne

Goals: To understand ethical dilemmas relating to neonatal transport.

Link: https://www.mayoclinicproceedings.org/article/S0025-6196(12)61527-4/fulltext

Citation: Berseth, C., 1987. Ethical Dilemmas in the Neonatal Intensive Care Unit. Mayo Clinic Proceedings, [online] 62(1), pp.67-72. Available at: <https://www.mayoclinicproceedings.org/article/S0025-6196(12)61527-4/fulltext> [Accessed 12 October 2022].

Content:

Medical care of neonatal patient involves many complicated decisions which have ethical implications. The main ethical considerations are as follows:

1. Dependent Patient: A neonate has no autonomy and as a result, is completely dependent on its caregiver. One must consider what decisions they can make for a neonate which cannot make decisions for itself.

2.Uncertain Outcome: When performing some procedures or medical care, there is no certain or predictable outcome.

3. Potential Trauma: During care in an intensive unit, trauma can be caused to a neonate. A medical care proffessional must decide which kinds of care are worth the trauma caused.

4. Prolonged Support: Another issue is the practical aspects of caring for a preterm infant with a disability throughout its lifetime.

Conclusions/action items:

There are many ethical decisions to make when caring for a neonate. These considerations should be taken into account when designing our prototype.

2022/12/14-Medical Research Ethics

Joseph Byrne - Dec 14, 2022, 1:14 PM CST

Title: Ethics in Medical Research

Date: 12/14/2022

Content by: Joseph Byrne

Present: Joseph Byrne

Goals: To investigate ethics relating to conducting medical research properly.

Link: **https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3574464/**

Citation: Avasthi, A. et al. (2013) "Ethics in medical research: General principles with special reference to psychiatry research," Indian Journal of Psychiatry, 55(1), pp. 86–91. Available at: https://doi.org/10.4103/0019-5545.105525.

Content:

The article discusses four principles of ethics in research:

1. Autonomy: Acting intentionally after receiving sufficient information and taking time to understand that information
2. Non-maleficence: Using careful decision making and training to do no harm.
3. Beneficence: With the intention of promoting well-being
4. Justice: Distributing social benefits equally among a population

The article also discusses other principles related to research:

- Principles of essentiality
  - Judging the usefulness and essentiality of information after receiving it.
  - Only using information that is absolutely essential.
- Principles of voluntariness, informed consent, and community agreement
  - Giving research participants full disclosure of the study and risks and benefits.
- Principles of non-exploitation
  - Informing research participants about dangers related to the study and providing compensation for the risks.
- Principles of accountability and transparency
  - Conducting the research in an honest and impartial fashion
  - Disclosing all results from the study, not just the results you want to see.

Conclusions/action items:

These principles of research ethics are important for conducting research which is respectable. In writing the final deliverables and conducting future research, these guidelines should be followed.

2022/10/12- Trends in Neonatal Transport

Joseph Byrne - Oct 12, 2022, 12:49 PM CDT

Title: Neonatal pre-transport stabilization –caring for infants the STABLE way

Date: 10/12/2022

Content by: Joseph Byrne

Present: Joseph Byrne

Goals: To gain understanding of how many neonatal transports occur in a given period of time and the importance of neonatal transport.

Link: https://www.stableprogram.org/pdf/Mears_and_Chalmers_2005_Neonatal_pretransport_stabilisation_caring_for_infants_the_STABLE_way.pdf

Citation: Mears, M. and Chalmers, S., 2005. Neonatal pre-transport stabilisation – caring for infants the STABLE way. 1st ed. [ebook] Available at: <https://www.stableprogram.org/pdf/Mears_and_Chalmers_2005_Neonatal_pretransport_stabilisation_caring_for_infants_the_STABLE_way.pdf> [Accessed 12 October 2022].

Content:

1 in 10 neonates require admission to a NICU in the first week of life. For babies born outside of the NICU, they require ex utero transport (this is the case for 1.3% of neonates). Ex utero transport is far more dangerous than in-utero transport as the neonate is exposed to noise, vibration, deceleration and acceleration forces, and temperature instability. Since the neonate is already struggling to maintain homeostasis, these stressors can be fatal.

Conclusions/action items:

Neonatal transports are a common occurrence that are necessary for a small population of neonates. Although the number of neonates needing transport is small, the enormous number of babies born a day makes this number add up. This information should be used to understand the importance of quality transport.

2022/09/28- Shock Design

Joseph Byrne - Sep 28, 2022, 2:38 PM CDT

Title: Shocks Design

Date: 9/28/2022

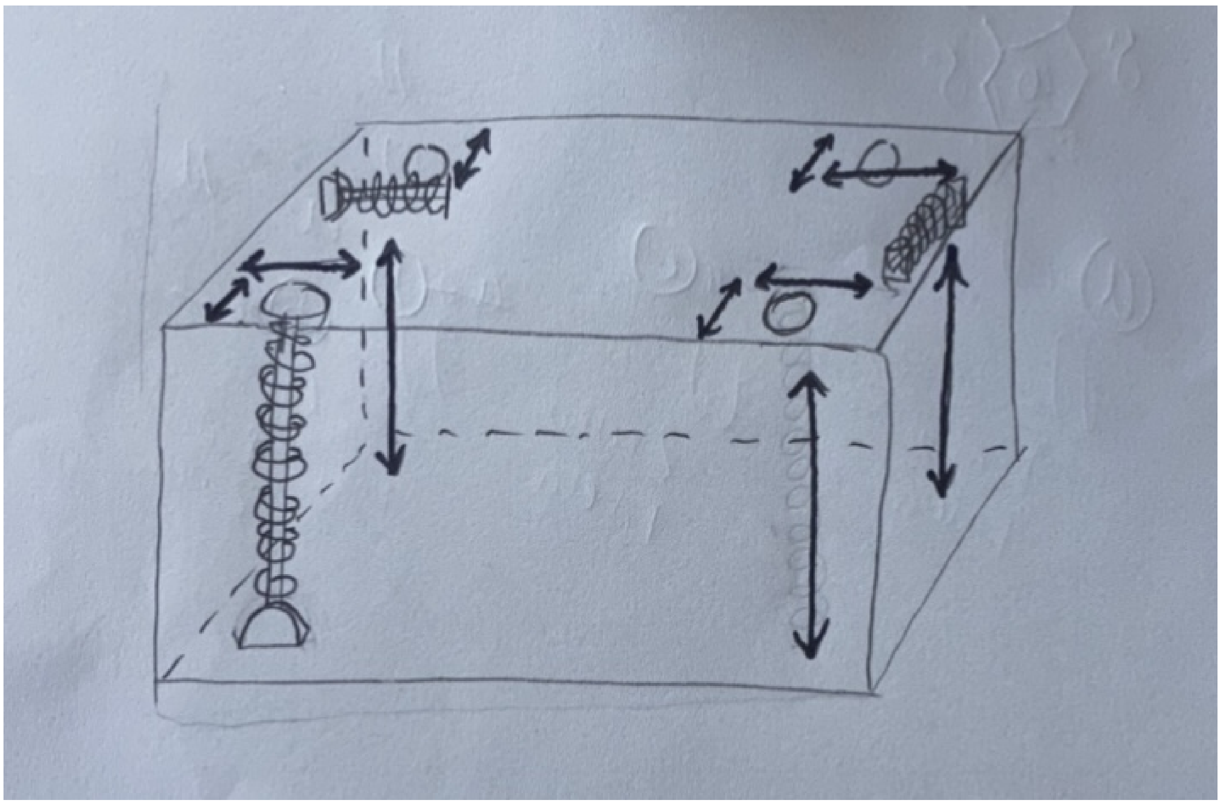
Content by: Joseph Byrne

Present: Joseph Byrne

Goals: To create a design that could potentially be used for the project and to analyze its pros and cons.

Content:

The prospective device modifies the large box below the incubator. As seen in the picture, it features 12 shocks (i.e. springs) which oppose motion vertically and horizontally (2 directions in the horizontal plane at the top of the box). Just like a vehicle's shock system, the shocks used in the box are meant to attenuate the remaining vibrations that the ambulance's shocks do not.



Conclusions/action items:

The design features 12 shocks or springs which will absorb mechanical forces from the ambulance. This design should be presented to the team and compared to other designs. If chosen, it should be further developed, prototyped, and tested.

2022/09/28- Piston Design

Joseph Byrne - Sep 28, 2022, 2:43 PM CDT

Title: Piston Design

Date: 9/28/2022

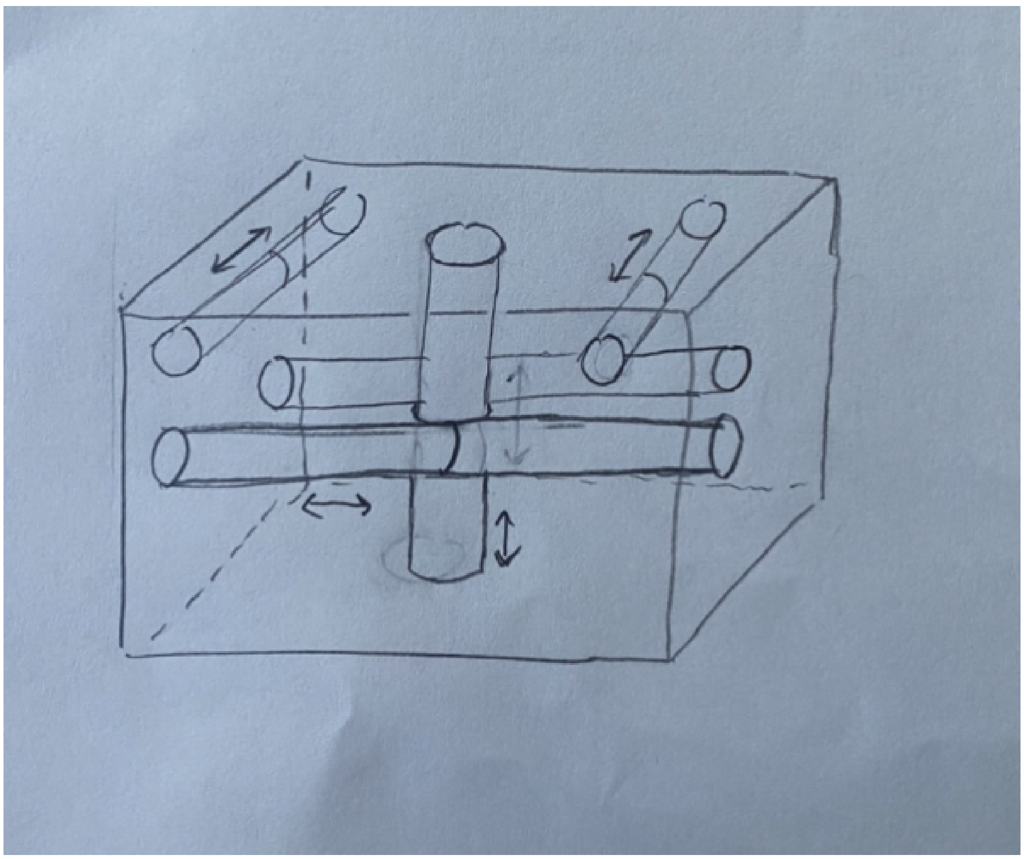
Content by: Joseph Byrne

Present: Joseph Byrne

Goals: To create a design that could potentially be used for the project and to analyze its merits and downfalls.

Content:

This design features 5 pistons. One which acts vertically and two pairs which act horizontally, but in perpendicular directions. The various directions of the pistons are meant to oppose forces in each respective direction. Note this design is based off of a competing design, the "Vibration Attenuating Medical Platform." A variety of sensors (mainly accelerometers) will be put in the box to measure vibrations, as well as translational and rotational motion. The information from the sensors will be sent to a microcontroller which will then output the correct opposing force for each respective piston.



Conclusions/action items:

While more complicated than other designs, this design has the potential to completely attenuate vibrations and motion. This design should be presented to the team and compared to other designs. If chosen, it should be further developed, prototyped, and tested.

2022/10/12- Biosafety

Joseph Byrne - Oct 12, 2022, 12:22 P

Title: Biosafety Training

Date: 10/12/2022

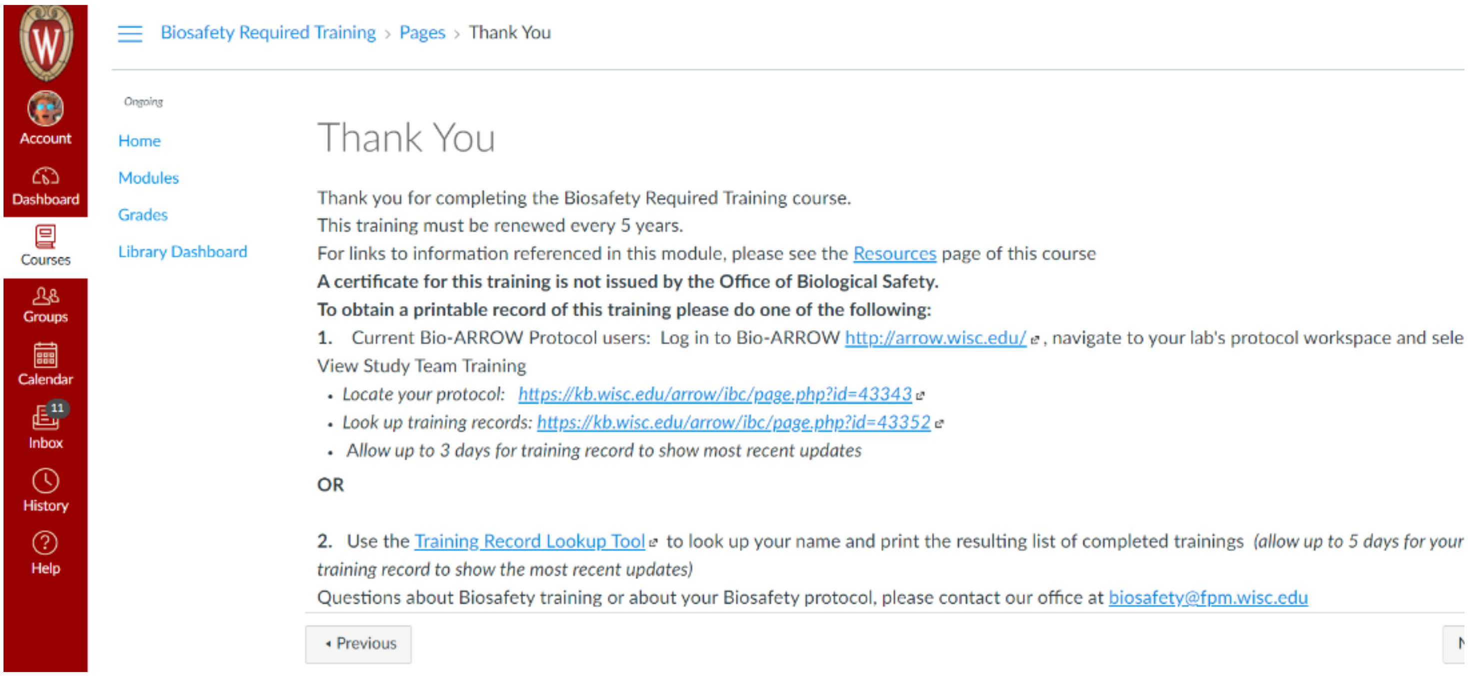
Content by: Joseph Byrne

Present: Joseph Byrne

Goals: To gain skills and knowledge relating to biosafety in the laboratory.

Content:

The screenshot below shows that I have finished the biosafety training course.



Conclusions/action items:

Use this training to complete necessary biosafety-related experiments for the project.

2022/10/12- Chemical Safety

Joseph Byrne - Oct 12, 2022, 12:24 PM CD

Title: Chemical Safety Training

Date: 10/12/2022

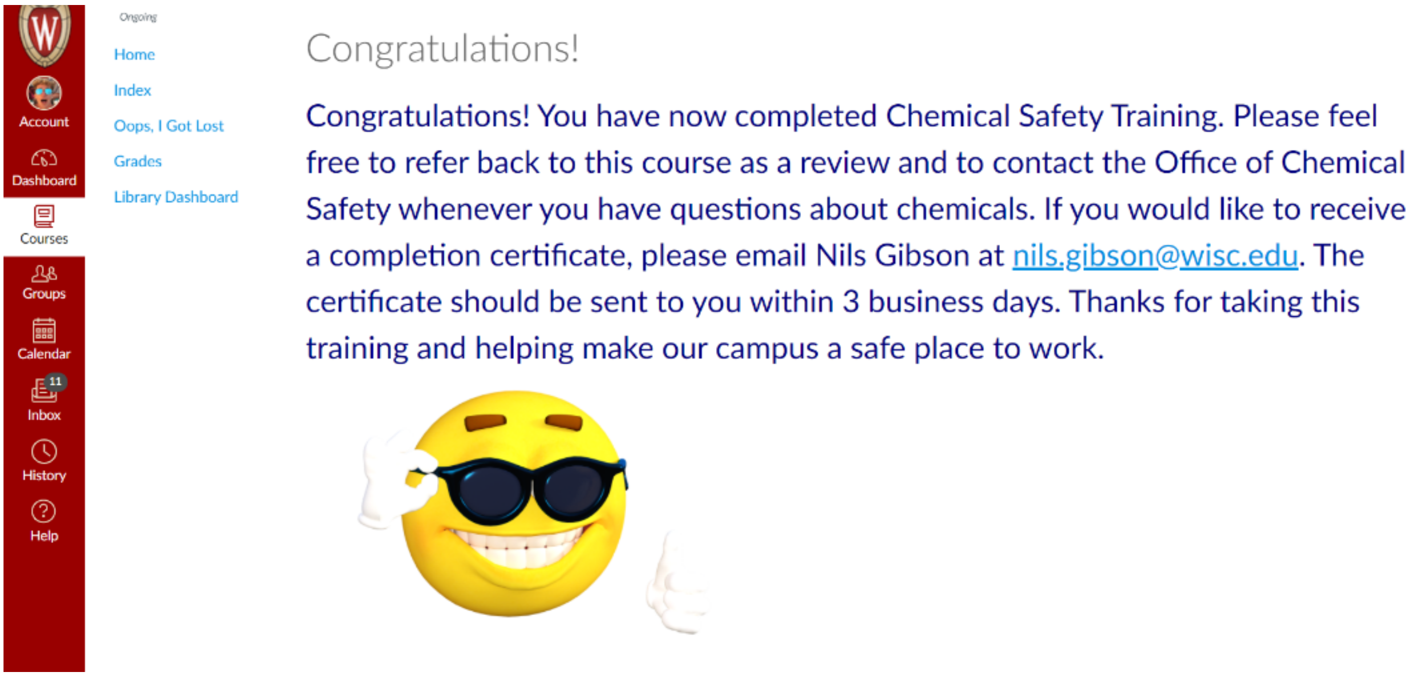
Content by: Joseph Byrne

Present: Joseph Byrne

Goals: To acquire skills and understanding relating to chemical safety in the laboratory.

Content:

The screenshot below shows that I have completed the chemical safety course:



Conclusions/action items:

Use this certification to complete necessary chemical experiments relating to the project.

2022/10/12- Red and Green Permit

Joseph Byrne - Oct 12, 2022, 12:28 PM CDT

Title: Red and Green Permit

Date: 10/12/2022

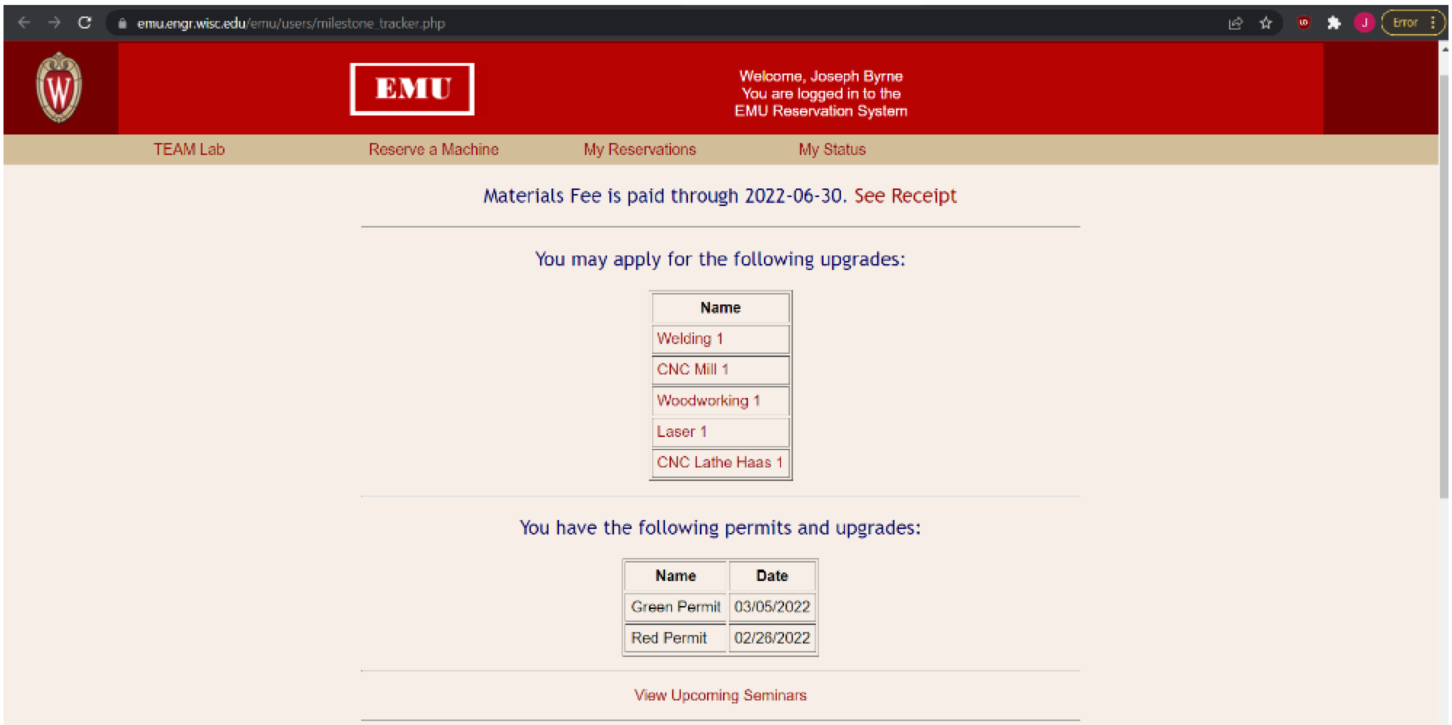
Content by: Joseph Byrne

Present: Joseph Byrne

Goals: To gain skills and understanding of various tools and equipment in order to fabricate a variety of things.

Content:

The screenshot below shows that I have completed the Red and Green Permit training through UW TeamLab.



Conclusions/action items:

These permits can be used to gain access to the tools and equipment at UW's Team Lab for fabrication of the prototype.

2022/10/20- Matlab Code

Joseph Byrne - Oct 20, 2022, 3:54 AM CDT

Title: Matlab Code for Analyzing Accelerometer Data

Date: 10/20/2022

Content by: Joseph Byrne

Present: Joseph Byrne

Goals: To develop and understand a Matlab code which can parse through data and produce useful graphs.

Content:

The first code parses through the accelerometer sensor data and saves the acceleration in the x-, y-, and z- directions as well as the acceleration magnitude and total time:

```
clear;
clc;

%% load the data
[filename, pathname] = uigetfile('*.mat','MultiSelect', 'on');
%% extract the data arrays
for j=1: numel(filename)

close all;
fn = fullfile(pathname, filename{j});
load(fn);

Ax = Acceleration.X;
Ay = Acceleration.Y;
Az = Acceleration.Z;
T = Acceleration.Timestamp;
to = T(1);
t= T - to;
t = seconds(t);

% magnitude of Acceleration
Amag = sqrt(Ax.^2 + Ay.^2 + Az.^2);

% save the data into useful variables
 savename = filename{j};
 save([savename(1:end-4) 'components.mat'], "Ax", "Ay", "Az", "Amag", "t")
 end
```

The second code uses the saved variables from the first code to create useful plots for acceleration vs. time:

```matlab
clear;
clc;

% make a cell array of all data file names

load('file');


figure

    subplot(4,1,1)
        plot(t, Ax)
        hold on
        title('')
        xlabel('Time (s)')
        ylabel('X Acceleration (m/s^2)')

    subplot(4,1,2)
        plot(t, Ay)
        hold on
        xlabel('Time (s)')
        ylabel('Y Acceleration (m/s^2)')

    subplot(4,1,3)
        plot(t, Az)
        hold on
        xlabel('Time (s)')
        ylabel('Z Acceleration (m/s^2)')

    subplot(4,1,4)
        plot(t, Amag)
        hold on
        xlabel('Time (s)')
        ylabel('Acceleration Mag. (m/s^2)')

```

Conclusions/action items:

The codes above parse through accelerometer data and then produce meaningful acceleration vs. time graphs. This code should be used to analyze the data from the accelerometer tests.

2022/10/27- Preliminary Data Analysis (Accel vs. Time)

Joseph Byrne - Oct 27, 2022, 12:59 PM CDT

Title: Preliminary Testing Acceleration vs. Time Analysis

Date: 10/27/2022

Content by: Joseph Byrne

Present: Joseph Byrne

Goals: To use figures created by MATLAB for the preliminary sensor data to understand baseline measurements for improvement.

Content:

Preliminary data was collected using accelerometers from six phones in different locations of an ambulance during a mock drive. A mannequin baby was used and attached to the incubator the same way a neonate would be during a transport. Two phones were placed on the babies head and chest. Two more phones were placed in the middle of the sled and the back of the sled. Finally, two more phones were placed in front of and behind the stretcher on the floor.

The figure below was produced using MATLAB. The four graphs are acceleration vs. time graphs for each component of acceleration, where the first graph is acceleration in the x-direction, the second is acceleration in the y-direction, the third is acceleration in the z-direction, and the fourth is the magnitude of acceleration. The various colors represent each of the six phones that were placed in different parts of the ambulance.

The key for phone placement is as follows:

Red = Head

Green= Chest

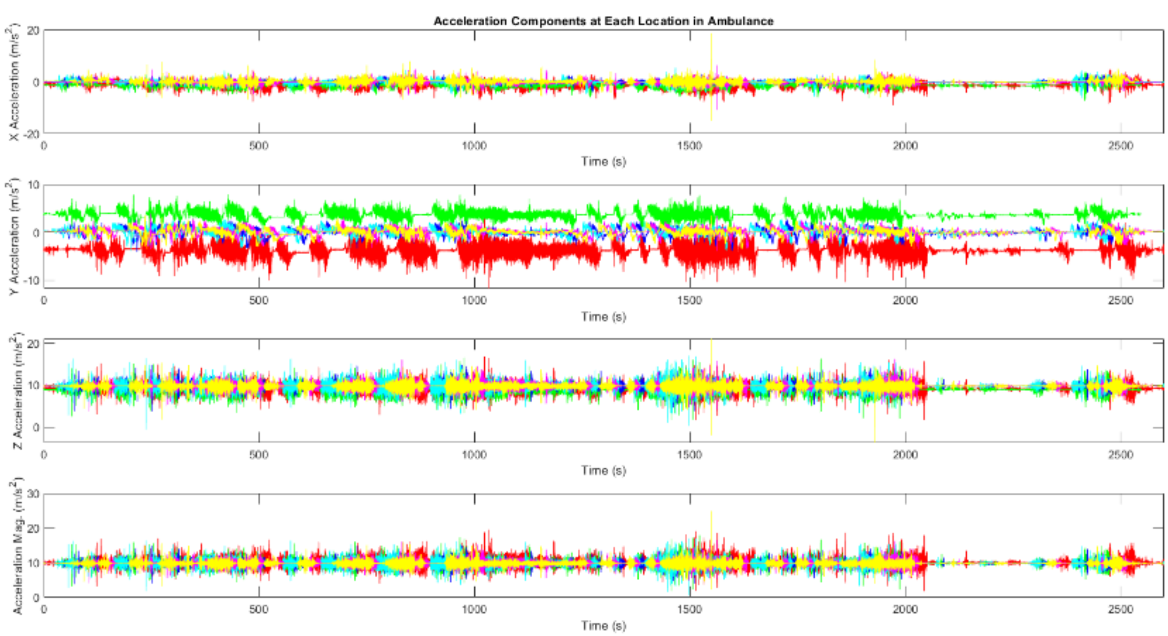
Dark Blue = Middle of the Sled

Cyan = Back of the Sled

Magenta = On the floor directly in front of the stretcher.

Yellow = On the floor directly behind the stretcher

The main differences occurred for acceleration in the y-direction. As expected, the amplitude of the vibration for the head of the baby was the largest and therefore means that this area experienced the greatest vibrations.



Conclusions/action items:

The preliminary data shows areas of the most and least vibrations and what components of acceleration those vibrations are in. The team should fully analyze these graphs to determine the areas of most vibration (particularly for the phones attached to the mannequin) and compare this to data collected after the dampers are installed for final testing.

2022/11/03-Updated Matlab Accel vs. Time Graph

Joseph Byrne - Nov 03, 2022, 4:04 PM CDT

Title: Updated Matlab Accel versus Time Graph

Date: 11/3/2022

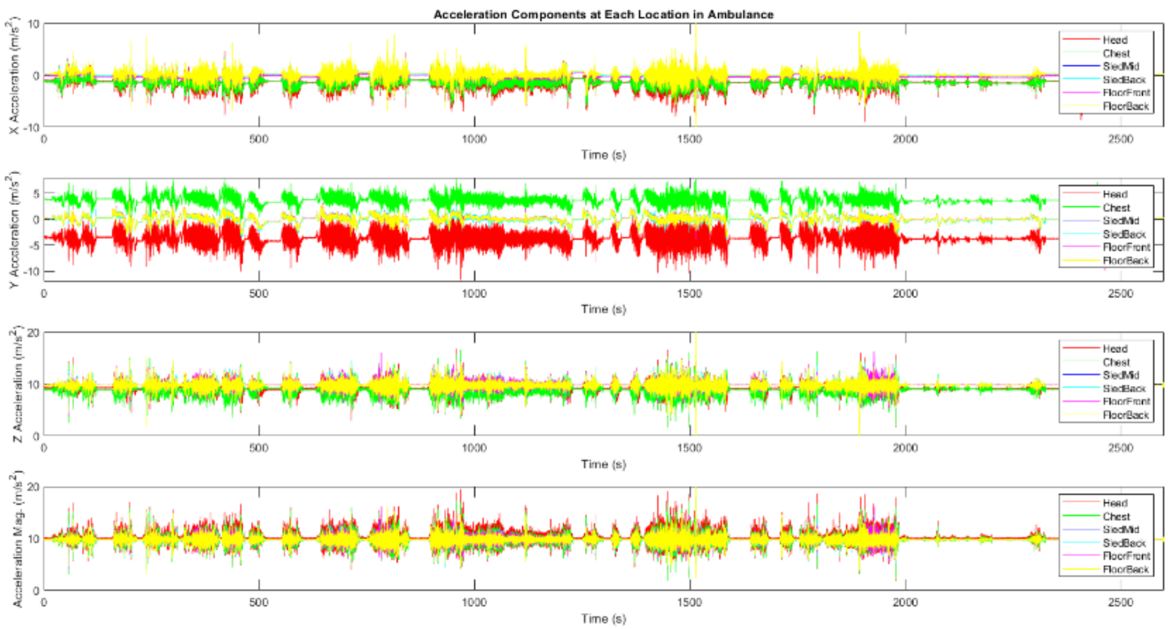
Content by: Joseph Byrne

Present: Joseph Byrne

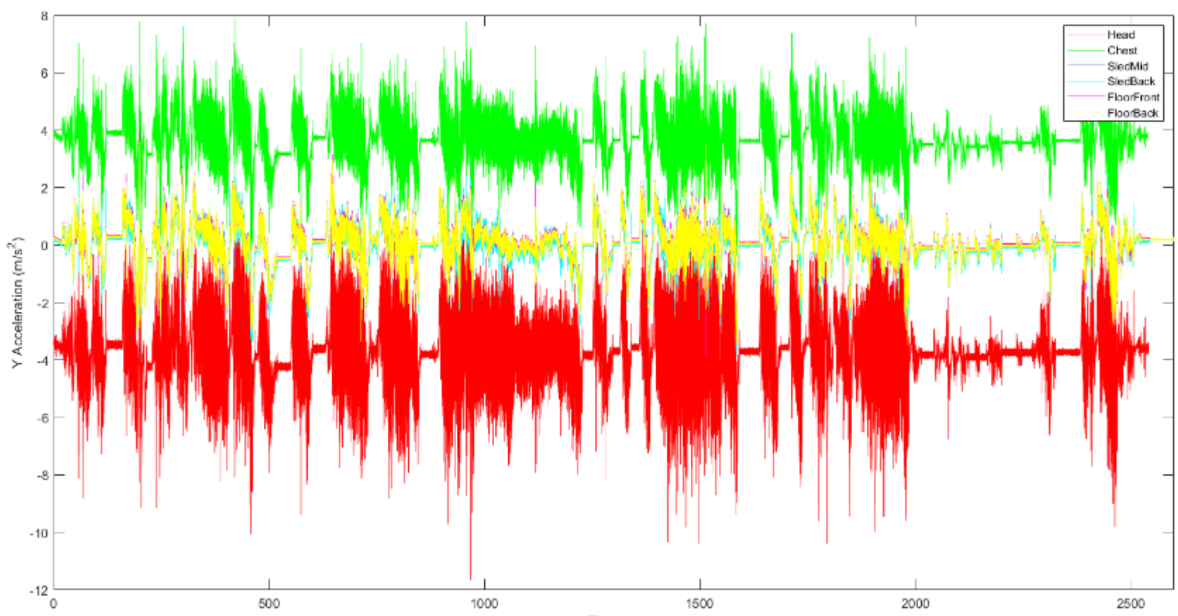
Goals: To refine the previous Matlab graph made in order to better analyze it.

Content:

The following graph is an updated version of the one shown in the "Preliminary Data Analysis (Accel vs. Time)" post. This version includes a legend, normalized time across each of the six sensors, and normalized y-axis for better understanding of magnitudes.



The following is just a zoomed in version of the Y-acceleration vs. time graph which best shows each of the sensors:



Conclusions/action items:

The graphs above show data for acceleration changes along a roughly 40 minute ambulance ride. This updated version should continue to be developed and should be used for further analysis.

2022/11/09- Accel vs. Time Threshold and Maxima

Joseph Byrne - Nov 09, 2022, 11:07 PM CST

Title: Maxima and Threshold Analysis

Date: 11/9/2022

Content by: Joseph Byrne

Present: Joseph Byrne

Goals: To further analyze the acceleration versus time graphs from the baseline data to gain understanding of key values.

Content:

Using matlab, each sensor's data was parsed through to find the local maxima throughout the entire ambulance drive using pks = findpeaks(Acceleration Magnitude). From there, the "pks" data for each sensor was copied into an excel spreadsheet in order to find the number of times the local maxima was above 0.87 m/s^2 (the identified acceptable vibration threshold) and the maximum peak. The findings are summarized in the following table:

Head (A)	# of times acceleration > 0.87 m/s^2	*13649*
	Max Accel of AllLocal Maxima	9.533261
Chest (G)	# of times acceleration > 0.87 m/s^2	*8293*
	Max Accel of AllLocal Maxima	8.165381
SledMid (I)	# of times acceleration > 0.87 m/s^2	*4861*
	Max Accel of AllLocal Maxima	5.131168
SledBack (K)	# of times acceleration > 0.87 m/s^2	*8444*
	Max Accel of AllLocal Maxima	7.215453
FloorFront (M)	# of times acceleration > 0.87 m/s^2	*4839*
	Max Accel of AllLocal Maxima	6.723949
FloorBack(O)	# of times acceleration > 0.87 m/s^2	*4887*
	Max Accel of AllLocal Maxima	15.64431

While the back of the ambulance (on the floor) experienced the greatest maximum vibration, the sensor on the head of the mannequin baby experienced the most vibrations above 0.87 m/s^2.

Conclusions/action items:

The data concludes that the head of the mannequin experienced the highest number of vibrations over 0.87 m/s^2 throughout the 40 minute ambulance drive. This is significant because head injuries are the primary concern of the project and this is where vibrations are the most intense.

2022/12/14- Layer Fabrication Description

Joseph Byrne - Dec 14, 2022, 1:28 PM CST

Title: Layer Fabrication Description

Date: 12/14/2022

Content by: Joseph Byrne

Present: Joseph Byrne

Goals: To describe the fabrication of the layers in order for the prototype to be replicable.

Content:

[Much of this is from what I wrote in the final report]

The layers follow an iteration pattern of foam, aluminum, and silicone which sit in an outer steel housing. The first layer in the pattern, foam, was cut from a stock sheet. Three strips were cut matching the length and width of the outer steel housing for the side dampers. To reduce the thickness and create the necessary six total foam layers, the thickness of each of the three strips were cut in half using a utility knife. From the stock sheet, six more rectangular layers were cut and thinned to match the two vertical faces of the corner dampers. The next layer in the pattern, aluminum, was cut using scissors to the same length and width as the foam layers from a roll of aluminum foil. Six total aluminum strips were made for the side dampers and 12 total aluminum segments were made for the corner dampers. The final material, silicone, was cut from a stock sheet. Scissors were used to create the same number of individual layers with the same dimensions as the foam and aluminum layers described above.

To assemble the straight dampers, a layer of spray adhesive was applied to the inner wall of the steel housing that opposes the removed face. The first layer of the pattern was placed against the steel wall, compressed, and allowed a short time to dry. In order, subsequent layers were attached face-to-face with spray adhesive applied between each. This was repeated until three iterations of the pattern were complete and the last layer of silicone extended just past the steel housing. The assembly of the corner dampers was very similar in that adhesive was applied first followed by the addition of another layer in the pattern. Two separate segments of each layer were added at a time to cover both vertical faces of the corner dampers. The layers were added outward until the pattern extended past the horizontal face. Any extra material extending past the lengths of the corner dampers or side dampers were trimmed using tin snips to create neat ends.

Conclusions/action items:

The description of layer fabrication can be used to replicate the prototype in the future. The team should update this description as the prototype is modified and create an official fabrication protocol that matches this description.

09/15/22 Investigating Vibration Levels in a Neonatal Transport System

SYDNEY THERIEN - Sep 15, 2022, 4:49 PM CDT

Title: Investigating Vibration Levels in a Neonatal Transport System

Date: 09/15/22

Content by: Sydney Therien

Present: Sydney Therien

Goals: To develop a preliminary understanding of the forces experienced by the neonate during transport, specifically with regard to vibration.

Content:

- they put accelerometers all around a fake neonate and its transport device (fig #1)

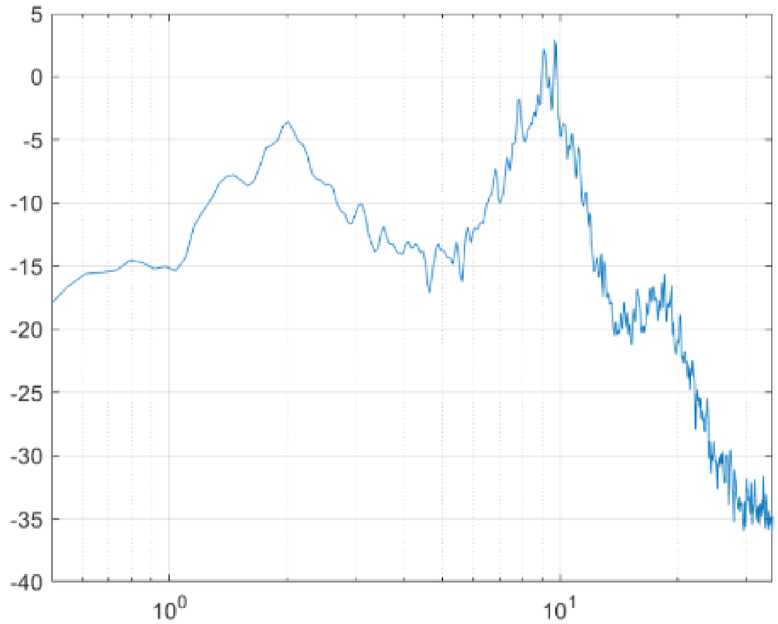


Figure 4: Power spectrum density of "Highway" road segment (80 km/hr) from the accelerometer mounted on the mannequin head in the incubator. The x-axis is in Hz using a log scale, while the y-axis is in dB.

- will look more into how to interpret this data

Conclusions/action items:

- share this information with the team

- investigate forces experienced by adult patients to develop a free-body diagram template to understand the forces experienced by a patient in transport

SYDNEY THERIEN - Sep 15, 2022, 4:42 PM CDT


Investigating Vibration Levels in a Neonatal Transport System

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869-Article_Text-1729-1-10-20190727.pdf (576 kB)

10/12/22 Magnet Levitation

SYDNEY THERIEN - Oct 12, 2022, 11:58 AM CDT

Title: Repulsive Magnetic Levitation Force Calculation for a High Precision 6-DoF Magnetic Levitation Positioning System

Date: 10/12/22

Content by: Sydney Therien

Present: Sydney Therien

Goals: To further knowledge about magnet levitation to assess whether or not the design that utilizes it would even be physically possible.

Link: https://ieeexplore.ieee.org/abstract/document/7775084

Content:

- this paper derives an equation for the calculation of the levitating force in a magnetic levitation positioning system

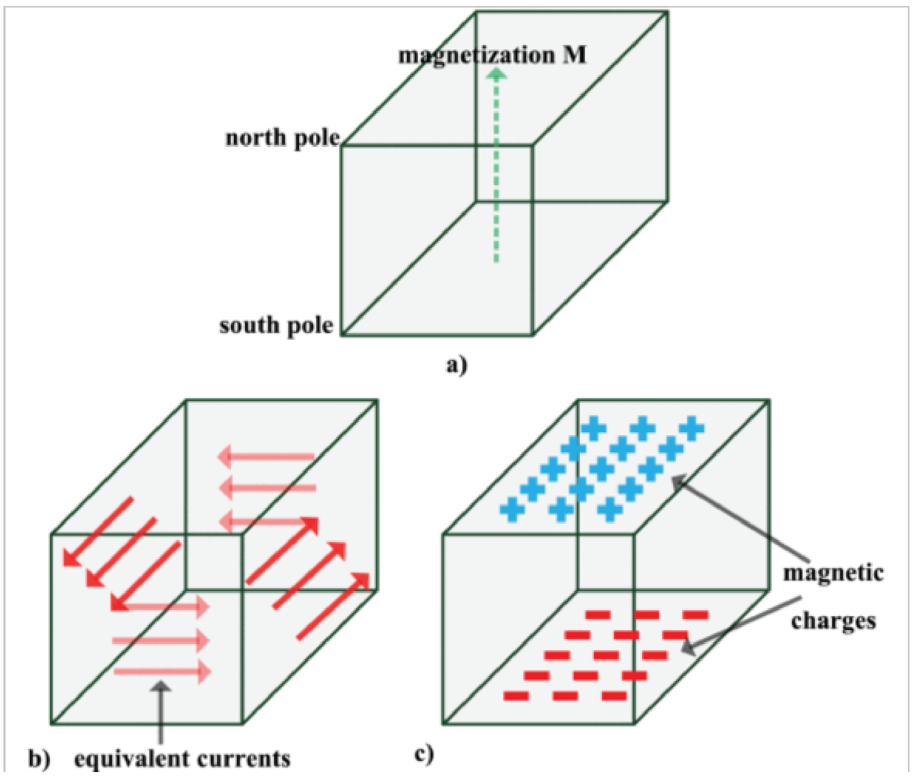

Figure 1: Diagrams of the force, current, and magnetic charges in a magnetic levitation system.

$$\mathbf{F} = \int_{V_{\text{coil}}} \mathbf{J} \times \left(\frac{\mu_0}{4\pi} \oint_{S_{\text{mag}}} \mathbf{M}(\mathbf{r}_\text{Q}) \cdot \mathbf{n} \cdot \frac{(\mathbf{r} - \mathbf{r}_\text{Q})}{|\mathbf{r} - \mathbf{r}_\text{Q}|^3} dS_{\text{mag}} \right) dV_{\text{coil}}.$$

Equation 1: Their final derived equation (derived from Lorenz force law among other things).

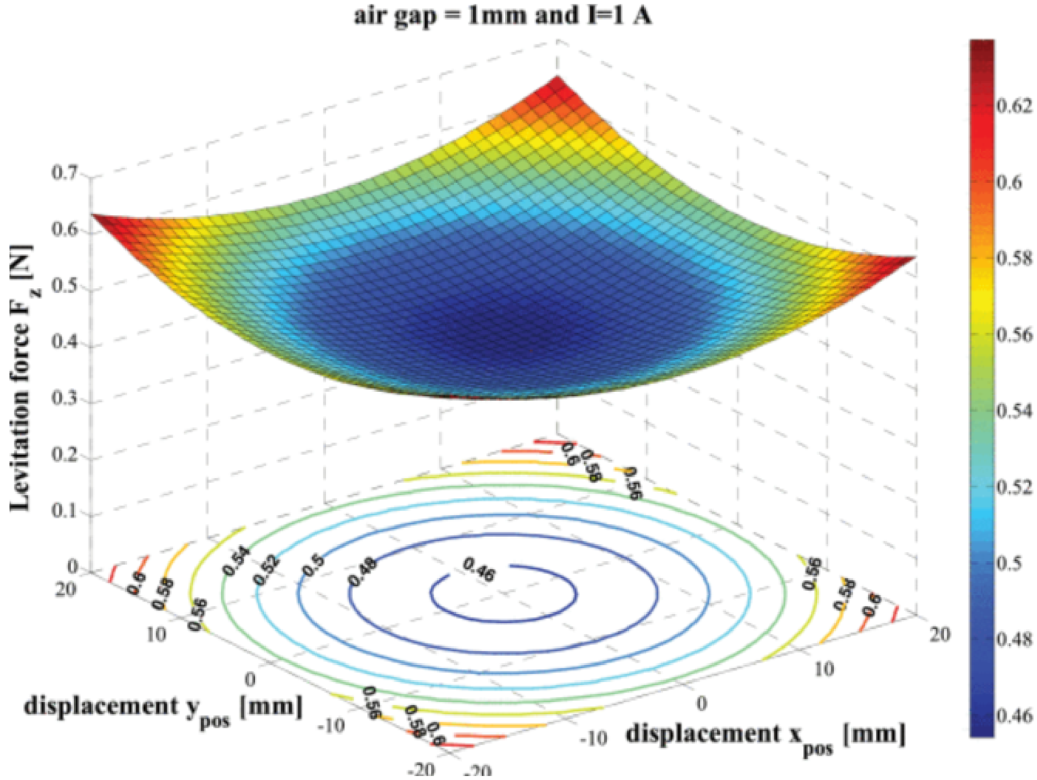

Figure 2: A 3D graph representing how the levitation force changes as the displacement from the center of the magnet increases.

Conclusions/action items:

What this basically proved is that it *is* possible to calculate this number theoretically. However, this equation used magnetic coils, and the magnet-induced levitation device has no coils at this time. Either the device or the equation would need to be modified for this information to be of utility. It is also perhaps possible to just set certain variables equal to what they would be in a no or one coil system.

10/12/22 FDA Standard for Sterilization of Medical Devices

SYDNEY THERIEN - Oct 12, 2022, 12:13 PM CDT

Title: Sterilization for Medical Devices

Date: 10/12/22 (I remember doing this research way back in September but never made a LabArchives for it)

Content by: Sydney Therien

Present: Sydney Therien

Goals: To develop an understanding of how medical devices are sterilized for the design process.

Content:

- was doing research into why things are always white or grey in hospitals for aesthetics section of PDS, wasn't finding anything legit

- doctor mom said it was to help identify when cleaning was needed, which makes sense

- Dr. Williams said that it'll be important in the design process to ensure that whatever we fabricate can be done with materials that are hospital-grade and sanitizable

from the standard:

- ethylene oxide is the standard hospital sanitizing chemical

- in order for FDA approval to be granted, the device must withstand an ethylene oxide sanitation check

ANSI AAMI ISO 11135:2014 and ANSI AAMI ISO 10993-7:2008(R)2012

- those standards take a closer look into how to quantify the results of this ethylene oxide test

Conclusions/action items:

- when writing testing protocol, look more into those standards for quantifiable objectives during ethylene oxide exposure

10/12/22 Adverse neonatal outcomes: examining the risks between preterm, late preterm, and term infants

SYDNEY THERIEN - Oct 12, 2022, 12:35 PM CDT

Title: Adverse neonatal outcomes: examining the risks between preterm, late preterm, and term infants

Date: 10/12/22

Content by: Sydney Therien

Present: Sydney Therien

Goals: To develop an understanding of the most significant risk factors for preterm neonates and keep these in mind when modifying the way that they are transported.

Link: https://www.sciencedirect.com/science/article/pii/S0002937808009101

Content:

examined most common risk factors for preterm neonates

comp-1: set of adverse outcomes in preemies that typically result in longer hospital stay

comp-2: set of adverse outcomes in preemies that have been linked to higher chance of mortality

System	COMP-1 outcome	COMP-2 outcome
CNS	Intraventricular hemorrhage (grades I-IV) Witnessed seizures Treatment of apnea/bradycardia	Intraventricular hemorrhage (grades I-IV) Witnessed seizures Treatment of apnea/bradycardia Home apnea monitoring
PULM	Respiratory assistance (cpap, ventilator)	Longer than 21 days ventilator therapy
GI	Necrotizing enterocolitis Reflux Hypoglycemia Longer than 4 days to achieve full per os/nasogastric feeds	Necrotizing enterocolitis
ID	Antibiotics for any sepsis (longer than 48 h)	Antibiotics for confirmed sepsis (longer than 7 days)
HEME	Hyperbilirubinemia requiring phototherapy Blood transfusion for anemia	Hyperbilirubinemia requiring phototherapy Blood transfusion for anemia

Table 1: A table describing what conditions are comp-1 and comp-2 for the purposes of this study.

Table 2: The results of the study showing which conditions were significantly correlated to delivery date (below).

Conclusions/action items:

- use this information in the construction of the prototype being mindful for the more significant risk factors that preterm neonates might experience

SYDNEY THERIEN - Oct 12, 2022, 12:28 PM CDT

Outcome	32 to 33 6/7 wks (n = 61)	P value	34 to 36 6/7 wks (n = 69)	P value	37 wks or later (n = 134)	Total (n = 264)	P value across 3 groups[a]
COMP-1	95.1% (58)	< .0001	56.5% (39)	< .0001	18.7% (25)	46.2% (122)	< .0001
COMP-2	86.9% (53)	< .0001	40.6% (28)	< .0001	11.9% (16)	36.7% (97)	< .0001
NICU longer than 7 d	82.0% (50)	< .0001	30.4% (21)	.15	2.2% (3)	28.0% (74)	< .0001
Full feed (ng plus po, longer than 4 d)	78.7% (48)	< .0001	20.3% (14)	< .0001	0.7% (1)	23.9% (63)	< .0001
Hyperbilirubinemia	75.4% (46)	.0001	40.6% (28)	< .0001	9.7% (13)	33.0% (87)	< .0001
Apnea/bradycardia	50.8% (31)	< .0001	13.0% (9)	.0001	0% (0)	15.2% (40)	< .0001
Sepsis (presumed or culture positive)	44.3% (27)	< .0001	7.2% (5)	.62	4.5% (6)	14.4% (38)	< .0001
Respiratory insufficiency	41.0% (25)	.01	18.8% (13)	.0001	2.2% (3)	15.5% (41)	< .0001
Hypoglycemia	36.1% (22)	.98	34.8% (24)	< .0001	6.0% (8)	20.5% (54)	< .0001
Need for surfactant	18.0% (11)	.02	4.3% (3)	.04	0% (0)	5.3% (14)	< .0001
IVH	9.8% (6)	.05	1.4% (1)	.34	0% (0)	2.7% (7)	.0003
Temperature instability	9.8% (6)	.05	1.4% (1)	.34	0.7% (1)	3.0% (8)	.0019
Home apnea monitoring	9.8% (6)	.001	0% (0)	1.00	0% (0)	2.3% (6)	< .0001
Reflux	8.2% (5)	.47	4.3% (3)	.04	0% (0)	3.0% (8)	.0063
NEC	8.2% (5)	.003	0% (0)	1.00	0% (0)	1.9% (5)	.001
Seizure	1.6% (1)	—	0% (0)	—	0.7% (1)	0.8% (2)	.56
Ventilator 2 d or longer	1.6% (1)	—	2.9% (2)	—	0% (0)	1.1% (3)	0.17
Anemia	1.6% (1)	—	1.4% (1)	—	0% (0)	0.8% (2)	0.35

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09/28/22 Design Brainstorm

SYDNEY THERIEN - Oct 11, 2022, 1:00 PM CDT

Title: Design Brainstorm

Date: 09/28/22 (uploaded 10/11/22)

Content by: Sydney Therien

Present: Sydney Therien

Goals: To cultivate some preliminary ideas to combine and develop into some designs.

Content:

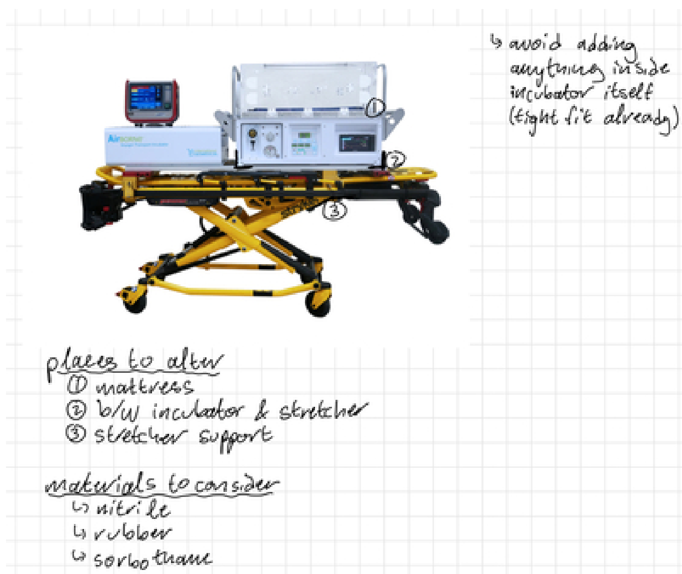
See the attached figures.

Conclusions/action items:

- develop designs based on shock-absorbing ideas

- share with team

SYDNEY THERIEN - Oct 11, 2022, 12:53 PM CDT



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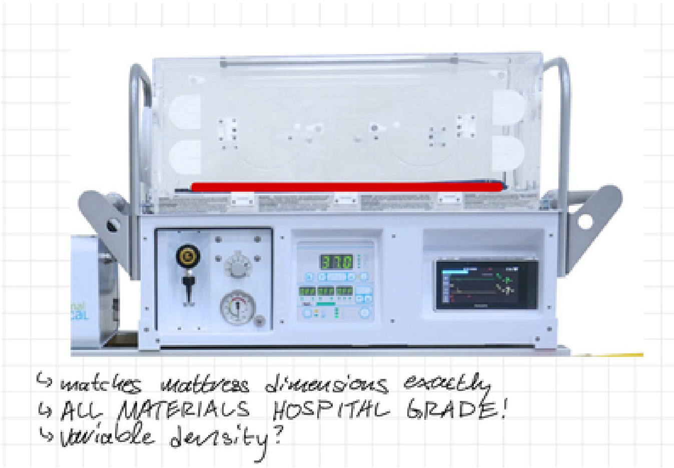
SYDNEY THERIEN - Oct 11, 2022, 12:54 PM CDT



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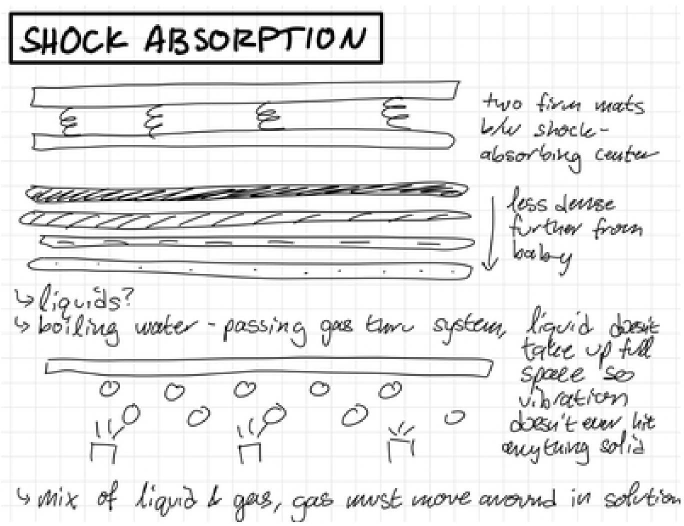
SYDNEY THERIEN - Oct 11, 2022, 12:59 PM CDT



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IMG_C2ABADEC8896-1.jpeg (504 kB)

09/28/22 Vibration-Reduction Mat

SYDNEY THERIEN - Oct 11, 2022, 1:33 PM CDT

Title: Vibration-Reduction Mat

Date: 09/28/22 (uploaded 10/11/22)

Content by: Sydney Therien

Present: Sydney Therien

Goals: To create a low-tech low-cost vibration-reducing mat that can be easily integrated into existing incubator setups.

Content:

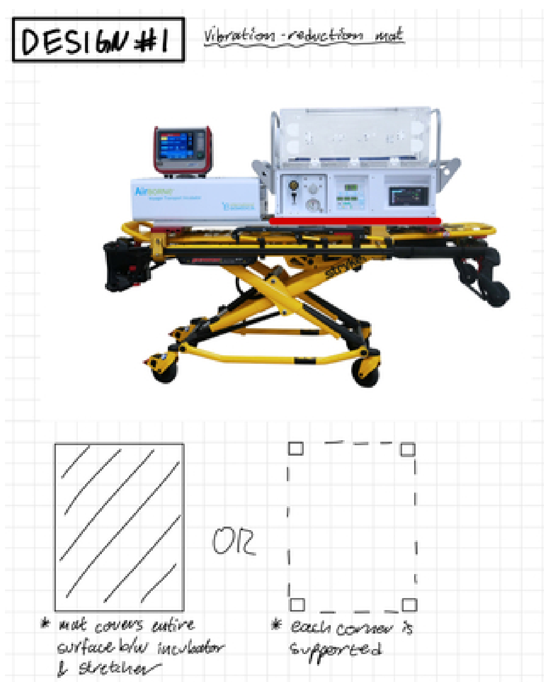
See the attached figure.

Conclusions/action items:

- share with team

- discuss merits and drawbacks of this design with them

SYDNEY THERIEN - Oct 11, 2022, 1:03 PM CDT



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09/28/22 Shake The Baby

SYDNEY THERIEN - Oct 11, 2022, 1:33 PM CDT

Title: Shake The Baby

Date: 09/28/22 (uploaded 10/11/22)

Content by: Sydney Therien

Present: Sydney Therien

Goals: To harness the power of destructive interference in waves to counteract any vibrational force incurred by the neonate during transfer.

Content:

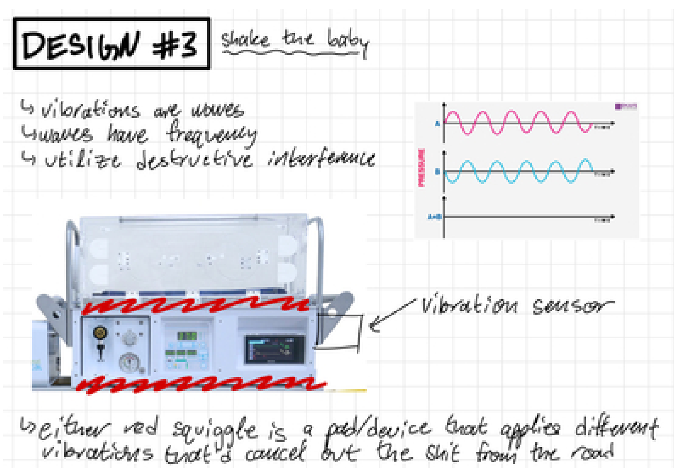
See the attached figure.

Conclusions/action items:

- show this design to the team

- discuss its merits and drawbacks

SYDNEY THERIEN - Oct 11, 2022, 1:16 PM CDT



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09/28/22 Magnet-Induced Levitation

SYDNEY THERIEN - Oct 11, 2022, 1:33 PM CDT

Title: Magnet-Induced Levitation

Date: 09/28/22 (uploaded 10/11/22)

Content by: Sydney Therien

Present: Sydney Therien

Goals: To utilize the repulsion force created by magnet ends of the same polarity in too close of a proximity to create a shock-absorbing cushion on which the incubator can sit.

Content:

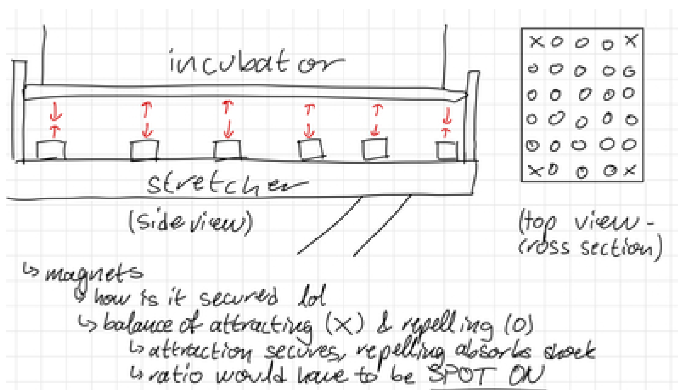
See the attached figures.

Conclusions/action items:

- show this design to the team

- discuss its merits and drawbacks

SYDNEY THERIEN - Oct 11, 2022, 1:23 PM CDT



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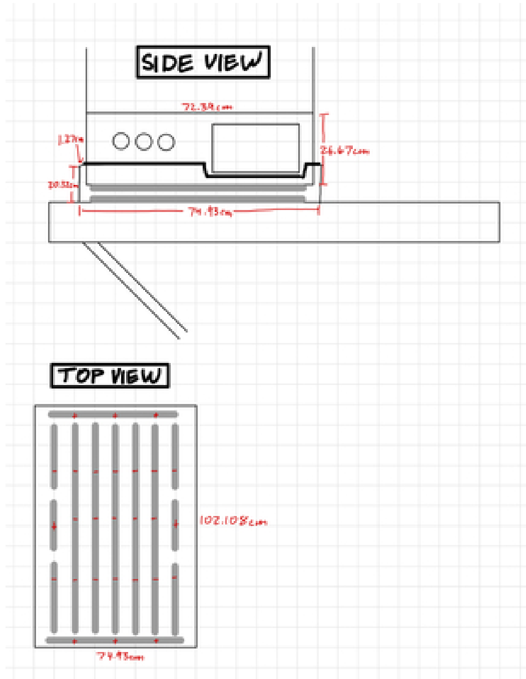
SYDNEY THERIEN - Oct 11, 2022, 1:25 PM CDT



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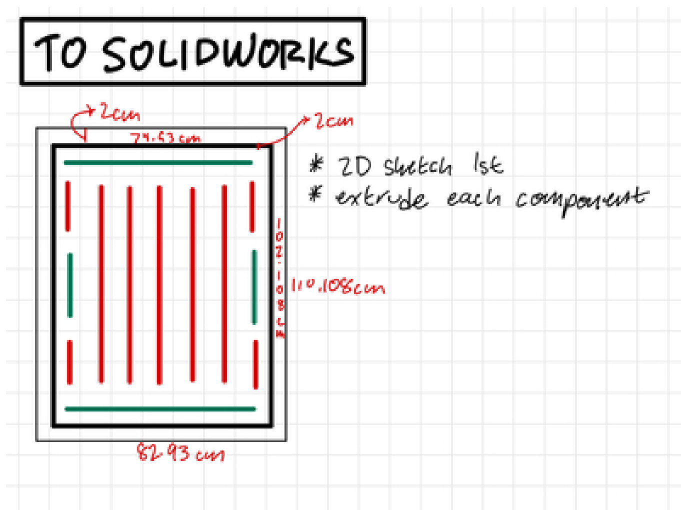
SYDNEY THERIEN - Oct 11, 2022, 1:29 PM CDT



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10/10/22 SolidWorks for Magnet-induced Levitation Device

SYDNEY THERIEN - Oct 11, 2022, 1:31 PM CDT

Title: SolidWorks for Magnet-Induced Levitation Design

Date: 10/10/22 (uploaded 10/11/22)

Content by: Sydney Therien

Present: Sydney Therien

Goals: To model the magnet-induced levitation design in SolidWorks.

Content:

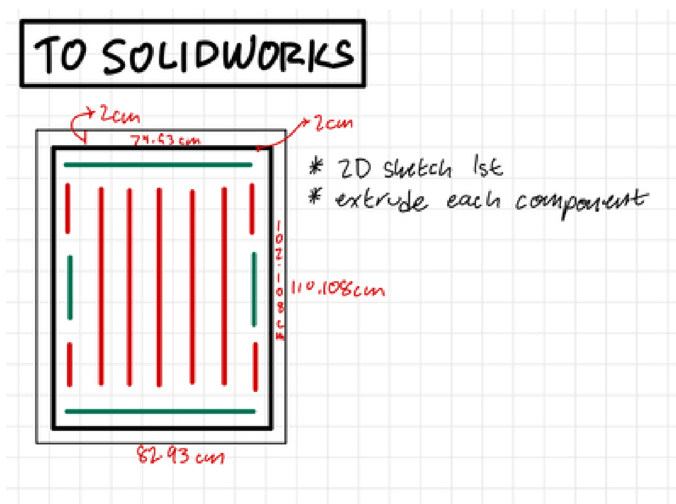
See the attached figures.

Conclusions/action items:

- add to preliminary report

- show the team

SYDNEY THERIEN - Oct 11, 2022, 1:32 PM CDT



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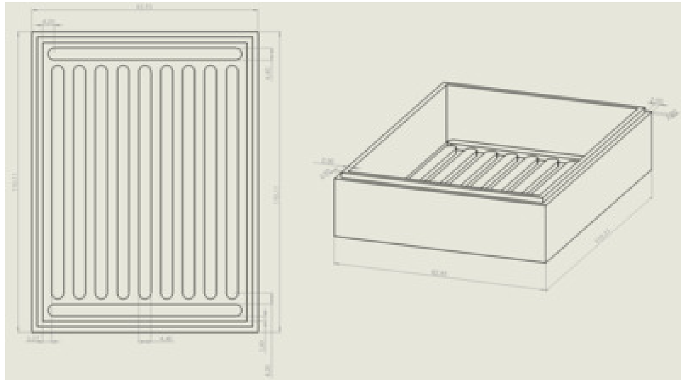
SYDNEY THERIEN - Oct 11, 2022, 1:32 PM CDT



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snipofmaglev.PNG (58.2 kB)

10/06/22 Rudimentary Prototyping of the Magnet-Induced Levitation Design

SYDNEY THERIEN - Oct 12, 2022, 12:35 PM CDT

Title: Rudimentary Prototyping of the Magnet-Induced Levitation Design

Date: 10/06/22 (uploaded 10/12/22)

Content by: Sydney Therien

Present: Sydney Therien

Goals: To prototype the magnet-induced levitation device to understand if magnet levitation could effectively reduce WBV on a moving surface.

Content:

See the attached image of the completed prototype, complete with the head strap restraint system on a poster-tack baby.

Conclusions/action items:

- use in conjunction with slides during the preliminary presentation

- give Dr. Nimunkar back his magnets and disassemble

SYDNEY THERIEN - Oct 12, 2022, 12:32 PM CDT

Download

IMG_5237.jpg (512 kB)

03/11/22 Green Permit

SYDNEY THERIEN - Oct 12, 2022, 8:21 AM CDT

Title: Green Permit

Date: 03/11/22 (uploaded 10/12/22)

Content by: Sydney Therien

Present: Sydney Therien

Goals: To complete the green permit trainings.

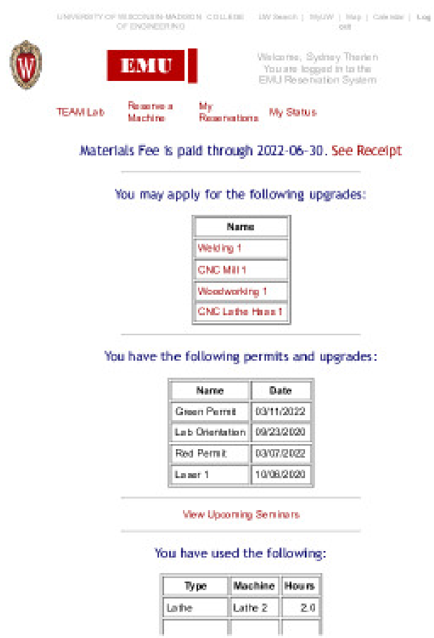
Content:

See the attached PDF.

Conclusions/action items:

- use this to help fabricate elements of our design

SYDNEY THERIEN - Oct 12, 2022, 8:12 AM CDT



UNIVERSITY OF WISCONSIN-MADISON COLLEGE OF ENGINEERING | UW Search | MyUW | Map | Calendar | Log out

EMU

Welcome, Sydney Therien
You are logged in to the EMU Reservation System

TEAM Lab | Reserve a Machine | My Reservations | My Status

Materials Fee is paid through 2022-06-30. See Receipt

You may apply for the following upgrades:

Name
Welding 1
CNC Mill 1
Woodworking 1
CNC Lathe Haas 1

You have the following permits and upgrades:

Name	Date
Green Permit	03/11/2022
Lab Orientation	09/23/2020
Red Permit	03/07/2022
Laser 1	10/08/2020

View Upcoming Seminars

You have used the following:

Type	Machine	Hours
Lathe	Lathe 2	2.0

Download

Therien_Green_Permit.pdf (143 kB)

10/27/22 Welding 1

SYDNEY THERIEN - Dec 14, 2022, 8:02 PM CST

Title: Welding 1

Date: 10/27/22, uploaded 12/14/22

Content by: Sydney Therien

Present: Sydney Therien, UW-Madison TEAMLab

Goals: To earn my Welding 1 permit so that I can help the team fabricate once the materials arrive.

Content:

See attached screenshot.

Conclusions/action items:

- help the team fabricate!

SYDNEY THERIEN - Dec 14, 2022, 7:59 PM CST

You have the following permits and upgrades:

Name	Date
Green Permit	03/11/2022
Lab Orientation	09/23/2020
Red Permit	03/07/2022
Welding 1	10/27/2022
Laser 1	10/06/2020

Download

Screen_Shot_2022-12-14_at_7.58.09_PM.png (84.4 kB)

2022/09/11 Review of current knowledge in neonatal transport

GRETA SCHEIDT - Sep 11, 2022, 11:44 AM CDT

Title: Whole body vibration in neonatal transport: a review of current knowledge and future research challenges

Date: 9/11/22

Source link: **https://pubmed.ncbi.nlm.nih.gov/32464450/**

Citation: I. Goswami, S. Redpath, R. G. Langlois, J. R. Green, K. S. Lee, and H. E. A. Whyte, “Whole-body vibration in neonatal transport: A review of current knowledge and future research challenges,” *Early Human Development*, vol. 146, p. 105051, May 2020.

Content by: Greta Scheidt

Present: N/A

Goals: Gain background knowledges on the existing issues of current neonatal transport systems.

Content:

- Types of forces the neonate experiences:
  - Mechanical shock: singular distinct accelerations vs. time profile
    - Typically short duration & high amplitude
  - Mechanical vibration: sustained rhythmic acceleration vs. time profile
- Common elements in current incubator/bed designs
  - Vibration isolation systems: act by altering the natural frequency of the system to produce a vibration attenuation
    - Active vs. passive vibration isolation
      - Active: require a feedback circuit w/ an actuator, sensors, & controller
  - Sensors: used to detect movement
  - Force generator: motor that limits translational movement
  - Dampers: allow incubator to move in various axes of motion & also absorb shocks
  - Air-filled and foam mattresses increase vibration
- Adverse effects in completed studies:
  - Vibration exposure in mice:
    - Chronic brain edema & neuronal atrophy → functional impairment
      - Brain injury is a result of decreased cerebral blood flow
  - Limited neonatal studies
- Inherent risks for premature infants:
  - Increased risk of intraventricular hemorrhage (IVH)
  - Low weight increases hazards of vibration
  - Inability to adapt to variations in sensory input
- Vibration standards for adults:
  - < 0.87 m/s^2
  - No standards for neonates

- Measured maximum vibrations in ambulance transport exceeded this level

- Known disparities in the current system:
    - Lack of ability to measure patient experience such as vibration levels, audible noise levels, temperature variations, etc.
    - Most studies confirm that WBV experienced by neonates exceeds ISO standards
- Future directions:
    - Develop and test methods of measuring neonatal stress
        - Saliva cortisol levels
        - Skin conductance measurements
        - Heart rate variability
    - Addition of safety checks focused on minimization of vibration before transport

Conclusions/action items: Observations have hypothesized connections between neonatal transport and neurological effects, and limited human studies have revealed mechanical force levels higher than the accepted work standards for adults. Further research should be done to understand the vibration isolation systems currently used for neonatal transport and the potentially linked effects.

2022/09/11 Effect on heart rate during transport

GRETA SCHEIDT - Sep 11, 2022, 12:02 PM CDT

Title: Sound and vibration: effects on infants' heart rate and heart rate variability during neonatal transport

Date: 09/11/22

Source Link: **https://onlinelibrary-wiley-com.ezproxy.library.wisc.edu/doi/pdfdirect/10.1111/j.1651-2227.2011.02472.x**

Citation: B.-M. Karlsson, M. Lindkvist, M. Lindkvist, M. Karlsson, R. Lundström, S. Håkansson, U. Wiklund, and J. van den Berg, “Sound and vibration: Effects on infants’ heart rate and heart rate variability during neonatal transport,” *Acta Paediatrica*, vol. 101, no. 2, pp. 148–154, 2011.

Content by: Greta Scheidt

Present: N/A

Goals: Continue developing background knowledge on the needs of the project and specifically why current devices pose a risk to neonates.

Content:

- Methods of study:
    - 16 infants transported by air ambulance with ground ambulance transport
    - Whole-body vibration & sound levels recorded
        - Accelerometer was fastened in the incubator directly under the mattress
    - Heart parameters obtained by ECG signal
- Results:
    - Sound & WBV exceeded recommended limits
        - Sound: 73 dBA
        - WBV: 0.19 m/s^2
            - WBV frequencies differed b/w air and ground transport
    - Higher WBV --> lower heart rate
    - Higher sound levels --> higher heart rate
- Conclusions: sound has a more stressful effect on infants than vibration

Conclusions/action items: This source had trouble establishing definitive correlations between heart rate and heart rate variability and the measured variables of sound and vibration as the two had somewhat conflicting effects. Next, a source should be identified that completed a similar study but used a different biological variable other than heart rate to monitor the physiological condition of the neonate during transport to determine if this can reveal more information about how stress on the neonate is affected by transport.

2022/09/14 Neonatal head and torso vibration

GRETA SCHEIDT - Sep 14, 2022, 5:06 PM CDT

Title: Neonatal head and torso vibration exposure during inter-hospital transfer.

Date: 9/14/22

Source Link: https://europepmc.org/article/PMC/5315199

Citation: L. Blaxter, M. Yeo, D. McNally, J. Crowe, C. Henry, S. Hill, N. Mansfield, A. Leslie, and D. Sharkey, "Neonatal head and torso vibration exposure during inter-hospital transfer," *Proceedings of the Institution of Mechanical Engineers, Part H: Journal of Engineering in Medicine*, vol. 231, no. 2, pp. 99–113, 2017.

Content by: Greta Scheidt

Present: N/A

Goals: Explore and understand an additional method of measuring vibration levels during transport in a previous study.

Content:

Methods:

- Measuring vibration levels: inertial sensing units were mounted on the forehead and torso of the neonatal patients.
    - A custom inertial datalogger and analysis software was used to quantify the vibration and linear acceleration.
    - Recorded angular rotation.

Findings:

- Vibration isolation is substantially different between sponge and air mattresses.
- A certain vibration frequency range causes the most damage to the brain as a result of causing the highest relative brain motion.
- As a result of the stiff locking mechanism used to clamp the incubator system directly to the ambulance floor, vehicle chassis vibration can be transferred directly to the incubator.

Incubator system used:

- Babies were transferred within a trolley mounted incubator which mechanical fixed to the ground.
- Neonate mannequin was placed in a harness/patient safety restraint inside the bed of the incubator.

Future directions needed:

- Investigate the difference in relative hazard posed by shocks (sudden jolt) vs. continuous vibration.

Conclusions/action items: This study applied vibration sensors directly to the baby rather than the incubator which differed from previous studies I have read. Their conclusions were similar in reflecting vibration values that exceeded adult standards for the workplace and identification of areas of improvement in the incubator system including the attachment of the incubator to the ambulance floor. Future work should including researching existing vibration dampening/absorbing systems and evaluate their feasibility in the context of the project.

2022/12/8 Mechanical analysis of woodpecker drumming

GRETA SCHEIDT - Dec 11, 2022, 11:56 AM CST

Title: A Mechanical Analysis of Woodpecker Drumming and Its Application to Shock-Absorbing Systems

Date: 12/8/22

Source Link: https://iopscience.iop.org/article/10.1088/1748-3182/6/1/016003/pdf

Citation: S.-H. Yoon and S. Park, "A mechanical analysis of woodpecker drumming and its application to shock-absorbing systems," *Bioinspiration & Biomimetics*, vol. 6, no. 1, p. 016003, 2011.

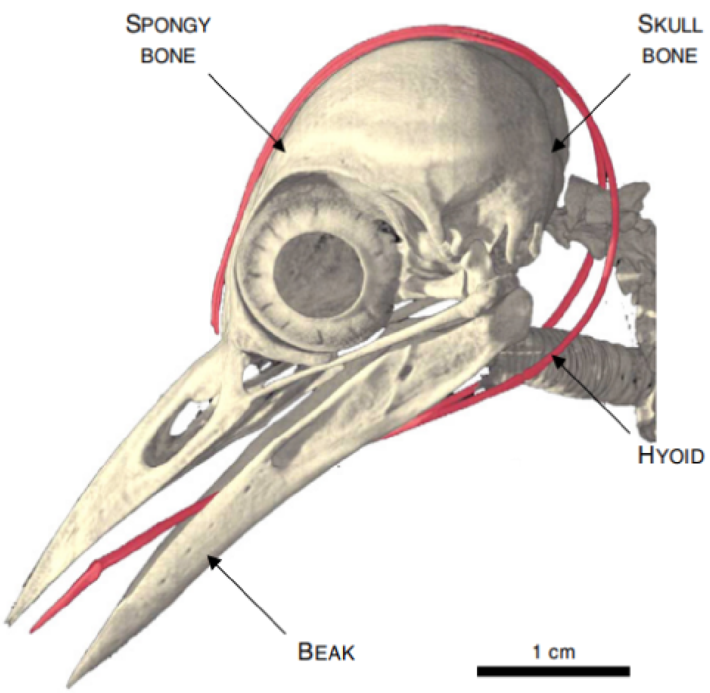
Content by: Greta Scheidt

Present: Greta Scheidt

Goals: Develop a better understanding of the material properties that constitute the natural damper present in the skull of woodpeckers and analyze how these material properties can be applied in building composite dampers/shock-absorbers.

Content:

- Foam is a viscoelastic material which can act as a shock-absorber
- Goal of aluminum is to simulate the role of the CSF, reducing transmission of the mechanical excitations
- Aluminum + Foam sheets are often used as damping material because they can absorb and dissipate vibration
  - Viscoelastic material can absorb/store strain energy rather than immediately transferring it to neighboring materials
- How does this layering prevent vibrations from directly reaching the brain?
  - The spongy bone (aluminum) is thought to evenly distribute incident mechanical excitation
    - Specifically, the spongy bone (silicone gel) eliminates high frequency vibrations by acting as a mechanical low-pass filter
  - The order of the layers is significant because the different structures sequentially absorb mechanical excitations
- Anatomical configuration of dampening components active in beak drumming: beak, hyoid (tendon that provides structure to tongue and extends around the outside of the skull), spongy bone countercoup (opposite) the beak, and skull bone with cerebral spinal fluid
  - The long length of the beak relative to the body prevents incident mechanical excitations from directly reaching the brain.
  - The hyoid extends from the floor of the mouth, goes behind the neck, divides into two bands, encompasses the head, and comes forward to the nostril.
    - This allows the woodpecker to extend it tongue in order to evenly distribute incident mechanical excitations
  - The spongy bone dissipates/evenly distributes vibrations before they propagate to the brain.
    - The spongy bone is a porous material.
    - The spongy bone acts a low-pass filter. This means that it transmits the majority of low frequency vibrational waves and absorbs almost all higher frequency waves.
  - The skull bone with CSF also plays a role in dissipating mechanical excitations.
  - In contrast to the layering pattern used in our prototype, the material analogous to the aluminum is after silicon gel instead of before.



*anatomical drawing of four layers in woodpecker head

- Vibrational/material properties of the layers:
  - Beak idealized to a lumped parameter model with one mass and two Kelvin models (each Kelvin model has one spring and one dashpot in parallel)
    - A dashpot is synonymous to a damper, or shock absorber
  - The hyoid bone and skull bone are idealized to be a lumped parameter model with one mass and one Kelvin model
  - Based upon this model, all three materials have some amount of viscoelastic properties
    - These properties are mathematically analyzed/quantified using masses (m), spring constants (k), and damping coefficients (c)

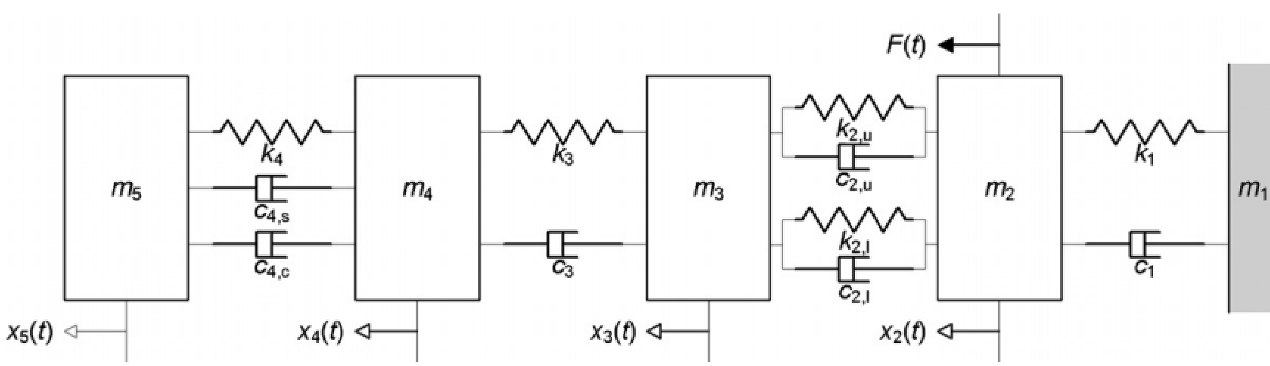


Figure 5. Equivalent mass–damper–spring model of the head structure of a woodpecker without considering the spongy bone.

*Idealized mass-damper spring system without inclusion of the spongy bone. m1 in this drawing is the tree, and m5 is the brain.

<u>In-depth description of variables in figure above and how each was derived in relation to the woodpecker's head:</u>

Beak:

- m2 = mass of the beak
- The stiffness/spring constant of the beak was calculated using this equation in which ub = upper beak, lb = lower beak, A2 = cross-sectional area, and E2 = young's modulus

$$k_2 = k_{2,\mathrm{ub}} + k_{2,\mathrm{lb}} = \frac{2A_2 \cdot E_2}{l_2},$$

For the beak, k2 = 6.5E4 Nm^-1

$$c_2 = c_{2,\mathrm{ub}} + c_{2,\mathrm{lb}} = \tan\delta\sqrt{m_2 \cdot k_2} = 0.37\ \mathrm{N\,s\,m^{-1}}.$$

- C2 = 0.37 Nsm^-1 for the beak

Hyoid:

$$k_3 = \frac{2l_3 \cdot w_3 \cdot E_3}{h_3} = 2.0 \times 10^8\ \mathrm{N\,m^{-1}}.$$

$$c_3 = \zeta\sqrt{m_3 \cdot k_3} = 5.63\ \mathrm{N\,s\,m^{-1}}.$$

Skull bone with CSF:

$$k_4 = \frac{2E_4}{\sqrt{3(1-\upsilon^2)}}\frac{t_4^2}{d_4} = 3.2 \times 10^6\ \mathrm{N\,m^{-1}}, \qquad (17)$$

$$c_4 = c_{4,s} + c_{4,c} = \tan\delta\sqrt{m_4 \cdot k_4} + 3\pi\,\mu_4\,d_4 = 3.88\ \mathrm{N\,s\,m^{-1}}, \qquad (18)$$

Other relevant parameters:

Beak	Length	l_2	2.6×10^{-2} m	DigiMorph Staff 2004
	Diameter	d_2	6×10^{-3} m	DigiMorph Staff 2004
	Density[b]	ρ_2	1456 kg m^{-3}	Oda *et al* 2006
	Young's modulus[c]	E_2	3×10^7 Pa	Seki *et al* 1998
	Damping coefficient[d]	Tan δ	0.032	Fortis *et al* 2004
Hyoid	Length	l_3	6.67×10^{-2} m	DigiMorph Staff 2004
	Height	h_3	6.5×10^{-4} m	DigiMorph Staff 2004
	Width	w_3	6.5×10^{-4} m	DigiMorph Staff 2004
	Density[e]	ρ_3	1200 kg m^{-3}	Oda *et al* 2006
	Young's modulus[f]	E_3	1.5×10^9 Pa	Alexander *et al* 1977
	Damping coefficient[e]	ζ	0.25	Revel *et al* 2003
Skull bone with cerebrospinal fluid (CSF)	Diameter	d_4	2×10^{-2} m	DigiMorph Staff 2004
	Thickness	t_4	2.5×10^{-3} m	DigiMorph Staff 2004
	Density	ρ_4	1456 kg m^{-3}	Oda *et al* 2006
	Young's modulus	E_4	8.75×10^9 Pa	Oda *et al* 2006
	Poisson's ratio	ν	0.2	Oda *et al* 2006
	CSF viscosity[g]	μ	8.5×10^{-4} N·s m^{-1}	Oda *et al* 2006
Brain	Diameter	d_5	1.5×10^{-2} m	DigiMorph Staff 2004
	Density	ρ_5	1040 kg m^{-3}	Oda *et al* 2006

<u>Application of these properties to a shock-absorbing system:</u>

- In the shock-absorbing system described in this article, the high strength external materials (analogous to stainless steel in our prototype) was used to protect the rest of the damper from physical damage/deformation.
- The viscoelastic layer (synonymous to foam in our prototype) dissipates vibrations
- The porous structure (silicone gel in our prototype) acts as a low-pass filter and suppresses high frequencies excitations. Medical grade silicon is not porous but may still be able to act as a low-pass filter.
- The aluminum layer utilized to represent the skull bone with CSF is placed between the microglass (silicon) and rubber/foam (viscoelastic layer) to apply precompression to the viscoelastic layer. **Pre-compression minimizes any amplification of mechanical excitation**

Table 3. Analogy between a woodpecker and a bio-inspired shock-absorbing system.

Woodpecker (*Melanerpes aurifrons*)	Bio-inspired shock-absorbing system
Beak	Metal (steel) enclosure I
Hyoid	Viscoelastic layer (rubber)
Spongy bone	Close-packed microglass
Skull bone with CSF	Metal (aluminum) enclosure II
Brain	Micromachined devices

Conclusions/action items: The most significant material property of the anatomical components of the woodpecker's anatomy is the ability to dissipate mechanical excitation. There is no way to completely eliminate energy/vibrational force that is transmitted into the inner tray of the isolette from inside the incubator, however you can spread out/redirect applied forces to reduce how concentrated the force is that is applied to the inner tray and the neonate. Several properties of the materials we chose to incorporate into the composite damper reflect the properties discussed in this article, however there is one significant difference. The article elaborates on the significance of the porosity of the spongy bone and the relationship between this property and the ability of the structure to act as a low-pass filter. The silicon gel used to mimic the spongy bone shares some material properties with the spongy bone but is not porous.

2022/09/20 Vibration isolation using quasi-zero-stiffness isolation

GRETA SCHEIDT - Sep 21, 2022, 5:35 PM CDT

Title: Vibration isolation in neonatal transport using quasi-zero-stiffness isolator

Date: 09/20/22

Link: https://journals.sagepub.com/doi/full/10.1177/1077546317703866?casa_token=FV2uPXVEwugAAAAA%3AghxZy-P4dyZzNkhhNqqTW9lK-x_eA-lytQx_opKANysRIVZM5d-5lxetrPlP48VSyClC1lGysi_c

Citation: J. Zhou, K. Wang, D. Xu, H. Ouyang, and Y. Fu, "Vibration isolation in neonatal transport by using a quasi-zero-stiffness isolator," *Journal of Vibration and Control*, vol. 24, no. 15, pp. 3278–3291, Aug. 2018, doi: 10.1177/1077546317703866.

Content by: Greta Scheidt

Present: N/A

Goals: Evaluate the effectiveness and disadvantages of a competing design that utilizes a specific passive vibration isolation device.

Content:

Set-up of proposed design:

- Infant compartment is supported by quasi-zero-stiffness isolators
- The quasi-zero-stiffness isolator is composed are a pair of mutually repelling permanent magnets in parallel connection with a coil spring
    - This system is reflective of a passive style of vibration isolation
- The QZS isolator was chosen due to its intrinsic ability to isolate low-frequency disturbances
    - Has a high-static-low-dynamic stiffness and does not require a power supply
        - This property allows support of a payload but low stiffness around the static equilibrium position
- A lumped-mass model was used to determine an effective stiffness for the QZS isolator. This lumped-mass system included the mass of the infant, the stiffness of the mattress, the damping coefficient of the mattress, the mass of the transport incubator, stiffness of the rubber wheels.

Evaluation of the design:

- Performance of the design is estimated in terms of displacement and acceleration transmissibility.
- Results revealed the need for damping to prevent sudden jumps in the displacement of the system.

Justification for development of design:

- Previous experiments on adults and animals have revealed adverse effects of vibration on cardiorespiratory functions and peripheral and central nerve systems
- Premature infants are more likely to incur intraventricular hemorrhage and cerebral palsy due to vibratory stresses.
- No standard for experimental tests and vibration measurements during neonatal transport

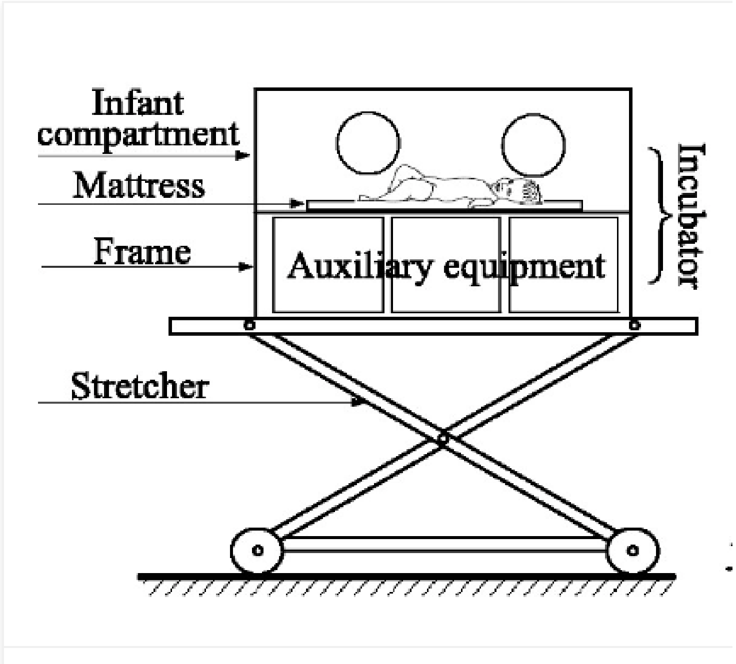


Figure 1:Typical transport unit set-up shown below:

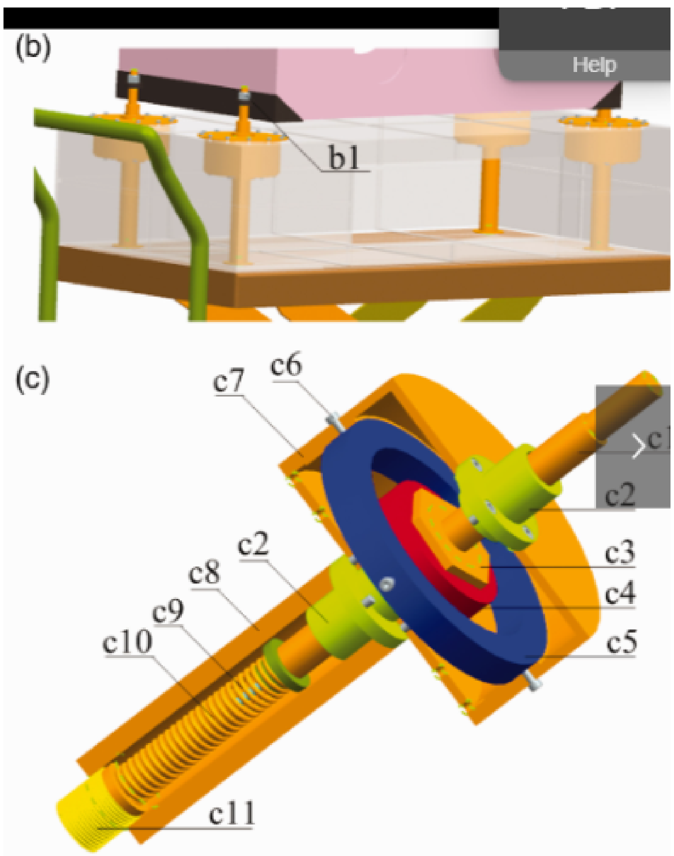


Figure 2: Placement of QZS isolators and inside view of magnet and coil components inside the isolator.

Conclusions/action items: The device had promising results in attenuating low frequency vibrations, however needs modification to prevent jumping at other frequencies. Additionally, the device has not been tested with patients yet. Explore additional examples of active and passive vibration isolation systems that have been developed for use in neonatal transport and assess their relatives successes and failures for application to brainstorming of preliminary designs. Several other isolation systems are referenced in this journal publication.

2022/09/25 Effectiveness of vibration damping with bicycle suspension systems

GRETA SCHEIDT - Sep 27, 2022, 9:04 PM CDT

Title: Effectiveness of vibration damping with bicycle suspension systems

Date: 9/25/22

Content by: Greta Scheidt

Present: N/A

Link: https://link.springer.com/content/pdf/10.1007/BF02844008.pdf

Citation:

Goals: Determine the most effective type of bike suspension system and learn the details of it to evaluate applications to a suspension system below the transport isolette.

Content:

Air-Oil Suspension:

- Telescoping design, tubes slide in relation to one another
- The suspension system is designed to smooth out input signals

Conclusions/action items:

2022/09/25 International Biomed Voyager Spec Sheet

GRETA SCHEIDT - Sep 30, 2022, 10:02 AM CDT

Title: International Biomed Voyager Transport Incubator Spec Sheet

Date: 9/25/22

Content by: Greta Scheidt

Present: N/A

Link: https://int-bio.com/wp-content/uploads/2022/03/Voyager-DOM-Spec-Sheet-web.pdf

Citation: International Biomedical, *Voyager DOM Spec Sheet*. IB, Austin, TX, 2019.

Goals: Gather important dimension specifications of the transport incubator used in the UW Hospital system to set the constraints of what our device must fit into.

Content:

- Device can be used in the NICU, and in air and ground transport

Technical Specifications:

- Standard Features:
  - Slide out intubation tray
  - Humidification reservoir
  - 2 pairs of infant positioning straps
- Dimensions: 20.9 in. H x 19.0 in W x 39.2 in L
- Weight: 85 lbs (without cart, accessory module, monitor, ventilator, or airway management)
- Digital Air Temperature Control: 17.0 degrees C to 38.9 degrees C

Conclusions/action items: This spec sheet gave an overview of the components provided by the incubator and the overall dimensions, however the measurements recorded by hand when the team was able to see this incubator in person will need to be used to determine constraints between parts of the existing incubator.

2022/09/18 ISO 2631 Standards for WBV

GRETA SCHEIDT - Sep 18, 2022, 10:13 AM CDT

Title: ISO 2631 - 1: Mechanical vibration and shock - Evaluation of human exposure to whole body vibration.

Date: 9/18/22

Link: https://www.iso.org/obp/ui/#iso:std:iso:2631:-1:ed-2:v2:en

Citation: "ISO 2631-1: 1997," ***ISO,*** **Jun-1997. [Online]. Available:** https://www.iso.org/obp/ui/#iso:std:iso:2631:-1:ed-2:v2:en. [Accessed: 18-Sep-2022].

Content by: Greta Scheidt

Present: N/A

Goals: Understand relevant standards related to whole body vibration levels for humans and the relation of these standards to human health.

Content:

- Set standards for the frequency ranges which would result in comfort vs. motion sickness
  - 0.5 - 1.0 hz for motion sickness
  - 0.5 - 80 hz for health, comfort, and perception
- Standard is applicable to motions transmitted to the human body as a whole through supporting surfaces.
- Majority is standard specifications are hidden without buying access

Conclusions/action items: Find a way to access the complete standard information in order to obtain quantitative specifications for standards related to whole body vibrations levels and their effect on health

2022/12/14 Material Properties Research

GRETA SCHEIDT - Dec 14, 2022, 12:11 PM CST

Title: Material Properties Research

Date: 12/14/22

Content by: Greta Scheidt

Present: Greta Scheidt

Citation: S.-H. Yoon and S. Park, “A mechanical analysis of woodpecker drumming and its application to shock-absorbing systems,” *Bioinspir. Biomim.*, vol. 6, no. 1, p. 016003, Jan. 2011, doi: 10.1088/1748-3182/6/1/016003.

Goals: Analyze the visco and elastic properties of each material used in the damper in order to analyze the ability of each material to mimic the material properties of aspects of the woodpecker anatomy as outlined in the source linked above.

Content:

Grade 304 Stainless Steel: (8.25 x 0.50 x 0.065) → (209.55 x 12.7 x 1.651) mm^3

Literature value of Young's Modulus for stainless steel used in calculations

Citation: F. S. S. Instruments, F. F. P. Instruments, F. T. E. S. C. A. N. U. S. A. Inc., F. G. Inc., F. Mo-Sci, and F. TOFWERK, “Properties: Stainless steel - grade 304 (UNS S30400),” AZoM.com, 09-Dec-2022. [Online]. Available: https://www.azom.com/properties.aspx?ArticleID=965. [Accessed: 11-Dec-2022].

- The stainless steel layer is meant to emulate the beak of a woodpecker, which can withstand any direct and forceful impacts, so the spring constant and damping ratio of stainless steel were compared to that of the beak.

$$k_{steel} = \frac{A_{steel} * E_{steel}}{l_{steel}} = \frac{(2661.285\ mm^2)*(1.90E5 MPa)}{209.55\ mm} = 2.413E6\ N/mm = 2413\ N/m \quad (1)$$

- Published or experimental values for the damping coefficient or ratio of stainless steel could not be found, so the average value for metals in their elastic deformation range was used. Below their yield point, metals typically exhibit a damping ratio of around 0.01, and the experimental damping ratio for the beak was 0.032.

Nitrile rubber - foam (8.25 x 0.50 x 0.065) → (209.55 x 12.7 x 1.651) mm^3

Citation: Seals Eastern, Inc., “Seals Eastern 5353 Nitrile Rubber,” MatWeb. [Online]. Available: https://www.matweb.com/search/datasheet.aspx?matguid=6885f5466aaf4ccd93122b6c25fee040&ckck=1. [Accessed: 11-Dec-2022].

- The foam/nitrile rubber is intended to mimic the characteristics of a woodpecker’s hyoid, which supports its tongue, used to block vibrations from penetrating further within the skull.

$$k_{foam} = \frac{A_{foam} * E_{foam}}{l_{foam}} = \frac{(2661.285\ mm^2)*(0.855\ MPa)}{209.55\ mm} = 10858.5\ N/mm = 10.859\ N/m \quad (2)$$

- Damping coefficients are used to quantify the relative damping/dissipating ability of the material. Higher damping coefficients and ratios typically indicate better damping ability.

$$c_{foam} = \zeta * \sqrt{m_{foam} * k_{foam}} = 0.1 * \sqrt{5.04E-3\,kg * 10.849\,N/m} = 0.023\ N\,s\,m^{-1} \qquad (3)$$

- It was difficult to draw conclusions directly from the damping coefficient, however a helpful comparison could be made between the damping ratio of nitrile rubber and that of the hyoid. The damping ratio of nitrile rubber is 0.1 (qualified as "good"), and the damping ratio of the hyoid was 0.25 (qualified as "high")
    - Although the two damping ratios fell into two categories, it is difficult to achieve high damping ratios in man-made material, so a damping ratio of 0.1 is still considered effective.

Aluminum foil (8.25 x 0.5 x 0.065) → (209.55 x 12.7 x 1.651) mm^3

Citation: American Elements, “Aluminum foil,” American Elements, 13-Jun-2017. [Online]. Available: https://www.americanelements.com/aluminum-foil-7429-90-5. [Accessed: 11-Dec-2022].

- The foil acts like the woodpecker’s skull with cerebrospinal fluid, which is rigid and has little space for fluid to transmit vibrations.

$$k_{alum} = \frac{A_{alum} * E_{alum}}{l_{alum}} = \frac{(2661.285\,mm^2)*(7E4\,MPa)}{209.55\,mm} = 889000\ N/mm = 889\,N/m \qquad (4)$$

- The damping ratio of aluminum is approximately 0.01, and the experimental damping ratio of the skull bone was reported to be around 0.032, both considered low damping ratios.

Matte Non-Reinforced Silicone (Class VI Silicone) - 8.25 x 0.50 x 0.06 in^3 → (209.55 x 12.7 x 1.651) mm^3

Citation: I. Rotaru, C. Bujoreanu, A. Bele, M. Cazacu, and D. Olaru, “Experimental testing on free vibration behaviour for silicone rubbers proposed within lumbar disc prosthesis,” Materials Science and Engineering: C, vol. 42, pp. 192–198, Sep. 2014.

- The silicone gel attempts to mimic a woodpecker’s spongy bone, which can dissipate mechanical vibrations before they penetrate further.
    - This is primarily due to the ability of the spongy bone to act as a low-pass filter. High frequency vibrations are absorbed, while lower frequency vibrations pass through.

$$k_{gel} = \frac{A_{gel} * E_{gel}}{l_{gel}} = \frac{(2661.285\,mm^2)*(1.30E5\,MPa)}{209.55\,mm} = 1.651E6\,N/mm = 1651\,N/m \qquad (5)$$

- A published experimental study obtained damping ratios that ranged between 0.058 and 0.077, however no damping ratios for spongy bone were included in the study, so a direct comparison could not be made.

Conclusions/action items: Several of the materials exhibited similar material properties to structures of the woodpecker's head under theoretical calculations. Direct and effective comparisons could be made between the damping ratios for each corresponding part, however there were limitations to how the spring constants and damping coefficients could be compared. Future research should focus on establishing an accurate method of comparing material properties in the context of the project.

2022/09/25 Bike Shock Based Design Sketch

GRETA SCHEIDT - Sep 27, 2022, 9:36 PM CDT

Title: Bike Shock Based Design

Date: 9/25/22

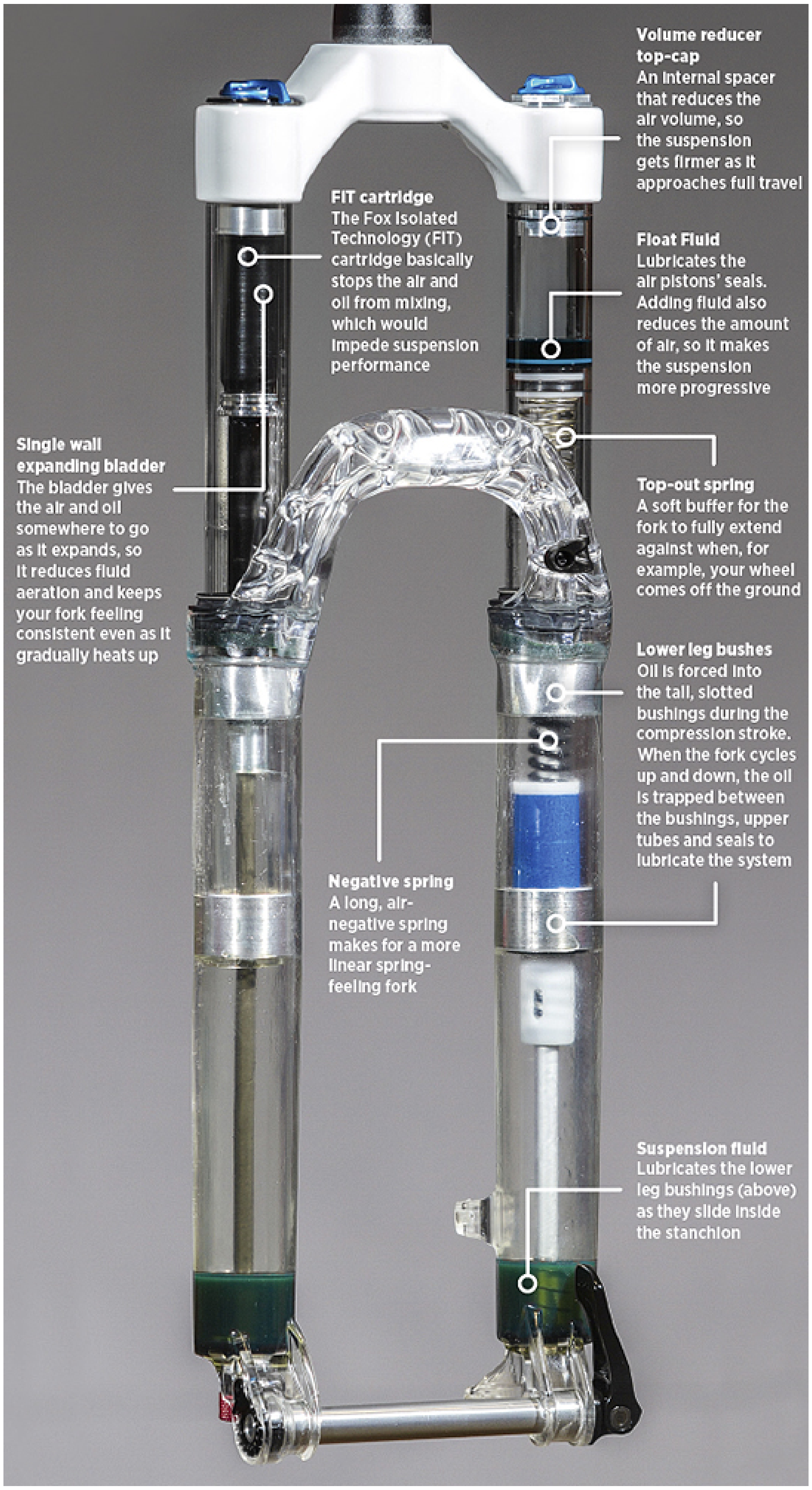
Content by: Greta Scheidt

Present: N/A

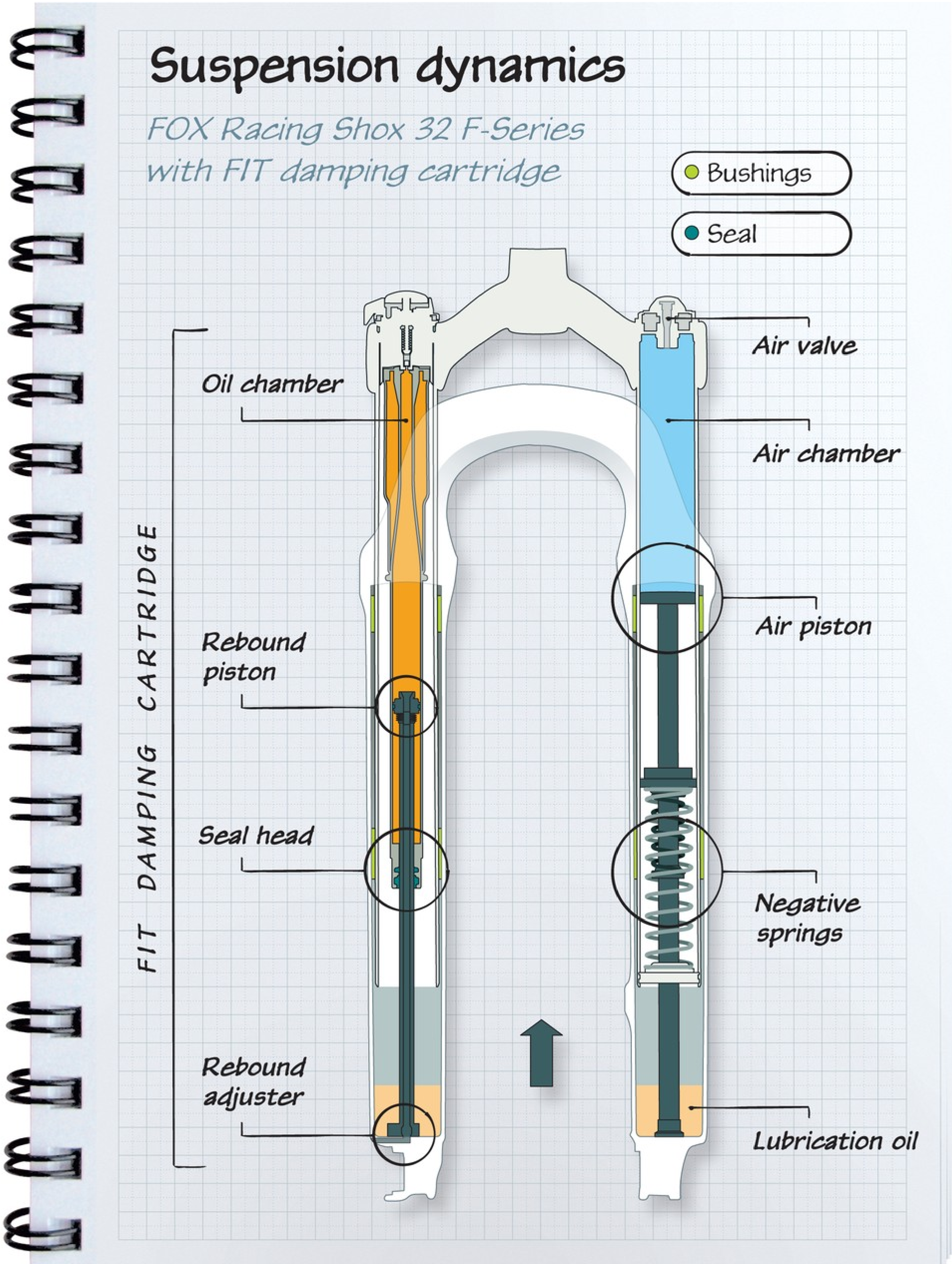
Goals: Sketch a design idea based upon the concept of air-oil fork mountain bike shocks to conceptualize the application of an existing passive vibration isolation system to the project.

Content:

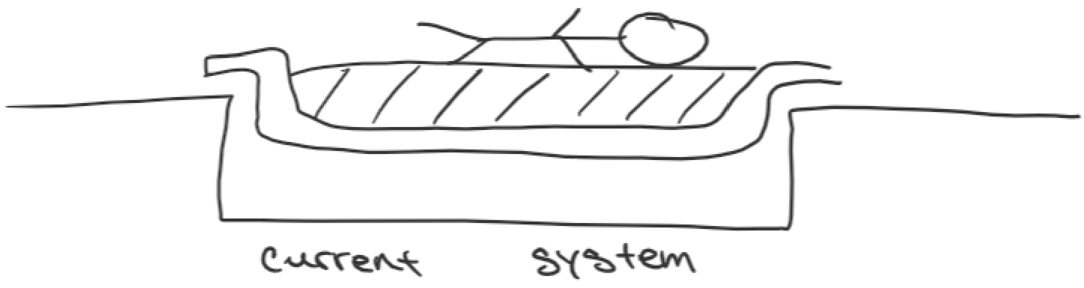
Diagram of existing air-oil mountain bike shock:



Dynamics of shock absorption system: forces applied by the ground or from above can compress the shock

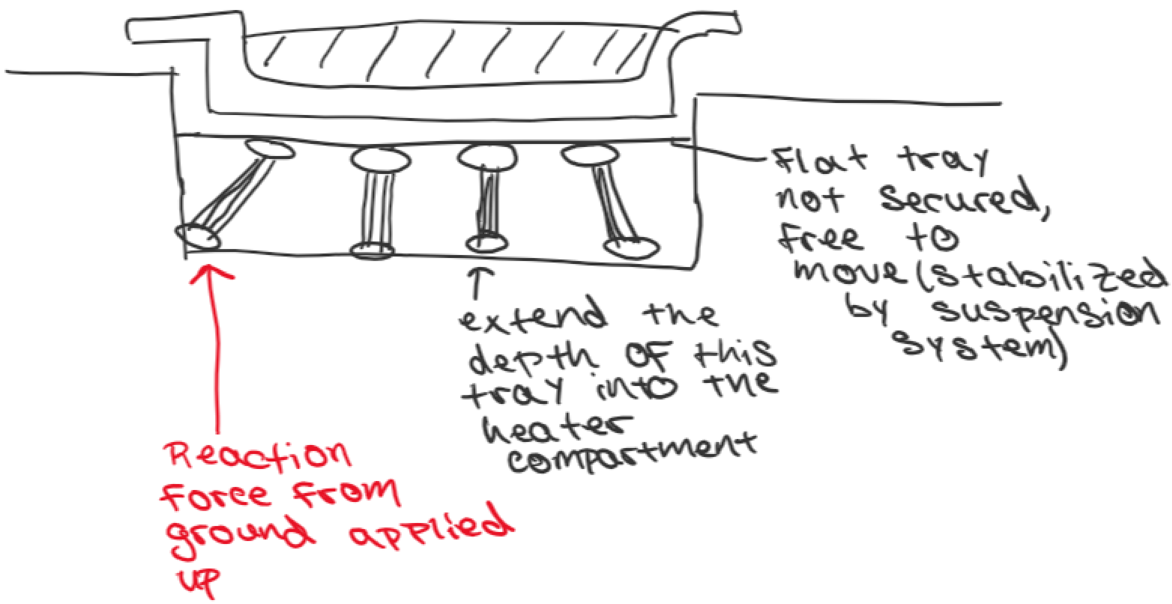


Current system immediately below neonate in transport isolette:



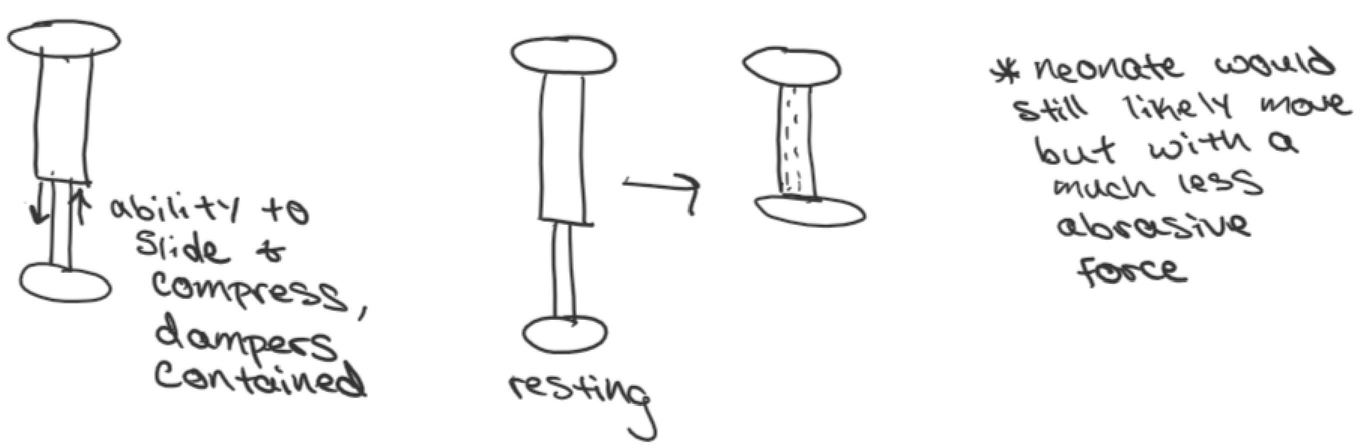
- No system of shock absorption or attenuation, the tray that slides out to allow access to the baby is rigidly fixed with plastic components and it sits directly on an additional plastic tray with limited space underneath the top tray.
- Beneath the base tray depicted above, there is a small cavity in which there is a heater and other electronic components. Any components added to this area would need to be able to withstand being exposed to high levels of heat.

Proposed modification:



- Air-oil suspension system featuring shock absorbers/dampers placed below an unsecured flat tray. The flat tray would move in accordance with displacements of the shock absorbers. This would not completely prevent movement of the neonate but would reduce the level of force applied by reducing the magnitude of the force being applied by the floor into the rigidly secured gurney base.
- The shock absorbers would be oriented at several different angles to allow for absorption of forces from several direction, reducing rotational motion.

Reduction of vibrational force:



Conclusions/action items: This idea incorporates the use of a passive vibration isolation method. Further research needs to be done to determine the most common frequencies encountered during transport that result in significant movement of the patient. The stiffness of the shock absorber can be selected based upon a combination of the frequency range and the weight range of neonates. Additionally, further research and brainstorming should be completed to determine potential modifications of the translational ability of the isolette base to explore a design where the base would move up/down in response to applied force, allowing the components of the isolette that enclose the neonate to remain stationary.

2022/10/04 Gel/Metal Damper Solidworks Sketch

GRETA SCHEIDT - Oct 04, 2022, 8:20 PM CDT

Title: Gel/Metal Damper Solidworks Sketch

Date: 10/4/22

Content by: Greta Scheidt

Present: N/A

Goals: Develop a 3-D image of one of the preliminary designs, the gel/metal damper to aid in visualization of the design to scale and determine feasibility of fabrication.

Content:

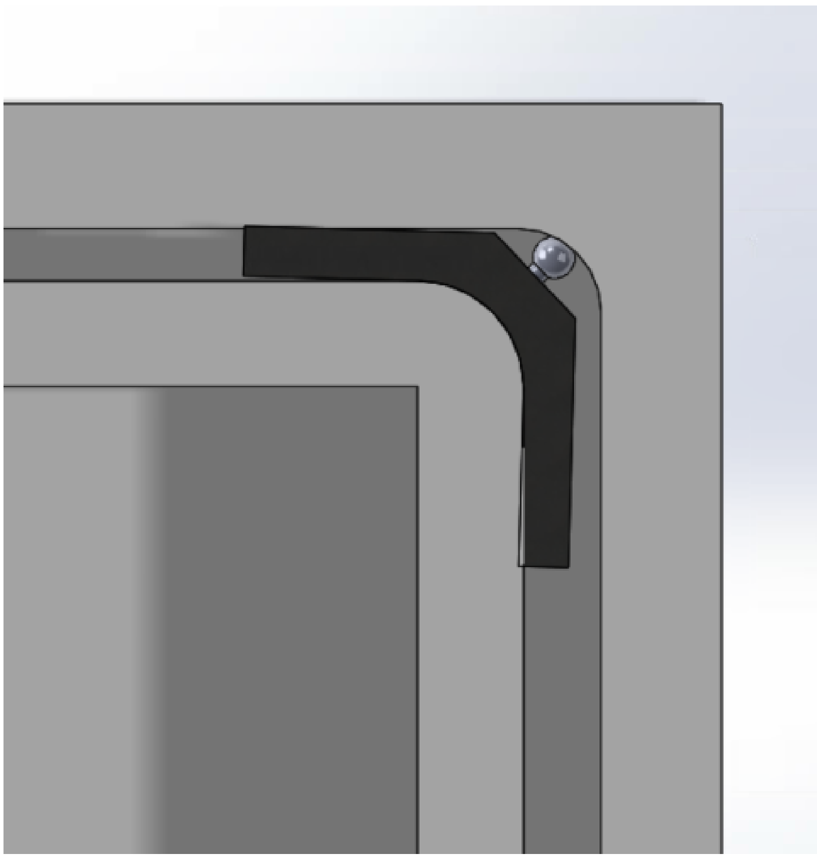


Figure 1: Close-up view of damper in top right corner. Damper is wedged between the inner intubation tray which can be removed to gain access to the baby and the outer tray which acts as a stabilizing and separation layer between the baby and the heater. The darker section depicted above has four different material layers. The outer layer is steel, the next layer going inwards is foam, then aluminum, and then silicon gel in the center. The thickness is 6 mm with a length of 15 mm. A ball and socket joint is fixed to the damper edge, allowing free rotation against the filleted inside of the outer tray.

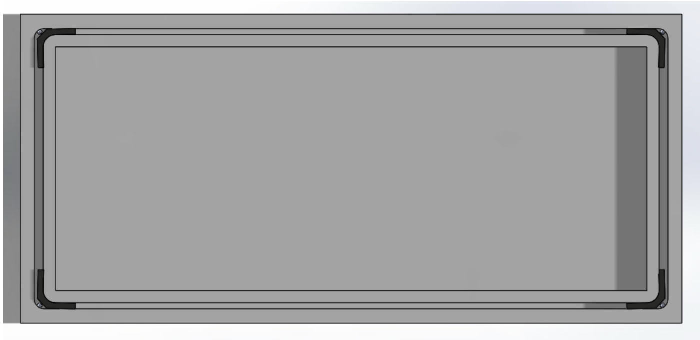


Figure 2:Top view of the entire system with dampers in place in all four corners.

Conclusions/action items: Creating a sketch of the gel/metal damper design in 3-D helped with visualization of how the design would function, but also revealed potential challenges in fabrication. The gap between the intubation tray and outer tray was measured to be approximately 5-6 mm. With concentric layers of 4 materials and a ball and socket joint, this results in extremely small dimensions that would be extremely difficult to fabricate. The team had considered proceeding with a design that only has two material layers instead of 4. Further investigation should be completed to evaluate the effect removing two of the layers would have on the ability of the device to mitigate vibration. Additionally, further research and brainstorming should be dedicated to the exact design of the ball and socket joint to determine which directions of rotation should be allowed.

2022/10/21 Coiled Spring Pin Component

GRETA SCHEIDT - Oct 21, 2022, 1:16 PM CDT

Title: Coiled Spring Pin Component of Metal and Gel Composite Damper

Date: 10/21/22

Content by: Greta Scheidt

Present: N/A

Link: https://www.sciencedirect.com/science/article/pii/S0022460X13005701

Citation: Y. Araki, T. Asai, K. Kimura, K. Maezawa, and T. Masui, "Nonlinear vibration isolator with adjustable restoring force," *Journal of Sound and Vibration*, vol. 332, no. 23, pp. 6063–6077, Nov. 2013.

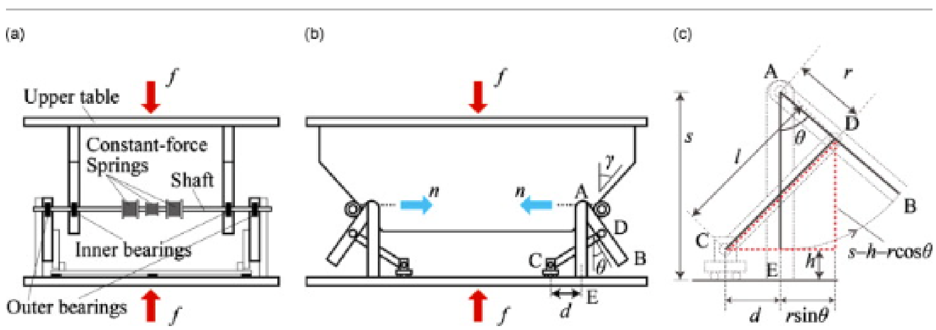
Goals: Increase understanding of how coiled spring pins work and how they can be used to reduce vibration.

Content:

Mechanism for minimizing vibration:

- The coiled spring pin can provide a nonlinear restoring force

Vibration isolator used to divert applied force utilizing a constant-force spring:



- Similar to this set-up, our design proposes placing coiled spring pins horizontally, perpendicular to the applied vertical force.
- In design referenced in this article, there is an upper and lower limit to the stroke of the vibration isolator based upon the maximum extension of the coil spring.
- The restoring force is proportional to the sum of the capacities of all force springs involved in the set-up.
- Pros of vibration isolator studied:
  - The coil spring is used to avoid high frequency accelerations caused by sudden, or discontinuous, changes

Conclusions/action items: Testing should be done to determine the maximum deflection of the coil spring and the maximum force that the coil spring pin can respond to before failure. This will allow the team to determine the spring stiffness/constant and estimate the magnitude of vibration reduction that the coiled spring pin can offer in the context of the typical vibration forces exerted by the ambulance floor on the isolette during transport. Our design has several similarities with this device, but one aspect that is evaluated here and should

be expanded upon in further research is how the vertical vibrational force will be converted into a horizontal restoring/absorbing force because all components of the metal and gel composite damper are placed in the space between the inner and outer trays but not underneath of the tray.

2022/10/25 Modification to Gel/Composite Damper

GRETA SCHEIDT - Oct 25, 2022, 8:55 PM CDT

Title: Modification to Metal/Gel Composite Damper After Baseline Measurement

Date: 10/25/22

Content by: Greta Scheidt

Present: N/A

Goals: Modify components of the current metal/gel composite damper to align with restrictions discovered during baseline measurement collection.

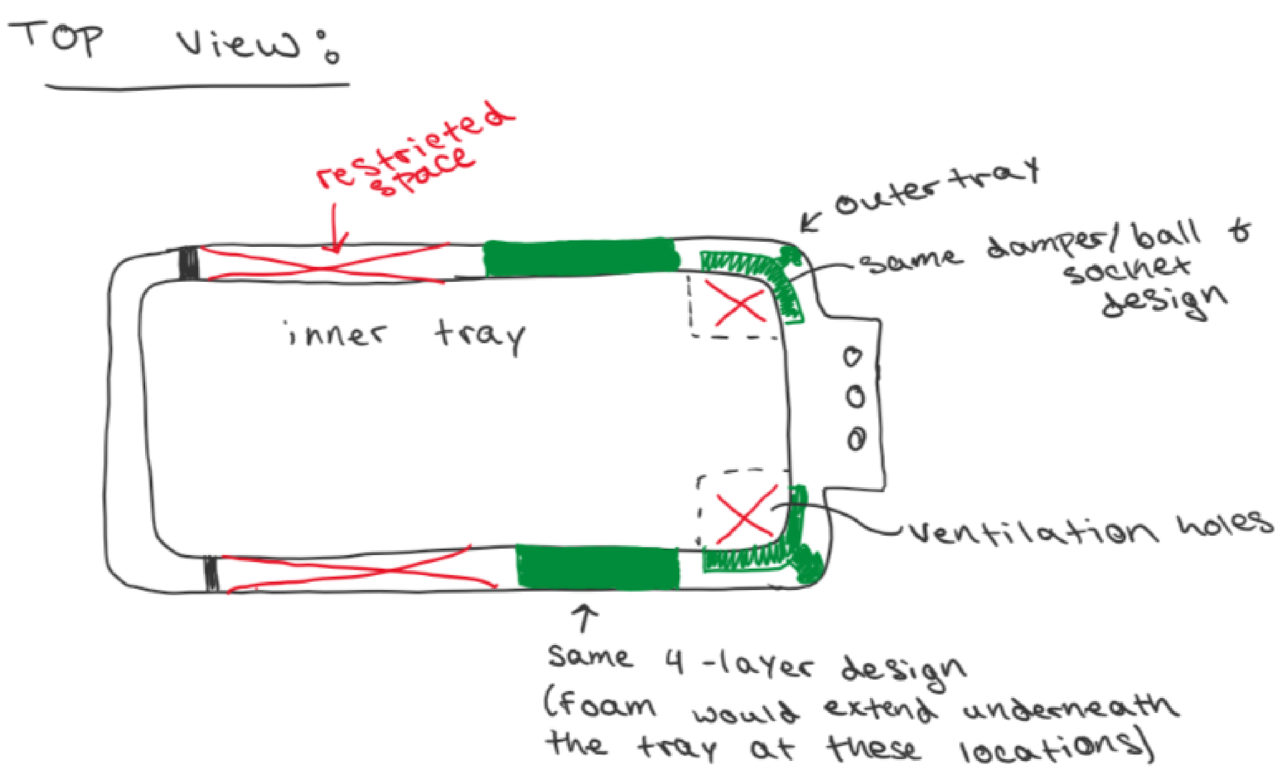
Content:

New restrictions:

- Runners at the back two corners of the tray prevent a damper from being placed in these locations
  - The runner involves a cut-out on both sides of the inner tray that runs from the back corner about halfway up the side
  - There is a cylindrical rod that is attached to one of the trays and can be slid along the cut-out to move the tray. This is primarily used for transitioning the baby into the isolette and for emergency access of the airway.
- Ventilation holes on the bottom of the front two corners restrict available space there. These holes cannot be covered because they are used to regulate flow of oxygen/air throughout the isolette.
  - Damper material could still be placed between the inner and outer trays at this location but could not be inserted below the inner tray at the corner, as this would cover the ventilation hole.

Proposed modifications:

- Two dampers with ball and socket joints as previously planned in the front two corners (no material can go beneath the inner tray)
- No damper in the back two corners
- Use the same layering design to add a cushioned layer between the cut-out section and the front corners on either side to prevent translational motion side to side.
  - Foam layer could also extend below the inner tray at this location to minimize vibrational forces exerted in the vertical direction. We would need to evaluate if this modification would cause the inner tray to sit at an angle if material was placed below it.



Conclusions/action items: Modifications will be proposed in the next team meeting. From there, if the team proceeds with this modification, updated formal sketches will be made and the fabrication plan will be modified to incorporate the new changes. Additionally, I think it would be helpful to revisit and evaluate the idea of placing the damping material outside of the isolette because there is limited space and many restrictions on this space, as it is the environment that the baby is directly exposed to.

2022/11/13 Side Damper Steel Housing Sketch

GRETA SCHEIDT - Nov 29, 2022, 4:41 PM CST

Title: Side Damper Steel Housing Sketch

Date: 11/13/22

Content by: Greta Scheidt

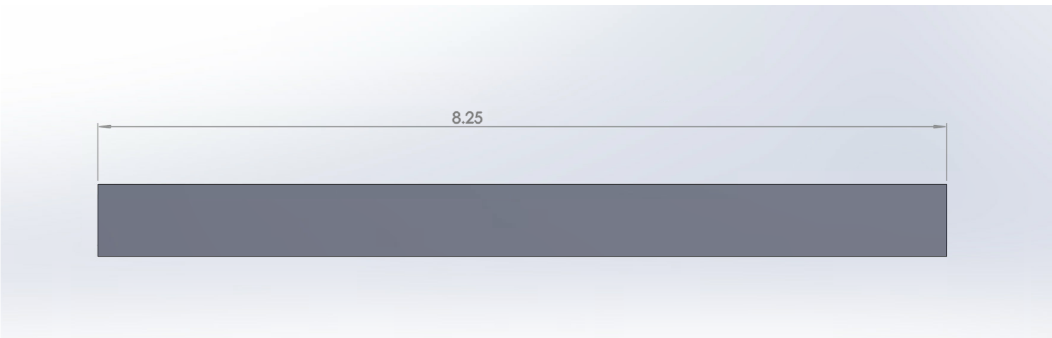
Present: Greta Scheidt

Goals: Develop a dimensioned sketch of the steel housing component of the side dampers for use in fabrication.

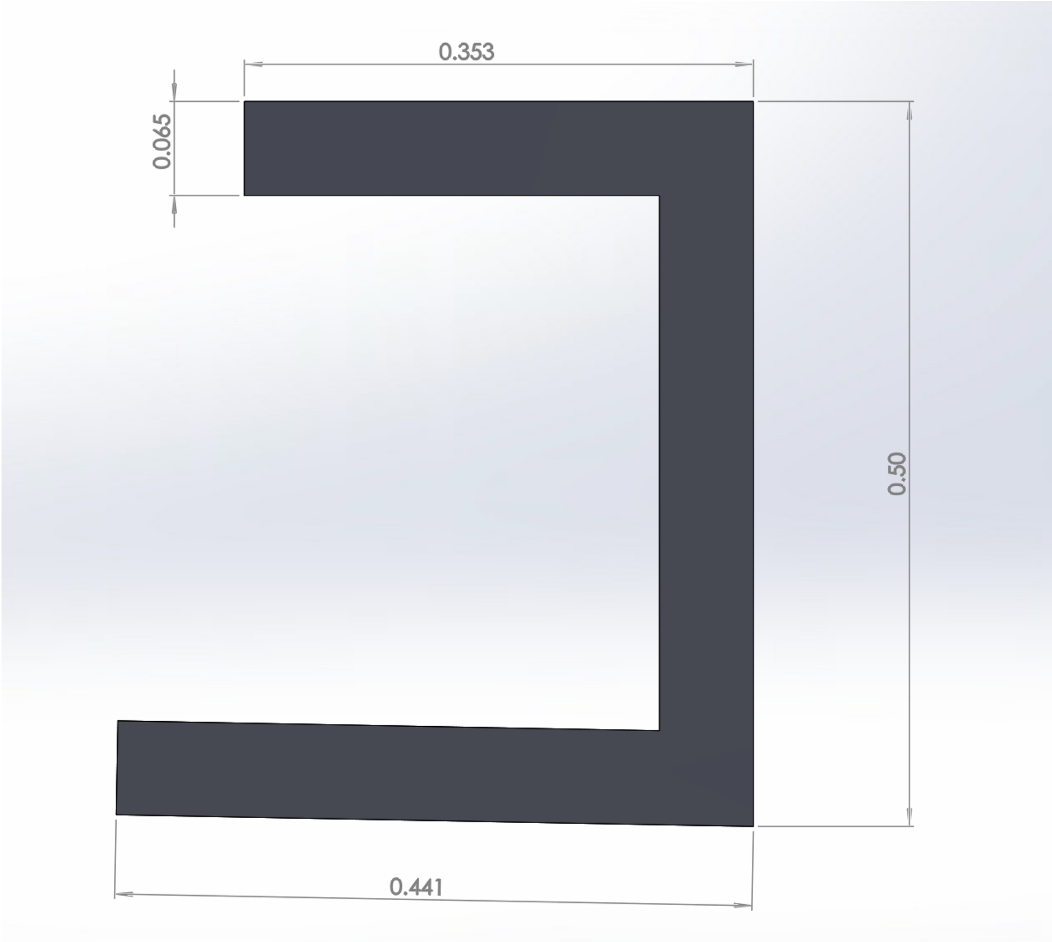
Content:

A dimensioned sketch of the steel housing for the side dampers was created in SolidWorks for use in fabrication. Specifically, the length and heights of two of the remaining walls were included to make it clear how much material needed to be removed and the dimensions of the remaining material.

Right side view:



Front view:



*After one wall was removed, 0.09" was removed from one of the remaining upper walls.

Solidworks file attached to this entry for reference.

Conclusions/action items: This drawing was used to fabricate the steel housing for the side dampers. Creating this drawing also set the finalized overall dimensions that the three other materials of the damper must fit inside of.

GRETA SCHEIDT - Nov 29, 2022, 4:42 PM CST

Download

Steel_Component_Side_Damper.SLDPRT (66.2 kB)

2022/03/05 Green Permit Documentation

GRETA SCHEIDT - Mar 05, 2022, 8:03 PM CST

Title: Green Permit Documentation

Date: 3/5/22

Content by: Greta Scheidt

Present: N/A

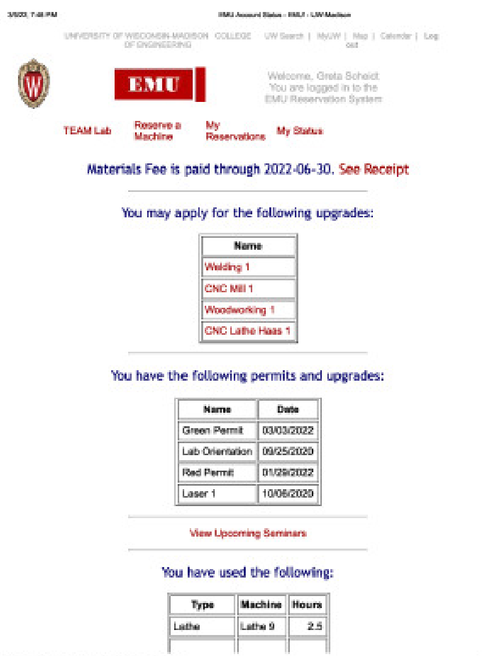
Goals: Obtain the training necessary for fabrication of the sample holder

Content:

Documentation record of green permit completion

Conclusions/action items: Apply skills learned in green permit training to fabrication methods for the sample holder.

GRETA SCHEIDT - Mar 05, 2022, 8:03 PM CST


UNIVERSITY OF WISCONSIN-MADISON COLLEGE OF ENGINEERING | UW Search | MyUW | Map | Calendar | Log out

EMU

Welcome, Greta Scheidt
You are logged in to the EMU Reservation System

TEAM Lab | Reserve a Machine | My Reservations | My Status

Materials Fee is paid through 2022-06-30. See Receipt

You may apply for the following upgrades:

Name
Welding 1
CNC Mill 1
Woodworking 1
CNC Lathe Haas 1

You have the following permits and upgrades:

Name	Date
Green Permit	03/03/2022
Lab Orientation	09/25/2020
Red Permit	01/29/2022
Laser 1	10/06/2020

View Upcoming Seminars

You have used the following:

Type	Machine	Hours
Lathe	Lathe 9	2.5

Download

Green_Permit_Training_Documentation_Greta_Scheidt.pdf (121 kB)

GRETA SCHEIDT - Mar 05, 2022, 8:03 PM CST

2022/02/21 Red Permit Documentation

GRETA SCHEIDT - Feb 21, 2022, 9:50 PM CST

Title: Red Permit Documentation

Date: 2/21/22

Content by: Greta Scheidt

Present: N/A

Goals: Obtain the training necessary for fabrication of the sample holder for the bioreactor

Content:

You have the following permits and upgrades:

Name	Date
Lab Orientation	09/25/2020
Red Permit	01/29/2022
Laser 1	10/06/2020

Apply for a new/additional permit

Conclusions/action items: Complete all green permit training.

2022/09/14 Review of current neonatal transport knowledge

NEHA KULKARNI - Sep 14, 2022, 7:05 PM CDT

Title: Acceleration during neonatal transport and its impact on mechanical ventilation

Date: 2022/09/14

Source link: https://fn.bmj.com/content/fetalneonatal/early/2022/06/14/archdischild-2021-323498.full.pdf

Content by: Neha Kulkarni

Present: Neha Kulkarni

Goals: Understand how transport affects the ventilation mechanisms that neonates require, and consider interventions/modifications to retain full function of ventilation mechanisms during transport.

Content:

1. Considers road conditions, vehicle turning, vehicle accelerations as sources of vibration
2. Vibration can affect ventilator performance and deviation from set target values
    1. increase variability of peak inflating pressure
    2. increase variability of tidal volume
    3. ventilator-patient interactions: irregular ventilator waveforms and loops
3. Testing parameters
    1. experienced neonatal transport team
        1. ambulance drivers
        2. neonatologist
        3. neonatal nurse practitioner
        4. journey time >10min
    2. acceleration measurement
        1. using software (Accelerometer Analyzer, V.16.11.27, https:// chipapk.com/app/39720) installed on mobile phone
        2. mobile phone attached to top of incubator
4. Results
    1. acceleration occurs most in direction of ambulance movement
    2. vibration did not affect ventilator parameters
    3. vibration made pressure-volume loops more irregular
    4. significant vibration with or without vehicle speed increase

Conclusions/action items: This study considers how ventilator function is affected by vibrations during neonatal transport. Though the study did not find that ventilator parameters were significantly affected, it is important that we consider how vibration of the transport affects not only the neonate itself but also the support treatment it receives during transport. This paper also provides a good model for observational testing of acceleration using software and a mobile device.

2022/09/14 Acceleration during neonatal transport and its impact on mechanical ventilation

NEHA KULKARNI - Sep 14, 2022, 5:17 PM CDT

Title: Whole-body vibration in neonatal transport: a review of current knowledge and future research challenges

Date: 2022/09/14

Source link: https://pubmed.ncbi.nlm.nih.gov/32464450/

Content by: Neha Kulkarni

Present: Neha Kulkarni

Goals: Understand current baseline knowledge of whole-body vibrations in neonatal transport, and consider future challenges as they relate to our project.

Content:

1. Inter-facility transport
    1. Important in maintaining equity in access to neonatal/infant care
    2. Transport team ensure cardiopulmonary, metabolic, and thermal homeostasis is maintained
    3. Increased rate of mortality and morbidity following neonatal transport
        1. likely due to immaturity of infant CNS
2. Whole-body shock and vibration
    1. shock = singular, distinct acceleration over short time period
    2. vibration = sustained rhythmic acceleration over varying frequencies
    3. shock and vibration is transmitted through transport vehicle
        1. properties of transport equipment determine shock and vibration experienced
    4. translational and rotational motion occurs
    5. adverse effects
        1. increased heart rate
        2. indicators of increased neonatal stress
        3. intraventricular hemmorage
    6. vibration burden
        1. ISO standards measure WBV in m/s^2 (acceleration)
        2. study suggested that lower-weight infants experience more hazardous WBV
        3. frequencies measured in neonatal transport research are usually much higher than accepted thresholds for adults in the workplace
    7. infant transport/incubator designs
        1. infant lies on mattress supported by tray
        2. tray can pivot/rotate up
        3. lower tray holds equipment
        4. aluminum frame
        5. passive vibration isolation
            1. rubber wheels, suspension, mattress
            2. not as effective
        6. active vibration isolation
            1. sensory feedback with circuitry
        7. other interventions
            1. gel mattresses > air/foam mattresses
            2. swell latches
            3. safety checks, ensuring rigid attachment

        4. thicker wheels
        5. balancing speed vs travel time
            1. both increase vibration, but speed affects more
3. Concepts for further evaluation
    1. benefits of mechanical vibration in calming babies?
    2. include real-time measurements?
    3. effects of types of ambulances?

Conclusions/action items:

Studies show that neonates experience considerable stress during transport. Various interventions and modifications to transport vehicles have been effective, but little research confirms or combines an optimal set of interventions. In our design, we should incorporate and test these various interventions.

2022/09/22- Sound and Vibration: Effects on Infants' Heart Rate

NEHA KULKARNI - Sep 23, 2022, 10:30 AM CDT

Title: Sound and Vibration: Effects on Infants' Heart Rate and Heart Rate Variability During Neonatal Transport

Date: 09/22/2022

Content by: Neha Kulkarni

Present: Neha Kulkarni

Goals: Understand effects of neonatal transport on heart rate.

Content:

- measured heart rate and heart rate variability during air transport
- Sound measurement during study carried out by using microphone placed on incubator wall, 10-20 in from infant's head
    - microphone directed towards center of incubator
- WBV measured by placing accelerometer under infant's foam mattress
    - measured in x, y, z direction
- heart rate variability measured via ECG
- results
    - no significant changes in heart rate over time, but heart rate variability changed significantly throughout transport
    - WBV levels exceeded 0.31 m/s^2 (level deemed to be "uncomfortable) during 36%-46% of the time during ground transport
    - average sound level was 73 dBA, higher than current recommendation of IEC standard
        - in flight was worst period for sound levels
    - higher sound levels associated with higher heart rate
    - higher sound levels had worse effects than higher vibration
    - earmuffs were effective in decreasing effects of sound

Conclusions/action items:

2022/09/28 - Woodpecker inspired shock absorbing material

NEHA KULKARNI - Oct 04, 2022, 8:42 PM CDT

Title: Woodpecker inspired shock absorbing material

Date: 09/29/2022

Content by: Neha Kulkarni

Source link: https://www-sciencedirect-com.ezproxy.library.wisc.edu/science/article/pii/S2214785319341987?ref=pdf_download&fr=RR-2&rr=751ef6e19b82e21b

Present: Neha Kulkarni

Goals: Understand how woodpeckers limit vibrational stress, and how their structures can be mimicked in a shock-absorbing material.

Content:

- Woodpecker characteristics
    - beak made of elastic material to limit vibrations reaching brain
    - spongy bone evenly distributes vibrations
    - little cerebrospinal fluid that transfers vibrations to brain
- layered shock absorbing material
    - inner: silicone gel
    - aluminum
    - foam
    - stainless steel
    - 8 mm thickness
- decreased time of vibrational stress
    - damping curve shorter

Conclusions/action items: The beneficial effects of this layered structure could be modeled or recreated in our product.

2022/09/18 ISO 14937

NEHA KULKARNI - Oct 12, 2022, 1:31 PM CDT

Title: ISO 14397

Date: 9/18/22

Link: https://www.iso.org/obp/ui/#iso:std:iso:14937:ed-2:v1:en

Citation:

> "ISO 14937:2009(en), Sterilization of health care products — General requirements for characterization of a sterilizing agent and the development, validation and routine control of a sterilization process for medical devices." https://www.iso.org/obp/ui/#iso:std:iso:14937:ed-2:v1:en (accessed Sep. 21, 2022).

Content by: Neha Kulkarni

Present: Neha Kulkarni

Goals: Understand relevant standards related to sterilization processes of devices used in medical settings

Content:

- Standard for sterilization process
- device must be resterilizable
- things to consider:
  - packaging
  - sterilizing agents used and material compatibility
  - personnel using device

Conclusions/action items: Compare this standard with those used by UW Health, to make sure this is the standard our device must follow.

2022/10/08- Materials to Order

NEHA KULKARNI - Dec 13, 2022, 11:49 AM CST

Title: 2022/10/08 Materials to Order

Date: 2022/10/08

Content by: Neha Kulkarni

Present: Neha Kulkarni

Goals: Figure what materials are available that we could use to fabricate the device.

Content:

- Stainless steel
    - Grainger stainless steel sheets https://www.grainger.com/category/raw-materials/stainless-steel/stainless-steel-sheets-plates/standard-stainless-steel-sheets-plates?categoryIndex=1
    - Grainger stainless steel foil: https://www.grainger.com/category/raw-materials/stainless-steel/stainless-steel-foil?categoryIndex=6
    - Grainger stainless steel rectangular tubes: https://www.grainger.com/category/raw-materials/stainless-steel/stainless-steel-tubes/rectangular-stainless-steel-tubes?categoryIndex=2
    -
- Aluminum
    - Grainger aluminum sheet: https://www.grainger.com/category/raw-materials/aluminum/aluminum-sheets-plates/standard-aluminum-sheets-plates?categoryIndex=1
    - Grainger aluminum foil: https://www.grainger.com/category/raw-materials/aluminum/aluminum-foil?categoryIndex=6
    - Grainger aluminum tube: https://www.grainger.com/category/raw-materials/aluminum/aluminum-tubes/rectangular-aluminum-tubes?categoryIndex=2
- Foam
    - Couldn't find foam but did find neoprene elastomer on grainger which is used for sound and mechanical vibration absorption
    - https://www.grainger.com/product/AIRLOC-Vibration-Isolation-Pad-Sheets-3ECL9
- Silicone gel sheet
    - Medical grade silicone sheet: https://www.grainger.com/search/raw-materials/rubber/rubber-sheets-strips-rolls/silicone-high-temperature-rubber?filters=webParentSkuKey&searchQuery=silicone&webParentSkuKey=WP13435109&sst=4&tv_optin=true
- Ball and socket joint/pin joint
    - Coiled spring pin: https://www.grainger.com/category/fasteners/pins/spring-pins?categoryIndex=9
    - Cap nut
    - https://www.grainger.com/category/fasteners/nuts/cap-nuts?categoryIndex=3

Based on available materials, possible modifications:

1. Lose layers due to size constraints
    a. Could fill a stainless steel tube with the foam and/or silicone, rather than nesting an aluminum layer within a stainless steel layer
2. Ball and socket as modeled currently might have to be fabricated. Coiled spring pin provides a good alternative since it is capable of adapting to various forces

Conclusions/action items: The team will decide which of these materials are best to order and develop a fabrication plan.

2022/10/10-Proposed fabrication plan

NEHA KULKARNI - Dec 13, 2022, 11:51 AM CST

Title: 2022/10/10 Proposed fabrication plan

Date: 2022/10/10

Content by: Neha Kulkarni

Present: Neha Kulkarni

Goals: Come up with a loose fabrication plan to follow based on materials ordered.

Content:

Proposed fabrication plan (concentric layers):

1. Outer layer: stainless steel tube
    a. Removes need for welding and any errors that could cause
2. Next layer in:
    a. Neoprene elastomer
3. Innermost layer:
    a. Silicone gel

** This proposed plan removes the aluminum layer due to size constraints.

Proposed fabrication plan (stacked layers):

1. Outer layer: stainless steel tube
2. Multilayered pattern within tube
    a. Neoprene
    b. Aluminum foil (or sheet if we can get it thin enough)
    c. Silicone gel
    d. Repeat these layers as many times as can fit in tube

Conclusions/action items: The team will decide whether to continue with stacked or concentric layer configuration.

2022/10/26-Update on Fabrication Plans

NEHA KULKARNI - Dec 13, 2022, 11:57 AM CST

Title: 2022/10/26 Update on Fabrication Plans

Date: 2022/10/26

Content by: Neha Kulkarni

Present: Neha Kulkarni

Goals: Modify fabrication plan to better fit current incubator setup.

Content:

Side dampers (x2):

1.
2. Measure and cut stainless steel tube to 8.25 in long
3. Cut tube in half crosswise
4. Cut foam to 8.25 x 0.375 x 0.0625 in pieces
5. Cut gel to 8.25 x 0.375 x 0.06 in pieces
6. Cut foil to 8.25 x 0.375 in pieces
7. Spray tube with adhesive and place foam piece in bottom of tube
8. Spray foam with adhesive and place aluminum foil piece on top
9. Spray foil with adhesive and place gel piece on top
10. Repeat steps 6-8 until layers are flush with top of tube
11. Cover top with aluminum foil to seal layers.

Corner dampers (x2):

1.
2. Measure and cut stainless steel tube to 1.2 long
3. Cut in half diagonally
4. Cut foam to 1.2 x 0.375 x 0.0625 in pieces
5. Cut gel to 1.2 x 0.375 x 0.06 pieces
6. Cut foil to 1.2 x 0.375 in pieces
7. Spray tube with adhesive and place foam piece in bottom of tube
8. Spray foam with adhesive and place aluminum foil piece on top
9. Spray foil with adhesive and place gel piece on top
10. Repeat steps 6-8 until layers are flush with top of tube
11. Cover top with aluminum foil to seal layers.

Conclusions/action items: The team will follow this plan to fabricate the device.

2022/11/07 Composite Damper Material Analysis Methods

NEHA KULKARNI - Dec 13, 2022, 2:08 PM CST

Title: 2022/11/07 Composite Damper Analysis Methods

Date: 2022/11/07

Source link: https://www-sciencedirect-com.ezproxy.library.wisc.edu/science/article/pii/S0263822399000410?casa_token=WwFQDK9tjkAAAAAA:z-by0tRXlf6ism2fLTK37QZiNXZB9SeOTv9zRLmEbelhV0ANca2MSt5yAmZrFS82pA3TRAntqA

Content by: Neha Kulkarni

Present: Neha Kulkarni

Goals: Understand how composite dampers can be analyzed by their material properties.

Content:

- Strain energy analysis
  - Relates total damping to damping by each element and fraction of energy stored in each element
  - Represented as ratio
- Correspondence principle
  - Apply corresponding dynamic forces to the ones used in static analysis.
  - Comparison can help reveal damping qualities
- Both of these methods can be used to analyze/predict damping qualities of composite dampers.

Conclusions/action items: The team will take these into account when deciding how to analyze testing data.

2022/09/28 - Shock Absorbing Tray Corner Liner

NEHA KULKARNI - Sep 28, 2022, 3:14 PM CDT

Title: Shock Absorbing Tray Corner Liner

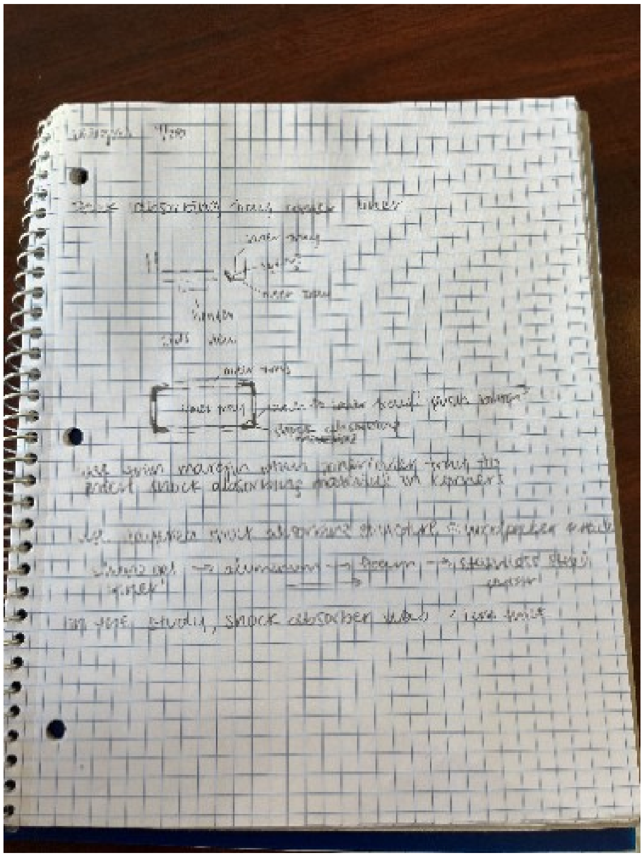
Date: 09/28/2022

Content by: Neha Kulkarni

Present: Neha Kulkarni

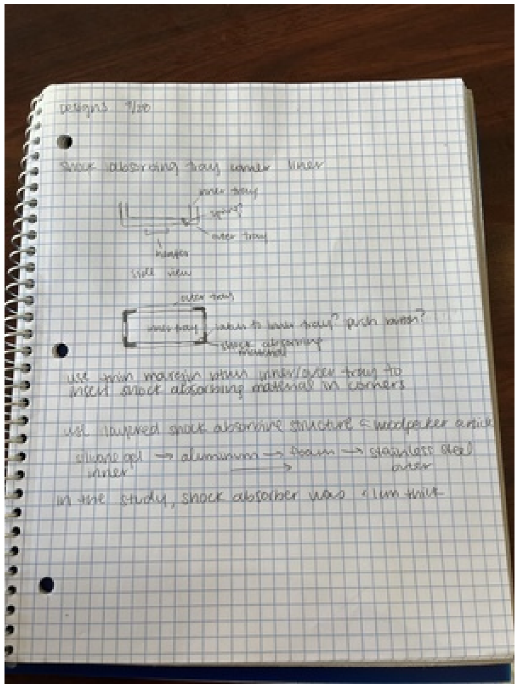
Goals: Create a preliminary design to reduce vibrations absorbed by a neonate during a transport

Content:



Conclusions/action items: Consider the feasibility and effectiveness of this design with the team and with the client.

NEHA KULKARNI - Oct 12, 2022, 1:26 PM CDT



Download

IMG_0947.jpg (4.39 MB)

2022/10/13 - Dimensioning with Materials Ordered

NEHA KULKARNI - Dec 14, 2022, 1:08 PM CST

Title: 2022/10/13 - Dimensioning after Material Ordering

Date: 2022/10/13

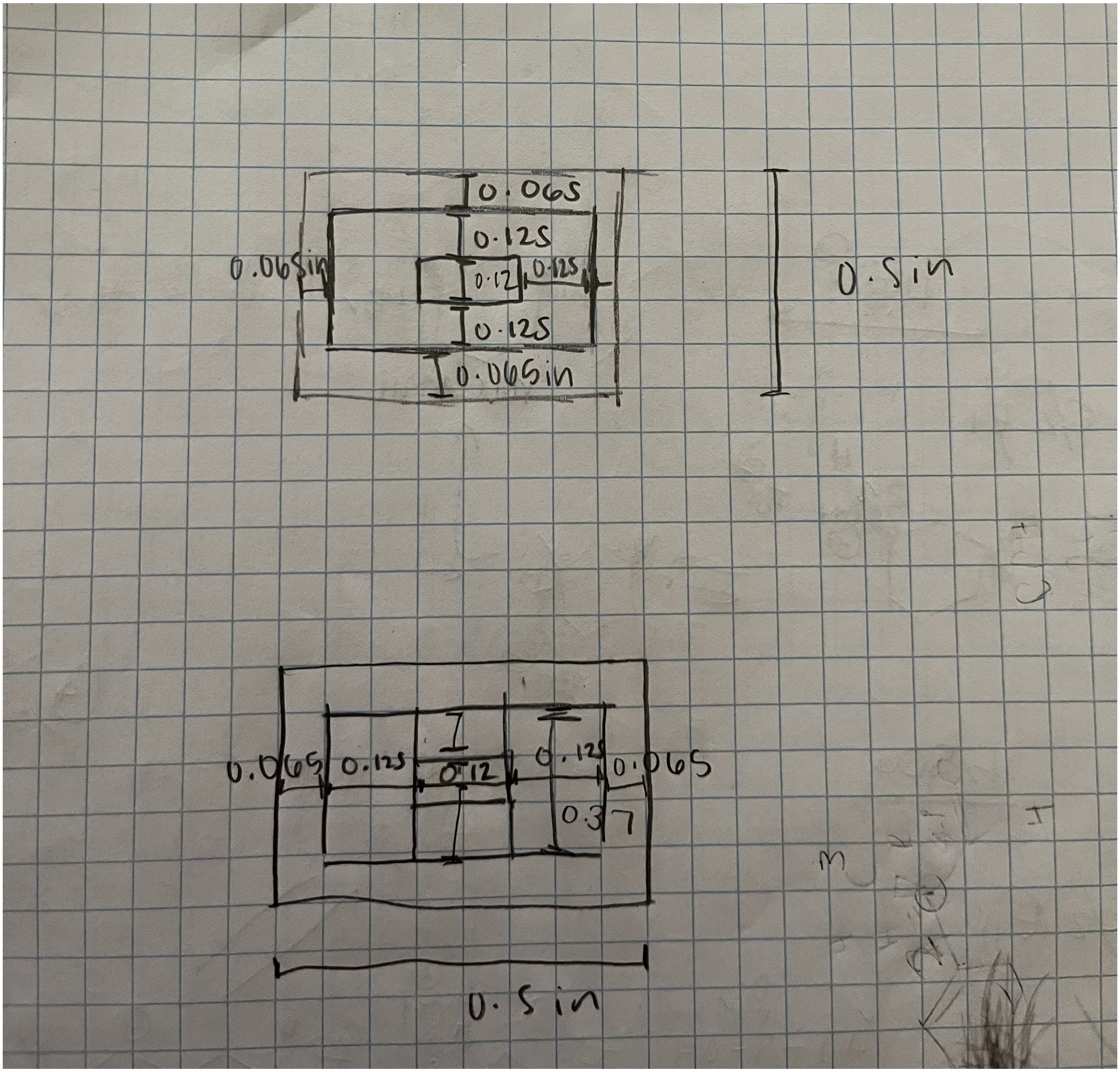
Content by: Neha Kulkarni

Present: Neha Kulkarni

Goals: Re-calculate the dimensions of the prototype after ordering materials

Content:

I calculated the dimensions using the sketches below:



Conclusions/action items: The team will use these dimensions during fabrication.

Spring plates

JULIA SALITA - Sep 28, 2022, 4:05 PM CDT

Title: mounting plates and springs

Date: 9/28/2022

Content by: Julia Salita

Present: Julia Salita

Goals: reducing vibration

Link: https://www.freepatentsonline.com/y2007/0089236.html

Citation:

M. Bailey-vankuren and A. Shukla, “Isolation device for shock reduction in a neonatal transport apparatus,” 20070089236, Apr. 26, 2007 Accessed: Sep. 22, 2022. [Online]. Available: https://www.freepatentsonline.com/y2007/0089236.html

Content:

- A plate mounted to the incubator and another to the stretcher with a gap in between. Between the parallel plates springs are attached, “preferably gas springs, with a range and a damping effect” [23]. The spring reduces vibrations transmitted to the infant during transport.

Ambulance

JULIA SALITA - Sep 22, 2022, 12:28 PM CDT

Title: Weight and size

Date: 9/21/2022

Content by: Julia Salita

Present: Julia Salita

Goals: To understand the operating environment for our product

Link: https://stsurg.com/product/ge-airborne-750i-infant-incubator/

Citation: kgrant, "GE Airborne 750i Infant Incubator - Seattle Technology: Surgical Division." https://stsurg.com/product/ge-airborne-750i-infant-incubator/ (accessed Sep. 21, 2022)

Content:

the incubator is about

1. 170 lbs
2. 48.25 inches tall
3. 24 inches wide
4. 50 inches long

Brief history

JULIA SALITA - Sep 22, 2022, 12:43 PM CDT

Title: history of neonatal transportation

Date: 9/22/2022

Content by: Julia Salita

Present: Julia Salita

Goals: to learn about neonatal transportation

Link: https://emedicine.medscape.com/article/978606-overview?reg=1

Citation: Bryan L Ohning, MD. “Transport of the Critically Ill Newborn.” *Overview, Administrative Aspects of Neonatal Transport Services, Neonatal Team Skills*, Medscape, 20 Dec. 2019, https://emedicine.medscape.com/article/978606-overview?reg=1.

Content:

- brief history of neonatal transport
- problems of transporting
- vehicles they are transported in

neonatal

JULIA SALITA - Sep 22, 2022, 12:46 PM CDT

Title: vibrations in medical transport

Date: 9/22/2022

1. **Content by:** Julia Salita

   Present: Julia Salita

   Goals: to learn about vibrations in an ambulance and if there has been any strive towards fixing it

   Link: https://pubmed.ncbi.nlm.nih.gov/7965249/

   Full text: https://www.sciencedirect.com/science/article/abs/pii/S0884217515331531?via%3Dihub

   Citation: Sherwood HB, Donze A, Giebe J. Mechanical vibration in ambulance transport. J Obstet Gynecol Neonatal Nurs. 1994 Jul-Aug;23(6):457-63. doi: 10.1111/j.1552-6909.1994.tb01905.x. PMID: 7965249.

   Content:

   1. Modifications made can reduce vibrations
   2. Certain areas vibrate more
      1. How to make it all equal during transport
   3. Gel mattress
      1. How thick separate from carrier or attached

mattress study for reducing whole body vibrations in neonatal transport

JULIA SALITA - Sep 22, 2022, 12:54 PM CDT

Title: mattress study for reducing whole body vibrations in neonatal transport

Date: 9/22/2022

Content by: Julia Salita

Present: Julia Salita

Goals:

Link: https://pubmed.ncbi.nlm.nih.gov/10920789/

Full text: https://www.nature.com/articles/7200349

Citation: Gajendragadkar G, Boyd JA, Potter DW, Mellen BG, Hahn GD, Shenai JP. Mechanical vibration in neonatal transport: a randomized study of different mattresses. J Perinatol. 2000 Jul-Aug;20(5):307-10. doi: 10.1038/sj.jp.7200349. PMID: 10920789.

Content:

1. Gel mattress reduces vibrations
2. Not as effective in smaller babies
3. Using a get and other type of mattress did not change amount of vibrations as much as without the gel mattress

Whole-body vibration in neonatal transport: a review of current knowledge and future research challenges

JULIA SALITA - Sep 22, 2022, 12:57 PM CDT

Title: Whole-body vibration in neonatal transport: a review of current knowledge and future research challenges

Date: 9/22/2022

Content by: Julia Salita

Present: Julia Salita

Goals: to understand past and current problems with neonatal transport

Link: https://pubmed.ncbi.nlm.nih.gov/32464450/

Citation: Goswami I, Redpath S, Langlois RG, Green JR, Lee KS, Whyte HEA. Whole-body vibration in neonatal transport: a review of current knowledge and future research challenges. Early Hum Dev. 2020 Jul;146:105051. doi: 10.1016/j.earlhumdev.2020.105051. Epub 2020 May 6. PMID: 32464450.

Content:

Abstract

Interfacility transport to tertiary care for high-risk neonates has become an integral part of equitable access to optimal perinatal healthcare. Excellence in clinical care requires expertise in transport medicine and the coordination of safe transport processes. However, concerns remain regarding environmental stressors involved in the transportation of sick high-risk neonates, including noise and vibration. In order to mitigate the potential deleterious effects of these physical stressors during transport, further knowledge of the burden of exposure, injury mechanisms and engineering interventions/modifications as adjuncts during transport would be beneficial. We reviewed the current literature with a focus on the contribution of new and emerging technologies in the transport environment with particular reference to whole-body vibration. This review intends to highlight what is known about vibration as a physical stressor in neonates and areas for further research; with the goal to making recommendations for minimizing these stressors during transport.

Reducing sound and vibrations in neonatal transport

JULIA SALITA - Sep 22, 2022, 12:50 PM CDT

Title: Reducing sound and vibrations in neonatal transport

Date: 9/22/2022

Content by: Julia Salita

Present: Julia Salita

Goals:

Link: https://pubmed.ncbi.nlm.nih.gov/25429381/

Full text: https://www.nature.com/articles/jp2014172

Citation: Prehn J, McEwen I, Jeffries L, Jones M, Daniels T, Goshorn E, Marx C. Decreasing sound and vibration during ground transport of infants with very low birth weight. J Perinatol. 2015 Feb;35(2):110-4. doi: 10.1038/jp.2014.172. Epub 2014 Nov 27. PMID: 25429381.

Content:

1. Sound maybe comes from low tone vibrations
    1. Nothing on incubator quieted it
2. Stopping vibrations changes depending on weight

redesigning the neonatal ground transport

JULIA SALITA - Sep 22, 2022, 12:42 PM CDT

Title: Redesigning the neonatal ground transport

Date: 9/22/2022

Content by: Julia Salita

Present: Julia Salita

Goals: to analyze and rethink the vehicle neonates are transported in

Link: https://pubmed.ncbi.nlm.nih.gov/31391074/

Citation: Bellini C, de Biasi M, Gente M, Ramenghi LA, Aufieri R, Minghetti D, Pericu S, Cavalieri M, Casiddu N; Neonatal Transport Study Group of the Italian Society of Neonatology (Società Italiana di Neonatologia, SIN). Rethinking the neonatal transport ground ambulance. Ital J Pediatr. 2019 Aug 7;45(1):97. doi: 10.1186/s13052-019-0686-y. PMID: 31391074; PMCID: PMC6686524.

Content:

- in the uk they are designing special vehicles to transport neonates when needed

gel component (silicone)

JULIA SALITA - Nov 03, 2022, 5:39 PM CDT

Title: How to cut a non-reinforced USP class VI silicone sheet

Date: 11/03/2022

Content by: Julia Salita

Present: Julia Salita

Goals: to learn how to cut silicone

Link: 1) https://engineering.stackexchange.com/questions/18874/how-to-cut-silicone-and-leave-smooth-edges

2) https://www.lasercut4.com/en/material/silicon

3) General searches and many things about baking sheets

4) https://www.smimfg.com/off-the-shelf/

Citation: 1)

Content:

1) cut silicone with a laser

2) also laser cutter

3) silicone sheets may be cut with scissors but often is not advised because some like baking silicone sheets have fiberglass imbedded in them so if ours does not It would be safe to cut but may not have super smooth edges

4) website recommends die cutting

Foam Mat

JULIA SALITA - Nov 03, 2022, 5:29 PM CDT

Title: How to cut Nitrile rubber (our foam mat)

Date: 11/03/2022

Content by: Julia Salita

Present: Julia Salita

Goals:

Link: 1) https://www.rubbercal.com/sheet-rubber/how-to-cut-rubber/#:~:text=A%20sharp%20utility%20knife%20is,accessible%20because%20it's%20relatively%20affordable.

Citation:

Content:

1) using an exact-o/utility knife and a straight edge should do the trick

Stainless Steel

JULIA SALITA - Nov 03, 2022, 5:35 PM CDT

Title: Cutting Stainless steel

Date: 11/03/2022

Content by: Julia Salita

Present: Julia Salita

Goals:

Link: 1) https://www.wikihow.com/Cut-Stainless-Steel

2) https://blog.dakecorp.com/en-us/horizontal-bandsaw-or-cold-saw-why-choose-one-over-the-other#:~:text=Both%20the%20bandsaw%20and%20cold,alloy%20steel%2C%20and%20stainless%20steel.

Citation:

Content: 1) a circular saw with a diamond blade

2) a horizontal band saw or a cold saw

Aluminum foil

JULIA SALITA - Dec 09, 2022, 2:31 PM CST

Title: aluminum cutting

Date: 11/03/2022

Content by: Julia Salita

Present: Julia Salita

Goals:

Link: common knowledge/sense

Citation:

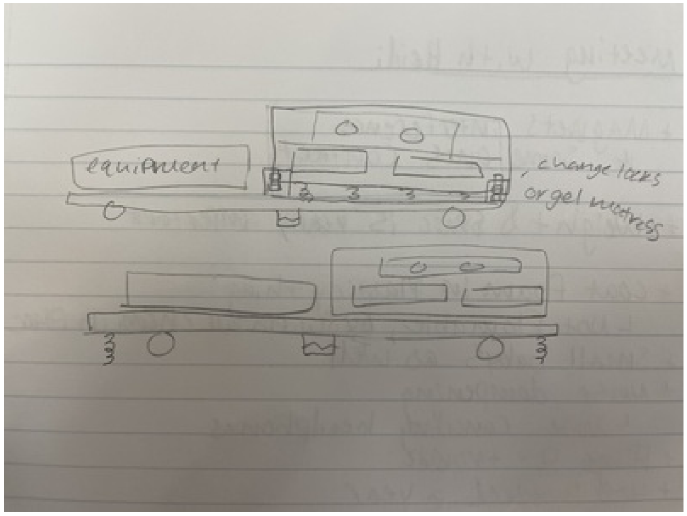
Content: The container has a serrated edge to cut the foil on but a scissors would most likely be used. (its the stuff you use in the kitchen)

Julia's design

JULIA SALITA - Nov 02, 2022, 9:05 AM CDT

A design to put springs underneath the sled. they would come down after it locks in.

JULIA SALITA - Nov 02, 2022, 9:06 AM CDT



Download

juliasdesign.jpg (184 kB)

JULIA SALITA - Nov 02, 2022, 9:09 AM CDT

Sorry this is so late I kept forgetting to upload it.

research notes template

JULIA SALITA - Sep 22, 2022, 12:54 PM CDT

Title:

Date: 9/22/2022

Content by: Julia Salita

Present: Julia Salita

Goals:

Link:

Citation:

Content:

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

JULIA SALITA - Dec 09, 2022, 2:38 PM CST

Title:

Date:

Content by:

Present:

Goals:

Content:

Conclusions/action items: