BME Design-Fall 2025 - Alex Conover
Complete Notebook

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Team contact Information

Celia Oslakovic - Sep 19, 2025, 1:59 PM CDT

Last Name	First Name	Role	E-mail	Phone	Office Room/Building
Williams	Justin	Advisor	jwilliams@engr.wisc.edu		1152 ME
Eggleston	Debbie	Client	debmegg@gmail.com		
Conover	Alex	Leader	ajconover@wisc.edu	(920) 241-5667	
Lyons	Avery	Communicator	allyons3@wisc.edu	(248)5150273	
Matthai	Claire	BSAC	cematthai@wisc.edu	(414) 458-5813	
Carey	Sean	BWIG	srcarey@wisc.edu	(480) 621-1053	
Singhdeo	Aditi	BPAG	singhdeo@wisc.edu	(312) 451-1923	
Oslakovic	Celia	BPAG	oslakovic@wisc.edu	(617) 301-0403	

Project description

Alex Conover - Sep 24, 2025, 10:52 AM CDT

Course Number: BME 200/300

Project Name: Inconspicuous Ankle Brace for Teen

Short Name:

Team AFO

Project description/problem statement:

From project list:

This project aims to develop an Ankle Foot Orthosis (AFO) specifically tailored for teenagers and individuals concerned with discretion and comfort. The AFO is designed to offer dorsiflexion assistance during the swing phase of gait, ensuring functionality without impeding other daily activities. Key objectives of the AFO include:
1. Positioning the ankle in sufficient dorsiflexion when unweighted, to facilitate foot clearance and prevent gait deviations.
2. Being narrow and thin in design, enabling it to be easily concealed under pants or minimally noticeable with any type of clothing, thereby not drawing attention to the individual's physical limitation.
3. Possessing sufficient flexibility, or the ability to articulate, to ensure that other functional activities, such as squatting or descending stairs, are minimally impacted.

The target demographic for this device comprises young individuals diagnosed with Facioscapulohumeral Dystrophy (FSHD), a specific form of Muscular Dystrophy. It would be ideal if the Ankle Foot Orthosis (AFO) is designed to allow active concentric ankle movements in those who retain this ability. Simultaneously, because eccentric contractions can be damaging to muscles, it would be beneficial if the AFO could reduce the necessity for eccentric muscle contractions, such as during the loading phase of gait, while also preventing foot slap. Such a design would likely benefit others with ankle

About the client:

Debbie Eggleston is a physical therapist who lives in Michigan. She has a daughter, Maggie, who suffers from FSHD. Maggie is 16 years old and currently attends high school as a sophomore. Maggie enjoys riding horses and experiences judgment for her condition, so she would like a brace that resembles an athletic brace design

Show and tell - 10/31/2025

Celia Oslakovic - Oct 31, 2025, 2:00 PM CDT

Title: Show and Tell

Date: 10/31/2025

Content by: Celia + Aditi :)

Present: Whole group. + other BME 200/300s

Goals: To share our problems and questions and get answers from our peers

Content:

- Suggestion - think about adding something to the heel to help with help strike.
- What were the main changes - in fall 2024, it was a bungee method that pulled the foot from the front but it was pulling the fabric more than the foot.
- Could add a rigid bar from the heel to the elastic strap to keep the strap away - could also put rigid support from the side of the heel to the strap so there isn't discomfort while walking
- Could use velcro on the strap to stick to the sock.
- Could use the same design as grippy/pilates sock on the sides and the strap to add more friction.
- Could merge the insole that she currently has with our ankle brace
- Have we considered the strain of excessive flexion could have on the shin?
- A strengthening plan would not be applicable in this scenario since it's a progressive disease that continues to get worse.
- Could incorporate an arch compression sleeve to give more support
- Using a full sock/sleeve was suggested but that would make the brace more bulky and the patient would have to wear the same socks every time which is not ideal.
- Flipflop style potentially to keep front of the foot thing to stay on the foot
- Backpack strap like method to keep straps adjustable
- Belt method to keep straps adjustable
- Strap around the back
- Strapless Dress attachment material
- Petg- 3d material (More flexible and stronger than PLA, but it shatters...)
- Velcro on the bottom to stick the sock
    - Make the velcro detachable
    - Make more than one strap, one with velcro one without
- Button or something to sew the two cross straps together
- The pin would allow it to be infinately adjustable.
- 

Conclusions/action items:

Meet on Sunday in person to go over testing plans and potentially pivot our design.

Team Meeting 1 - 09/08/2025

Alex Conover - Sep 08, 2025, 4:25 PM CDT

Title: Team Meeting 1

Date: 09/08/2025

Content by: Alex Conover

Present: Whole Team

Goals: Update the team on the project from the previous semester, set a meeting time, and flesh out client meeting plans.

Content:

Organized team meetings for Sundays 1-2 pm, Zoom or in person, whatever works best at the time. Team will complete 2 research entries per person based off on physiology and anatomy, as well as other ideas for ankle braces, materials, or other necessary research.

Client meeting will occur at 8am central time on Wednesday, September 10th, a document is being created to collect questions for the meeting. The goal of the meeting will be to get an update on the last semester of work on the brace and plan our next steps forward.

Conclusions/action items:

Complete the research required per person to stay up to date on the project, create more questions for the client meeting, and read up on anything that happened last semester that team members may have questions about.

Team Meeting 2 - 09/14/2025

AVERY LYONS - Sep 21, 2025, 12:14 PM CDT

Title: Team Meeting 2

Date: 09/14/2025

Content by: Avery Lyons

Present: Whole Team

Goals: Go over design ideas and pros/cons of previous designs.

Content:

- Spring 2025 design broke
  - maybe add more material to the medial side to avoid breakage
- Dorsiflexion ideas
  - previously bungee cord used
  - straps over top of bungee made sure it didn't stick out
  - maybe need something that is elastic enough to hold foot up but not elastic enough to hinder movement
    - maybe print clear band to add to Spring 2025 design
- Maybe stick w/ same design, eliminate extra material, and use stronger material
  - could add a cross strap that goes from front of the foot to wrap in an 'X' around the ankle
  - maybe add another 'X' cross strap under the foot
  - have to figure out material for 'X' cross strap; maybe get most elastic material
- For image of design below (with red shoe), maybe make it so that it could fit inside the shoe to make the brace more inconspicuous
  - also would need to use a more comfortable material that long rigid bars
  - questionable if could wear around the house without shoes
  - could add a bottom to make more comfortable

- team will break up responsibilities for the next week, aim to get the PDS completed sooner rather than later for review. Other relevant documentation should be uploaded to lab archives if it is applicable to the project.
- Prelim presentation work will begin this week, kick into gear next week.

Conclusions/action items:

Everyone will come up with at least one design idea for their own notebooks. The PDS draft is due Friday, but we are aiming to have it done by Wednesday to submit to Professor Williams for review. We will come up with refined designs for the three that we have so far.

Alex Conover - Sep 14, 2025, 7:48 PM CDT

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Alex Conover - Sep 14, 2025, 7:49 PM CDT

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Alex Conover - Sep 14, 2025, 7:49 PM CDT

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Team Meeting 3 - 09/21/2025

AVERY LYONS - Sep 21, 2025, 12:27 PM CDT

Title: Team Meeting 3

Date: 09/21/2025

Content by: Avery Lyons

Present: Whole Team

Goals: The goal is to finalize design ideas and begin formulating criteria for the design matrix that is due Friday.

Content:

Design Criteria	**Design 1: Combination Design 24-25 *Celia**		**Design 2: Inversion with Straps *Alex**		**Design 3: In the Shoe *Sean**	
	Raw Score	Weighted Score	Raw Score	Weighted Score	Raw Score	Weighted Score
Dorsiflexion Support (20)	/5	/20	/5	/20	/5	/20
Mediolateral support (20)	/5	/20	/5	/20	/5	/20
Ease of user assembly (15)	/5	/15	/5	/15	/5	/15
Comfort (15)	/5	/15	/5	/15	/5	/15
Durability (10)	/5	/10	/5	/10	/5	/10
Discreteness (10)	/5	/10	/5	/10	/5	/10
Fabrication Quality (5)	/5	/5	/5	/5	/5	/5
Cost (5)	/5	/5	/5	/5	/5	/5
Total	/100		/100		/100	

Conclusions/action items:

Everyone has been assigned 1-2 categories of the design matrix to write paragraphs on explaining them. Additionally, Celia, Alex, and Sean will draw the three designs. The team aims to have this done on Tuesday so that it can be put in

this week's progress report. Additionally, we began to discuss the requirements of the preliminary presentation and some expectations.

Team Meeting 4 - 09/28/2025

AVERY LYONS - Sep 28, 2025, 12:19 PM CDT

Title: Team Meeting 4

Date: 09/28/2025

Content by: Avery Lyons

Present: Whole Team

Goals: The goal is to assign slides to each team member.

Content:

- Celia: Slides: 1-3
- Alex: Slides 4-5
- Sean: Slides 6-7
- Avery: Slides 8-9
- Claire: Slide 10
- Aditi: Slides 11-12

Conclusions/action items:

Everyone has been assigned 1-3 slides that they will complete and present this Friday at the Preliminary Presentation. Sean, our BWIG, will send the finished slides to everywhere that they need to be before 10 AM on Friday.

Team Meeting 5 - 10/12/2025

AVERY LYONS - Oct 12, 2025, 2:41 PM CDT

Title: Team Meeting 5

Date: 10/12/2025

Content by: Avery Lyons

Present: Whole Team

Goals: The goal is to assign slides to each team member.

Content:

- Avery will email client about Madison travel to confirm this weekend (10/18) or the weekend of 11/8-11/10
- Tasks
    - SolidWorks file: Avery 2 x 1x8 in strips to email to Alex
    - Talk to Makerspace and print test strips: Alex
    - Stress testing: Sean and Aditi
    - Putting materials together (later): Claire and Celia

Conclusions/action items:

All team members will perform their assigned tasks this week.

Team Meeting 6 - 10/19/2025

AVERY LYONS - Oct 19, 2025, 12:08 PM CDT

Title: Team Meeting 6

Date: 10/19/2025

Content by: Avery Lyons

Present: Whole Team

Goals: The goal is to discuss this week's goals and tasks.

Content:

- Tasks
  - Finish SolidWorks file for lateral sides: Celia and Sean
  - more test strips in SolidWorks: Avery
    - 2 x 1inchx12inchx1/32 inch
  - Order materials for padding: Aditi
  - Repeated Stress testing: Sean and Aditi
  - Putting materials together (later): Claire and Celia

Conclusions/action items:

All team members will perform their assigned tasks this week. MTS testing is aimed for next week.

Team Meeting 7 - 10/26/2025

AVERY LYONS - Oct 26, 2025, 12:13 PM CDT

Title: Team Meeting 7

Date: 10/26/2025

Content by: Avery Lyons

Present: Whole Team

Goals: The goal is to discuss this week's goals and tasks.

Content:

- Tasks
  - Monday: Sean pick up 3D printed designs
  - Tuesday: Avery and Alex MTS Testing at 1 pm
  - Wednesday: assemble
  - Show and Tell: ask for method for straps to stay on foot to avoid slipping and also nylon strips for straps
  - figure out timing for client visit in Madison

Conclusions/action items:

All team members will perform their assigned tasks this week. MTS testing is aimed for this week.

Team Meeting 8- 11/09/2025

Celia Oslakovic - Nov 09, 2025, 2:10 PM CST

Title: Team Meeting 8

Date: 11/09/2025

Content by: Celia Oslakovic

Present: Celia, Alex, Sean, and Aditi

Goals: The goal is to discuss this week's goals and tasks. Adjust design before additional testing tomorrow.

Content:

Design Adjustments

-Update design to have the malleolus holes actually sit where they are supposed to

-Wider straps, ease in comfortability and helps position brace correctly

-Lengthen the top of the brace with a thick strap around the top of the ankle to secure it in place

-Offset one side from the other

-Move strap from red AFO to black AFO

-Add velcro to the bottom of the ankle so it is more adjustable

-Look in Makerspace for more velcro, order more

- Tasks
  - Adjust CAD design (Done)
  - Organize MatLab files from Saturday testing (Done mostly)
  - Test with client tomorrow, mainly gait cycle
  - Print dogbones out of TPU for MTS testing

Conclusions/action items:

Get tasks done by tomorrow and Friday.

Team Meeting 9 - 11/14/2025

AVERY LYONS - Nov 14, 2025, 12:51 PM CST

Title: Team Meeting 9

Date: 11/14/2025

Content by: Avery Lyons

Present: Whole Team

Goals: The goal is to discuss testing and prototyping.

Content:

- Info
  - main concern is that brace was pulled forward on her ankle
    - raise both sides to same side
    - add another band
    - used tape while on her foot which worked for both dorsiflexion and stability
  - folding padding over edge helped with discomfort
    - maybe drop brace to floor for increased stability and comfort (future work?)
  - probably have to make 2 prototypes and send one to client
  - work on better method to keep back aligned

Conclusions/action items:

We will make the final report next week and poster. The goal is to have most of the final report and poster done before Thanksgiving break.

Team Meeting 10 - 11/16/2025

AVERY LYONS - Nov 16, 2025, 12:55 PM CST

Title: Team Meeting 10

Date: 11/16/2025

Content by: Avery Lyons

Present: Avery, Alex, Claire, Sean, and Aditi

Goals: The goal is to discuss final deliverables and final prototyping.

Content:

- Info
  - created poster template
  - created final report template
    - will assign sections of final report and then correlate that to poster
  - making 2 prototypes
    - 1 to send to client

Conclusions/action items:

We will work on the final report next week and poster. The goal is to have most of the poster done before Thanksgiving break. The goal is to have the final report done by 12/4 to get some feedback before it is due 12/10.

Team Meeting 11 - 11/23/2025

AVERY LYONS - Nov 23, 2025, 12:22 PM CST

Title: Team Meeting 11

Date: 11/23/2025

Content by: Avery Lyons

Present: Avery, Alex, Claire, Celia, Sean, and Aditi

Goals: The goal is to discuss final deliverables and get some of the poster done.

Content:

- Info
  - going to meet after break to practice presenting poster
  - going to print poster the Monday/Tuesday after break
  - adding a section of previous work

Conclusions/action items:

We will work on the final report next week and poster. The goal is to have most of the poster done by Tuesday. The goal is to have the final report done by 12/4 to get some feedback before it is due 12/10.

Team Meeting 12 - 12/01/2025

Alex Conover - Dec 09, 2025, 4:07 PM CST

Title: Team Meeting 12

Date: 12/01/2025

Content by: Alex

Present: Team

Goals: Finish the Poster and work on the final report.

Content:

The team met in person after the break was over to go over any remaining details of the poster, as well as start hashing out more of the final report. These are the sections everyone is going to work on:

Who is doing what

Celia - PDS (all?)

Avery - final design, current prototype, strengths and limitations

Aditi - Methods

Sean - Design Evaluation, ethics

Claire - materials

Alex - testing methods

aditi asking for materials - velcro

Tuesday poster done

12/4 - drafts / mostly done for Dr. Williams to review

The team also decided to lock in the print date for 12/03, and double check 12/04. Presentation practice will happen 12/04 in the evening, and the presentation is at 12:35 on Friday in ECB.

Conclusions/action items:

Finish the poster and print by 12/04.

Finish the final report, final pds, and lab archives.

Make sure to send final email to Debbie to work out shipping, as well as give her the final reports and poster.

09/10/2025-Client Meeting 1

Claire Matthai - Sep 12, 2025, 11:39 AM CDT

Title: Client Meeting 1

Date: September 10, 2025

Content by: Avery Lyons

Present: Avery, Alex, Aditi, Sean, and Claire

Goals: The goal is to get updates on Maggie's condition, set up a time for Maggie to come to Madison for design/testing, and learn what has been working the past semesters and what has not.

Plan:

Notes:

Background and Current Condition:

- Maggie was diagnosed with FSHD 2 years ago
- Age: 16, junior in high school
- Foot drop on right side, no heel strike
- Has problem where ankle rolls side-to-side
- Has right arm weakness, lost left arm function quite a bit (can’t raise hands high)
    - Shouldn’t impact her ability to put on/take off the AFO
- Very involved in advocacy and trying to balance being a normal teen
- Involved in horseback riding

Clinical Trials and Treatment:

- Some treatments and clinical trials exist for FSHD, but most exclude children
- Maggie failed a clinical trial screen (very rigid)
- Went to orthotist – couldn’t get heel strike and tripped and fell

Past Orthotics and Problems Identified:

- Got a regular AFO → rarely wears it
- Has MPO that helps with medial-lateral movement
- Received last year’s AFO, tested with video capture, but issues:
    - Hole for malleolus was too thin and broke
    - Didn’t help with eccentric contractions (did not hold ankle up)
    - Uncomfortable while sitting in car
    - Needs stronger materials (suggestion: carbon fiber)
    - Bungee in front bunched up fabric instead of aiding dorsiflexion
    - Heel spot caused discomfort

Design Priorities:

- Appearance matters: should look like an athletic brace, not a medical device
- Wants a finished product
- Wants to build off of/learn from previous designs rather than starting over
- Wants something comfortable she can wear at home without shoes to work on heel strike
- Wants articulation (joint at the ankle) but may be beyond our scope
- We are limited in ROM - want it to flex and change throughout different sitting and walking positions

Conclusions/action items:

Look at the results from previous semester- how did the testing go?
Calendar for meeting!! - Late October 3rd / Early October 4th
Send reminder on Sunday for meeting in October!

09/18/2025 - Client Information

Alex Conover - Sep 18, 2025, 2:30 PM CDT

Title: Client information update

Date: 9/18/2025

Content by: Alex Conover

Present: N/A

Goals: Catalog the update from the client in an entry for documentation purposes.

Content:

This is the clip from Debbie's email to confirm the breakage from the previous device:

Debbie Eggleston <debmegg@gmail.com> Apr 21, 2025, 11:08 AM
to Madison, John, LUCIA, SADIE, Kate, PRESLEY, Lizzie

I'm sorry for the delay, but we are traveling. I was able to glue the brace so it should be set to record today.
I was originally thinking what happened was that it broke when I took it off.
now i suspect it broke because it slide down. though i'm also thinking about the design and how it is a rigid piece at a joint that is moving. how is that piece to accommodate her ankle during dorsiflexion and plantarflexion?

Madison Grace Michels <mmichels2@wisc.edu> Apr 21, 2025, 1:33 PM
to me, John, LUCIA, SADIE, Kate, PRESLEY, Lizzie

Hi Debbie,

Hope you had a great weekend and a happy Easter.

We are sorry the brace isn't working as intended. The rigid support is not meant to aid or hinder dorsiflexion/plantarflexion. It is simply there for inversion and eversion support.

Our timeline for the week is narrow, as we print our presentation Wednesday and need to perform data analysis still. If you do not have time to get through the OpenCap testing tonight, please just try to fill out the comfort form attached to this email.

Best,
Maddie

This is the email clip from us confirming design changes, as well as the pictures of the broken brace:

I was looking back at notes and was reminded that it broke when she first tried it on. I glued it so we could try to use it for testing, but it broke again. They had sent us 2 braces that were a bit different, and the other one (red) didn't break. It's a little strange that I didn't see anything about this in their progress notes. It’s on the lateral side - anterior and posterior to the malleolus.

Conclusions/action items:

We will have to adapt this design to make sure the breakages don't happen again, as well as maybe create new padding to eliminate pain. Overall, the process to create a new version might be more intensive and require some help from someone more versed in CAD, but this is great.

10/01/2025-Client Meeting 2

AVERY LYONS - Oct 01, 2025, 1:14 PM CDT

Title: Client Meeting 2

Date: 10/01/25

Content by: Avery Lyons

Present: Avery, Alex, Aditi, and Claire

Goals: The goal is update the client on our designs and explain how these address the dorsiflexion aspect. Additionally, we will discuss Madison travel plans.

Notes:

- Dorsiflexion
  - bungee maybe helped in Fall 2024 but did not help with inversion prevention
  - bungee only helped pull up fabric not foot very much
- Spring 2025 helped with inversion prevention but did not address dorsiflexion very much
  - final report said to focus on putting future designs together for future groups
- Design Matrix
  - Design 1 is combo design
  - Design 3 is similar to Fall 2024 but in the shoe
  - Design 2 has inversion prevention and straps underneath foot eliminates some/all foot drop hopefully
- Concerns
  - Fall 2024 and Spring 2025 designs had hole for malleoli
  - movement when dorsiflex
  - mediolateral supports working well?
  - add something for comfort to avoid rubbing maybe
  - concerns that straps are not far enough away from angle of movement to get enough force to pull ankle up
    - triangle too small to get enough force?
  - typical AFOs go up higher
- will check schedule and get back to us about visiting Madison
  - now seeming like November will work better than October
  - October 31- November 1?

Conclusions/action items:

Alex and Avery will look at X-crossing of straps - possible truss problem. Alex will meet with the Makerspace staff to discuss Spring 2025 breakage, materials, and how to decrease the risk of this happening again.

09/12/2025 - Advisor Meeting 1

AVERY LYONS - Sep 12, 2025, 1:29 PM CDT

Title: Advisor Meeting 1

Date: 09/12/2025

Content by: Avery Lyons

Present: Alex, Avery, Claire, Sean, Celia, Aditi

Goals: Update our advisor on the status of the project, what we learned from the client, and what next steps are.

Content:

- Use notebook for feedback
  - Notebook checks nearly weekly
  - Anything done goes into notebook
  - Very important for tracking and IP
- PDS Draft due next week on Friday
  - send to Williams before class for feedback
- Design Matrix criteria + 3 design ideas due Week 3 Friday
- Preliminary Presentation on Week 4 Friday
- Progress Report
  - researched FSHD, competing AFOs, went through old files on previous semesters for accomplishments/still needs to be done
  - met with client Wednesday morning to ask about previous project failures/successes
  - trying to get client to visit Madison for designs and testing
  - dorsiflexion affects patient's range of motion/gait
- company that does tibialis interior muscle stimulation
- devices that can help dorsiflexion
- could use software package for gait analysis just based off video recordings in biomechanics lab
  - Is there something about the gait that is especially causing problems?
- Work with same materials, modify design based on previous breakage
- Is there a stretchy material to 3D print with?
  - Check Makerspace and possible expenses

Conclusions/action items:

In conclusion, we are to have a team meeting via Zoom on Sunday. We will discuss coming up with new designs, in which everyone is expected to contribute. Using different materials is an option, however the carbon fiber-reinforced PLA seems to still be a good option. The PDS draft will be slightly altered from previous semesters, but will remain mostly the same due to similar specifications and goals. We can send it to Professor Williams for review 24+ hours before it is due.

09/19/2025 - Advisor Meeting 2

AVERY LYONS - Sep 19, 2025, 1:18 PM CDT

Title: Advisor Meeting 2

Date: 09/19/2025

Content by: Avery Lyons

Present: Alex, Avery, Claire, Sean, Celia, Aditi

Goals: Update our advisor on the status of the project and get recommendations on the PDS draft.

Content:

- Design Matrix criteria and design ideas due next Friday
- PDS Feedback
    - think about where you can put values that you will eventually test
    - set goals for what you want the design to do/what you want it to withstand to look back on
- Progress Report #2
    - catching up and research on different types of AFOs
    - patents and standards included in PDS
    - began drafting first designs/what we want to keep from previous semesters
        - how can we help dorsiflexion?
        - 1. throwing previous 2 designs together 2. adding X-cross straps across current Spring 2025 design 3. loosely based on another AFO that we found but not very inconspicuous
    - need to start thinking about materials for
        - maybe TPU filament or polyester
        - how much force can it withstand?
        - make design matrix possibly for designs and materials
        - should look into thickness and geometry of material

Conclusions/action items:

In conclusion, we are to begin the slides for the preliminary presentation, especially the background ones. The design matrix is due next Friday, so we will begin finalizing our three designs and putting together our categories. We will also look into different elastic materials that can withstand the test of time and will not wear down quickly. Our weekly team meeting is this Sunday, so we will continue to discuss and work then.

09/26/2025 - Advisor Meeting 3

AVERY LYONS - Sep 26, 2025, 1:21 PM CDT

Title: Advisor Meeting 3

Date: 09/26/2025

Content by: Avery Lyons

Present: Alex, Avery, Claire, Sean, Celia, Aditi

Goals: Update our advisor on the status of the project and get feedback on Design Matrix.

Content:

- Preliminary Presentation on 10/3
- Design Matrix
  - Design #1 is a combo of Fall 2024/Spring 2025. Same brace design that prevents angle inversion as Spring 2025, but added bungee cords from Fall 2024.
  - Design #2 is current inversion design but with dorsiflexion straps. It is hence a continuation of Spring 2025, but does not include a sleeve to improve comfort and reduce bulkiness. Currently researching materials for the straps.
    - will talk to Makerspace staff about material ideas and ideas on how to avoid breakage
  - Design #3 has bungee support as well, but also has a 3D printed bar that would go under shoe tongue to improve stability. No sleeve to reduce bulkiness.
- Matrix Feedback
  - nice job showing who won each category
  - was Design #2 who you thought was going to win? Yes, however 3 was a close second. We liked the bar under the shoe idea, but we weren't sure if this was what the client looked for
  - what drove the scores?
  - was there any 1 category where scoring/weight should have been increased/decreased
  - in presentation, explain each category and your reasoning for weighting and maybe which category was really the driving factor for the winner
  - if the client likes specific aspects of a design that was not picked, can you bring in those aspects to the chosen design?
- Presentation
  - bring previous prototypes
  - business casual

Conclusions/action items:

In conclusion, we are to start working on the Preliminary Presentation slides this week. The team has our weekly meeting on Sunday, where we will begin working on this. We will send any specific slides that we need feedback on to Professor Williams. Avery will be emailing the client on Sunday (9/28) to get an update on the client's travel plans to Madison. This will determine if the client will come to Madison the weekend of 10/9 or 10/18. We will also begin ordering and building the prototype either this week or next week. The BPAGs will have to fill out forms due to the project being university-funded. BME 200 trainings are due 10/31.

10/10/2025 - Advisor Meeting 4

AVERY LYONS - Oct 10, 2025, 1:30 PM CDT

Title: Advisor Meeting 4

Date: 10/10/2025

Content by: Avery Lyons

Present: Alex, Avery, Claire, Sean, Celia, Aditi

Goals: Update our advisor on the status of the project and get feedback on Preliminary Presentation and Report.

Content:

- Preliminary Presentation Thoughts
  - 13 minutes, a bit too long
  - evident that it was practiced
  - intro and background was good
    - liked having background first to know what problem is
  - liked linking testing back to PDS
  - liked use of numbers
  - Slide 9:
    - highlighting was off
    - already fixed
  - cost should still be considered despite university-funded
  - figure text a bit hard to see
    - make dimensions bigger
    - maybe try practicing in presentation room to make sure writing is legible
- Progress Report Thoughts
  - preliminary report done and turned in
  - finish ordering materials
    - polyester has been ordered
  - trying to get client testing figured out
- next deliverable is Show and Tell on 10/31
- Testing Thoughts
  - How to convince client that prototype meats PDS standards
  - stress-testing
    - could make up test structure/apparatus
  - MTS testing from BME 201
    - print specific pieces for testing so they can break
  - Work in factor of safety
- TEAM COMMENTS (Please put your name)

Conclusions/action items:

We need to talk to Dr. Willy about professors at the University of Michigan that could collaborate with us if the client cannot make it to Madison. Alex will meet with Makerspace to discuss final materials. There is an area in the

Makerspace that is dedicated to fabrics. We will stress-test the polyester. We will do another order for other materials such as inside cushioning further down the timeline. Also, we need to print the dog bones.

10/17/2025 - Advisor Meeting 5

AVERY LYONS - Oct 17, 2025, 1:18 PM CDT

Title: Advisor Meeting 5

Date: 10/17/2025

Content by: Avery Lyons

Present: Alex, Avery, Claire, Sean, Celia, Aditi

Goals: Update our advisor on the status of the project and get feedback on Preliminary Presentation and Report.

Content:

- Show and Tell (10/31)
  - want to have our prototype
    - both sides printed with padding and straps
    - may want to have 2 versions: 1 with polyester straps and 1 with TPU straps
    - get into lab before to use machines, show BME 200 how it machines work, test healthy ankle
- Updates
  - had meetings with Makerspace and Design Lab people
  - Alex talked to Jessie in the TeamLab
    - walked through design process to build new medial side of brace
  - Alex talking to previous teams for original SolidWorks file
- Printed test strips with TPU
  - 1 x 1inchx8inchx1/8inch
  - 1 x 1inchx8inchx1/16inch
  - Too thick most likely
  - will try to test w/ 1/16 inch strip but probably go back and print longer ones
- Will order rest of materials to create padding for interior
  - most likely have to use sewing tables in Makerspace
- finish lateral side of brace (made in SolidWorks) and print with Carbon-fiber enforced PLA
- Get parking permit for Ms. Eggleston 11/8-11/10
- create agenda for Ms. Eggleston for Madison visit
- get special permission to use labs the weekend of 11/8-11/10

Conclusions/action items:

We will order rest of materials to create padding for interior and finish lateral side of the brace and print. We need to get a parking permit for Ms. Eggleston 11/8-11/10, create an agenda for Ms. Eggleston for Madison visit, and get special permission to use labs the weekend of 11/8-11/10.

10/24/2025 - Advisor Meeting 6

Celia Oslakovic - Oct 31, 2025, 1:13 PM CDT

Title: Advisor Meeting 6

Date: 10/24/2025

Content by: Avery Lyons

Present: Alex, Avery, Sean, Celia, Aditi

Goals: Update our advisor on the status of the project.

Content:

- Show and Tell (10/31)
    - want to have our prototype
- Updates
    - printed new TPU strip 1inchx12inchx1/32inch
        - Suggestion: maybe look at ballistic nylon, can laser cut it
    - Sean finished the lateral side in OnShape
    - requested access to 1002 and 1002A in ECB for weekend of 11/8-11/10
    - obtain client address to send parking passes for 11/9 and 11/10
    - client will have parking at Alex's house on 11/8 due to home football game
    - Stuck on how to get straps to stay in place on foot
        - maybe put thermoplastic on straps
            - would only work for barefoot

Conclusions/action items:

We will look into ballistic nylon as an alternative material for the straps. We will write up an itinerary after Show-and-Tell to make sure everything is ready for the client visit. We will try to get MTS testing done this week. We will get suggestions at Show-and-Tell for how to get the straps to stay in place on the foot.

11/07/2025 - Advisor Meeting 7

AVERY LYONS - Nov 07, 2025, 1:46 PM CST

Title: Advisor Meeting 7

Date: 11/07/2025

Content by: Avery Lyons

Present: Alex, Avery, Sean, Celia, Aditi

Goals: Update our advisor on the status of the project.

Content:

- Fabricated new prototype with TPU straps
  - will measure on Saturday, make changes Sunday, test Monday
  - 1 strap still needs to be sewed, make sure it fits tomorrow
  - make sure TPU strap is long enough
- Will test with OG prototype on Saturday
- Analyze data from the weekend and figure out best way to display it for poster (e.g. table, graph, etc.)
- questionnaire in final report
  - open-ended questions
- MTS again at some point using "dog bone" design
- poster needs to be printed by Wednesday 12/3

Conclusions/action items:

The client is coming this weekend. We have plans to meet with her for testing tomorrow (11/8) at 2 PM and again sometime (~9AMish) on Monday. Available team members will meet Sunday for editing the new prototype for Monday testing.

11/14/2025 - Advisor Meeting 8

AVERY LYONS - Nov 14, 2025, 1:21 PM CST

Title: Advisor Meeting 8

Date: 11/14/2025

Content by: Avery Lyons

Present: Alex, Avery, Sean, Celia, Aditi

Goals: Update our advisor on the status of the project.

Content:

- Final presentation is 12/5
  - same order of presentations as preliminary
  - final deliverables due 12/10
    - feedback in presentation can be updated in final report
  - start registering to print final poster to ensure you get a spot
- Client Testing
  - tested with red brace on Saturday
  - met Sunday to make changes to brace
  - retested with black brace on Monday
  - tested w/ and w/o shoe, w/ and w/o brace, right and left foot, etc.
  - data is a bit inconsistent, so Alex will check with Dr. Willy if there is an issue with code to process data
- do we want to make a "better" prototype?
  - cannot be tested with client
  - possibly use next semester if continued

Conclusions/action items:

We intend to try to file for a patent. We will begin final deliverables: report and poster. We will refabricate this prototype.

11/21/2025 - Advisor Meeting 9

AVERY LYONS - Nov 21, 2025, 1:26 PM CST

Title: Advisor Meeting 9

Date: 11/21/2025

Content by: Avery Lyons

Present: Alex, Avery, Sean, Celia, Aditi, Claire

Goals: Update our advisor on the status of the project.

Content:

- Final presentation is 12/5
    - 12:35 PM
    - client cannot make it
    - print poster Tuesday and Wednesday (if needed) before 12/5
    - have poster done and ready for feedback by Tuesday 11/25
- Patent
    - first do WARF disclosure form
- Info
    - final prototype is done
    - going to make a second copy to send to client
    - Updates:
        - sides are taller
        - no strap under bottom, replaced with strap in the middle that is adjustable
        - still some issues with slippage but mitigated with shoe on
        - impact was clear visually and in data
            - still need to do stabilogram data
        - need to summarize data for poster and report
            - unpaired T-test using MATLAB
                - fine just lose some statistical power
                - tails depend on hypothesis
                - Compare control vs. Maggie's normal, control vs. brace, and Maggie's normal vs. brace

Conclusions/action items:

We intend to try to file for a patent. We will continue working on final deliverables: report and poster. We will fabricate a second copy of the prototype.

09/14/2025 - Team Brainstorm

Alex Conover - Sep 14, 2025, 8:02 PM CDT

Title: Team Meeting 2

Date: 09/14/2025

Content by: Avery Lyons

Present: Whole Team

Goals: Go over design ideas and pros/cons of previous designs.

Content:

- Spring 2025 design broke
  - maybe add more material to the medial side to avoid breakage
  - add padding for more comfortability
- Dorsiflexion ideas
  - previously bungee cord used
  - straps over top of bungee made sure it didn't stick out
  - maybe need something that is elastic enough to hold foot up but not elastic enough to hinder movement
    - maybe print clear band to add to Spring 2025 design
- Maybe stick w/ same design, eliminate extra material, and use stronger material
  - could add a cross strap that goes from front of the foot to wrap in an 'X' around the ankle
  - maybe add another 'X' cross strap under the foot
  - have to figure out material for 'X' cross strap; maybe get most elastic material
- For image of design below (with red shoe), maybe make it so that it could fit inside the shoe to make the brace more inconspicuous
  - also would need to use a more comfortable material that long rigid bars
  - questionable if could wear around the house without shoes
  - could add a bottom to make more comfortable

Conclusions/action items:

Everyone will come up with at least one design idea for their own notebooks. The PDS draft is due Friday, but we are aiming to have it done by Wednesday to submit to Professor Williams for review. We will come up with refined designs for the three that we have so far.

Alex Conover - Sep 14, 2025, 8:01 PM CDT

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IMG_2944.jpeg (4 MB)

Alex Conover - Sep 14, 2025, 8:01 PM CDT

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IMG_2943.jpeg (3.9 MB)

Alex Conover - Sep 14, 2025, 8:01 PM CDT

Download

IMG_2942.jpeg (4.2 MB)

09/24/2025 - 3 Preliminary Designs

Claire Matthai - Oct 02, 2025, 4:47 PM CDT

Title: 3 Preliminary Designs

Date: 9/24/2025

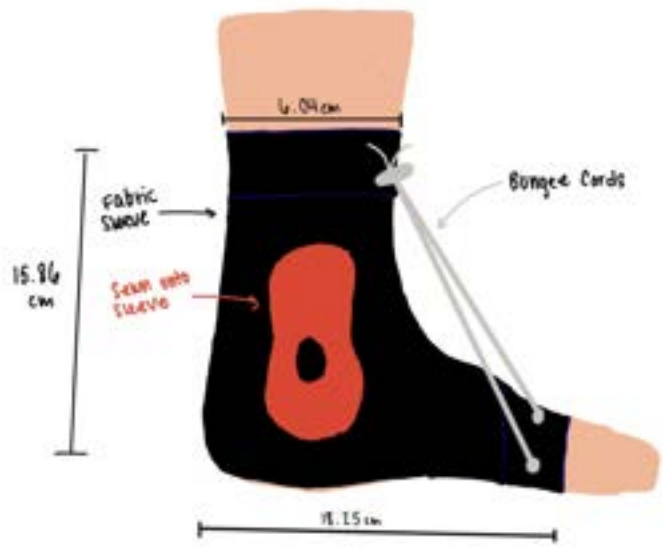
Content by: Alex Conover

Present: Team

Goals: Upload the 3 preliminary designs that will be used in our design matrix.

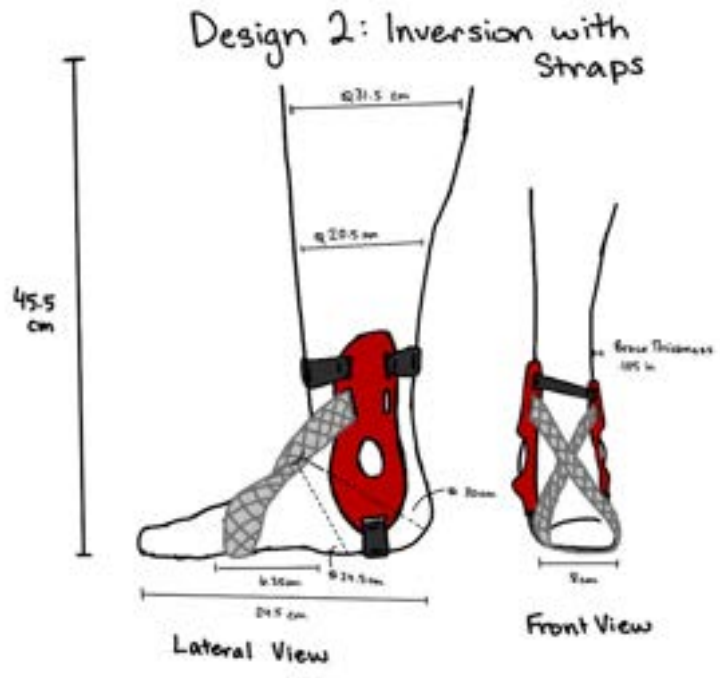
Content:

Design 1: 24-25 Combination Design



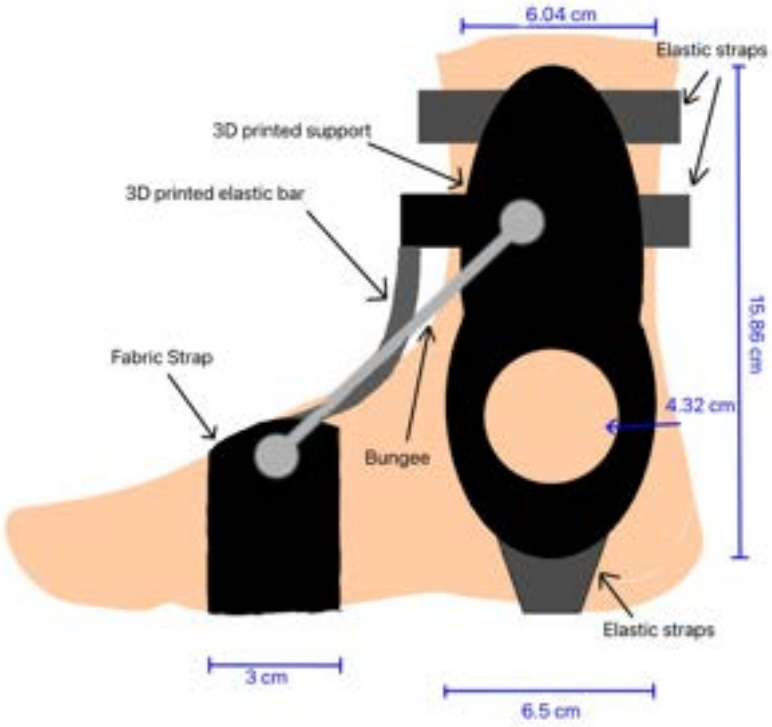
- This design combines both designs from the previous 2 semesters. It combines the ankle inversion prevention device with the sleeve of the original dorsiflexion design. This design was directly inspired by the future work section of spring 2025, where they detailed adding the 2 designs together in a similar fashion to this.

Design 2: Inversion Prevention with Straps



Design 2 implements the inversion prevention design from spring 2025 with minor changes to fit the patients' requests for more comfort. The inversion prevention design was successful, but broke upon first contact with the patient. Various aspects of the design, including thickness, width of holes for the malleolus, and other elements, will be updated to prevent breakage again. Dorsiflexion will be the main focus again, as this is what is causing the patient the most difficulty. This design implements the straps that are already used within the inversion support, and adds a strap around the center of the foot to aid with the dorsiflexion. The material is still unknown, but it needs to be strong enough to support 266 N worth of force.

Design 3: In the Shoe



Design 3 implements a similar bungee design as Design 1, but ultimately adds an extra bar of support that is inserted into the top of the shoe, below the tongue. It is designed to help lift the foot during the normal gait cycle, just like the strap in design 2. The inversion support will also be implemented here, the same as the other 3 designs.

Overall, these designs will be thrown into the design matrix to decide which we will be pursuing in the following months.

Conclusions/action items:

The designs will be rated in the design matrix today, per the criteria uploaded in a previous entry. The progress report will be made, and the matrix will be attached to it. Any other design ideas or comments from the client will be received post Thursday, after she receives the progress report.

10/16/2025 - ECB Design Meeting

Alex Conover - Oct 16, 2025, 11:02 AM CDT

Title: Team Lab Consultation

Date: 10/16/2025

Content by: Alex Conover

Present: Celia and Sean

Goals: Meet with the ECB people and have them help update our current design

Content:

Jesse is helping us recreate the files, basically, because we don't have the old ones.

Redesigning the brace with the same file as last time, but working to recreate the RED brace that was finalized last semester. We will be updating the brace to fix the issues that occurred last semester.

Measure the old brace will a caliper to get the dimensions, see picture attached (rough drawing).

The process of redrawing the race in Onshape is a lot of plane work. Jesse laid out the measurements with stacked planes, and is tracing that with an organic shape going downwards. Viewing each chunk in sections gives you a good look at what we're trying to sketch. We can use splines or curves, but whatever works best with this geometry.

First sweep will be rough, but we will cut the outsides out after extruding it to follow the curve of the actual mold. We're going to use splines instead of arcs, since we are using 2 arcs, and that's not as good as the one spline. It might be easier to loft with the spline, hence why we are switching to it. Splines fit so much better to the curve than just the arc.

- Copy and pasting the spline to the next plane we're working with, then moving the spline to be in line with the mold

- pulling the control lines moves the spline lines up and over to the edge of the brace to keep it in line

Eventually, we will spline around the whole thing, to build the outside edges

- we think the outside edges dont need to be so obnoxious as last time, they can be fairly smooth, just following the general geometry of the casting.

For the Loft:

- setting the "thin" loft right now - variable #.12 inches

    - Variable Studio can create variables for all files in a folder, or you can just have the variable in one section.

    - Creating a global variable for this scenario

- click through all guide splines, and it will create a basic shape following this geometry

    - red = bad (first attempt on thin was bad) - changed to surface instead of thin.

Now sketching on the front plane, cutting a circle hole out so that way the malleolus can stick through - coincident to the 2 planes.

Then splining the outside lines...

- creating a new surface with the splined lines, splitting the old reference with the new shape, then splitting again to create the final shape.

- cut holes for straps at the end so they are normal to the general plane, not the actual surface of the brace.

Thicken the brace to the desired thickness, (thicken tool) (use global variable)

- then add sketch on the plane for holes for the straps

- make sure to use parellel to guide lines, then measure to the correct sizing

- slot function makes a slot (go figure)

- Mirror across the center plane, add distance between them, and measure to your 0,0 point on the brace (center of malleolus)

Now we do this for the whole of the lateral side.

References:

Medial side (old files):
https://uwdi.onshape.com/documents/d842e32c8a8c6c73f37f54ac/w/74a569d0a6ae0967e46dc83d/e/92fad2bb738373d297a1dd9f?renderMode=0&uiState=67bdf730642f0d13676505a0

Lateral side (in progress):
https://cad.onshape.com/documents/1d9e263e890686ab4dbca9f0/w/a9155ecf293c39f0a99fbfd5/e/f656b1c2d6d10c64f90166e8?renderMode=0&uiState=68f112a1d197d7473d1e9536

Conclusions/action items:

We will be creating the lateral side of the brace from Jesse's instructions in the medial side. The process is easy enough, just might take some serious fiddling around with. We spent an hour and a half measuring and creating the medial side, and we want the lateral side to be just as good, so that will be a work in progress. Seeing as the red brace from last semester didn't break and only caused mild discomfort, we will be working off of that brace to create the new file. I asked around to see if Presley / last years team had the files on hand, so we will see if I can get those files, and if we can edit those lightly we will.

12/10/2025 - Final Expense Table

Aditi Singhdeo (singhdeo@wisc.edu) - Dec 07, 2025, 5:48 PM CST

Item	Description	Manufacturer	Vendor	Date	QTY	Cost Each	Total	Link
Category 1 - Rigid Support								
CF-PLA	3D printing for testing	Design Innovation Lab	Makerspace	10/27/2025	2	$2.25	$4.50	***covered by our given $50 per team**
CF-PLA	3D printed for testing of mediolateral support	Design Innovation Lab	Makerspace	10/27/2025	2	$2.25	$4.50	***covered by our given $50 per team**
CF-PLA	3D printing for final product	Design Innovation Lab	Makerspace	11/17/2025	1	$1.90	$1.90	***covered by our given $50 per team**
CF-PLA	3D printing for final product	Design Innovation Lab	Makerspace	11/17/2025	1	$2.18	$2.18	***covered by our given $50 per team**
CF-PLA	3D printing to send to client	Design Innovation Lab	Makerspace	11/19/2025	1	$2.17	$2.17	***covered by our given $50 per team**
CF-PLA	3D printing to send to client	Design Innovation Lab	Makerspace	11/19/2025	1	$2.50	$2.50	***covered by our given $50 per team**
Category 2 - Straps and Padding								
Elastic Strap	1 inch wide Polyester and Rubber blend. 10 yd in length	Cisone	Amazon	10/10/2025	1	$7.99	$7.99	link
TPU	TPU Test Strip for testing apparatus	Makerspace	Makerspace	10/22/2025	1	$0.39	$0.39	***covered by our given $50 per team**
Padding	Air Sponge Mesh Fabric	Tong Gu	Amazon	10/24/2025	1	$16.99	$16.99	link
Superglue	Superglue for fabrication	Makerspace	Makerspace	11/4/2025	1	$1.15	$1.15	***covered by our given $50 per team**
Superglue	Superglue for fabrication	Makerspace	Makerspace	11/5/2025	1	$1.15	$1.15	***covered by our given $50 per team**
Nylon Fabric	Fabric used for straps and padding	Xtreme Sight Line	Amazon	11/20/2025	1	$0.00	$0.00	**link *provided by previous semesters**
Velcro	Velcro pieces	Myuren	Amazon	11/20/2024	1	$0.00	$0.00	**link *found in makerspace**
						TOTAL:	**$45.42**	

11/04/25 Fabrication: Lateral Side

Alex Conover - Nov 05, 2025, 12:40 PM CST

Title: Lateral Side Fabrication

Date: 11/4/2025

Content by: Avery Lyons

Members Present: Claire, Avery, Sean, Aditi

Goals: The goal is to document how the lateral side was fabricated.

Content:

- 1. Two strips of 1x12x1/32 inch TPU fabric were hand-sewn together at the ends
- 2. Lateral side of brace was 3D-printed with carbon-fiber enforced PLA
- 3. 2 square cutouts of padding were made to fit the printed lateral side
- 4. The edges of the cutouts were trimmed to directly fit the printed lateral side.
- 5. The two pieces of padding were pinned together.
- 6. With help from a MakerSpace attendant in the sewing area, the two pieces were sewn together at the edges using a sewing machine.
- 7. Superglue was used to glue the finished padding to the printed lateral side.

Conclusions/action items:

The MakerSpace did not print the Medial side, so this process will be repeated again for that side. The TPU straps will be threaded through the holes to bring the two sides of the brace together.

11/19/2025 - Final Fabrication Notes

Alex Conover - Nov 24, 2025, 10:31 AM CST

Title: Final Fabrication Notes

Date: 11/19/2025

Content by: Alex Conover

Present: N/A

Goals: Detail the fabrication process of our prototype

Content:

To fabricate the final iteration of the prototype, the first step was to 3D print the medial and lateral portions of the brace, which were prepared by Sean. The old prototype was updated to increase the height on the superior end of both sides, so the strap across the superior ventral side of the brace is not at an angle. The new model also includes another slit for a secondary strap on the ventral side, removing the strap on the inferior side, as the slippage of the brace caused this strap to be irrelevant. The brace is printed from PLA that has a 50% in-fill with carbon fiber.

After the medial and lateral sides were printed, the next step was to add the mesh padding. The mesh padding eliminates discomfort from any of the edges rubbing against the malleolus or navicular bones. There are 2 layers of mesh padding that are sewn together with a sewing machine around the edges; the padding sits just around the edges of the printed part to prevent the edges of the part from rubbing into the rest of the foot and ankle.

Once the padding is sewn together, super glue is used to glue the mesh fabric to the PLA part. Once the medial and lateral sides have been glued, an exacto knife is used to cut the slits into the mesh padding through the slits printed on the sides. Once the cuts have been made, the straps can then be cut. The straps of the ventral side are fixed and are not able to be adjusted. This is to make sure the brace stays in place without moving and causing discomfort. The back straps measure 1 in in width, and were measured using the cast to give the closest fit possible to the patient. The straps are made of ballistic nylon.

The change of this design compared to the old design is the addition of the front adjustable strap. There were 2 slits cut in the dorsal side of the malleolus and tibia bone holes, creating space for the new strap. The strap is sewn onto the lateral side, and then threaded through the medial side, to then reconnect with the lateral side via velcro, allowing for the brace to be adjustable as well as to be taken on and off. The Velcro was sourced from the Grainger design lab, and has a strong adhesive to connect it to the strap on the lateral side.

Once secured, the final dorsiflexion element was added, the elastic polyester strap. Using the cast, the strap was created to be the right length. There are 2 layers of polyester sewn together across the grain in multiple directions to reduce the elasticity and provide the most support possible. That was sewn to the slits on the top of the brace, creating a static hold on the foot to provide adequate support for dorsiflexion.

The result is a fully functioning prototype, ready to send to the client and patient. The brace will be duplicated in the following week to provide the team with a physical prototype to present in the poster presentation.

Conclusions/action items:

The team will fabricate another prototype before Thanksgiving, leading to the least amount of work to do after Thanksgiving. Over, this prototype works, and is a well put together final product which we will be submitting for a patent!

Alex Conover - Nov 24, 2025, 10:09 AM CST

Download

IMG_3949.jpeg (4.28 MB)

Alex Conover - Nov 24, 2025, 10:09 AM CST

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IMG_3948.jpeg (4.06 MB)

Alex Conover - Nov 24, 2025, 10:09 AM CST

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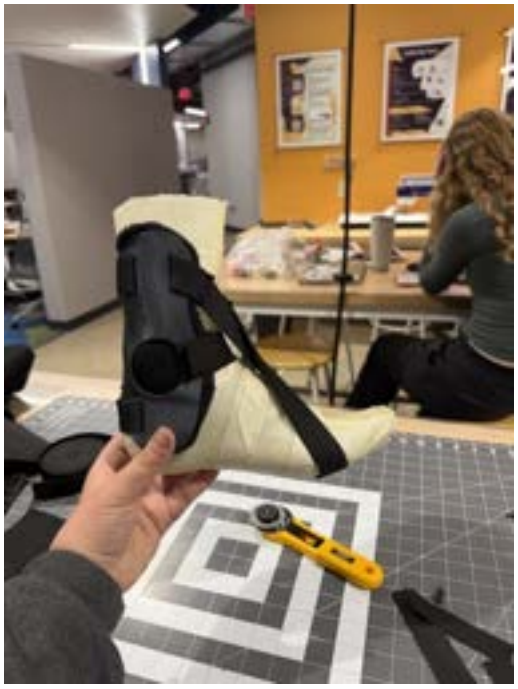
IMG_3947.jpeg (3.79 MB)

Alex Conover - Nov 24, 2025, 10:09 AM CST



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09/24/2025 - FEA Testing

Alex Conover - Sep 24, 2025, 12:51 PM CDT

Title: FEA (solidworks) Testing

Date: 9/24/2025

Content by: Alex Conover, Spring 2025 AFO Team

Present: N/A

Goals: Uploading the testing protocol for future reference, since we will have to test our improved model in solidworks.

Content:

Materials:

- SolidWorks downloaded

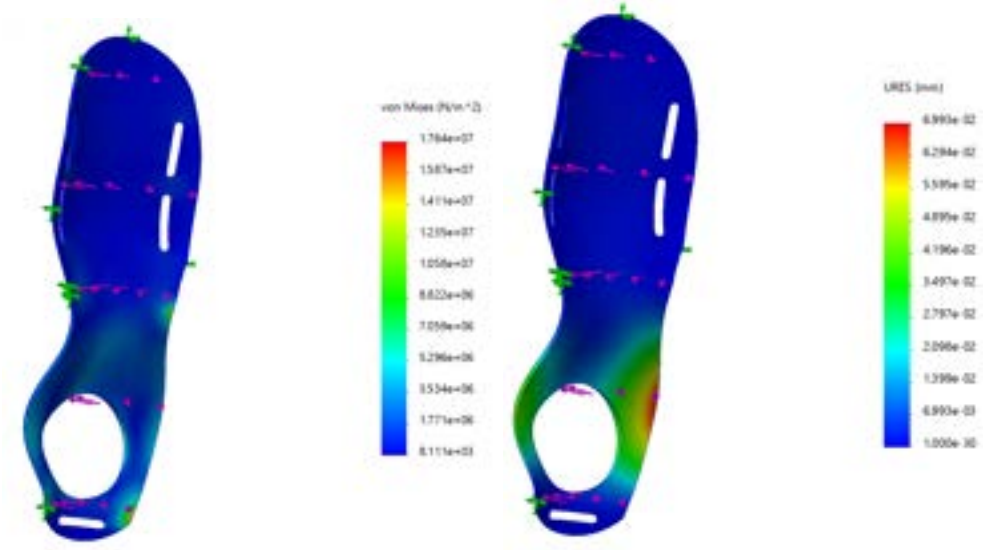
Protocol:

1. Open SolidWorks
2. Under “Open File”, choose to open your rigid support part
3. If not done already, enable the FEA add-in
    a. Click Tools → Add-Ins
    b. In the add-ins window, enable the SOLIDWORKS Simulation by clicking on the left checkbox
4. Select the Simulation Xpress
5. Set the default units to meters and specify the folder you’d like to save the results to
6. Click the “Next” button
7. Select “Add/Edit Fixture” on the right tab
8. Select the surface (s) of your part you would like to fix
    a. To represent ankle inversion, fix the top and bottom of the rigid support
9. Select “Next”
10. Select “Add/Edit Forces”
11. Add a force of 266 N pointing towards the concave side of the brace:

12. Select “Next”
13. Click “Material”
14. Because SolidWorks does not have CF-PLA, you will need to customize your own material

a. Based on literature searches and known material properties, enter in the following values to recreate a CF-PLA substrate

15. Select “Next”
16. Click “Run Simulation”
17. If the piece deforms how you would expect under ankle inversion, approve of the movement by clicking on “The parts deforms as expected”
18. The simulation will run and output its stress and displacement results like shown below:



Results:

- The results will show critical areas where the factor of safety is less than a specific value
- Shows stress distribution in the model
- Shows resultant displacement distribution
- Shows deformed shape of the model
- Generates a report

Conclusions/action items:

We will have to conduct our own FEA testing after the new model is made, and this is a great resource to reference.

Download

FEA_Testing_Protocol.pdf (489 kB)

09/24/2025 - Force Plate Testing Protocol

Alex Conover - Sep 24, 2025, 12:53 PM CDT

Title: Force Plate Testing Protocol

Date: 9/24/2025

Content by: Alex Conover, Spring 2025 AFO Team

Present: N/A

Goals: Upload and understand the Force plate testing protocol.

Content:

Recording Data with the Force Plates:

a. Pre-Test Measurements

i. Measure the subject's foot length in centimeters.

b. Power on the amplifier boxes for each force plate you intend to use (**Figure 1a**)

Figure 1. A.) Amplifier boxes for the in-ground force plates. The blue arrow indicates where the power switch is. **B.)** Bertec Acquire 4 software for data collection of force plate data.

c. Log in to the motion capture control computer using your CAE login

d. Open the Bertec Acquire 4 Software (**Figure 1b**)

e. Allow the software several minutes to identify the force plates. Ensure the force plates and all channels are selected (figure 8)

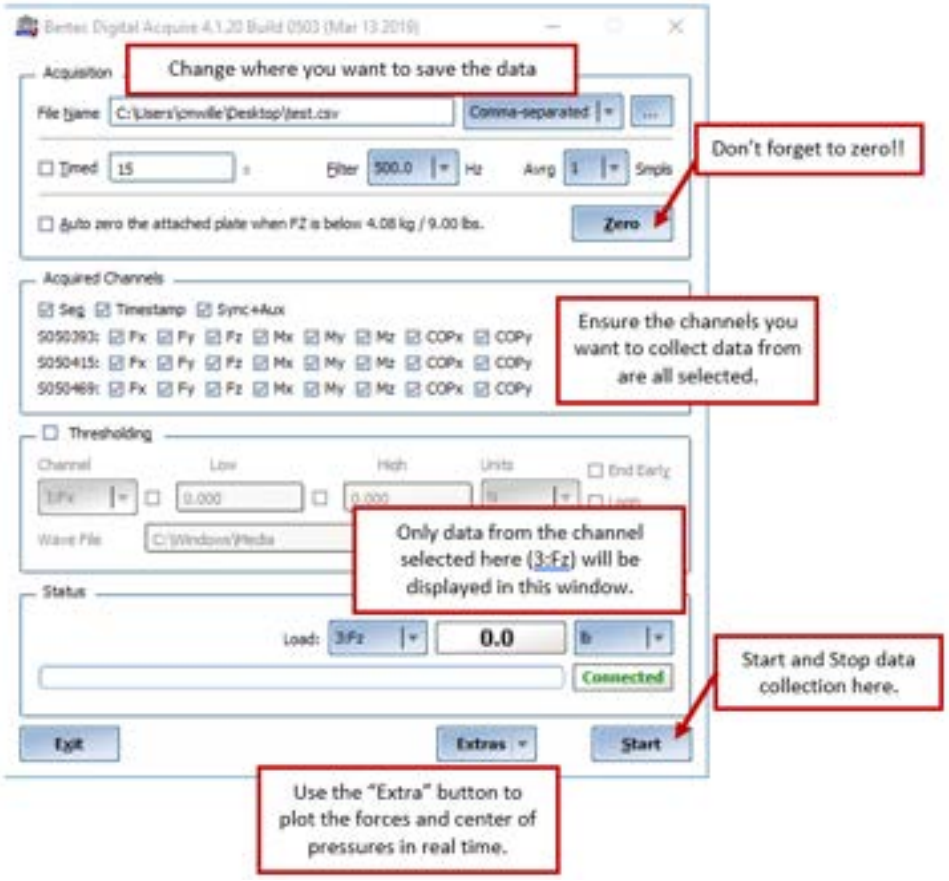


Figure 8. Annotated user interface for Bertec Acquire 4.

f. In the Acquisition box in **Figure 8**, select the time box and input 30 seconds. This ensures each text runs for exactly 30 seconds.
g. Zero the force plates (**Figure 8**)
h. Ensure the data is saved in the desired location:
    i. Under acquisition, rename each test with a descriptive title for each trial (see below), making sure it is a .csv file
i. Follow the instructions for trial 1
j. Press start to begin recording
k. The test will automatically end after 30 seconds
l. Data will be saved in a .csv file format, and output data will be in Newtons and meters
m. Repeat steps 1, j, k, and l for each trial listed below

TRIALS

1. One footed stance – eyes open – no brace (OFEONB)
    a. Zero the force plates
    b. Place your right foot in the center of the force plate **without the brace** on and keep your **eyes open**
    c. Stand on the force plate for thirty seconds without placing their left foot on the plate
2. One footed stance – eyes open – with RED brace (OFEORED)
    a. Zero the force plates
    b. Place your right foot in the center of the force plate **with the brace** on and keep your **eyes open**

    c. Stand on the force plate for thirty seconds without placing their left foot on the plate
3. One footed stance – eyes open – with **BLACK** brace (OFEOBLACK)
    a. Zero the force plates
    b. Place your right foot in the center of the force plate **with the brace** on and keep your **eyes open**
    c. Stand on the force plate for thirty seconds without placing their left foot on the plate
4. One footed stance – eyes closed – no brace (OFECNB)
    a. Zero the force plates
    b. Place your right foot in the center of the force plate **without the brace** on and keep your **eyes closed**
    c. Stand on the force plate for thirty seconds without placing their left foot on the plate
5. One footed stance – eyes closed – with RED brace (OFECRED)
    a. Zero the force plates
    b. Place your right foot in the center of the force plate **with the brace** on and keep your **eyes closed**
    c. Stand on the force plate for thirty seconds without placing their left foot on the plate
6. One footed stance – eyes closed – with **BLACK** brace (OFECBLACK)
    a. Zero the force plates
    b. Place your right foot in the center of the force plate **with the brace** on and keep your **eyes closed**
    c. Stand on the force plate for thirty seconds without placing their left foot on the plate
7. One footed stance – eyes open – with wedge – no brace (WEDGEEONB)
    a. Place your 10 degree wedge on the marked tape section of the force plate
    b. Zero the force plates
    c. Place your right foot **without the brace** onto the wedge
    d. Place your left foot on the force plate adjacent to the wedge in the marked foot zone
    e. Stand in this position for 30 seconds
8. One footed stance – eyes open – with wedge – with red brace (WEDGERED)
    a. Place your 10 degree wedge on the marked tape section of the force plate
    b. Zero the force plates
    c. Place your right foot **with the brace** onto the wedge
    d. Place your left foot on the force plate adjacent to the wedge in the marked foot zone
    e. Stand in this position for 30 seconds
9. One footed stance – eyes open – with wedge – with **BLACK** brace (WEDGEBLACK)
    a. Place your 10 degree wedge on the marked tape section of the force plate
    b. Zero the force plates
    c. Place your right foot **with the brace** onto the wedge
    d. Place your left foot on the force plate adjacent to the wedge in the marked foot zone
    e. Stand in this position for 30 seconds

***Sadie is one the farthest plate away
Black trials of kate's is actually red (for the no wedge data) → wedge data back to normal
Wedge_name refers to the wedge with no brace

**This was done for the previous prototypes; we will complete this testing with a new prototype.

Conclusions/action items:

We will complete our new prototypes after they have been completed.

Download

Force_Plate_Protocol.pdf (455 kB)

10/19/2025 - MTS Testing Information

AVERY LYONS - Oct 19, 2025, 12:07 PM CDT

Download

1002_Universal_Testing_System_-_MTS.pdf (1.3 MB)

Alex Conover - Oct 19, 2025, 12:07 PM CDT

Download

Lab_12__Mechanical_Testing.pdf (5.98 MB)

Claire Matthai - Oct 29, 2025, 11:53 PM CDT

Tensile Testing Procedure

(Notes from meeting with Dr. Willie)

Setup:

- “Favorites” → “Custom templates” → 315 tension
- “File” → “Save as”
- Name the test

System Overview:

- You need to input your own variables for the test protocol
- Monitor tab (keep in this when collecting data), Review tab (shows data)
- Set everything to zero and hit “go”
- For test rate, it is recommended we mimic a walking scenario
- Right click “now” and “export raw data”
- Make a new folder and save it to your folder, before you leave drop that file in your google drive

Machine:

- Place strip really snug in the vice grips (important to make this as tight as possible so we aren’t getting slippage that ruins data)
- Material failure happens when there is any breakage
- After you’re done, shut it down with button on the right side

11/04/2025 - Itinerary for Testing

Alex Conover - Dec 09, 2025, 4:48 PM CST

Title: Testing Itinerary for Debbie

Date: 11/04/2025

Content by: Alex Conover

Present: Team

Goals: Upload itinerary for testing with the client 11/08 and 11/10

Content:

See attached document for testing itinerary and extra details about testing.

Conclusions/action items:

Conduct testing the weekend of 11/08, and 11/10!

Alex Conover - Dec 09, 2025, 4:48 PM CST

Team AFO - Testing Weekend!

Parking on Saturday, November 8th (Gameday, Illinois vs Wisconsin)

Download

Itinerary_for_Client_Meeting.pdf (10.3 MB)

10/26/2025 - Experiment 1 Data

Alex Conover - Oct 26, 2025, 12:20 PM CDT

Title: Experiment 1 Data - Patient 1 Data

Date: 10/26/2025

Content by: Alex Conover

Present: Alex Conover, Rayona Kinny (315 partner)

Goals: Read and understand the data for a "healthy" patient.

Content:

This is going to be the same procedure that is done for our patient for our project. This is the data collected from Lab 1 of BME 315, which includes a stabilogram, gait analysis, balance tests, and cop analysis.

Conclusions/action items:

The team will use this data from Patient 1 (Alex) and utilise one more of the team members' data, to have a baseline for healthy data. Our patient for the project we will be studying the differences between the left and right legs. A protocol will be written up to follow for exactly what procedures we want to follow.

Alex Conover - Oct 26, 2025, 12:15 PM CDT

BME 315 Lab Report 1

Human Postural Balance and Jumping: Force Analysis

[76 points]

A. Postural Balance

Download

BME_315_Lab1__report.pdf (568 kB)

10/28/2025 - MTS Testing - Tensile Test

Alex Conover - Oct 28, 2025, 10:37 PM CDT

Title: MTS Testing - Tensile Test

Date: 10/28/2025

Content by: Alex, Claire

Present: Alex, Avery, Claire

Goals: Conduct MTS Testing - the Tensile Test.

Content:

Claire's notes about Set up:

Overall, the testing did not go well. All 3 tests that we did failed to stay in the clamps of the machine, leading us to have inconclusive results for the strength of these materials.

We ran the test, a standard tensile test, at 880 m/s, which is about an average slow walking rate. We're just trying to figure out how much force the materials could resist.

Upon physical examination, all materials looked relatively unscathed after the testing was completed, meaning we could at least apply high forces without instantaneous plastic deformation.

Conclusions/action items:

Testing results are inconclusive, and we will need to perform another test for tensile testing and compression testing. For compression testing, we need to print a spherical sample to press so that way the testing results aren't skewed. The material we printed for the brace we can hypothetically test in a 3-point bending test, upon the spot that broke last time. Future work will include repeating these tests for accurate results, and completing the rest of the tests.

2025/11/08 - Testing with Patient

Claire Matthai - Nov 10, 2025, 11:34 AM CST

Title: Patient Testing

Date: 11/08/2025

Content by: Aditi

Present: Avery, Sean, Debbie and the patient

Goals: Carry out force plate testing and receive feedback on the current AFO.

Content:

- Velcro kept detaching in the red AFO - make sure the velcro is sticky and the velcro section is long enough so straps can be tightened as needed
- Strap that clips to the back is long
- The hard shell of the AFO is touching the ground
- The TPU strap is gonna slip right off - we should stick to using the polyester
- The elastic strap slips back when patient puts the shoe on
- The AFO kept tipping forward - this got better when the AFO was worn with shoes
- The tape is where things need to be cut
- The is less/no digging and discomfort
    - Final design improvement: Make the padding overall larger and then wrap it around the edges of the hard shell
- Get fabric measuring tape to measure the diameter of her foot
- 23 cm - medial to lateral malleolus through the bottom of the foot
- Patient would be fine/prefer having a strap over the top of the foot near the toes to stop the strap from slipping

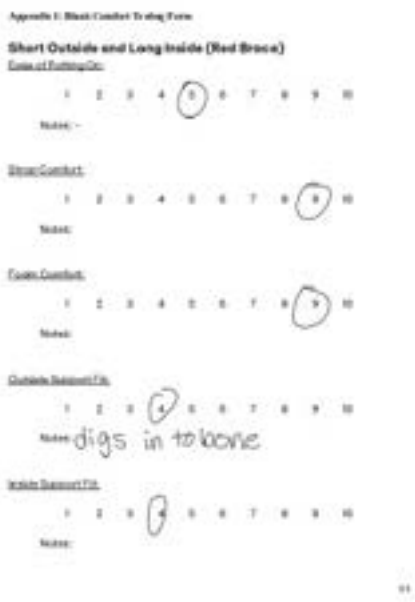




Conclusions/action items:

Use the measurements taken from today's testing to modify the prototype. Get a fabric measuring tape for Monday's testing. Use polyester for the elastic instead of the TPU.

Sean CAREY - Nov 08, 2025, 5:48 PM CST


Short Outside and Long Inside (Red Brace)
digs in to knee

Download

11-8_Comfort_Testing_Form.pdf (6.41 MB)

2025/11/10 - Testing with Patient (Day 2)

Claire Matthai - Nov 14, 2025, 12:38 PM CST

Title: Patient Testing Day 2

Date: 11/10/2025

Content by: Claire

Present: Celia, Alex, patient and Debbie

Goals: Repeat force plate testing using the adjusted prototype and receive feedback.

Content:

General Notes:

- Patient is not experiencing as much medial/lateral instability as reported in previous semesters
- Debbie suggested using **dycem grip** to help with slippage of the polyester strap

Brace Fit:

- There is some digging on the top part of the inversion plate on the medial side of the foot --- this is the only area the patient reports feeling discomfort
- Keeping the brace high enough is a priority
    - In the current design the top of the brace is being pulled down and forward by the polyester strap
- When we used painter's tape (see image below) it held the brace exactly in the place where we want it to be

Testing and Wear Feedback:

- Force place testing was performed with the black brace and painter’s tape in place
- Patient feels a big difference while wearing the shoe, which is how she intends to wear it most of the time
- Patient said she might feel a little bit of slippage of the polyester strap but overall, not too noticeable
- After taking the shoe off, we saw that the polyester strap had not moved at all

Design Ideas:

- Consider adding a PLA strap in the back near the heel to hold the two pieces together and prevent forward slippage

Patient also completed another comfort testing form (see below).

Conclusions/action items:

Analyze the data we gathered from the force plate testing and figure out a way to add in straps to the back of the brace.

Claire Matthai - Nov 10, 2025, 11:33 AM CST

Download

IMG_7190.jpg (2.15 MB) Measurement of foot drop angle with TPU straps

Claire Matthai - Nov 10, 2025, 11:31 AM CST

Download

IMG_7188.jpg (3.34 MB)

Claire Matthai - Nov 10, 2025, 11:33 AM CST

Download

IMG_7187.jpg (3.09 MB) Measurement of foot drop angle without brace

Claire Matthai - Nov 10, 2025, 11:32 AM CST

Download

IMG_7184.jpg (2.36 MB) Black brace with painter's tape

Claire Matthai - Nov 21, 2025, 1:16 PM CST

Short Outside and Long Inside (Red Brace)

Download

Comfort_test_11-10.pdf (171 kB)

11/16/2025 - Testing Analysis

Alex Conover - Dec 09, 2025, 4:14 PM CST

Title: Testing Analysis

Date: 11/16/2025

Content by: Alex Conover

Present: Team Present for Testing, Document by Alex Conover

Goals: Analyze the testing data we received 11/8 and 11/10

Content:

The testing data we received was fairly decent. More trials would be beneficial to achieve a consistent and significant result from the test values. Attached is the results of testing.

Conclusions/action items:

Continue updating the rest of lab archives.

Alex Conover - Dec 09, 2025, 4:15 PM CST

Testing Analysis: Stability and Gait

1. Prototypes

Download

25.pdf (4.02 MB)

09/17/2025 - PDS First Draft

Alex Conover - Sep 17, 2025, 7:09 PM CDT

Title: PDS First Draft

Date: 9/17/2025

Content by: Alex Conover

Present: Whole team present to create the PDS.

Goals: Upload the first iteration of the PDS.

Content:

The first draft of the PDS has been uploaded as an attachment to this entry. We adapted the PDS from the previous semester, as the project is the same, but the materials and design ideas are different. See attached file for full PDS.

Conclusions/action items:

Be sure to fill out the progress report for tomorrow, and upload the PDS after instructor feedback. Work on the preliminary presentation, and create the design matrix. We also have to create refined versions of the other designs for the matrix.

Alex Conover - Sep 17, 2025, 7:31 PM CDT

Download

1st_Draft_Product_Design_Specifications_-_AFO_for_Teen_1_.pdf (367 kB)

09/24/2025 - Prototype Design Matrix 1

Alex Conover - Sep 24, 2025, 12:56 PM CDT

Title: Prototype Design Matrix (1)

Date: 9/24/2025

Content by: Alex Conover

Present: Team

Goals: Upload the design matrix for the prototypes.

Content:

The criteria for the design matrix are as follows:

Dorsiflexion Support (20%): Dorsiflexion support is one of the most important aspects of this design. The patient is experiencing foot drop, which is when the foot experiences a constant negative angle from the neutral position, meaning excess dorsiflexion, when the foot is set at a neutral position. The device needs to eliminate the excess dorsiflexion by assisting in plantar flexion, the upward movement of the foot. This part of the support will help maintain proper gait and help reduce excessive heel strike.

Mediolateral Support (20%): Mediolateral support, crucial for any orthosis that aims to lessen the symptoms of FSHD, is the stabilizing force and support from the side-to-side axis of a body or joint. FSHD causes severe weakness in the muscles, leading to foot drop and problems with inversion of the ankle. This support helps maintain proper foot and ankle alignment during the stance and swing phases of gait.

Ease of User Assembly (15%): This criteria is important to consider when designing the AFO because our patient has FSHD, causing weakness in their right arm and a significant loss of function in the left. Therefore, the AFO needs to be easy to assemble to ensure they can use it independently without relying on others. If the device has intricate assembly steps, they will be less likely to use it consistently. By prioritizing ease of user assembly, the AFO is more practical for daily use making it more effective in the long run.

Comfort (15%): Comfort is an important criterion because the orthosis will be worn throughout the day for extended periods of time. The AFO must minimize pressure points, prevent skin irritation, and distribute forces evenly across the foot and ankle. If the device causes pain, rubbing, or excessive heat buildup, the user will be less likely to wear it consistently, therefore reducing its effectiveness. A higher score represents a design that avoids irritation and feels natural to the user.

Durability (10%): Durability is an important aspect of the AFO because it needs to withstand repeated daily use and exposure to different environments. The AFO needs to support the users gait without wearing down too quickly or losing effectiveness over time. A durable AFO reduces the risk of breakage or frequent repairs, which is especially important because breakage during use can put the user at risk of falling and injuring themselves.

Discreteness (10%): The discreteness of the AFO has proven to be an important aspect of the design over the last semester's work due to the age of the patient. The AFO needs to draw no more attention than a regular ankle brace for an ordinary injury would. The patient has demonstrated that they will not wear the brace if it is bulky, highlighting their FSHD. One of the goals of this design is to make it discrete enough that it can be covered with loose pants.

Fabrication Quality (5%): The fabrication quality of the AFO is key to its functionality. If it breaks like in previous years, it is crucial to ensure that there would be no sharp edges that could cause harm to the patient. Additionally, rough edges would need to be sanded and deburred to avoid discomfort during everyday wear. The AFO would also need to withstand many years of wear so that the patient does not need a new one to be fabricated immediately when the project is finished.

Cost (5%): The cost of the AFO is an important factor to consider in the choice of design. The materials chosen should not only perform their own functionality adequately, but also be within the scope of our budget of $100. This budget should account for not only up front costs of fabrication of the AFO, but also any maintenance costs that may be needed for the design to continue to perform sufficiently.

Conclusions/action items:

Using this criterion, we will decide which design will work the best for our upcoming prototype. This document will be uploaded to Labarchives in its completion, as well as the designs being uploaded here. A second design matrix may be necessary to complete the material selection.

Alex Conover - Sep 24, 2025, 2:05 PM CDT

Download

Design_Matrix_Criteria.pdf (405 kB)

10/12/2025 - Preliminary Presentation

Alex Conover - Dec 09, 2025, 3:43 PM CST

Title: Preliminary Presentation

Date: 10/12/2025

Content by: Alex

Present: Team

Goals: Upload the preliminary presentation to lab archives.

Content:

This is the preliminary presentation from 10/12/2025. We performed very well and received good feedback.

Conclusions/action items:

Continue adding things to lab archives, uploading to canvas, and the website.

Alex Conover - Dec 09, 2025, 3:43 PM CST

Download

Fall_2025_-_Prelim_Presentations.pptx (10.1 MB)

12/10/2025 - Final Report

Alex Conover - Dec 09, 2025, 3:28 PM CST

Title: Final Report

Date: 12/10/2025

Content by: Alex Conover

Present: Team

Goals: Upload the final report.

Content:

The final report was completed on December 9th and uploaded right after. This entry serves to hold the massive document attached. Please see attached for the final report.

Conclusions/action items:

Complete uploads to canvas and the website.

Alex Conover - Dec 09, 2025, 3:29 PM CST

Download

AFO_for_Team_Final_Report_-_12_10_2025.pdf (14.4 MB)

12/10/2025 - Final PDS

Alex Conover - Dec 09, 2025, 3:30 PM CST

Title: Final PDS

Date: 12/10/2025

Content by: Alex Conover

Present: Team

Goals: Upload the final PDS.

Content:

Same for this entry as the final report. Attached to this entry is the final PDS for the AFO project.

Conclusions/action items:

Upload everything to lab archives, to canvas, and to the website.

Alex Conover - Dec 09, 2025, 3:30 PM CST

Download

Product_Design_Specifications_-_AFO_for_Teen.pdf (366 kB)

09/11/2025 - FSHD Research

Alex Conover - Sep 11, 2025, 11:29 AM CDT

Title: FSHD Research

Date: 9/11/2025

Content by: Alex Conover

Present: Alex Conover

Goals: Learn as much as we can about FSHD, current treatments for FSHD, and more.

Content:

What is FSHD

- FSHD is a genetic (inherited) form of muscular dystrophy.
- It usually affects muscles of the face, shoulders (around the shoulder blades), and upper arms first: (facio = face, scapulo = shoulder blade, humeral = upper arm).
- Symptoms often begin in adolescence or from age 20 to 30, they can start earlier
- There are two types:
    - **FSHD1** (~95% of cases): caused when the normally inactive DUX4 gene is reactivated, producing a protein that damages muscle cells.
    - **FSHD2**: involves mutations of the gene

Symptoms & Effects

- Early signs include difficulty pursing lips, problems closing eyes completely, weak shoulder muscles, and weakness in upper arms.
- Other muscles may be affected later: lower abdomen, weak or drooping wrists, general fatigue, and sometimes pain.
- Possible complications or side effects:
    - Eye issues
    - High-frequency hearing loss.
    - Abnormal gait (Trendelenburg gait), foot drop
    - Spinal curvature (scoliosis), exaggerated lumbar curve (lordosis)
    - About 20% of people with FSHD need a wheelchair by age 50.

Cause & Inheritance

- Autosomal dominant inheritance: only one copy of the mutated gene (from one parent) is enough to cause the disease.
- There is about a 50% chance of passing it to children.
- In ~30% of cases, there is no prior family history; this may be due to new mutations.

Diagnosis

- Physical exam: look at muscle weakness pattern, family history.
- Blood tests for muscle enzymes (elevated levels of creatine kinase, aldolase)
- Neurologic evaluation: reflexes, coordination, possibly electromyography (EMG) to see electrical activity of muscles.
- Muscle biopsy sometimes used to examine affected tissue under microscope.
- Genetic testing is definitive: tells which type (FSHD1 vs FSHD2), confirms diagnosis.

There is no cure for FSHD so far.

- Treatment is supportive and aimed at maintaining quality of life and function:
    - Physical therapy to preserve muscle strength and flexibility.
    - Orthotic devices: braces/supports for weak muscles (shoulder, abdomen, back), footwear aids to improve walking and reduce risk of falls.
    - Surgery in some cases: e.g.,

Outlook / Prognosis

- Most people with FSHD have a normal life expectancy.
- But the disease is progressive: symptoms may worsen over time, new muscles may be affected.

Living With FSHD

- Practical strategies include:
    - Working with occupational therapists to find ways to maintain independence.
    - Gentle aerobic exercise can help maintain mobility and reduce stress.
    - Using supports/orthotics, adapting the environment to reduce strain or risk of injury.
    - Emotional/social support: connecting with others with FSHD, asking questions, understanding what to expect.

Citations:

[1] “FSHD (Facioscapulohumeral Muscular Dystrophy),” Cleveland Clinic. Available:

https://my.clevelandclinic.org/health/diseases/facioscapulohumeral-muscular-dystrophy-fshd

Conclusions/action items:

There is no cure to FSHD, but many clinical trials exist to ease symptoms, and various mobility aids exist to help with muscle weakness.

09/11/2025 - Ankle and Foot Anatomy Review

Alex Conover - Sep 11, 2025, 11:35 AM CDT

Title: Anatomy of Ankle and Foot Anatomical Review

Date: 9/11/2025

Content by: Alex Conover

Present: Alex Conover

Goals: Review the anatomical structure of the foot.

Content:

The foot and ankle are made up of many bones, joints, ligaments, muscles, tendons, and nerves, all organized into regions and compartments that allow both stability and mobility.

Regions of the Foot:

- Hindfoot: talus and calcaneus
- Midfoot: navicular, cuboid, and three cuneiforms
- Forefoot: metatarsals, phalanges, and sesamoids

Columns:

- Medial column: more mobile (involving talus, navicular, medial cuneiform, first metatarsal, great toe)
- Lateral column: stiffer (calcaneus, cuboid, 4th & 5th metatarsals)

Bones & Joints:

- 28 bones total
- Major mobile joints include ankle, subtalar, talonavicular, and metatarsophalangeal joints
- Other joints have limited movement but contribute to overall foot architecture (e.g. tarsometatarsal, intercuneiform)

Ligaments:

- A number of strong ligaments stabilize the ankle and foot (e.g., ATFL, CFL, deltoid ligament)
- The Lisfranc ligaments stabilize midfoot and support the arch
- The spring ligament supports the talar head

Muscles & Tendons:

- Extrinsic muscles (start in leg, attach in foot) in four compartments: superficial posterior, deep posterior, anterior, lateral

- Intrinsic foot muscles (entirely inside foot), help control toes and stabilize arches
- The plantar fascia also plays a big role in maintaining arch integrity (via the windlass mechanism)

Nerves:

- Major nerve supply comes from tibial, peroneal (deep & superficial), sural, and saphenous nerves
- They control both movement and sensation in different foot/ankle areas
- Some nerve damage can lead to issues like “drop foot” (inability to dorsiflex)

Citation:

“Anatomy Of The Foot Ankle,” OrthoPaedia. Accessed: Sept. 11, 2025. [Online]. Available: https://www.orthopaedia.com/anatomy-of-the-foot-ankle/

Conclusions/action items:

Review of the ankle and foot is complete. This terminology is important for discussing clinical applications and maintaining technical relevance.

09/17/2025 - Standard Research for PDS

Alex Conover - Sep 17, 2025, 7:51 PM CDT

Title: Standard Research for the PDS

Date: 9/17/2025

Content by: Alex Conover

Present: N/A

Goals: Understand what standards we are using for this project.

Content:

FDA Regulations

- **21 CFR § 890.3025 – Limb Orthosis**
  Classifies limb orthoses (including AFOs) as **Class I medical devices** unless they incorporate an electronic component, in which case they may fall under Class II.
- **501(k) Requirements (Premarket Notification)**
  Most Class I devices are exempt from 501(k) submission. However, if the FDA deems it necessary for safety and effectiveness, a 501(k) premarket submission may be required.
- **21 CFR § 890.3475 – Limb Orthosis Definition**
  Defines a limb orthosis as a device worn on the upper or lower limbs to support, correct, prevent deformity, or align body structures. Examples include braces, splints, corrective shoes, and elastic stockings.
- **21 CFR Part 803 – Medical Device Reporting (MDR)**
  Requires manufacturers and device-using facilities to report deaths, serious injuries, or malfunctions that the device caused or contributed to.

ISO Standards

- **ISO 14971:2019 – Risk Management for Medical Devices**
  Provides a framework for identifying, evaluating, and controlling risks through processes like Failure Modes and Effects Analysis (FMEA). Emphasizes both probability and severity of harm.
- **ISO 8549-3:2020 – Prosthetics and Orthotics: Definitions**
  Establishes standardized terminology. Defines “orthosis” as an externally applied device that compensates for structural or functional impairments, and defines AFOs specifically as devices encompassing the ankle and all or part of the foot.
- **ISO 8551:2020 – Functional Deficiencies in Orthotics/Prosthetics**
  Provides clinical guidelines for orthotic treatment, including patient evaluation, treatment objectives, and functional requirements of orthoses.
- **ISO 22675:2016 – Testing of Ankle-Foot Devices**
  Specifies test methods for prosthetic ankle-foot devices and foot units. Simulates repeated loading during gait (heel strike to toe-off) to evaluate durability, strength, and service life.

References:

"CFR - Code of Federal Regulations Title 21." Accessed: Sep. 15, 2025. [Online]. Available: https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm?fr=890.3025

C. for D. and R. Health, "Class I and Class II Device Exemptions," *FDA*, Aug. 2024, Accessed: Sep, 15, 2025. [Online]. Available: https://www.fda.gov/medical-devices/classify-your-medical-device/class-i-and-class-ii-device-exemptions

"CFR - Code of Federal Regulations Title 21." Accessed: Sep. 14, 2025. [Online]. Available: https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm?fr=890.3475

"21 CFR Part 803 -- Medical Device Reporting." Accessed: Sep. 15, 2025. [Online]. Available: https://www.ecfr.gov/current/title-21/part-803

"ISO 14971:2019(en), Medical devices — Application of risk management to medical devices." Accessed: Sep. 14, 2025. [Online]. Available: https://www.iso.org/obp/ui/#iso:std:iso:14971:ed-3:v1:en

"ISO 8549-3:2020(en), Prosthetics and orthotics — Vocabulary — Part 3: Terms relating to orthoses." Accessed: Sep. 16, 2025. [Online]. Available: https://www.iso.org/obp/ui/en/#iso:std:iso:8549:-3:ed-2:v1:en

"ISO 8551:2020(en), Prosthetics and orthotics — Functional deficiencies — Description of the person to be treated with an orthosis, clinical objectives of treatment, and functional requirements of the orthosis." Accessed: Sep. 15, 2025. [Online]. Available: https://www.iso.org/obp/ui/en/#iso:std:iso:8551:ed-2:v1:en

"ISO 22675:2016," ISO. Accessed: Sep. 15, 2025. [Online]. Available: https://www.iso.org/standard/70203.html

"Product Classification." Accessed: Sep. 15, 2025. [Online]. Available: https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfPCD/classification.cfm?id=IQO

Conclusions/action items:

Our device is a class one medical device, and adding electronics would make is a class 2, but we shouldn't end up adding them. These are super important for our PDS, as we have a lot of medical information used with this project and we need to know what standards to follow.

09/24/2025 - Materials Research (TPU vs Fabric)

Alex Conover - Sep 24, 2025, 12:46 PM CDT

Title: Materials Research

Date: 9/24/2025

Content by: Alex Conover

Present: N/A

Goals: Determine whether or not TPU filament or a fabric would be good to include for the dorsilfexion strap. These notes were reviewed and summarized by ChatGPT.

Content:

Technical comparison (practical view for a 1.25″ / 31.75 mm strap carrying 266 N):

- **Printed TPU (reference geometry from your earlier calc)** — to carry 266 N with a conservative printed-TPU tensile capacity (~15 MPa) and a safety factor ≈4 you need on the order of **~2.2 mm thickness** when printed flat and solid. TPU is flexible and abrasion-resistant but shows creep and fatigue under long-term or cyclic loads; it must be printed with filament paths parallel to load to preserve strength. (from your earlier calculation / TPU print guidance).
- **Polyester (PET) woven webbing** — high-tenacity polyester fibers and tight woven constructions produce **very large breaking strengths** (commonly thousands of pounds for 1″ webbing). Typical 1″ polyester webbing examples list breaking strengths in the multiple-kips range (e.g., 1,200–6,600 lb depending on grade), which is orders of magnitude above 266 N (≈60 lbf). Because of that, a thin polyester webbing (~0.07″ ≈ 1.8 mm thick) will easily support 266 N with huge safety margin and low permanent stretch; polyester also resists UV, mildew and abrasion. For practical AFO straps, polyester webbing is therefore an excellent, proven choice.
- **Nylon webbing** — also extremely strong (many 1″ nylon webbings rated thousands of pounds breaking strength). Nylon tends to **stretch more** than polyester under load (can help absorb shocks) but also can absorb moisture and creep differently. For the AFO use case, nylon is mechanically acceptable but may feel bouncier and may change tension with humidity.
- **Acrylic (polyacrylonitrile) fabric / fiber** — bulk acrylic fibers can have relatively high *fiber* tensile strength in technical grades, but acrylic is **not commonly used for heavy-duty woven webbing** and typical acrylic textiles do not perform as well as polyester/nylon for load-bearing straps (more used for apparel and appearance). There are high-tenacity PAN fibers used as precursors for carbon fiber or specialized applications, but ordinary acrylic webbing will typically be a poor / less reliable choice for a primary structural strap under repeated loading. For load-bearing webbing, choose materials sold specifically as high-tenacity polyester or nylon webbing.

Practical implications & recommendations

- If your goal is to support dorsiflexion reliably with minimal thickness and minimal creep, **use commercial polyester webbing (1–2 in wide)** or high-tenacity nylon webbing rather than relying on a thin printed TPU

strap alone. Polyester webbing delivers far higher breaking strength per unit thickness and lower long-term stretch.

- If you prefer the comfort/flexibility of TPU, consider a **hybrid design**: a printed TPU outer layer for comfort/damping with an **embedded or sewn-in polyester webbing** or thin stiffener carrying most of the load. That gives the compliance of TPU with the proven load capacity of textile webbing.
- Always prototype and run static, cyclic (fatigue), and creep tests with the final geometry and anchors; real-world behavior depends on stitching, anchor design, edge radii, and connector hardware (knots, seams, folded ends reduce effective strength).

References:

“Complete Guide to TPU 3D Printing.” Accessed: Sept. 24, 2025. [Online]. Available: https://bigrep.com/posts/tpu-3d-printing/

“Polyester Fiber - an overview | ScienceDirect Topics.” Accessed: Sept. 24, 2025. [Online]. Available: https://www.sciencedirect.com/topics/engineering/polyester-fiber

“How Strong is Nylon Webbing? Understanding Tensile Strength and Using it Safely.” Accessed: Sept. 24, 2025. [Online]. Available: https://www.nationalwebbing.com/nylon-webbing-articles/nylon-webbing/strong-nylon-webbing-tensile-strength-293.html?

“Polyacrylonitrile Fiber - an overview | ScienceDirect Topics.” Accessed: Sept. 24, 2025. [Online]. Available: https://www.sciencedirect.com/topics/materials-science/polyacrylonitrile-fiber

Conclusions/action items:

Polyester may be the material of choice here, as it is creep-resistant, as well as sweat, mold, and abrasion-resistant. It may yield a higher strength result, however, we still want to consider how much flexibility we want with the patient. Since the goal is to hold the foot to about 20-degree angle above parallel, a strong material is needed to get it there in the first place, but the materials should be flexible enough to allow for the flexibility of the foot. Both prototypes could be made, one with TPU filament as the strap, and another with polyester, and then mechanical testing can ensue with both, as well as how well it will work.

09/10/2025 - General AFO creation

Alex Conover - Sep 11, 2025, 11:47 AM CDT

Title: AFO (Competing Design) Research

Date: 9/11/2025

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:

An Ankle-Foot Orthosis (AFO) is a support device for the foot and ankle meant to help mobility while maintaining comfort. There are different types (flexible, rigid, jointed), each with their own uses.

Before prescribing an AFO, clinicians assess both passive (e.g. range of motion, muscle strength, sensation) and active functions (how someone moves, gait pattern, what compensations they use, pain, etc.). They also look at the patient's pathology (cerebral palsy, stroke, neuropathy, trauma, etc.).

Goals for using an AFO include: positioning the foot/ankle in the least painful but functional alignment, supporting structures, preventing contractures, improving mobility, increasing stability, reducing pain, and tailoring to what the person needs.

Design/manufacture can be custom or off-the-shelf. Custom ones involve casting and making models; off-the-shelf ones need to be sized/adjusted. They use a "three-point pressure/force" system to control and correct motion: a main corrective force plus counter-forces above and below.

Specific types:

- **Flexible AFO**: allows some motion, good for drop foot, when ankle/foot are mobile; less good if there's side-to-side instability.
- **Rigid AFO**: no ankle movement; good for more severe deformity, instability; helps control knee alignment via how the ground reaction forces act.
- **Jointed AFO**: has a hinge at the ankle so some motion; can aid in stairs, chairs, but the bulkier parts may wear.

Also important: tuning the AFO in conjunction with proper footwear to optimize gait and reduce risk or side effects.

Citation:

Foundations for Ankle Foot Orthoses. (2022, November 1). Physiopedia, . Retrieved 11:47, September 11, 2025 from https://www.physio-pedia.com/index.php?title=Foundations_for_Ankle_Foot_Orthoses&oldid=319489.

Conclusions/action items:

AFO's are clunky, but useful for supporting the ankle through movement. The patient does not like these bulky AFO's, so we have to manufacture something that is still supportive, but without this clunky aspect, maintaining a slim

(inconspicuous) profile.

09/18/2025 - Competing Designs Overview

Alex Conover - Sep 17, 2025, 7:31 PM CDT

Title: Competing Designs Overview

Date: 9/17/2025

Content by: Alex Conover

Present: N/A

Goals: Dive deeper into the different types of AFO's.

Content:

Competing Designs

Most AFOs rely on the **three-point force system**. This means one main force is applied to correct or limit movement, and two counterforces are placed above and below to balance it out. The idea is to keep the ankle stable, reduce unwanted rotation, and spread pressure so it's not uncomfortable. The longer the brace, the farther apart these forces can be, which usually makes the support more effective.

There are several types of AFOs that apply this principle in different ways:

Rigid AFO
The most basic design, usually made from plastic or composite material. It holds the ankle in a set position, often dorsiflexion, to prevent foot drop. These are reliable and simple, but they don't allow much natural motion.

Passive-Dynamic AFO (PD-AFO)
A lighter, more flexible option. It stores energy during walking and releases it during push-off to help lift the foot. These braces are more comfortable and allow smoother movement, but the level of stiffness can't always be tailored to each patient.

Supramalleolar Orthosis (SMO)
A smaller brace that sits just above the ankle bones. It mainly controls side-to-side movement and keeps the heel in a neutral position. Because it's low-profile, it's easy to wear inside regular shoes, though it doesn't give as much support for foot drop.

Jointed AFO
This version has a hinge at the ankle. It allows a more natural walking pattern and flexibility for things like stairs or squatting. The downside is that it's bulkier, can make noise, and the moving parts are more likely to break.

Variable Stiffness Orthosis (VSO)
A newer, powered design that can adjust stiffness while walking. It has potential to adapt to different activities and levels of weakness, but it's still experimental and not available for everyday use.

Citations:

[1] "What is an SMO and its function?" Accessed: Sept. 18, 2025. [Online]. Available: https://www.infinitetech.org/what-is-an-smo-and-its-function

[2] “Foundations for Ankle Foot Orthoses - Physiopedia.” Accessed: Sept. 18, 2025. [Online]. Available: https://www.physio-pedia.com/Foundations_for_Ankle_Foot_Orthoses

[3] “Variable Stiffness Orthosis – Neurobionics Lab.” Accessed: Sept. 18, 2025. [Online]. Available: https://neurobionics.robotics.umich.edu/research/wearable-robotics/variable-stiffness-orthosis/

Conclusions/action items:

Most of these (if not all) of these AFO's are too bulky for what we are looking for, or don't implement all the options that we want to include in this design. We can learn from the AFO's and decide what materials would be good, or other methods of control within the AFO itself.

09/10/2025 - Final Report Research and Analysis

Alex Conover - Sep 11, 2025, 12:00 AM CDT

Title: Final Report Research and Analysis

Date: 09/10/2025

Content by: Alex Conover

Present: Alex Conover

Goals: Gain a clear understanding of where the project ended last semester. This work was aided by chatGPT to summarize the final report, and ML from our data has been turned off, preventing the model from learning from our data, and protecting the peace for the project. This is something I learned to do at my internship this summer.

Content:

The team designed a custom ankle-foot orthosis (AFO) for a high school student with **Facioscapulohumeral Muscular Dystrophy (FSHD)**. The challenge was to create something that provided the right level of support while staying **discreet enough** to avoid unwanted attention from peers.

Key takeaways from the project:

- **Design choice:** Out of three prototypes, the *"We Support U"* design was selected because it balanced support, comfort, and long-term usability. It used **carbon fiber-reinforced PLA (CF-PLA)** for strength while keeping a slim profile. The design also included **gel padding** for comfort and **elastic straps** for adjustability.
- **Functionality:** The device aimed to prevent foot drop (loss of dorsiflexion) and ankle inversion (rolling inward), both of which increase fall risk in FSHD patients.
- **Testing results:**
    - **Strength testing (MTS):** The rigid supports held up well, with 50% infill proving the strongest. Even at lower infills, all supports met the required load threshold (260 N).
    - **Force plate testing:** Showed trends toward improved balance and stability with the brace, though results weren't statistically significant due to variability in healthy test subjects.
    - **Comfort testing:** The client reported pressure and discomfort on the medial side of the foot and found the current donning system (sleeve + straps) difficult to manage. A lace-up closure was suggested for future versions.
    - **Motion capture testing:** Knee and hip motion were unaffected, meaning the brace didn't interfere with normal gait. However, data on ankle inversion was inconclusive, likely due to errors in the motion capture method.
- **Limitations:** Because the client lives out of state, most testing had to be done on healthy individuals or remotely, which limited precision. Also, the bungee cord mechanism for dorsiflexion didn't provide enough support as the client's condition progressed.

- **Future work:** The next steps would be to integrate the rigid supports and bungee cord into **one cohesive, lace-up brace**, make it easier to wear, and directly test on the client with more reliable motion capture and force plate analysis.

Big picture: The project successfully demonstrated that a **discreet, supportive, and affordable AFO** is possible using 3D-printed CF-PLA and simple fastening systems. While not perfect, the design lays the groundwork for future iterations that could better support FSHD patients and reduce the stigma that comes with visible orthotics.

Conclusions/action items:

Future work sections yield conclusions drawn by the previous team for how they would have liked to keep progressing; however, after speaking with the client, a new direction might be necessary to create the product that would best help the patient. I also need to figure out when we would have access to the testing labs/where/what the testing labs are that do the testing for either the IMU (inertial measurement units), electromagnetic field angles, and gait analysis, and force plate testing. More diving into the previous semester is likely necessary to create the best product and have the best testing equipment necessary.

09/11/2025 - Other information research

Alex Conover - Sep 11, 2025, 12:10 AM CDT

Title: Other Information/Documentation Research in Drive

Date: 09/11/2025

Content by: Alex Conover

Present: Alex Conover

Goals: Find out any other relevant information from the previous year of this project, and update and include information from client meeting 09/10/2025.

Content:

- The side supports broke, meaning either the material was too thin, or not strong enough (or both) to support Maggie's weight.

- A stronger material may need to be fabricated, or the design can be altered to prevent this from happening again.

- Maggie did experience some discomfort from the previous brace, so changes would have to be made in order to create the most comfortable, usable product.

- Lace-up designs were mentioned, both in brief talks with advising (Dr. Williams and I quick talk before BME connections), and in the future work section, ish.

- Further testing should be completed to determine if there is a better material out there. Reaching out to various people to ask about fabrication may be necessary.

Conclusions/action items:

I might need to talk to Dr. Willie, see if she remembers this project and any other things that may go with it, as well as Lizzie. They could be useful resources to push for questions about the project, especially Lizzie, if necessary. Continuation of the research from the prior notebook may be necessary.

09/11/2025 - Notebook Analysis

Alex Conover - Sep 11, 2025, 12:11 AM CDT

Title: Notebook Analysis

Date: 9/11/2025

Content by: Alex Conover

Present: Alex Conover

Goals: Use ChatGPT to analyze the notebook from last semester, picking out details that may have been glossed over in the Google Drive. Improving the model for everyone has been turned off to eliminate the sharing of data from this project to the internet.

Content:

Project Overview

- **Course**: BME 301 – Spring 2025
- **Project Name**: *Inconspicuous Ankle Brace for Teen* (short name: *Rise and Stride*)
- **Client**: **Debbie Eggleston**, physical therapist in Michigan.
- **End User**: **Maggie Eggleston**, 16-year-old sophomore with **Facioscapulohumeral Muscular Dystrophy (FSHD)**.
    - Current orthotics: Carbon fiber AFO (too bulky, rigid) and SMO for ankle control.
    - Pain points: rigidity, rubbing on heel, difficulty putting on, shoe compatibility, slipping on snow, ankle rolling.
    - Wants: brace that looks athletic, slim, discreet, allows flexibility.
    - Possible clinical trial in summer (targeting protein suppression at mRNA level). - *Maggie did not make it into clinical trials*

Key Meetings & Testing Contacts

- **01/29/25 – Advisor Meeting**:
    - Dr. Puccinelli suggested reaching out to **Peter Adamczyk** (BADGER Lab, UW), who works on gait devices.
- **02/03/25 – Client Meeting**:
    - Discussed Maggie’s current orthoses, preferences, and issues.
- **02/12/25 – Advisor Meeting**:
    - Dr. P suggested contacting **Josh Roth** (CAD files) and **Christie Wille**.

    - Warning about legal issues with Boa laces (IP concerns).

- **02/19/25 – Jesse (3D scanning)**:
    - Helped team with foot scanning workflow (Onshape/SolidWorks recommended).
- **03/18/25 – Meeting with Peter Adamczyk**:
    - Suggested **force plate testing**, wedges (5–10°) for ankle moment changes, range of motion focus instead of raw values, and looking at **ankle bot research (Neville Hogan)**.
    - Mentioned difficulties with motion tracking with braces and suggested subtracting offset displacement.
- **04/01/25 – Meeting with Dr. Wille**:
    - Testing framework using **OpenCap** + **force plates**.
    - Target outcomes: decreased ankle inversion (≤25°), improved dorsiflexion, minimized plantarflexion.
    - Suggested transverse stiffness ≥100,000 Nm.
    - Emphasis on sagittal plane data, knee/hip mechanics, balance symmetry.

Major Design/Fabrication Notes

- **Client's cast** was cut in half (01/31/25) → scanned for CAD modeling.
- **Design Matrix (02/13/25)**: Team selected *"We Support U"* design.
    - Material: **Carbon fiber reinforced PLA (CF-PLA)**, possibly fiberglass-coated.
    - Balance of discreetness, support, and comfort.
- **Material research**:
    - CF-PLA: cost $0.05/g (Makerspace). Recyclable with strong mechanical properties.
    - Fiberglass: water-based gel technique improves comfort/accuracy.
    - Thermoplastics: PP vs. PE comparison — PP stiffer, PE more flexible and recyclable.
- **Prototype fabrication**: Began in March with scanning, CAD, and 3D printing. Final prototype completed April 17.

Testing Research & Protocols

- **Gait analysis**: Wearable IMUs (practical for clinical testing), motion capture options (OptiTrack vs. Optotrak Certus).
- **Force testing**: Minimum required medial force support ~26–53 N (based on Maggie's weight).
- **OpenSim modeling**: Used to estimate brace stiffness requirements.

- **Comfort testing**: Protocols included balance on force plates, eyes open/closed, wedges, brace vs. no brace comparisons.
- **Motion capture**: Dot placement challenges for ankle inversion measurement.
- **Client testing plan**: Prototype to be sent mid-semester for at-home OpenCap testing.

Global & Social Impact Notes

- Children with visible disabilities are ~2x more likely to be bullied (study cited). Relevance: Maggie wants brace to blend in.
- 3D-printing AFOs improves **sustainability and cost** vs. traditional plaster/fiberglass methods.
- Recycling CF-PLA feasible: maintains or improves strength after remanufacture.

Key Takeaways

- **Core Problem**: Maggie’s current braces are bulky, rigid, uncomfortable, and socially stigmatizing.
- **Design Path**: Custom 3D-printed CF-PLA brace (*We Support U*) with athletic-brace aesthetics.
- **Testing Support**: UW resources (OptiTrack, force plates, BADGER Lab), external advisors (Adamczyk, Wille, Jesse).

Conclusions/action items:

Many people were consulted for completing this project last semester, and we would be wise to reach out again. Honestly, the team needs to get together and brainstorm new ideas for the project, as we just need to get into building and creating at this point.

09/14/2025 - Design Idea

Alex Conover - Sep 14, 2025, 8:59 PM CDT

Title: Design Idea

Date: 9/14/2025

Content by: Alex Conover

Present: Alex Conover

Goals: Rehash the design idea that I came up with during our team meeting.

Content:

The new design idea will be to implement another strap within the existing straps and solidify the existing design.

- The medial and lateral design needs 2 major changes:

- Make the overall design more comfortable for the patient
- Create more stability at the weak point of the brace
    - double-check where and what side the breakage occurred on.

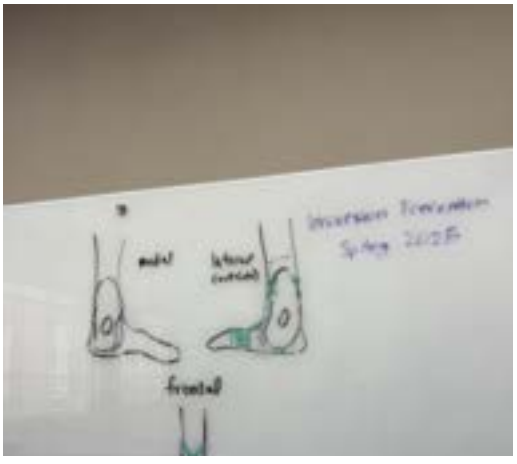
- The upgraded design:

- thicken the strap holes on the upper front side to add a stretchy dorsiflexion element
    - research to commence about what material would be best to use (stretchy PLA, fabric, etc - design matrix likely to come)
- Will combine elements from both previous semesters to bring good dorsiflexion to the foot
    - this is in the form of a strap around the middle aspect of the foot/arch. Design testing will have to commence to ensure the design doesn't slip from optimal position.
- Keeping the inversion prevention device with the same material (50% carbon fiber-filled PLA)

Conclusions/action items:

Design the final updated version of this brace, either with CAD or a drawing. Converse with various resources to ask about testing and printing of the prototype.

Alex Conover - Sep 14, 2025, 8:49 PM CDT



Download

F6901D2E-67B8-43D2-AF07-E0801B31EF76_1_105_c.jpeg (128 kB)

09/24/2025 - Design #2 Sketch

Alex Conover - Sep 24, 2025, 12:29 PM CDT

Title: Sketch of Design #2 of our Design Matrix

Date: 9/24/2025

Content by: Alex Conover

Present: N/A

Goals: Upload the design drawing.

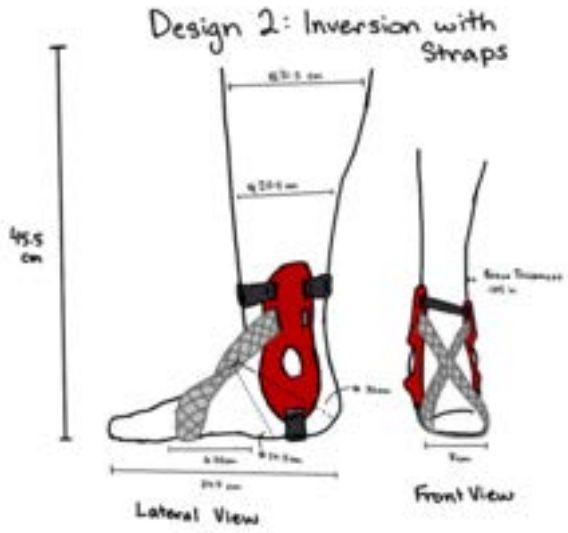
Content:

See attached drawing.

Conclusions/action items:

Some of the exact measurements will be specified in the final design idea, as well as our PDS. Material research is still ongoing, but TPU filament is looking likely. Progress Report will be updated today, and the design matrix will be completed and added to the doc.

Alex Conover - Sep 24, 2025, 12:29 PM CDT



Download

IMG_1496.png (160 kB)

09/30/2025 - All safety documentation

Alex Conover - Sep 30, 2025, 10:17 PM CDT

Title: All Safety Documentation

Date: 9/30/2025

Content by: Alex Conover

Present: N/A

Goals: Upload all safety training from the prior year.

Content:

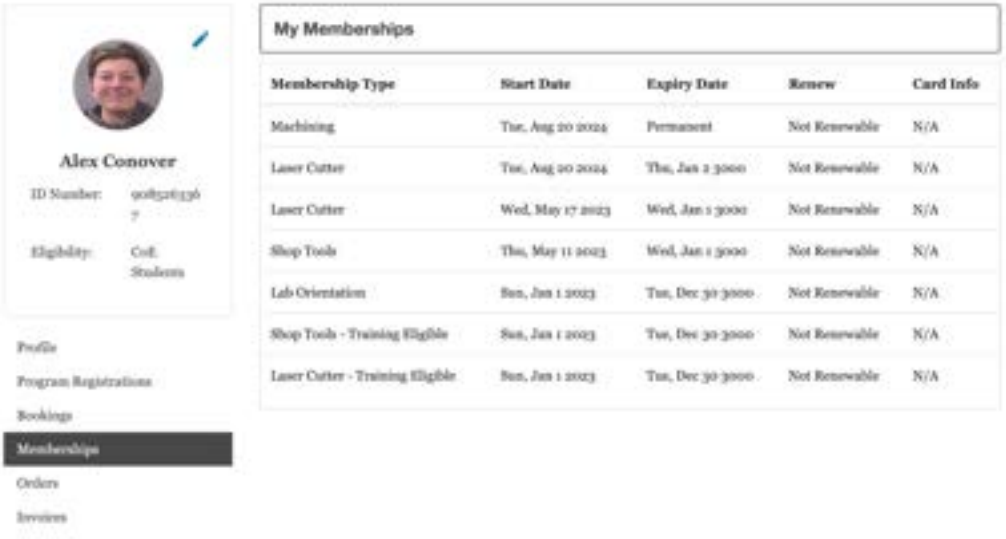
Biosafety Training completion:

Biosafety Required Training Quiz 2024 Assignments	Jan 18 at 11:14am	24 / 25	
Assignments		96%	24.00 / 25.00
Imported Assignments		N/A	0.00 / 0.00
Total		96%	24.00 / 25.00

Chemical Safety Training completion:

Name	Due	Submitted	Status	Score	
Final Quiz Assignments		Jan 18 at 11:06am		20 / 20	
Required Self-Check 1 Assignments		Jan 18 at 10:47am		4 / 4	
Required Self-Check 2 Assignments		Jan 18 at 10:52am		14 / 15	
Required Self-Check 3 Assignments		Jan 18 at 10:58am		10 / 10	
Required Self-Check 4 Assignments		Jan 18 at 11am		6 / 6	
Required Self-Check 5 Assignments		Jan 18 at 11:02am		4 / 4	
Assignments				98.31%	58.00 / 59.00
Total				98.31%	58.00 / 59.00

Lab Training:



Conclusions/action items:

This training was completed prior to this semester and is uploaded for the sake of having documentation of it. A second training will be uploaded for HIPPAA certification.

09/30/2025 - HIPPAA Training

Alex Conover - Sep 30, 2025, 10:19 PM CDT

Title: HIPPAA Training

Date: 9/5/2025

Content by: Alex Conover

Present: N/A

Goals: Upload the HIPAA certification.

Content:

WISCONSIN
UNIVERSITY OF WISCONSIN-MADISON

This certifies that Alex Conover has completed training for the following course(s):

Course	Assignment	Completion	Expiration
2024-2025 HIPAA Privacy & Security Training	2024-2025 HIPAA Privacy & Security Training	1/18/2025	
Biosafety Required Training	Biosafety Required Training Quiz 2024	1/18/2025	1/18/2030
Chemical Safety: The OSHA Lab Standard	Final Quiz	1/18/2025	

Data Last Imported: 01/21/2025 12:15 PM

Conclusions/action items:

Because we are working with a client and patient with confidentiality, we have to undergo the hipaa training to certify that we are maintaining patient confidentiality.

10/13/2025 - CITI Training

Alex Conover - Oct 13, 2025, 3:01 PM CDT

Title: CITI Training

Date: 10/13/2025

Content by: Alex Conover

Present: N/A

Goals: Complete the required CITI training

Content:

Course Completion for Alex Conover

Congratulations on your recent course completion!

Name:	**Alex Conover** (ID: 13972938)
Institution:	**University of Wisconsin - Madison** (ID: 1160)
Course:	**UW Human Subjects Protections Course**
Stage:	**1 - Level 1**
Completion Date:	**13 Oct 2025**
Expiration Date:	**13 Oct 2028**
Completion Record ID:	**72937755**

To view or share the **Completion Report** for this course, use the following link:

citiprogram.org/verify/?k1839aba8-e7c8-4e23-89bb-b712cc263472-72937755

Note that this link will share the full two-part report, which includes all quiz scores.

To view or share the **Completion Certificate** for this course, use the following link:

citiprogram.org/verify/?wa0430251-58eb-4a1c-8b9a-433b88c234fb-72937755

Note that this link will share only the certificate, which does not include quiz scores.

These links are permanent, and may be used to access or share the Completion Report and Completion Certificate at any time. It is not necessary to log in to the CITI Program site to view these links.

We suggest you retain this email for your records.

CITI program completion for the 2025 school year.

Alex Conover - Oct 13, 2025, 3:01 PM CDT

Download

CITI-completion.pdf (78.6 kB)

Alex Conover - Oct 13, 2025, 3:04 PM CDT

Download

citiCompletionCertificate_13972938_72937755.pdf (77.2 kB)

09/10/2025 - BME Career Prep

Alex Conover - Sep 10, 2025, 1:59 PM CDT

Title: BME Career Prep

Date: 09/10/2025

Content by: Alex

Present: Avery, Myself, and the rest of the junior class...

Goals: Learn about BME Career prep resources, and how to be successful in the job search.

Content:

Job Search Tips:

- Keep track of what you do (ECS tracking sheet)
- Quality of source matters - handshake, linkedin, indeed
    - Real vs Aggregator sites - aggregator = indeed, google, etc. Real site is linkedin, handshake, linkedin
- Connect before candidacy, use your connections/people
- Applying is 1 step - follow up afterwards! (2-3 weeks)
- focus on skills, industry, exposure, etc

Resume Tips

- Tailor resume to position
- create balance, its a summary, not a research paper
- create a flawless product
    - MS Word (highly recommended)
    - no columns, charts, colors
    - design projects without years or semesters, what did you do?
        - create nuanced differences in your resumes from other people
    - Technical skills, coursework
    - Jobs - organization, location, position title and dates

Cover Letter Tips

- Always based on the job posting
- Customize to each job opportunity

- Clear and concise support

- Demonstrate employer knowledge

- address to person

- recommended vs required

Outline (basics)

- Intro: who you are, applying for what, where you found it, and "thesis" statement (based on a and b, I would make a difference in role X at Y company).

    - Paragraph about A

    - Paragraph about B

    - Why employer/role and closing/next steps

BME Career Fair Advice

- Identify purpose - more than an internship

- looking beyond the obvious, overlap with other disciplines

- research the employer - feedback from our partners

- develop your "valued added" statement, sell yourself, why you?

Engineering Career Fair

Sept. 15-18

Conclusions/action items:

09/17/2025 - Leadership Seminar

Alex Conover - Sep 17, 2025, 2:06 PM CDT

Title: BME 300 Leadership Seminar

Date: 9/17/2025

Content by: Alex Conover

Present: Avery and Alex

Goals: How to define leadership, leadership styles, and goals for the future.

Content:

Leadership Stuff

- Personal

- Self-awareness & management
- competency, goals

- Interpersonal

- Recognizing & responding to others' needs
- Active listening, building trust, engaging in difficult conversations

- Team

- Facilitate team interactions
- support others' development
- design and improve team process
- empower others

- Organizational

- Collaborate beyond individual teams, contribute to organizational culture
- address systemic issues that affect the work and well-being of others

Styles of Leadership

- Power Model: leadership = power

- "Someone has to be in control; it should be me."
- "Great Man Theory" - only certain people are born to lead
- Being in control is the most important thing
    - Hierarchy authority, command

- Servant: Leadership = mutual service

- "It's not about me, what is most important for my followers"
- Sharing power

- Being of service
- listening and understanding
    - empathetic, empowering, shared decision making

- Authenticity: an authentic leader, being yourself

- By being my genuine self, I will gain and build trust
- building self-esteem and self-awareness
- emotional intelligence
- creating authentic relationships
    - transparency, genuineness, honesty

- In discussion:

- I've worked with both sides of leadership:
    - Boss at Keysight was super servant-focused, shared decision-making with others, which was how the 200/300 group was last fall, too.
    - Power boss also at Keysight (VP) - he was very much the top of the ladder, would tell others what was needed, but was still authentic and gave genuine feedback
    - Shared power between employees is always a bonus - everyone makes decisions that benefit the company.

- Leaderships

- People-Oriented Leader
    - Glue that holds the team together
- Process-Oriented Leader
    - Set the pace; works alongside everyone
- Though-Oriented Leader
    - big picture, anticipates future.
- Impact-oriented leader
    - set bar high, push for excellent performance

My leadership is people-oriented and/or process-oriented. Impact-oriented is also a big push, especially now with things due quickly and the bar being pretty high with BME.

<u>Connect</u>

- Leadership doesn't require a particular job title:

- developing leadership skills regardless of your position

- How do you want to lead?

- Self-assess
    - What you enjoy (motivations)
    - What you're good at (strengths)
    - What drives you (values)
- observe and reflect
- seek out feedback

<u>Goal Setting - How to put leadership skills into practice?</u>

- Semester Goal with Leadership Skills?

- start small, slow down
- one leement to practice
- look for mentors
- ask questions, partner with others
- consider tracking progress

This semester I want to practice being self-aware of my talking and speaking. I can tend to be louder and not exactly listen to others. It's gotten much better since the beginning of engineering, even 170, but I think that it will develop more this semester, especially once the team feels like it's together more. Right now, I think the 200s are super nervous/unsure of how this project is going, and they don't have the depth of knowledge that I do with this project, or that Avery has (as a 300), but the team will develop, and I can work on adapting my style once they come out of their shells.

Conclusions/action items:

Share findings with BME 200 classmates. Continue to advise them on class loads and how to handle BME courses. If they have questions, answer them! I want to be a good leader this semester.

09/24/2025 - Near Peer Mentoring

Alex Conover - Sep 24, 2025, 1:57 PM CDT

Title: Near Peer Designs

Date: 9/24/2025

Content by: Alex Conover

Present: Avery Lyons

Goals: Learn from Dr. TJ Puccinelli about peer mentoring.

Content:

Why?

We mentor BME 200 students so that they can gain valuable insights into coursework and the design process, especially from those who have been through the process before, and have had multiple experiences.

- Additional instructional support

- BME 300 students are more approachable (hopefully) than other faculty members; they are more willing to ask us questions.

- share experiences with them

- increase belonging

- mutual benefits

Transferrable Skills (buzz word!)

- Leadership

- Communication

- Active Listening

- Study practices

- self awareness (gaps in your own knowledge)

- interpersonal skills

General Benefits of Mentoring

- increased self-esteem/confidence

- increased patience

- build positive habits

- foster personal growth

"Good Mentor"

Being a good mentor means sharing as much information as you can when asked for it. There's no reason to hold back information when you have it, especially when you could help your younger peers perform better. It also means helping to keep the team/group on track when necessary, and reinforcing good study/work habits is key. Providing ample communication is also important; establishing a regime where everyone is working together and actively listening and responding is crucial to good teamwork.

- Building Trust

- Psychological safety

- Humanizing their challenges

- support and enthusiasm

- good listening skills

Listening Effectively

- Get rid of distractions

- stop talking

- Act interested

- look at your teammates

- get the main idea

- ask questions

- check for understanding

- react to ideas, not to the person

- avoid hasty judgments

What do you wish you knew in BME 200?

- CAD / Solid Works

- Zotero (I learned in 170)

- Jeff Hanson / online resources

- What classes were offered in which tracks (spreadsheet!)

- etc

Conclusions/action items:

See uploaded Student mentoring map for final activities today.

Download

IMG_3110.HEIC (3.29 MB)

10/01/2025 - Sustainability in BME

Alex Conover - Oct 01, 2025, 2:05 PM CDT

Title: Sustainability in BME

Date: 10/01/2025

Content by: Alex Conover

Present: 300 team (Avery)

Goals: Learn about the sustainability in BME from Andrea Hicks, an associate professor in civil engineering, environmental engineering, and is the assistant dean of sustainability education and research.

Content:

What is Sustainability

- Everything that we need for our survival and well-being depends, either directly or indirectly, on our natural environment.

Paradigms of Sustainability

- Social

- Environmental

- Economic

Circular Economy

- resources circulating in the economy instead of letting them become waste; parts manufacturing, product manufacturing, service providers all put into collection to minimize systematic leakage and negative externalities.

Carbon Footprint

- Environmental impact from various sources:

- Disposal/recycling
- Raw material extraction
- manufacturing
- distribution
- usage

Random Sustainability things

- In doctor's offices, they no longer use paper on the examination tables, as disinfecting the tables is more efficient and safer than paper. It also costs les

- Metal (reusable) vs Acrylic (single use) speculums

- cost effectiveness, environmental impacts, and usages

- Life cycle assessment aids with finding these discoveries.

How do we use these tools to engineer a more sustainable world?

Lifecycle assessment - how do we change our designs? How do we implement these things (circular economy, research) into these designs?

Labor is a huge factor when thinking about these things - washing medical equipment takes time and energy, who is going to do all that?

- Then you also have to consider infection control.

- For the gown examples: wash 12 brings the breakdown of the gown, therefore buy new one. But that is 12 other wears that come out of that.

Applicable to our project:

- Figure out ways to reuse wasted 3D printed material, if applicable (can you reuse 50% carbon fiber infill PLA print?) If we cannot reuse, then we should consider printing as little as possible to prevent the wasting of materials. This will also prevent excess emissions/energy being expended to print our prototypes.

- Don't over-order materials (Amazon, Grainger, etc), only order what we need, as well as order within the same timeframe to receive materials on time and all at once.

- Use efficiency in testing: how much would we need to test, how much material do we need for that, etc.

Conclusions/action items:

Being sustainable is more than just recycling your aluminum cans. It takes into account all reasons, effects, processing, etc, for creating prototypes, medical devices, drugs, etc. Being sustainable takes all criteria into account, including the environment as one of the main things to consider, as well as waste production and greenhouse gas emissions. On our level we really just have to be aware of the waste we create when building our prototype, but if we were going further into manufacturing, it would be something to consider on a larger scale of production.

10/08/2025 - Design Patenting

Alex Conover - Oct 08, 2025, 2:20 PM CDT

Title: Introduction to WARF, IP, etc

Date: 10/08/2025

Content by: Alex Conover

Present: Avery

Goals: Learn about WARF and how they help with patenting

Content:

WARF works at the technology transfer interface to facilitate securing IP rights and commercial licenses.

Technology transfer includes:

- IP licenses

- Industry-sponsored research

- consulting arrangements

- fee for service

WARF gets involved for patentable inventions

IP Overview

- four common types of IP:
  - Patents
  - Copyrights
  - Trademarks
  - Trade Secrets
- Other, WARF IP:
  - biomaterials
  - technique and know-how (akin in some ways to Trade Secrets)
  - Data
- Non-Patent IP
  - Copyrights
    - protection for creative works that re expressed in a tangible medium
    - wide range of subject matter, including software code
  - Trademarks
    - protection for names, marks, logos, dress, etc
    - requires use in commerce
    - source-identifying function
  - Trade Secrets
    - can be sued to protect anything of value
    - Protection is good so long as the concept is not generally known.

- Patents Generally:
    - Property right, granted by a governmental agency
        - US patent and trademark office (USPTO)
        - no global patent!
            - Patent holder has right to exlude others from making, using, selling, or importing the claimed invention
    - 3 Different types of US patents:
        - Design (15 year term, limited to ornamental features)
        - Plant (new variety, 20-year term, asexually reproducing, non-tuber)
        - Utility
            - provisional (effectively a 1-year placeholder
            - non-provisional (20-year term, can claim priority to a provisional)
- Utility (non-provisional) patents
    - issued for the invention of a new and useful process, machine, manufacture, or composition of matter
        - also includes new and useful improvements therof
    - A quid pro quo with the USPTO and the public
        - applicant gets a ltime limited monopoly on your invention (20 years from filing)
        - but applicant must teach others how to make and use claimed invention
    - Often takes 2-5 years to issue after filing (patent examination)
    - Costs on average $30k (attorneys fees)
    - 90% of patents issued by USPTO are non-provisional utility patents
- Requirements for patenting
    - statutory requirements for pateneting include:
        - 101 - eligible; cannot be a product of nature, abstract idea, or natural phenomeon
        - 102 - Novel; it must be new
        - 103 - non-obvious; it cannot be simple modification or combination of existing concepts
        - 112 - enabled and described; must provide enough detial to teach others how to make or use the invention
    - Patent examiners - scientists hired and trained by the USPTO to review patent applications for these requirements
- Disclosing an innovation to WARF
    - WARF recieves ~400 new innovation disclosures each year
        - disclosing:
            - describe the innovation
            - identify its advantages and potential applications
            - name contributors (inventors, authors, etc)
            - Provide funding and public disclosure detials
        - Meeting with WARF:
            - Discuss the innovation in more detail
            - ask questions about the WARF and patenting processes
            - discuss next steps
- Assesing University Inventions
    - WARF bases its decision on accepting an innovation into our protfoliio on:
        - IP Considerations;
            - type of IP protection
            - Potential breadth and strength of IP protection
            - Public disclosure (past and planned)

        - Stage of development
    - Licensing Considerations:
        - Applications
        - Likelihood of identifying a commercial partner
        - likely return from licensing
- Marketing and Licensing
    - Licensing the IP is the next step in transferring the technology
        - Market Analysis
            - Market status: established, emerging, new
            - Size and type: large and growing, medium and contracting, etc
            - Potential licensees: companies in the market
        - License Negotiation
            - Type and terms: excusive and field limited, sub-licensing, etc.
            - consideration: upfront payment, royalties, reimbursement
        - Ongoing
            - technology development, enforcement, amendment, termination
- Value of Licensing
    - Benefits to the Company:
        - Reduced R and D costs
        - Improved time to market
        - opportunity to enter new markets and expand company quickly
        - new features or products provide additional revenue opportunities
    - Determining the Value:
        - technology application
        - key selling points/feature/benefits
        - technology trends
        - market size, trend, competition
- AI and IP
    - Patents:
        - can AI invent? (no)
            - "inventor" = natural person, conception
        - Limited to US only?
            - South africa is the exception
        - Can AI assist in Inventing?
            - Evolving but likely yes under Pannu Factors
    - Copyright:
        - Original works of human authorship
        - AI must be incidental to conception and creation
        - original conception by human master mind - are prompts sufficient (no)
        - Combinations of derivative works requires more than de minimis contribution from human
        - traditional elements of authorship generated by AI? (no)

Conclusions/action items:

We might be able to submit a patent for our project, it would be a long process, but ultimately worth it to put our names on something. We will discuss as a team whether or not we want to proceed later on with a patent submission. WARF was super helpful with this idea.

10/15/2025 - Protecting IP

Alex Conover - Oct 15, 2025, 2:10 PM CDT

Title: Protecting IP

Date: 10/15/2025

Content by: Alex Conover

Present: Avery

Goals:

Content:

Andrea L. Arndt - in the marching band from 2000-2004. (Rank 4)

- IP Attorney (Nationally Recognized)

Importance of IP for BME's

- BMEs create life-changing solutions

- IP protection allows research to safely transfer into products, processes, and/or systems

  - medical device - patent filing - marketplace

- IP enables investment, partnerships and ethical competition

Legal Career Paths for Engineers in IP

- Technical Advisor: STEM degree (no Law Degree or Patent Bar)

- Patent Agent - STEM degree + Patent Bar

- Patent Examiner - STEM degree (Patent Bar eventually)

- Patent Attorney - Law degree + Patent Bar

- Patent Litigator - Law degree (STEM degree + Patent Bar Optional)

- IP License Attorney - Law degree (Stem degree + Patent Bar Optional)

- Tech Transfer Manager - STEM degree preferred (Law Degree optional)

- Engineer - STEM degree (work with IP lawyers to protect your inventions)

Skills from Engineering to IP

How engineers influence law and innovation:

- Research - determine if an invention is truly new

- Analytical reasoning - claim drafting / infringement analysis

- Technical writing - translate complex technical concepts into clear, precise language

- Communication - explaining tech to non-experts and patent examiners

- creativity - problem solving in patents / creating competitive products

- collaboration - cooperate with colleagues and external professionals

- project management - manage resources, meet deadlines, and organize tasks (patent creation process from concept to product launch.

IP ownership

- University

- disclose before publishing; university owns all IP; possible license opportunities

- Company

- employer owns inventions, trademarks, copyrights, etx
- review employee agreements

- Startup

- you own IP; file early

Timing and Publication

- Disclose internally first

- publishing before filing and offers for sale = lost patent rights abroad and possible loss of rights in US

- posters or abstracts can count as public disclosures

- first to file system, not first to invent

Legal and Ethical Duties of Engineers

- Respect others' IP

- Keep invention notebooks

- Understand inventorship vs authorship

- maintain confidentiality agreements

What makes something patentable?

- Novelty - must be new

- Non-obviousness - more than a routine change

- utility - must work

- enablement - must describe how the device works

Why patent?

- Creates a monopoly / stops others:

  - From making, using, selling, or importing the invention

- 2 Main types:

  - Utility patents: protect how a product works or is made (20 years)
  - Design Patents: protect the unique visual appearance of a product (15 years)

- Patents are especially critical in biomedical engineering, where innovation drives competitive advantage.

Trademark, Copyright, and Trade Secret Protection

- Trademarks = words, devices, symbols, composite of both

- sounds, smells, colors, buildings, package shapes...

- Distinguishes your goods or services from others

Key Takeaways:

- engineering and patenting work closely, therefore the law industry is also highly involved. If one wanted to work in this industry, it would likely be an easy transition within your sphere of knowledge.

Conclusions/action items:

If we were to file for a patent, I doubt they would find that our design is unique enough from other existing AFO's to grant us a patent, but it might be worth a shot. There aren't many inconspicuous versions of AFO's around.

10/22/2025 - Post-Grad Planning

Alex Conover - Oct 22, 2025, 2:01 PM CDT

Title: Post-Grad Planning

Date: 10/22/2025

Content by: Alex Conover

Present: Avery

Goals: Gain the knowledge for Post Graduate Planning slideshow from Dr. P

Content:

Use your undergraduate experience to "build a story"

- gain experience while you can - eaiser while you are in school

- Tie them together - Big Picture of who you are ,what you want, and what do you want to be

- Research = important for all post-degrees and helpful for industry

Do your homework - never too late

- What does your ideal career look like?

- What programs have the opportunities you are looking for?

- Location career development, people, disease, research, courses

Think about letter writers or references early - 3 strong ones

- school: prepare for MCAT, GRE, summer before senior year

<u>How to write your story in a better way</u>

- general thesis stemement
    - narrow experiences and how that applies to your broad interest
    - specific to each position
- Personal statement
    - be specific

<u>Graduate School Options</u>

- Masters, MS
    - stepping stone, change directions, gain depth, expand credentials for future
        - medical school

        - PhD Programs

    - Industry focused

    - Generally one year!

- Doctoral, PhD

    - Desire to be an independent researcher

    - Write research grants

    - work in academia

    - lead projects in industry, startups, and consulting

MS Stepping Stone

- Reasons:

    - Rewrite story

    - MD - prep for MCAT, apply for med schools

    - PhD, cannot find a fundeding

- MS will make you more desirable

    - Fill gaps in your resume

    - Higher level of skills - more lab time with less class time

    - More experiences - teaching, mentoring, research thesis

    - older, more maturity

- really powerful if you add in industry experience.

- getting MS increasing starting salary by 10k

BME graduate program

- Research (1.5-2 years)

    - continuing on to PhD here

    - Can be funded as RA/RA/PA (tuition remission and stipend)

    - thesis required (must have lab PI identified and willing to support before applying)

- Accelerated Programs (1 year)

    - Funding (TA only) stipend only (no tuition remission $1200/credit)

    - NO co-op, internship ok

    - Accelerated:

- Coursework only, independent study/research is allowed

- Biomedical Innovation, Design, and Entrepreneurship (BIDE)

- Project-based - project required (BME Design project continuity)

- Partnership with the business school

Applying for BME Accelerated MS Programs

- Applying online, pay fee, and submit (fall and spring available)

- for UW BME Students: add Janna Pollock: janna.polluck@wisc.edu, tenbruggenca@wisc,edu, and bmegradadmission@engr.wisc.edu

- Application is reviewed seperately, they have special consideration to the BME undergraduate program, 3.0 minimum (automatic admission) / 3.0 in the last 60 credits - can make it work w/out 3.0, may need letters of rec. (12/15 deadline)

Masters Elsewhere

- Explorer opportunities and interests

- MEng

- MS in Global Health

- MS in other engineering dept (takes longer)

- MBA - generally industry pays for credits or evening options

- Similar to advice earlier and for PhD programs later

- find faculty/labs performing research/work in passion areas and industry interest alignments

-Less competitive than PhD programs, generally not funded, some admit to MS or PhD programs.

PhD Research

- follow your passion - network and go to conferences early!

- Build your resume/CV - REU - research experience for undergraduates (summer) - research is a must for PhD

- External funcing NSF - GRFP

PhD application process

- apply early, list names, rolling review

- greater than 3.5 GPA, high quantitative GRE

- Hard lol - extensive interview process

Medical School

- 2 semesters of gen chem (109 = 1 year equiv)

- Chem

- Physics

- English

- CommB

- Psych and Sociology

- Biochem

- Research is required, volunteer (clinical setting), shadow physicians, patient contact time, build relationships = letter writers!

- use design experiences (physicians, clients, etc)

- Requirements can vary by degree, check pre-health website (dental, phys therapy, phys assistant, public health, etc)

How do you do all of this?

- Make your story make sense. Balance your life!

Conclusions/action items:

The BIDE program would be beneficial for me I think. Need to work on my GPA / keep it above a 3.0, but it would be feasible money-wise, probably.

10/29/2025 - To Regulate or not to Regulate

Alex Conover - Oct 29, 2025, 2:09 PM CDT

Title: To Regulate, Or Not To Regulate... That is the Question

Date: 10/29/2025

Content by: Alex Conover

Present: Alex, Avery

Goals: Learn about regulation in the medical device industry

Content:

Regulatory Pathway

- What pathway are you following?

New medical devices

- Class 1 (low risk)

- Class 2 (moderate/controlled risk)

- Class 3 (high risk)

- all go through many trials, pathways, controls, clinical data, then finally clearance and approval to market devices
- FDA approval required for Class 2 or 3 devices
    - 510k or 510k De Novo pathway (class 2)
    - HDE or PMA pathway (class 3)
        - class 3 devices = if fail, you die

- More Regulation, less regulation, or just right?

- levels of involvement from the FDA (are we at too much or too little?)
- medical devices were not regulated until 1976 (by FDA)
    - cardiac pacemaker - engineers worked with doctors, "this could probably work"
        - a patient went through 28 pacemakers, lived, but that was cray work
        - variable time of usage (some hours, some years, etc)
    - lots of human testing - faster results... but animal testing is accurate right?
        - animal model is typically not going to be as accurate as the human model, but we just don't study humans.
- When FDA pushes out "unnecessary" regulations (pre and post 1997)
- Dalkon Shield (contraceptive device to prevent pregnancy)
    - no oversight - just went straight to market - it didn't actually stop pregnancy (4.7% pregnancy rate, and had complications (6.3% expulsion rate))
        - also septic pregnancy, maternal death, etc
            - gee, regulations should be in effect here...
- company then recieved a mandate for regulating devices. but nobody told them how...

- 1982 - center for devices and radiological health was formed within FDA to regulate devices and radiation-emitting products.

- Empirical exploration of sources and financial consequences:

- devices that are effecting people right now! shortcomings in medical devices!
    - CPAP machine: killed 500 people by poking holes in people's lungs
    - Neurostim systems - Abbott recalled 200K recalled (class 1 medical device) - vagus nerve stimulation
        - recalled due to not being MRI compatibility (the compatibility mode = off, but the wireless coms were turned off, and it would never turn back on)
    - Fraudulent medical devices - "just a piece of plastic"
        - batter vs no batter systems
        - 3-4 years of covering up (CEO covering up issues)
- 2020 FDA guidance on Spinal Cord Stimulators
    - 50k SCS devices implanted annually
    - 107k medical device reports (MDR) related to spinal cord stimulation for pain in a 4 year period
        - ~500 associated with a patient death
        - 78k associated with a patient injury
        - 29k associated with device malfuntion
            - injuries and death 'may be related to the product' and/or corresponding device failure.
- Alzheimer's Disease in recipients of cadaveric pituitary-derived growth hormone
    - some patients had early onset symptoms at 30 (too early)
    - these people had cadaver grafts - proteins (amyloid plaques) were in those donors
        - how are these proteins screened for in donors, why did this happen to some of the patients?

- Failure modes affect analysis

- what happens when [x] fails? apply to every single aspect of the device

Conclusions/action items:

Consider what could go wrong in every single aspect of your projects. What happens when the project is at scale, what happens with supply chain and shipping? How could different materials affect that? How does one deal with devices? The FDA? Safety data is available online, look that up and figure out what you need to do.

11/05/2025 - Therapeutic Product Development

Alex Conover - Nov 05, 2025, 2:10 PM CST

Title: Therapeutic Product Development

Date: 11/05/2025

Content by: Alex Conover

Present: Avery

Goals: Gain knowledge from this iteration of the BME 300 lecture with Dr. Bill Murphy about FDA and the Therapeutic Product Development.

Content:

FDA

- Understand the overall structure of FDA, including the framework of laws, regulations, and guidances for advanced therapeutics
- Better understanding of FDA = higher paying job later on

US regulatory resources (today's focus)

FDA Structure and Advanced Therapeutics

- Device (CDRH)
  - PMA
  - 510k
  - IDE
- Drug (CDER)
  - NDA (new drug application)
    - once approved you can market drugs to larger scope of people
    - approval to market!
  - IND (investigational new drug application)
- Biologic (CBER)
  - BLA (biologics licensing application)
  - IND

- Advanced Therapeutics

- Genome Editing
  - target a precise genome locus and delete, insert, or change existing sequences
- Gene delivery
  - transfer molecular too.s and assembled gene systems into the cell
- Cell Therapy
  - Use expanded cells to transfer medicinal bioactivity to regenerate damaged tissue or restore health

FDA Framework: Developing CGT Products for Hemophilia

- US Laws (made by Congress)
    - Federal food, drug, and cosmetic act
        - key law giving FDA responsibility to oversee the safety of drugs, medical devices, and other products like food and cosmetics
        - Public Health Service Act
        - 21st century Cures Act (CURES) of 2016
        - Coronavirus Aid, Relief, and Economic Security Act (CARES) of 2020
            - covid response, gives FDA greater responsibility for managing interruptions and disruptions in drug manufactuing.
- Regulations (CFR TItle 21) - made by FDA based on laws
- FDA guidance (made by FDA with help from the public to help industry and the public interpret regulations)

Dramatic Implications: Human cells, tissues, and cellular and tissue-based products (HCT/Ps)

- 351 vs 361 Products

- Markedly different: in terms of the time, effort and expense required to bring a product.
- Basically, 351 products are regulated as drugs and/or biologics, while 361 products are relatively unregulated.

- Industry examples

- 351
    - Camell BHA, Humaxyte HUMACYL
        - takes years to work through regulatory process
- 361
    - Amniotic tissue, peripheral nerves
    - demineralized bone tendons/ligaments
        - can be used almost immediately.

Product Development Life Cycle

- "each stage of the product development cycle faces it's own risks and challenges, and proper management of these risks is vital for successful commercialization."
- extremely important to be able to distinguish between studies that are "on the critical path" vs "good research projects"

A Target Product Profile (TPP) is your Product Vision

When to use it, why to use it, how to use it.

- patient ientificaiton: indication

- patient benefits: efficacy profile

- patient risks: safety profile

Is it medically and commercially compelling?

- Core
    - Indication and patients

    - efficacy
    - safety
    - dose and regimen
    - route of administration
    - dose form
- Clinical development planning
    - clinical pathway
    - regulatory pathway
    - timelines
    - cost
    - risk
- CMC (Quality TPP)
    - Product attributes
        - purity, degradants, biocompatibility
    - Storage, stability, container, pharmacopoeial compliance

4 important questions...

1. Will patients and perscribers want it? ----> Validate TPP with Key Opinion Leaders

2. Will regulators accept it? ----> Discuss plans with regulatory agencies

3. Will payers reimburse for it? -----> Understand the evidence payers require

4. Why should I fund development ------->

- Show people will buy it
- Is the cost and timeline reasonable?
- What are the risks?

<u>Considerations when developing a 351-regulated CGT</u>

- Consider: Time is money... Every section here adds value to your company

- Non clinical
    - non-GLP nonclinical studies and pilot tox studies - pivotal GLP tox studies $
    - (toxicity studies, proof of concept, does it work?) $
- Quality
    - CMC Development ($$)
    - Demonstration of manufacturing consistency
    - Initiation of stability studies
    - Product characterization and development of potency assays
        - Result of nonclinical and quality -----> BMP batches release process and method validation, defined product characterization and potency assays, defined shelf life and shipping stability ($$$)
- Clinical Applications
    - Phase 1/2 Trial ($$$)
    - Phase 3 Trial ($$$)
        - Filing and launch preperation
        - Post-marketing studies and RWE (post-approval)
- Regulatory

        - TPP Interact meeting
        - Pre-IND meeting, IND Submission
        - EU/US Orphan drug designation and Paediatric Development plans
            - US Fast track designation
                - EU Prime US Breakthrough Therapy and RMAT designations
        - EOP1/2 meeting or Special Protocol Assessment
        - Pre-BLA meeting
        - BLA Submission
            - Gain approval!
        - US sBLA

Qualtiy - Where the money is in Industry

- Quality managemet stystem implementation

- A system that documents policies, processes, internal rules, procedures, and other records to ensure consistent quality
- quality management system:
    - Risk management
    - Asset management
    - Equipment management
    - Document management
    - Audits and inspections
    - corrective and preventative actions
    - supplier management
    - training management
        - takes *everything* into account...
- Professional labs are well controlled. Classroom labs, eh...

- Quality Exercise

- What factor into unexpected outcomes, emerging differences, pre, in, and post run
    - materials/input
        - contamination
            - multiple grades (low, intermittent, high)
    - expansion process/output
        - growth rate, cell numbers/yield, viability, detachment
    - system
        - local/within machine air handling differences
    - machine
        - hardware
        - software
    - Up and down stream processes
        - standardization of processes
    - people
        - team building, training, interpretation of imagery, etc

Career Options within a Regulated Environment

- Chemistry, Manufacturing, Controls...

- Quality Compliance, and regulatory...

Conclusions/action items:

This provided a lot of useful information of how therapeutic drugs go through the FDA system to become certified for usage. This doesn't apply to our project, but it's cool to know for safety and the actual process of creating these drugs.

11/12/2025 - IRB Review Processes

Alex Conover - Nov 12, 2025, 2:10 PM CST

Title: IRB Review Processes, History, etc

Date: 11/12/2025

Content by: Alex Conover

Present: n/a

Goals: Learn about the IRB review processes

Content:

Historic Problematic Research

- US Public Health Service untreated syphilis study at Tuskegee AL, 1932 - 1972

- WW2 Nazi prisoner experiemnts, ~1941-1945

- US Public Health Service Guatemala syphilis experiments, 1946-1948

- Willowbrook State School hepatitis experiments, 1956-1971

- Common elements: populations who "couldn't object" to testing
    - weren't told the truth, prisoners, just overall vulnerable subjects
    - not a ton of scientific rigor - questionable ethics within these experiments

Ethical Research Frameworks

- Nuremberg Code, 1947
    - emphasis on voluntary consent
- Declaration of Helsinki, 1964
    - Focus on medical research
    - do no harm
- National Research Act, 1974
    - US response to US Public Health Service Untreated Syphilis Study at Tuskegee

Belmont Report

- Respect for Persons/Autonomy
    - The principle of respect for persons thus deivdes into two seperate moral requirements: the requirement to acknowledge autonomy and the requirement to protect those with diminished autonomy"
- Beneficence
    - Maximize possible benefits and minimize possible harms
        - harm vs help with research (cancer drug example)
- Justice
    - "Who ought to recieve the benefits of research and bear it's burdens"

Applying Belmont Principles

- 1991 Department of Health and Human Services (DHHS) 45 CFR 46
  - Common Rule
    - Criteria for approving research
    - protections for vulnerable groups
    - requirements for IRB operations
  - 2018 Revised Common Rule
    - Modifications to reduce administrative burden

IRB Composition

- Diversity of membership required
  - Race, gender, cultural backgrounds
  - scientific expertise
    - MD, PhD, MPH
    - Faculty, clinicians
  - Non-scientists
    - Community members
    - IRB staff

IRB Purpose

- Protect the rights and welfare of people enrolled in research
  - Participants/subjects
- IRB's review of human research according to:
  - Ethical principles
    - Belmont Report
  - Federal regulations
    - common rule, HIPAA, FERPA
  - State law
  - institution rules

IRB Review Requirements

- UW-Madison requires IRB review of all research involving human subjects, including exempt human subjects research
- Research cannot begin without IRB review and approval

Common Rule Criteria

- Risks
  - no unnecessary risks; unavoidable risks as low as possible
  - appropriate monitoring to prevent adverse effects or identify adverse outcomes as soon as possible
- Benefits
  - potential direct benefits to participants or scientific/societal benefits
- Risk/Benefit Ratio
  - risks are reasonable in relation to the potential benefits of the research
  - study design enables researchers to answer the research question, with appropriate procedures/data collection, and an appropriate number of participants

- Equitable selection of subjects
    - appropriate to answer the research question
    - appropriate recruitment strategies
    - justification and safeguards for vulnerable participants
    - The population that bears the burdens of research also benefits from it
- informed consent
    - participants make an informed choice about taking part in research OR
    - criteria for waiver of consent are met
- privacy and confidentiality
    - Adequate protections for participant privacy
    - adequate protections for data confidentiality.

Common Rule Definitions

- research defined by the common rule as:
    - a systematic investigation, including research development, testing, and evaluation, designed to develop or contribute to generizable knowledge.
- Human subject defined under the common rule as:
    - a living individual...

Applicable Research

- drugs, devices, or products developed through research in humans
- data from surveys interviews and observation
- employment information
- etc

Not Considered Research*

- QI/PE projects do not meet the definition of research
    - The project may not be performed systematically, or
    - The project may not be generalizable
- *except for device studies
    - FDA has a broader definition of human subjects research
    - contact FDA regulated research oversight program

HIPAA considerations

- working with MD's, it could apply
- IRB heavily involved

De-identifying Data

- Directly Identifiable
    - identifiers included with data
- coded/indirectly identifiable
    - identifiers removed from data but linked via study ID code
- anonymized/de-identified
    - all identifiers removed

Category 2: Research with Surveys and Interviews

- Research that only includes interactions involving educational tests, surverys, interviews focus gropus, or observation of public behavior (not in clinics)

Category 3: Benign Beharioral Interventions

- Research involving only cognitive/behavioral tasks and/or manipulation of subjects environment
  - cannot involve physical activities or physical procecures...

Category 4: Research with Data and Samples

- Allows for secondary use of information and samples

Non-exempt Research

- Surveys of children
- identifiable samples
- intervention with participants that goes beyond except category 3
  - blood draws, blood pressure, yoga, wearing an activity watch
- administering a drug
- Device studies
  - evaluating the safety/efficacy of a medical device

Examples of Medical Devices

- anything that acts directly/indirectly on the body to affect it's workings
  - prostheses
  - contact lenses
  - MRI hardware and software
  - diagnostic software
  - assay for detecting antibodies in blood
  - bandage adhesive
  - olive oil... (people use an inhaler, swish olive oil to remove drug...) - did it present risk...

How to submit a study

- create a study in ARROW
  - https://irb.wisc.edu/how-to-submit/new-study/
- application type page
  - health care records research
  - full review
  - exemption
- amending an existing study
  - submit change of protocol if changing:
    - study objectives
    - data or specimin collecting
    - etc
  - easier than submitting new study

IRB Review Process

- Administrative Review
  - checks for required training, pre-IRB ancillary reviews

    - checks for basic completeness of the application
- IRB Pre-Review
    - identifies applicable regulations, state law, campus policy
    - checks for consistency, clarity, completeness
    - helps researchers achieve review ready applications
- committee or non-committee review
    - convened IRM or designated IRB member reviews submission
    - determines if the criteria for approval are met
    - requests modifications if needed
    - approves when criteria are met

After Approval?

- Begin your study!
    - make sure to use/follow IRB-approved documents
- Changes of Protocol
    - must have approval of the change before implementing the change
- Reportable events
    - when something unexpected happens
        - noncompliance
        - unanticipated problem/SAE
        - new information
- continuing reviews
    - annual progress report for some non-exempt studies

Successful submission tips

- Answer the question being asked
- Rushing or cutting corners will not save time
- It's ok if you don't agree with a reviewer note - explain why or contact the reviewer
- Remember that IRB staff are here to help!

Resources:

- IRB website
    - investigator manual, and other tools in toolkit library
    - education and training
- ARROW
    - IRB submission software/website
- More resources:
    - QI/PE projects
    - Exemptions
    - IRB Review and Application Types
    - Templates
    - FDA-Regulated research oversight program

Conclusions/action items:

Our project could maybe be considered an IRB reviewable research thing. We should look into verifying whether or not we need approval. Better safe than sorry.

11/19/2025 - New Product Development

Alex Conover - Nov 19, 2025, 1:57 PM CST

Title: New Product Development

Date: 11/19/2025

Content by: Alex Conover

Present: Avery

Goals: Understand how NPD works at most medical devices companies

Content:

Introudction

- NPD in the medical device industry is:

- Highly regulated: FDA and other regulatory bodies have a significant impact
- Expensive: Requirement for verification and validation (clinical testing ex) is a cost multiplier
- Resource intense: involves sizable teams to execute porjects
- competetive: competition is fierce, focus on go-to-market speed

Selecting and prioritizing projects

- Corporate Business Strategy
  - Define how the business will sustain itself over the next 3-5 years
- Product Portfolio Review
  - Define which product categories to develop, to sustain, and to eliminate
- Project Review
  - select and prioritize projecst to support over the next 1-3 years
- Budgeting and resouce allocation
  - allocate budget and resources towards projects

Types of NPD Projects

- Line extensions: addition of additional sizes and configurations
- Product improvements: Existing product change due to market feedback and/or new customer needs
- New-to-company: Productl ine that is not new to market but is new for company
- New-to-world: onnovating products that create completely new markets
  - Top-Bottom - increasing risk, cost, and time-to market

Typical NPD Team Members

- Product Development Engineer
- Marketing
- Project Management
- Quality Assurance
- Clinical/Regulatory Assurance
- Manufacturing Engineer, etc

Managing NPD: Stage-Gate Process

- Stage 0 "The Cloud"
  - ideation, what do we want to create?
- Stage 1 "The Funnel"
  - exploration
  - sketches
  - research, talking to customers
- Stage 2
  - Concept Development
  - go through all options, develop one solid option
    - Go / no go decision
- Stage 3
  - "real engineering"
  - what do you want to do - make it work.
  - testing, development, etc
- Stage 4 "The Tunnel"
  - Design Confirmation
  - verification/validation testing
  - longest stage (FDA submission, etc)\
    - design freeze
- Stage 5
  - Design transfer and commercialization
  - manufacturing - how to mass produce products
    - launch
- Post-market Surveillance
  - follow up and see how your product is doing

Case Study

- Fluid management solutions for high volume cases existing in 2007 - Cardinal Health
  - Manual: suction canisters
  - Automated: Stryker Neptune
- ORwell Fluid Management System
  - GOAL: provide clinicians with an innovative solution for high fluid volume (>8 liters) collection during surgical procedures

- Product Development of Response to Stryker

- Stage 0: Ideation
  - Typical Activities:
    - Choose area of opportunity
    - Review Market trends and/or competitive threats
    - conduct primary and secondary market research
    - identify customer unmet needs
    - create high-level, "back of the napkin" ideas
  - figure out what clinicians and others who used the product thought of various products
- Stage 1: Exploration
  - Define problems to be solved and customer requirements

    - review, refine, and screen the list of ideas from stage 0 for exploration
    - create concepts for 8-10 ideas
    - develop high-level business case (Market size, value proposition, etc)
    - Conduct preliminary technical scouting and IP landscaping
        - Defining the Problem: Defining the problem statement is arguably the most important step of the design process.
            - how will what you do be a part of the winning success, the solution for the customers.
- Stage 2: concept definition
    - Based on customer interviews and use case asseesments, down-select from 8-10 to 2-3, to 1 leading concept
    - Develop robust business case including marketing opportunity, initial forecastm and projected expenses
    - Conduct comprehensive IP examination
    - Gate Review = Go / No Go business decision
        - highly similar to BME design, prototyping and creating 3 to pitch to your exec and figure out which one are you going to do (rough design matrix similarity)
- Stage 3: Design Development
    - Move to functional prototype
    - continue iterative design process including initial tesitng and reviews with customers
    - confirm regulatory pathway
    - begin formal Design Control Documentation
        - "Frankenstein Model" fabricated
        - Design Control
            - Mandatory for FDA Class 2 and 3 and almost all EMA devices
            - includes documentation of customer needs, design requirements, etc
            - Tightly aligned with Risk management profile
- Stage 4: Design Confirmation
    - most intense part of development
    - activities:
        - conduct extensive verification and validation testing
        - finalize product nad component drawings/models
        - accelerate manufacturing process development along with plans for quality control (make vs. Buy)
        - "Freeze" Design at the end of this stage (submit to FDA)
        - Submit regulatory documentation (ex: FDA 510k) ((min 3 months, max 1 year)
- Stage 5: Design Transfer and Commercialization
    - Complete any remaining testing
    - make final design changes
    - build molds, assembly/test equipment
    - create instructions for use (IFU) and user manuals
    - develop service plan and resources
    - finalize go-to-market strategy and start limited release (if applicable)
- Post-Market Surveillance
    - Regulatory agencies expect that companies are monitoring and documenting customer complaints and field issues post launch
    - Companies continuously track customer and salesforce feedback via interviews and surverys
    - On a 4-6 month cadence, project teams report out to stakeholders:

        - Account sales
        - Business and regulatory issues observed
        - complaints
        - product and process improvement opportunities
- Summary:
    - Medical device development is an expensive, complex, and highly-collaborative effort
    - Having limited resources, most businesses have instituted processes like stage-gate to reduce risk and increase probability of success
    - good product Design and development is necessary for commercial success but not sufficient.

Conclusions/action items:

This was super helpful for me personally, as I am looking into product management internship positions, which I don't know much of the background here, so this really helped organize thoughts behind business ideas and the "stages" of creating a new product.

10/03/2025 - Preliminary Presentations

Alex Conover - Oct 03, 2025, 1:06 PM CDT

Title: Preliminary Presentations

Date: 10/03/2025

Content by: Alex

Present: Team

Goals: Give our preliminary presentation and listen to the rest of the presentations.

Content:

Our presentation went well, and we got some interesting questions. One was about the weather resistance of the CF PLA, and one was about how the patient would control the dorsiflexion aspect of the brace. The other instructor also asked about the numbers behind our dorsiflexion (degree of drop), which all came from our preliminary research.

I thought the knee crutch presentation was interesting, and it looks like a fun project to be a part of.

Conclusions/action items:

Overall, the presentation went well. Everyone performed great, and I believe we only went over time by like a minute.

11/107/2025 - Tong Lecture

Alex Conover - Nov 07, 2025, 12:44 PM CST

Title: Building a Career of Impact

Date: 11/07/2025

Content by: Alex Conover

Present: Whole Team

Goals: Learn from Kristin Myers, BME Class of 2002

Content:

Run towards the hard problems; they are the ones that change the world.

Career Journey

1. The Foundation - Solve Tangible Problems, Work Hard, Add Value

- UW BME
  - Boston Scientific, Baird, Guidant, etc
- Medtronic
  - engineering, marketing/product launch, technical sales
- Harvard MBA
- Skyline Ventures
  - investor in healthcare startup
- Arboretum Ventures
  - Investor in healthcare startup technology

2. The Growth Curve - Combine EQ with IQ to multiply impact and reach

- Aetna
  - Chief of staff to the CEO (business equivalent to residency)
  - President, Student Health President, Great Lakes Region - Commercial and Medicare
- Unified Women's Healthcare
  - President and Chief Operating Officer

3. Build and Transform

- Hopscotch Health
  - Founder and CEO
  - Advanced Primary care for rural communities
- Blue Cross Blue Shield Association
  - Chief Operating Officer Enable Access
  - Affordability
  - Outcomes and Experience for 1 in 3 Americans

- You don't need to know your final destination - just follow hard problems and build skills that allow you to make an impact

The Heathcare System

- What does great look like?

- Quadruple aim:
  - Improved Provider experience
  - Improved patient outcomes
  - improved patient experience
  - lower cost of care

- How much do we spend on healthcare in the US? ($$ and % of GDP)

- US ranked last on equity, access & outcomes
  - lower life expectancy
  - icky
- Why is it complicated?
  - >900 insureres
  - too much stuff, archaic ways
- Underlying challenges
  - misaligned incentives
  - fragmented financing and regulation (federal, state, employer)
  - Data silos and legacy IT
  - Inequities (10-15 year gap between zip codes)

- Healthcare isn't broken, it was never designed to be one system

What if we build an integrated system to enable health and wellness for all?

- The future of healthcare is an integrated ecosystem of health and care
  - critical care hospital
  - flex zone
  - ASC+
  - Logistics Hub
  - Community Health Hub
  - Mobile Fleet
  - Home
  - Blue and Green
    - Food and Nutrition
- What would make a better healthcare system?
  - Interoperable data infrastructure
    - seamless exchange of clinical, claims, and social data across payers, providers, and patients
  - human-centered design
    - care build around people not processes, intuitive, empathetic, seamless
  - aligned incentives and measurement
    - Everyone rewarded for outcomes, not activity
    - Performance is transparent and known to all
  - connected care delivery platforms
    - integration of virtual in-person, home, and community care
    - real-time data integration and feedback loops

    - simplified and automated infrastructure
        - admin tasks (billing, prior auth) run automatically and accurately
    - systems thinking - see how the parts connect in big
    - analytical rigor - data-driven analysis
    - design and iteration
    - process optimization
    - Reliability and safety
- Healthcare needs better systems - systems are what engineers build best

Things to do as an engineer trying to grow:

1. Work Hard and Build Range

- Take on the hardest projects, classes, and experiences you can find. Effort and range are your foundation.
- work hard, get stuff done - you will be that person who gets elevated

2. Seek Diverse Exposure

- Explore different sectors, teams, and geographies.
- Gain perspective and learn how systems connect, not just how parts work
    - Medtronic experience - technical experience, marketing, technical testing! She got to scrub in and test these pacemakers in NYC.

3. Choose your people wisely

- Surround yourself with curious, driven, high-integrity people; they will shape who you become
    - The 5 people you are around the most; they influence you the most.

4. Know Your Values and Protect Them

- Define what matters most - family/friends, health, career/impact, values - and make decisions that align
- Your decisions drive you.

5. Embrace Challenge and Keep Growing

- Run towards the hard problems; growth lives on the edge of discomfort, where big impact starts.
- Embrace your surroundings, use them to get where you need to be.
    - You've worked hard to get here, keep working hard once you've left!

Conclusions/action items:

Key takeaways:

1. Run towards the hard problems

2. Figure out what works for you, and keep growing in that area. Make the hard decisions!

3. Figure your what you value the most, and keep those values close. Keep your people close.

Stay curious!

09/06/25 Research: "The Top 6 Foot and Ankle Injuries in Kids and Teens"

AVERY LYONS - Sep 06, 2025, 2:19 PM CDT

Title: Research: "The Top 6 Foot and Ankle Injuries in Kids and Teens"

Date: 9/6/2025

Content by: Avery Lyons

Goals: The goal is to research the most common ankle disorders/issues in teens that may warrant the use of an AFO.

Citation:

[1] "The Top 6 Foot and Ankle Injuries in Kids and Teens - GPOA." Accessed: Sep. 06, 2025. [Online]. Available: https://www.gpoa.com/blog/the-top-6-foot-and-ankle-injuries-in-kids-and-teens

Content:

- Kids more prone to foot and ankle injuries than adults due to still-developing musculoskeletal system
  - Bones, muscles, joints, and other tissue elements still in the process of maturing and strengthening
- Youth sports that involve sudden stops, starts, and changes in direction put extra strain on the body
- 1) Ankle Sprains
  - Caused when the ligaments that support the ankle are overstretches or torn
  - Can take several weeks to heal
- 2) Foot/Ankle Fractures
  - Range from minor stress fractures to more serious fractures (e.g. those from car accidents)
  - Treatment depends on the type and severity of the fracture; may involve wearing a cast or crutches for several weeks
- 3) Plantar Fasciitis
  - An inflammation of the plantar fascia, which is a band of connective tissue that runs along the bottom of the foot from heel to toe
  - Most common symptom is pain in the heel, which can also be accompanied by swelling and stiffness
- 4) Achilles Tendinitis
  - Occurs when the Achilles tendon becomes enflamed due to overuse or overstretching
  - Symptoms include pain, tenderness, and swelling in the heel area and difficulty flexing/extending the foot fully with each step taken
- 5) Sever's Disease
  - Occurs when there is inflammation of the growth plate at the back of a child's heel bone (calcaneus)
  - Usually affects kids aged 8-14 and can cause pain during activities (e.g. running and jumping) as well as tenderness in either foot near where it meets up with the tibia and fibula
- 6) Ankle Instability
  - Weakened ankle joints can often be unstable leading to frequent sprains, falls, and other accidents
- In most cases for ankle injuries, non-surgical treatments such as immobilization (splinting/casting/bracing), physical therapy, and rest are utilized before surgical treatments are explored

Conclusions/action items:

Ankle and foot injuries are extremely common in teens due to the lack of full maturity in the musculoskeletal system. Pain, inflammation, and swelling are the most common symptoms of injury. The most common causes of these symptoms range from simple ankle instability to severe fractures. Non-surgical options should be explored prior to the possibility of surgery.

09/06/25 Research: "How to Choose the Best Ankle Brace"

AVERY LYONS - Sep 06, 2025, 2:31 PM CDT

Title: Research: "How to Choose the Best Ankle Brace"

Date: 9/6/2025

Content by: Avery Lyons

Goals: The goal is to research the different types of ankle braces available today and how the compare to one another.

Citation:

[1] "How to Choose the Best Ankle Brace," Mission Valley Heights Surgery Center. Accessed: Sep. 06, 2025. [Online]. Available: https://mvhsc.com/news/how-to-choose-the-best-ankle-brace

Content:

- Types of Ankle Braces
  - Compression Braces
    - Also known as elastic braces
    - Often used to treat mild ankle sprains and tendonitis
    - Made of lightweight stretchable materials that allow normal rotation and movement of the ankle
    - Designed to provide joint support, enhance balance, decrease muscle stiffness by keeping the ankle joint warm, and reduce swelling
    - Can usually be worn on either ankle and are typically sold by shoe size
  - Lace-up Braces
    - Semi-rigid
    - Used to treat mild to moderate ankle sprains
    - Limit side-by-side and up-and-down movement of the joint
    - Provide more support than compression braces
    - Usually fits into a shoe and can go on either ankle
  - Hinged Braces
    - Semi-rigid
    - Prevent the ankle from rolling side-to-side but do not hinder up and down movement
    - Typically have padded sides for comfort and Velcro straps so they can be easily adjusted or removed
    - Made for either the left or right ankle specifically
  - Rigid Braces
    - Usually prescribed to athletes or active people to help them recover from an ankle sprain or stress fracture
    - Made from hard plastic that extends up either side of the ankle and is secured by Velcro straps
    - Usually do not fit inside shoes
    - May be recommended to switch to a less limiting type of brace after the ankle begins to heal

Conclusions/action items:

There are many different kinds of ankle braces that are made for different injuries and treatment plans. For our project, we want the brace to be as inconspicuous as possible. Ideally, this would mean that it would be made to fit inside of a shoe. This fact would eliminate a rigid-type brace. Additionally, we would want to make the brace as comfortable for the client as possible. Many braces use Velcro straps, however, in my experience with knee braces, I have found that these can be quite itchy. The team will have to discuss alternative methods that may make the brace better suited for long-term wear. I have an idea about using a lock and turn type mechanism that may be more comfortable for the patient.

09/10/25 Research: "Facioscapulohumeral Muscular Dystrophy (FSH, FSHD)"

AVERY LYONS - Sep 10, 2025, 3:37 PM CDT

Title: Research: "Facioscapulohumeral Muscular Dystrophy (FSH, FSHD)"

Date: 9/10/2025

Content by: Avery Lyons

Goals: The goal is to research what FSHD is, the symptoms, and treatments.

Citation:

[1] "Facioscapulohumeral Muscular Dystrophy (FSH, FSHD) - Diseases," Muscular Dystrophy Association. Accessed: Sep. 10, 2025. [Online]. Available: https://www.mda.org/disease/facioscapulohumeral-muscular-dystrophy

Content:

- What is FSHD?
  - genetic muscle disorder in which the muscles of the face, shoulder blades, and upper arms are usually the most affected
  - muscular dystrophy is progressive muscle degeneration, with increasing weakness and atrophy
  - third most common type of muscular dystrophy
  - about 4 cases per 100,000 individuals
- What are the symptoms?
  - symptoms usually begin before 20 years old
  - weakness and atrophy of muscles around the eyes and mouth, shoulders, abdominal muscles, upper arms, and lower legs, usually with asymmetric involvement
  - adult-onset of the disease is much more common than infantile-onset that is associated with a larger piece of missing DNA
  - usually progresses very slowly
  - most people have a normal life span
- What causes it?
  - may be inherited through either father or mother
  - can occur without any family history
  - most probable cause if a genetic flaw (mutation) that lads to inappropriate expression of the double homeobox protein 4 gene (DUX4) on chromosome 4, in the 4q35 region

Conclusions/action items:

FSHD most commonly affects the upper body. For our patient, Maggie, it started in her ankle. However, after our recent client call with her mother, we have now learned that it is progressing into her upper body. Additionally, we have learned that Maggie's diagnosis has been in the last few recent years, which makes sense as it is usually diagnosed before 20 years old. It seems to be an uncommon condition, so it is understandable why Maggie wants to keep it and her ankle brace discrete. There are also clinical trials for treatment of it, however, Maggie's mother expressed that she was screened out.

09/17/25 Research: "Commonly Used Types and Recent Development of Ankle-Foot Orthosis: A Narrative Review"

AVERY LYONS - Sep 18, 2025, 9:33 AM CDT

Title: Research: "Commonly Used Types and Recent Development of Ankle-Foot Orthosis: A Narrative Review"

Date: 9/17/2025

Content by: Avery Lyons

Goals: The goal is to research different materials for AFOs.

Citation:

[1] Y. J. Choo and M. C. Chang, “Commonly Used Types and Recent Development of Ankle-Foot Orthosis: A Narrative Review,” *Healthcare (Basel)*, vol. 9, no. 8, p. 1046, Aug. 2021, doi: 10.3390/healthcare9081046.

Content:

- Typical plastic AFO
  - mainly made of thermoplastics such as polypropylene
  - relatively low cost, good aesthetics, easy to clean, easy desorption
  - customized to patient's body
  - consists of a shank shell, foot plate, and Velcro strap with hinges on ankle joints as needed
- Solid AFO
  - applied to completely limit the ankle joint movement in patients with food drop, weak dorsiflexion and/or plantarflexion, ligament injury about the ankle, and mild knee instability
  - example includes a posterior leaf spring orthosis
    - behind the ankle and has a leaf-shaped corrugation near the ankle
    - more elastic and flexible
- Hinged AFO
  - used when ankle movement is permitted but restrictions are required
  - uses hinges to connect two pieces, the shank and foot shells, with hinges usually located on the malleolus side
  - increases ankle dorsiflexion in the terminal stance and increases ankle plantar flexion during the pre-swing phase

Conclusions/action items:

It seems that most AFOs are made of plastic or carbon fiber. This leads me to believe that our choice to use the same material as previous teams, carbon fiber enriched PLA, is a valid choice. None of the braces pictured above would be suitable for our client due to the inconspicuous stipulations, but they are good design examples to keep in mind.

10/05/25 Research: "An experimental study on the wear performance of 3D printed polylactic acid and carbon fiber reinforced polylactic acid parts: Effect of infill rate and water absorption time"

AVERY LYONS - Oct 05, 2025, 9:33 AM CDT

Title: Research: "An experimental study on the wear performance of 3D printed polylactic acid and carbon fiber reinforced polylactic parts: Effect of infill rate and water absorption time"

Date: 10/05/2025

Content by: Avery Lyons

Goals: The goal is to research PLA enforced with carbon fiber.

Citation:

[1] B. Ergene, Y. E. İnci, B. Çetintaş, and B. Daysal, “An experimental study on the wear performance of 3D printed polylactic acid and carbon fiber reinforced polylactic acid parts: Effect of infill rate and water absorption time,” *Polymer Composites*, vol. 46, no. 1, pp. 372–386, 2025, doi: 10.1002/pc.28993.

Content:

- PLA
  - Density (g/cm^3): 1.2
  - Printing temperature (C): 190-220
  - Tensile strength (MPa): 50
  - Young modulus (MPa): 1500
  - Elongation at break (%): 6
- PLA/CF
  - Density (g/cm^3): 1.23
  - Printing temperature (C): 200-230
  - Tensile strength (MPa): 55
  - Young modulus (MPa): 2240
  - Elongation at break (%): 4.8

Material	Infill rate (%)	Average height (mm)	Nominal height (mm)	Accuracy in height (%)	Average diameter (mm)	Nominal diameter (mm)	Accuracy in diameter (%)
PLA	20	19.28 (SD:0.036)	20	96.43 (SD:0.184)	9.93 (SD:0.039)	10	99.35 (SD:0.398)
	60	19.26 (SD:0.037)		96.31 (SD:0.185)	9.94 (SD:0.028)		99.41 (SD:0.288)
	100	19.24 (SD:0.039)		96.23 (SD:0.195)	9.95 (SD:0.039)		99.51 (SD:0.395)
PLA/CF	20	20.23 (SD:0.015)		98.84 (SD:0.078)	9.71 (SD:0.053)		97.12 (SD:0.539)
	60	20.25 (SD:0.018)		98.73 (SD:0.090)	9.63 (SD:0.060)		96.39 (SD:0.604)
	100	20.20 (SD:0.030)		98.98 (SD:0.150)	9.54 (SD:0.072)		95.42 (SD:0.727)

Conclusions/action items:

PLA enforced with carbon fiber is a much better choice for our AFO inversion supports than typical PLA. It has a higher density and is stronger. Additionally, there will be less elongation should there be a break. This means that it would be easier to fix than something made with typical PLA.

10/15/25 MTS Testing Standards: ISO- 527-4

AVERY LYONS - Oct 15, 2025, 1:21 PM CDT

Title: Research of MTS Testing Standards: ISO- 527-4

Date: 10/15/2025

Content by: Avery Lyons

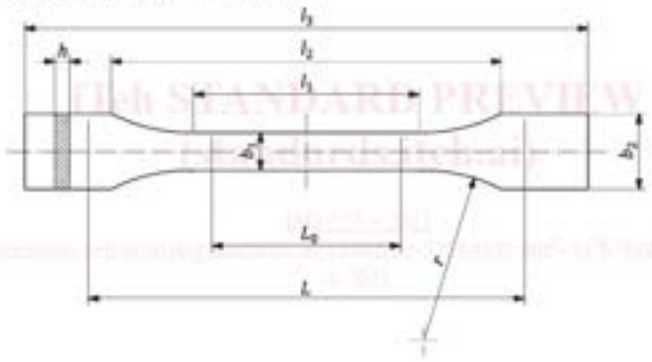
Goals: The goal is to research and review how MTS testing is done safely and correctly.

Citation:

[1] "MTS," MTS. Accessed: Oct. 15, 2025. [Online]. Available: https://www.mts.com/en/applications/materials/test-standard/iso/www.mts.com

Content:

- 1 Scope
- This document specifies the test conditions for the determination of the tensile properties of isotropic and orthotropic fiber-reinforced plastic composites, based upon the general principles given in ISO 527-1.
- NOTE 1 Unidirectional reinforced materials are covered by ISO 527-5. The methods are used to investigate the tensile behavior of the test specimens and for determining the tensile strength, tensile modulus, Poisson's ratios and other aspects of the tensile stress-strain relationship under the defined conditions. The test method is suitable for use with the following materials: iTeh STANDARD PREVIEW (standards.iteh.ai) — fiber-reinforced thermosetting and thermoplastic composites incorporating non-unidirectional reinforcements such as mats, woven fabrics, woven rovings, chopped strands, combinations of such reinforcements, hybrids, rovings, short or milled fibers or reimpregnated materials (prepregs);
- NOTE 2 Injection molded specimens are covered by ISO 527-2. ISO 527-4:2021 https://standards.iteh.ai/catalog/standards/sist/c08bf202-523f-49f0-9df7-3a7b7bdf241c/iso-5274-2021 — combinations of the above with unidirectional reinforcements and multidirectional reinforced materials constructed from unidirectional layers, provided such laminates are symmetrical;
- NOTE 3 Materials with completely or mainly unidirectional reinforcements are covered by ISO 527-5. — finished products made from materials mentioned above. The reinforcement fibers covered include glass fibers, carbon fibers, aramid fibers and other similar fibers.
- 5 Apparatus
- ISO 527-4:2021 https://standards.iteh.ai/catalog/standards/sist/c08bf202-523f-49f0-9df7-3a7b7bdf241c/iso-5274-2021 The apparatus shall conform to ISO 527-1:2019, Clause 5, except for the following: The micrometer or its equivalent (see ISO 16012: 2015, 5.5) shall read to 0,01 mm or better. It shall have a suitable-size ball-ended anvil if used on irregular surfaces and a flat anvil if used on flat, smooth (e.g. machined) surfaces. When using extensometers with specimen type 4, use a gauge length of 25 mm (see ISO 527-1:2019, 5.1.5). It is recommended to check alignment of the specimen and loading train as described in Annex A.
- 6 Test specimens 6.1 Shape and dimensions Four types of test specimen are specified for use with this document, as detailed and illustrated in Figure 3 (type 1 B), Figure 4 (types 2 and 3) and Figure 5 (type 4). Type 1B is for testing fiber-reinforced thermoplastics. Type 1B specimens may also be used for fibre-reinforced thermosets if they break within the gauge length. Type 1B shall not be used for multidirectional, continuous-fiber-reinforced materials. Type 2 is rectangular without end-tabs, and Type 3 is rectangular with bonded end-tabs. They are for testing fiber reinforced thermosets and thermoplastics. Specimens with unbonded end tabs are considered as type 2. 5 © ISO 2021 – All rights reserved ISO 527-4:2021(E) The preferred width of type 2 and type 3 specimens is 25 mm, but widths of 50 mm or greater may be used if the tensile strength is low due to the particular type of reinforcement used. Type 4 is tapered without end-tabs and for testing fibre-reinforced composites, especially for testing multidirectional, continuous-fibre reinforced thermoplastics. Please refer to Annex B. The thickness of type 2, type 3 and type 4 specimens shall be between 2 mm and 10 mm. To decide whether to use specimen with or without tabs, first carry out tests without using tabs (specimen type 2 [rectangle] or type 4 [tapered]) and, if the tests are not successful, i.e. if almost all specimens break in the grips (see Clause 7), perform test with bonded end tabs on the specimens (specimen type 3). Refer to Annex C for guidance on unbonded tabs or gripping condition without tabs using fine grip faces and careful control of the gripping force. NOTE Continuous fiber reinforced composites typically have high fracture forces due to high tensile strength of their fibres. Using specimen thicknesses larger than 4 mm can require an increased clamping length to counter high clamping pressures. The recommended specimen thickness for continuous-fibre-reinforced composites is 2 mm. For compression-moulded materials, the thickness between the end-pieces of any type of specimen shall at no point deviate from the mean by more than 2 %.



Symbol	Name	Dimensions in millimetres
l_3	Overall length [a]	≥150
l_1	Length of narrow parallel-sided portion	60,0 ± 0,5
r	Radius [b]	≥60
b_2	Width at ends	20,0 ± 0,2
b_1	Width of narrow portion	10,0 ± 0,2
h	Thickness	2 to 10
L_0	Gauge length (recommended for extensometers)	50,0 ± 0,5
L	Initial distance between grips	115 ± 1

[a] For some materials, the length of the tabs can be extended (e.g. so that l_3 = 200 mm) to prevent breakage or slippage of the specimen in the jaws.

[b] It should be noted that a thickness of 4 mm gives a specimen which is identical to the type 1B specimen specified in ISO 527-2.

Figure 3 — Type 1B specimen

Conclusions/action items:

This standard can be used when doing MTS testing for the AFO.

09/22/25 Competing Designs Research: Push ortho AFO and Saebo Foot Drop Brace

AVERY LYONS - Sep 22, 2025, 4:46 PM CDT

Title: Research: "Push ortho AFO and Saebo Foot Drop Brace"

Date: 9/22/2025

Content by: Avery Lyons

Goals: The goal is to research competing designs of AFOs on the market today.

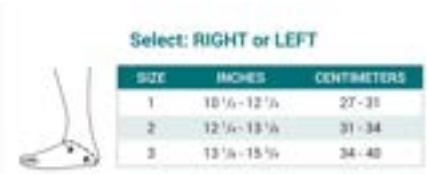
Citation:

[1] "Push ortho Ankle Foot Orthosis (AFO)." Accessed: Sep. 22, 2025. [Online]. Available: https://bracelab.com/push-ortho-ankle-foot-orthosis-afo.html

[1] "SaeboStep Foot Drop Brace | Best Soft AFO - Stroke," Saebo. Accessed: Sep. 22, 2025. [Online]. Available: https://www.saebo.com/products/saebostep

Content:

- Push ortho AFO
  - can be ordered for right or left foot
  - sizes 1-3
  - price: $319.99
  - drop foot brace design supports normal ankle movement during walking
  - lifts the foot in the swing phase and controls the foot's stability while walking, not impeding the natural movement of toes or forefoot
  - created from "moisture wicking Sympress microfibers"
  - can wear with many shoe styles, including sandals and slippers
  - can be worn to sleep in
  - machine washable
  - not recommended for those with loss of plantar flexion or have moderate to severe spasticity or extreme foot deformity
- Saebostep Foot Drop Brace
  - price: $199.00, on sale for $179.00
  - outside the shoe support system
  - wearable with all shoe styles
  - can be worn barefoot with a barefoot accessory kit also sold by the company
  - "twists and quickly adjust your foot's lift angle for safe walking"
  - magnetic clip to fasten
  - durable spectra cords
  - twist to release
  - not for flaccid/lose foot or ankle or moderate to severe tightness or spasticity of the foot or ankle or moderate to severe swelling
  - not discrete at all



Conclusions/action items:

The Saebo Foot Drop Brace seems extremely similar to the Fall 2024 design with the bungee cord. It is more affordable than the previous option, but not discrete at all. Additionally, to wear it with no shoes, you need to purchase an additional accessory from the company. The first product, the Push ortho AFO, seems more similar to the design that we are thinking for Fall 2025. It utilizes elastic straps, which is our current plan for the new design. It seems that a mixture between these two products is what our product will come out to be. Hopefully, however, our product will be much more affordable.

09/14/25 Design Ideas

AVERY LYONS - Sep 14, 2025, 1:47 PM CDT

Title: Design Ideas

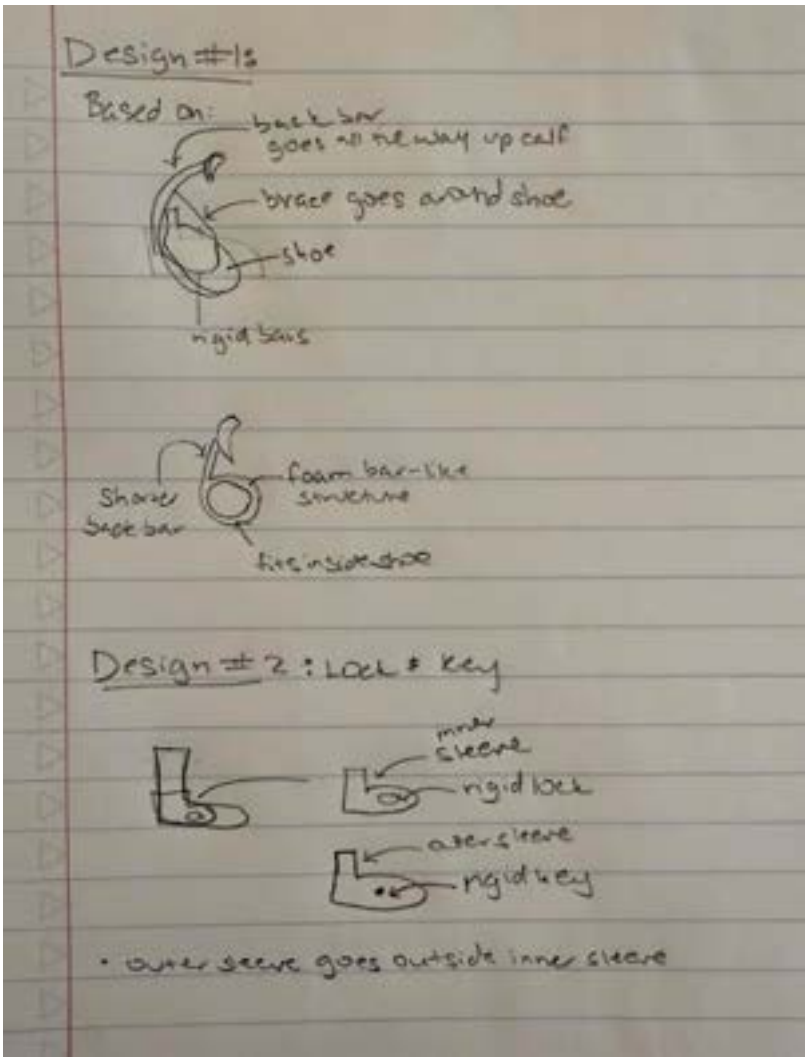
Date: 9/14/2025

Content by: Avery Lyons

Goals: The goal is come up with design ideas for an AFO.

Content:

- Design #1: Inner brace
  - brace goes around foot inside shoe
  - shorter back bar to be more inconspicuous
  - foam-bar like structure
  - bottom piece for stability
- Design #2: Lock and Key
  - 2 sleeves: inner and outer
  - inner sleeve has rigid lock
  - flexible, compressive sleeve
  - outer sleeve has rigid key
  - fit lock and key mechanisms together, and twist key mechanism to lock the two sleeves together



Conclusions/action items:

Design #2 may not provide enough support for dorsiflexion and foot drop. Design #1 may be difficult for Maggie to wear inside the house as it is designed specifically for a shoe. Design #1 may be able to be altered to be comfortable both with/without shoes. The bottom piece can be added on for inside wear and taken off for outside (shoe) wear.

CITI Program Completion

AVERY LYONS - Oct 25, 2025, 2:50 PM CDT

CITI PROGRAM

Completion Date 25-Oct-2025
Expiration Date 25-Oct-2028
Record ID 73197499

This is to certify that:

Avery Lyons

Not valid for renewal of certification through CME.

Has completed the following CITI Program course:

Basic/Refresher Course - Human Subjects Research
(Curriculum Group)
UW Human Subjects Protections Course
(Course Learner Group)
1 - Level 1
(Stage)

Under requirements set by:

University of Wisconsin - Madison

CITI
Collaborative Institutional Training Initiative
101 NE 3rd Avenue, Suite 320
Fort Lauderdale, FL 33301 US
www.citiprogram.org

Generated on 25-Oct-2025. Verify at www.citiprogram.org/verify/?wbf68bd8e-5f57-453e-85a9-8d8f42e5b6e3-73197499

2025/09/10- Lecture 1 Notes

AVERY LYONS - Sep 10, 2025, 2:08 PM CDT

Title: Lecture 1 Notes: BME Career Prep

Date: 09/10/25

Content by: Avery Lyons

Present: BME 300

Goals: The goal is to understand how to prepare for the career fair and searching for jobs.

Content:

- Job Search Tips
  - Keep track of what you do: ECS tracking sheet
  - Quality of source matters: LinkedIn, Indeed, Handshake
  - Connect BEFORE you're a candidate: use your people
  - Applying is step 1: follow-up is required in 2-3 weeks
  - Think beyond the title: focus on skills, industry, exposure
  - It takes time!
- Resume Tips
  - Tailor your resume to the position: quick changes
  - Always under construction
  - Create balance: show a full picture of your experience
  - ATS approved resume is do-able: MS Word, No columns, charts, and colors, Design projects WITHOUT years or semesters, Technical skills and coursework, past jobs
- Cover Letter Tips
  - ALWAYS based on job posting
  - CUSTOM to each job
  - Amplifying your greatest selling points
  - Clear and concise support
  - Demonstrate employer knowledge
  - Address to person
  - Recommended vs. required
  - Outline- BASICS
    - Intro: who you are, applying for, where you found it, and "thesis" statement
      - "Based on my experience in A and B, I believe that I would be able to make a difference in the X role at Y company."
    - Paragraph all about A
    - Paragraph all about B
    - Why employable and closing next steps
- Career Fair Advice for BMEs
  - Identify your purpose- more than just an internship
  - Looking beyond the obvious- overlap with other disciplines
  - Research the employer- feedback from our partners
  - Develop your "value added"- why you?
- Companies
  - Epic
  - AbbVie
  - GE Healthcare
  - Plexus Corp
- Career Fair Details
  - September 15-18, 2025
  - EH Lobby, ME Lobby, and ECB Lobby

- Different employers each day
- Wear business/business casual

Conclusions/action items:

I need to take the dates/semesters off my projects on my resume. I have contacts with many of the companies that I am applying to, so I believe that I am all set there. I have not yet been asked for a cover letter, but I did not know how to write one before this lecture. I am applying to almost all jobs through their direct company portal, so I am all set there as well. This lecture also gave me a few more companies to look into and apply to.

2025/09/17- Lecture 2 Notes

AVERY LYONS - Sep 17, 2025, 2:06 PM CDT

Title: Lecture 2 Notes: Exploring your Leadership Style

Date: 09/17/25

Content by: Avery Lyons

Present: BME 300

Goals: The goal is to understand my leadership style and how I can use that to help/mentor the BME 200s in my group.

Content:

- Leadership: how do you define a leader?
  - Do you consider yourself a leader? Why/why not?
  - What are important qualities of a leader?
  - Anatomy of a good leader
    - self-awareness
    - vision
    - transparent
    - communication
    - decision-making
    - empathy
- Clifton Strengths
  - Identifies areas of talent
  - strength-based approach
- Power model of leadership
  - thought process: "someone has to take control, and it should be me"
  - defining qualities: "great man theory" and trait theory- only certain people born to lead
- Authentic: My boss this past summer in Washington D.C. NSCEB internship was very transparent, genuine, and tried to help me in any way possible.
- People Oriented Leader vs. Process Oriented Leader vs. Thought-Oriented Leader vs. Impact Oriented Leader (What I think I am)
  - 1. glue that holds the team together
  - 2. sets the pace for the team
  - 3. sees the big picture
  - 4. set bar high and push for excellent performance
- Leadership doesn't require a particular job title
  - self-assess
    - what you enjoy (motivations), what you're good at (strengths), and what drives you (values)
  - observe and reflect
    - what are tasks and experiences that give you a sense of accomplishment?
  - seek out feedback
- Goal-setting
  - I would like to practice my team leadership skills by helping a BME 200 student to try something new when it comes to fabrication this semester. Previously, I have been very hesitant to try using machines that I have not previously used. For example, last fall I was very nervous to use the water jet because I had never used it before, but I felt better because I had a BME 300 teammate with me. I would like to do the same for one of my BME 200 teammates this year whether it be the water jet or something else. I think this would build better trust between me and my teammates. When it comes time for fabrication, I can ask a BME 200 student if they would like to accompany me when using one of the machines that may be new to them.

Conclusions/action items:

I intend to talk to the BME 200 students in our group and ask them about how they prefer to be led/what is or is not helpful. I will also take steps in accomplishing my goal by getting a sense of what machines we will be using for our fabrication. I will volunteer to use these machines and then ask a BME 200 if they would like to learn how to use it as well (permitting they have their mill/lathe training done).

2025/09/24- Lecture 3 Notes

AVERY LYONS - Sep 24, 2025, 5:17 PM CDT

Title: Lecture 3 Notes: Near Peer Mentoring by Professor Tracy Puccinelli

Date: 09/24/25

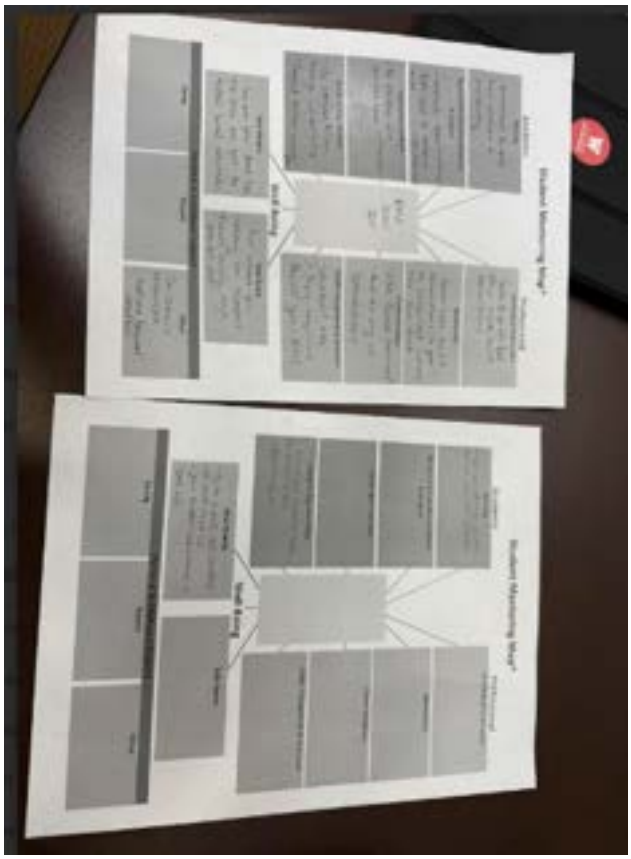
Content by: Avery Lyons

Present: BME 300

Goals: The goal is to understand my how I can be a better mentor for BME 200 students.

Content:

- Why are you mentoring BME 200 students?
    - learn about future coursework and ask class advice
    - get different track perspectives
    - learn about the design process and the right way to make a notebook
    - instructional and emotional support for BME 200 students
    - peers are more approachable than professors/faculty
    - share research, internship, and co-op experiences
    - increases belonging
    - transferrable skills
        - leadership
        - communication
        - active listening
        - study practices
        - self awareness
        - interpersonal skills
- Benefits of Mentoring
    - increased self-esteem/confidence
    - increased patience
    - build positive habits
    - foster personal growth
    - identify self gaps
- What do you think it means to be a good mentor?
    - answer questions, even the small ones
    - give advice on how to best succeed in classes
    - show examples of work that you expect
    - help create a sense of responsibility within students
    - organized and communicative and reliable
    - psychological safety (share w/o fear)
- Listening Effectively
    - get rid of distractions
    - stop talking
    - act like you're interested
    - look at the other person
    - get the main idea and ask questions
    - check for understanding
    - react to ideas and not the person
    - avoid hasty judgements
- What do you wish you knew in BME 200?
    - CAD
    - Zotero
    - Jeff Hanson (EMA classes)



Conclusions/action items:

I intend to talk to my BME 200 students about the resources listed above such as CAD, SolidWorks, Zotero, and Jeff Hanson YouTube videos for EMA classes. Additionally, I will ask them if they have any questions that Alex and I can answer, from class choices and tracks, to college in general. This week, our group will continue work on the Progress Report, finish the Design Matrix and drawings, and begin work on Preliminary Presentation slides.

2025/10/01- Lecture 4 Notes

AVERY LYONS - Oct 01, 2025, 1:59 PM CDT

Title: Lecture 4 Notes: Sustainability in Design

Date: 10/01/25

Content by: Avery Lyons

Present: BME 300

Goals: The goal is to understand my how I can be more sustainable in my designs.

Content:

- What is sustainability?
  - everything we need for survival and well-being
- 3 totems of sustainability
  - Social
  - Environment
    - recycling
    - taking away paper on doc office tables
  - Economic
    - aluminum cans recycled get paid by pound
    - other countries (e.g. Germany) they have "bottle bills"
    - taking away paper on doc office tables
- Keurig vs. Coffee pot
  - both the same
  - biggest environmental impact of brewing coffee is energy to grind beans and shipping beans to U.S.
  - life cycle assessment
    - answer questions without bias
- Plastic vs. Metal Utensils/Medical Devices
  - need autoclave for metal (reusable)
    - good if you do a lot of procedures
  - immediately throw out plastic: single use
    - good if you don't do a lot of procedures
- Supply vulnerabilities
  - difficult to get?
  - geopolitical instability?
- Strap options
  - 3D print
    - recyclable? most likely not due to carbon fiber infill
    - try to print as little as possible to reduce emissions and waste of materials
  - polyester

Conclusions/action items:

This helps when considering materials for our AFO and the straps. In the broader scheme of things, choosing materials depends on many factors (eg. how many uses is the product intended for?). Different states have different sustainability laws and opportunities. For example, only some states let you recycle glass. Additionally, in Wisconsin, you can turn in crushed cans for money. In Michigan, however, they cannot be crushed.

2025/10/08- Lecture 5 Notes

AVERY LYONS - Oct 08, 2025, 2:05 PM CDT

Title: Lecture 5 Notes: Intro to WARF, IP, Disclosing, and Licensing

Date: 10/08/25

Content by: Avery Lyons

Present: BME 300

Goals: The goal is to understand how WARF and IP work, as well as how to go about disclosing and licensing products.

Content:

- What is WARF?
    - non-profit
    - uses technology transfer to facilitate securing IP rights and commercial licenses
- Technology transfer examples
    - IP licenses
    - industry sponsored research
    - consulting arrangements
    - fee for service
- IP Overview
    - 4 common types of IP
        - Patents
        - copyrights
        - trademarks
        - trade secrets
    - Other, WARF IP:
        - Biomaterials
        - technique and know how (like trade secrets)
        - data
    - Non-patient IP
        - Copyrights
            - protection for creative works that are expressed in a tangible medium
            - wide range of subject matter, including software code
        - Trademarks
            - protection for names, marks, logos, dress, etc.
            - requires use in commerce
            - source-identifying function
        - Trade Secrets
            - can be used to protect anything of value
            - protection is good so long as the concept is not generally known
- Patents generally
    - property right, granted by a governmental agency
        - e.g. US Patent and Trademark Office (USPTO)
        - No global patent
        - patent holder has right to exclude others from making, using, selling, or importing the claimed invention
    - 3 types in US
        - Design
            - 15 year term, limited to ornamental features
        - Plant
            - new variety, 20 year term, asexually reproducing, non-tuber
        - Utility
            - provisional (like a 1-year placeholder)

        - most common at UW-Madison
        - covers new and useful process, machine, manufacture, or composition of matter
        - exchange with government
            - applicant get 20 years from filing to have a time limited monopoly on invention
        - often takes 2-5 years to issue after filing
    - Requirements
        - eligible
            - cannot be a product of nature, natural phenomenon, or abstract idea
        - novel
            - must be new
        - non-obvious
            - cannot be a simple modification or combination of existing concepts
        - enabled and described
            - must provide enough detail to teach others how to make or use the application
- Disclosing an innovation to WARF
    - WARF receives about 400 new innovation disclosures each year
    - Disclosing:
        - describe the innovation
        - identify advantages and potential applications
        - name contributors
        - provide funding and public disclosure details
    - Meeting with WARF:
        - Discuss the innovation in more detail
        - ask questions about WARF and patenting process
        - discuss next steps
- Assessing university inventions
    - IP Considerations:
        - type of IP protection
        - potential breadth and strength of IP protection
        - public disclosure (past and planned)
        - stage of development
    - Licensing Considerations:
        - applications
        - likelihood of identifying a commercial partner
        - likely return from licensing
- Marketing and Licensing
    - Market Analysis
        - market status
        - size and type
        - potential licensees
    - License Negotiation
        - type and terms
        - consideration
    - Ongoing
        - technology development, enforcement, amendment, and termination
- Value of Licensing
    - Benefits to the company
        - reduced R&D costs
        - improved time to market
        - opportunity to enter new markets
- AI and IP
    - Patents
        - AI cannot invent
        - AI can assist in inventing under Pannu Factors
    - Copyright

- original works of human authorship
- AI must be incidental to conception and creation
- original conception by human master mind
- combinations of derivative works requires more than de minimis contribution from human

Conclusions/action items:

We will discuss if we think our AFO design can be patented. Once it is made, we will go through the 4 requirements and see if it meets these.

2025/10/15- Lecture 6 Notes

AVERY LYONS - Oct 15, 2025, 2:10 PM CDT

Title: Lecture 6 Notes: Bioengineer It. Protect it.

Date: 10/15/25

Content by: Avery Lyons

Present: BME 300

Goals: The goal is to understand more about intellectual property from an attorney.

Content:

- Importance of IP for BMEs
  - BMEs create life-changing solutions
  - IP protection allows research to safety transfer into products, processes, and/or systems
    - medical device --> patent filing --> marketplace
  - IP enables investment, partnerships, and ethical competition
- Building your IP Knowledge
  - Legal career paths for BMEs
    - Technical Advisor: STEM degree
    - Patent Agent: STEM degree + Patent Bar
    - Patent Examiner: STEM degree + Patent Bar eventually
    - Patent Attorney: Law degree + Patent Bar
    - Patent Litigator: Law degree (STEM degree + Patent Bar optional)
    - IP License Attorney: Law degree (STEM degree + Patent Bar optional)
    - Tech Transfer Manager: STEM degree preferred (Law degree optional)
    - Engineer: STEM degree (work with IP lawyers to protect your inventions)
  - Protecting inventions and ownership
  - patent protection, searches, and infringement
  - trademark, copyright, and trade secret protection
    - counterfeit products in the BME industry
- Skills from Engineering to IP
  - Research- determine if invention is truly new
  - Analytical reasoning- claim drafting/ infringement analysis
  - technical writing- translate complex technical concepts into clear, precise language
  - communication- explaining tech to non-experts and Patent Examiners
  - creativity- problem solving in patents / creating competitive products
  - collaboration- cooperate with colleagues and external professionals
  - project management- manage resources, meet deadlines, and organize tasks
- IP Ownership in the BME Industry
  - University
    - disclose before publishing; university usually owns IP; possible license opportunities
  - Company
    - employer typically owns inventions, trademarks, copyrights, and other IP; review employee agreements
  - Startup
    - you own IP; file early, use NDAs, document development
- Timing and Publication
  - Disclose internally first
  - Publishing before filing and offers for sale = lost patent rights abroad and possible loss of rights in the US
  - Posters or abstracts can count as public disclosures
  - first to file system (not first to invent)
- Legal and Ethical Duties of Engineers
  - respect others' IP

        - Keep invention notebooks
        - understand inventorship vs. authorship
        - maintain confidentiality agreements
- BME Startups
    - invent something new, novel, and non-obvious
    - conduct patentability search / FTO
    - File patents early
    - use NDAs
    - file trademarks / obtain domain names
    - form business entity / assign IP rights
    - Obtain business insurance
    - funding, licensing, and franchising
- Patents
    - Creates a monopoly
    - stops others from making, using, selling, or importing the invention
    - 2 types
        - Utility: how it works (20 years)
        - Design: how it looks (15 years)

Conclusions/action items:

Our team is thinking of trying to get a patent. This means that we need to ensure that we do not accidentally disclose anything publicly or even use AI sites such as ChatGPT. This could ruin our chances of getting a patent. Additionally, I will do further research this week to see if our design would even qualify as something "new". Our use of LabArchives, however, is great documentation as an invention notebook and dated source.

2025/10/22- Lecture 7 Notes

AVERY LYONS - Oct 22, 2025, 2:00 PM CDT

Title: Lecture 7 Notes: BME Advising- Post Grad Planning

Date: 10/22/25

Content by: Avery Lyons

Present: BME 300

Goals: The goal is to make post-grad plans and learn about opportunities.

Content:

- General Pointers
  - Use undergrad to build a story
  - Do your homework on careers
  - Think about letters of rec: have 3 strong ones
  - Prepare for MCAT OR GRE
- Writing Your Story
  - General: Start with what you want to do- thesis statement
    - Your narrow experiences and how that applies to your broad interest
    - specific to each position
  - Personal Statement
- Grad School Options
  - Masters, MS
    - Stepping stone
      - Med school
      - PhD
    - Industry focused
    - Generally one year
    - Makes you more despirable
      - Fill resume gaps
      - higher level of skills- more lab time and less class time
      - more experiences
      - older, more maturity
  - Doctoral, PhD
    - Desire to be an independent researcher
    - write research grants
    - work in academia
    - lead projects in industry, startups, consulting
- 3 options for MS in BME
  - Research (1.5-2 years)
  - Accelerated (1 year)
    - Accelerated
      - coursework only
      - independent study/research allowed
    - Biomedical Innovation, Design, and Entrepreneurship
      - project-based
      - partnership with business school
- Applying for BME Accelerated MS Programs
  - Apply online, pay fee, and submit: Fall and Spring start available
  - Special for UW BME BS students
    - no 3 letters of rec
    - need to input rec email addresses

        - Research MS only: At least one letter from PI that has agreed to mentor
        - Deadline of 12/15; spring entry allowed
        - need at least a 3.0 overall or a 3.0 in last 60 credits
- Masters elsewhere
    - MEng
    - MS in Global Health
    - MS in other Engineering department
    - MBA- generally industry pays for credits or evening options
- Research
    - Follow your passion, who else working in your area?
        - Network
        - Conferences
        - Utilize your lab PI here = collaborators
    - Build your resume
        - Research experience for undergrads- summer
        - Research is a must
    - External Funding NSF- GRFP
        - Due October 15
        - Apply Fall senior year
        - UW hosts workshops
- PhD application process
    - apply early and list names - most do rolling review
    - generally above 3.5 GPA and 75% Quantitative GRE
- Pre health requirements
    - two semesters of general chemistry
    - chemistry 344 & 345
    - 2 semesters of physics, ema 201 and 303
    - 2 semesters of english
    - biochemistry 501
    - psychology 202 and sociology
    - volunteer in clinical setting
    - research!

Conclusions/action items:

I will look at my DARS again to ensure I am doing everything to graduate within the next 2 years. Additionally, I am looking at internships for this summer.

2025/10/29- Lecture 8 Notes

AVERY LYONS - Oct 29, 2025, 2:09 PM CDT

Title: Lecture 8 Notes: "Regulatory Pathways"

Date: 10/29/25

Content by: Avery Lyons

Present: BME 300

Goals: The goal is to understand regulations and the FDA.

Content:

- General
  - FDA has 3 major sectors
    - Devices vs. biologics vs. drugs
  - Does not make something is safe; just weights benefits vs. risks
- FDA Drug Path
  - Phase 1 Trial
    - healthy volunteers, determine side effects, how drug is metabolized and excreted
    - 20-80 patients
    - safety emphasis
  - Phase 2 Trial
    - begin if no toxicity in Phase 1
    - emphasis on effectiveness
    - preliminary data on whether drug works for condition
    - safety evaluated
    - few dozen-300 patients
  - Phase 3 Trial
    - begin if evidence of effectiveness in Phase 2
    - studies gather more information about safety and effectiveness, studying different populations and different dosages and using the drug in combination with other drugs
    - several hundred-3000 patients
- Devices
  - Class 1
    - Low risk
  - Class 2
    - Moderate/Controlled risk
    - HDE vs. 510k pathway
  - Class 3
    - High risk
    - PMA vs. HDE pathway
  - Brief History of Medical Devices
    - not regulated until 1976
    - pace makers put into patients before regulation
    - some doctors think we should go back to no/less regulation because animal subjects are not great for testing
    - Dalkon Shield stimulated regulations on medical devices
      - didn't stop pregnancy
      - huge rate of complication including maternal death and septic pregnancy
- FDA's Early Feasibility IDE Review: From FDA/Faris
  - focused on safety
  - critical issues - reasonable study conceptually?
    - adequate preclinical validation of device?
    - why is clinical really the next necessary step?

        - appropriate mitigation of potential risks?
        - appropriate enrollment criteria, are patients adequately informed of risks?
        - sample size appropriate?
- Hazard analysis- top down approach; start with hazard and work back to potential causes and risk mitigation strategy
- Failure Modes and Effects Analysis (FMEA)- bottom-top approach; start with each component, and imagine what would happen if something goes wrong
    - often the source for specific hazards in the hazard analysis and subsequent risk mitigation strategy
- Pathway to use products without FDA approval
    - Compassionate Use Exemption
    - Emergency Use Authorization
    - Off-Label Use
    - Basic Physiological Research Exemption

Conclusions/action items:

The FDA does not deem anything safe, thus why there are recalls. They place medical devices into 3 classes based on risk. Drugs are tested in 3 phases. Recalls can mean very little to big companies with many products, but can be detrimental to start-ups. For our project, we need to think about all possible risks and how to mitigate them.

2025/11/05- Lecture 9 Notes

AVERY LYONS - Nov 05, 2025, 1:43 PM CST

Title: Lecture 9 Notes: "Bringing biologics to market"

Date: 11/05/25

Content by: Avery Lyons

Present: BME 300

Goals: The goal is to understand the process of bringing biologics to market.

Content:

- FDA Structure and Advanced Therapeutics
  - Device (CDRH)
    - PMA
    - 510(k)
    - IDE
  - Drug (CDER)
    - NDA
    - IND
  - Biologic (CBER)
    - BLA
    - IND
  - Gene Delivery, Cell Therapy, and Genome Editing
- Risks and Safety Concerns
  - Minimally manipulated?
  - Homologous use?
  - Combined with another article?
  - Systemic effect or dependent on metabolic activity of cells?
- Target Profile is Product Vision
  - When to use it?
  - Why to use it?
  - How to use it?
  - Patient identification: indication
  - Patient benefits: efficacy profile
  - Patient risks: safety profile
  - Is it medically and commercially compelling?
- Time = $$
- Quality Management System Implementation
  - Asset Management
  - Equipment Management
  - Document Management
  - Audits and Inspections
  - Corrective and Preventative Actions
  - Supplier Management
  - Training Management
  - Risk Management

Conclusions/action items:

There are many career opportunities for BMEs in biologic regulations, testing, and development. Additionally, the most important aspect when developing biologics and bringing them to market is safety for patients that will be taking them. The biologic needs to go through rigorous testing and safety protocols to ensure that it is of supreme quality and safe for pubic use. No shortcuts!

2025/11/07- Tong Lecture Notes

AVERY LYONS - Nov 07, 2025, 12:42 PM CST

Title: Tong Lecture Notes: "Why Healthcare Needs More Engineers" with Kristin Myers

Date: 11/07/25

Content by: Avery Lyons

Present: BME 300

Goals: The goal is to understand why healthcare needs more engineers.

Content:

- The Story
  - Chapter 1: The Foundation
    - Grew up in Wisconsin and swam
    - worked many jobs: nanny, graded papers, TA, etc.
    - 4 internships and co-ops: Baird, ABIOMED, Guidant, Medtronic
    - worked in VC firm in California that invested in medical device and pharmaceutical start-ups
    - worked at VC firm in Michigan
  - Chapter 2: The Growth Curve
    - Was Chief of Staff to the CEO of Aetna (became part of CVS)
      - became President of Student Health
      - became President of the Great Lakes Region - Commercial & Medicare
    - started a cycling studio: tribe
    - was President and COO of Unified Women's Healthcare
      - network of OBGYNs
  - Chapter 3: Build and Transform
    - was Founder and CEO of Advanced Primary Care for Rural Communities for Hopscotch Health
    - Currently: COO of Blue Cross Blue Shield
- The Healthcare System
  - Quadruple Aim
    - Improved Provider Experience
    - Improved Patient Outcomes
    - Lower Cost of Care
    - Improved Patient Experience
  - How much do we spend on healthcare in the US?
    - $5.3 Trillion or 18% of GDP
    - 2x other countries
  - US
    - ranked last on equity, access, and outcomes
    - >900 insurers
    - >1000 EHRs
    - ~ 6000 hospitals
    - misaligned incentives
    - fragmented financing and regulation (federal, state, and employer)
    - inequities (10-15 year between zip codes)
  - What's required to build a better healthcare system?
    - Interoperable Data Infrastructure
    - Human centered design
    - aligned incentives and measurement
- 5 Things!
  - 1) Work hard and build range
    - take on the hardest projects, classes, and experiences you can find

        - effort and range are your foundation
    - 2) Seek diverse exposure
        - explore different sectors, teams, and geographies
        - gain perspective and learn how systems connect, not just how parts work
    - 3) Choose your people wisely
        - surround yourself with curious, driven, and high-integrity people
        - they will shape and change who you become
    - 4) Know your values and protect them
        - define what matters most- family/friends, health, career/impact, and values- make decisions that align
    - 5) Embrace challenges and keep growing
        - run towards the hard problems
        - growth lives on the edge of discomfort- where big impact starts

Conclusions/action items:

There are many career opportunities for BMEs in biologic regulations, testing, and development. Additionally, the most important aspect when developing biologics and bringing them to market is safety for patients that will be taking them. The biologic needs to go through rigorous testing and safety protocols to ensure that it is of supreme quality and safe for pubic use. No shortcuts!

2025/11/12- Lecture 10 Notes

AVERY LYONS - Nov 12, 2025, 2:51 PM CST

Title: Lecture 10 Notes: "Do I need an IRB?"

Date: 11/12/25

Content by: Avery Lyons

Present: BME 300

Goals: The goal is to understand how research and the IRB works.

Content:

- Historically Problematic Research
  - WWII Nazi prisoner experiments
  - US Public Health Service Untreated Syphilis Study at Tuskegee
- Ethical Research Frameworks
  - Nuremberg Code
  - Declaration of Helsinki
  - National Research Act of 1974
- Belmont Report
  - Respect for Persons/Autonomy
  - Beneficence
    - maximize possible benefits and minimize possible harms
  - Justice
- Applying Belmont Principles
  - 1991 Department of Health and Human Services
    - Common Rule
      - Criteria for approving research
      - Protections for vulnerable groups
      - Requirements for IRB operations
  - 2018 Revised Common Rule
    - modifications to reduce administrative burden
- IRB Composition
  - Diversity of membership required
    - race, gender, cultural backgrounds
    - scientific expertise
      - MD, PhD, MPH
      - Faculty, clinicians
    - Non-scientists
      - community members
      - IRB staff
- IRB Purpose
  - protect rights and welfare of people enrolled in research
  - review human research according to:
    - ethical principles
      - Belmont Report
    - Federal regulations
      - Common Rule, HIPAA, FERPA
    - State laws
    - institutional policies
- IRB Review Requirements
  - UW-Madison requires IRB review of all research involving human subjects, including exempt human subjects research
  - research cannot begin until IRB has reached a determination
- Examples of Applicable research

        - drugs, devices, or products developed through research in humans
        - data from surveys, interviews, and observatoion
        - employment information or records of earnings
        - medical records
        - bodily materials
- HIPAA Considerations
    - directly identifiable
        - identifiers included with data
    - coded/indirectly identifiable
        - identifiers removed from data but linked via study ID code
    - anonymized/deidentified
        - all identifiers removed
- HIPAA Resources
    - UW HIPAA website
    - De-identification policy
    - US Department of Health and Human Services website
- Exemptions defined
    - Category 2: Research involving surveys and interviews
    - Category 3: research involving benign behavioral interventions
    - Category 4: research with data and samples
- Non-exempt research
    - surveys of children
    - analysis of identifiable samples
    - intervention with participants that goes beyond Category 3
        - blood draws, blood pressure, yoga, wearing an activity patch
    - administering a drug
    - device studies
        - prostheses
        - contact lenses
        - diagnostic software
        - bandage adhesive
- IRB Review Process
    - Administrative Review
    - IRB Pre-Review
    - Committee or Non-committee review
    - begin your study after approval!

Conclusions/action items:

Our project would count as a medical device and would need IRB approval for any studies being conducted. We will look into this further at our meeting especially because we want to try for a patent.

2025/11/19- Lecture 11 Notes

AVERY LYONS - Nov 19, 2025, 1:57 PM CST

Title: Lecture 11 Notes: "How New Product Development Works in the Medical Device Industry"

Date: 11/19/25

Content by: Avery Lyons

Present: BME 300

Goals: The goal is to understand how product development works in the medical device industry.

Content:

- NPD in medical device industry is
  - highly regulated: FDA and other regulatory bodies
  - Expensive: requirement for verification and validation (e.g. clinical trials) is a cost multiplier
  - resource intense
  - competitive: speed to market is crucial
- Selecting and prioritizing projects
  - Corporate Business Strategy --> Product Portfolio Review --> Project Review --> Budgeting and Resource Allocation
- Types of NPD Projects
  - Line extensions: addition of additional sizes and configurations
  - Product Improvements: existing product change due to market feedback
  - New-to-company: product line that is not new to market but is new for company
  - New-to-world: innovative products that create completely new markets
    - most resource intense
    - most team members
- Managing NPD: Stage-Gate Process
  - Stage 0: Ideation
  - Stage 1: Exploration
  - Stage 2: Concept Development
  - Stage 3: Design Development
  - Stage 4: Verification/Validation Testing
  - Stage 5: Design Transfer and Commercialization
  - gate reviews at each stage (e.g. Go/No-Go Decision, Design Freeze, Launch)
  - post market surveillance
    - follow up with customers to ensure safety, quality, etc.
- Case Study: Fluid management solutions for high volume cases existing in 2007
  - Current Designs
    - Manual: suction canisters
    - Automated: Stryker Neptune
  - Stage 0: Ideation
    - choose area of opportunity
    - review market trends and/or competitive threats
    - conduct primary and secondary market research
    - identify customer unmet needs
    - create high level, "back of the napkin" ideas
  - Stage 1: Exploration
    - Define problem to be solved and customer requirements
    - Review, refine, and screen list of ideas from Stage 0 for exploration
    - create concepts for 8-10 ideas
    - develop high-level business case
      - market size, value proposition, etc.
  - Stage 2:
    - Based on customer interviews and use case assessments, down select from 8-10, 2-3, to 1 leading concept

        - develop robust business case including market opportunity, initial forecast, and projected expenses
        - conduct comprehensive IP examination
        - next gate review is "go / no-go" decision
    - Stage 3:
        - move to functional prototype
        - continue iterative design process including initial testing and reviews with customers
        - confirm regulatory pathway
        - begin formal design control documentation
            - mandatory for FDA class 2 and 3 and almost all EMA devices
            - includes documentation of customer needs, design requirements, etc.
    - Stage 4:
        - conduct extensive verification and validation testing
        - finalize product and component drawings/models
        - accelerate manufacturing process development along with plans for quality control (make vs. buy)
        - "freeze" design at the end of this stage
        - submit regulatory documentation (e.g. FDA 510k)
    - Stage 5:
        - complete remaining testing
        - make final design changes
        - build molds, assembly/test equipment
        - create instructions for use and user manuals
    - Post Market Surveillance
        - on a 4-6 month cadence, project teams report out stakeholders
        - companies continuously track customer and salesforce feedback via interviews and surveys

Conclusions/action items:

Product design is a long process. BME 300 is a sped-up version of this process. Our team is looking into patenting our design or possibly continuing it and improving it next semester.

2025/09/08 - Background on FSH Muscle Dystrophy

Aditi Singhdeo (singhdeo@wisc.edu) - Sep 25, 2025, 11:25 AM CDT

Title: Background on FSH Muscle Dystrophy

Date: 09/08/25

Content by: Aditi Singhdeo

Present:

Goals: Understand the impact of FSHD and explore how it tends to be treated.

Content:

[1]

N. H. M. Rijken, B. G. M. van Engelen, J. W. J. de Rooy, V. Weerdesteyn, and A. C. H. Geurts, “Gait propulsion in patients with facioscapulohumeral muscular dystrophy and ankle plantarflexor weakness,” Gait & Posture, vol. 41, no. 2, pp. 476–481, Feb. 2015, doi: https://doi.org/10.1016/j.gaitpost.2014.11.013.

https://www.sciencedirect.com/science/article/pii/S0966636214007802?via%3Dihub

- FSHD involves the weakening of ankle dorsiflexors - dorsiflexors are muscles located on the front of the shin that pull the foot upward towards the shin.
- It causes problems with postural balance, gait and leads to more recurrent falls.
- The weakening of the dorsiflexors leads to drop foot and an increased risk of tripping.
- Propulsion in walking - pushing off the ground with your toes allowing you to move forward.
- The calf muscles are the main contributors to walking speed along with iliopsoas and gluteus maximus muscles.

[2]

“FSHD (Facioscapulohumeral Muscular Dystrophy),” Cleveland Clinic, Dec. 06, 2023. https://my.clevelandclinic.org/health/diseases/facioscapulohumeral-muscular-dystrophy-fshd

https://my.clevelandclinic.org/health/diseases/facioscapulohumeral-muscular-dystrophy-fshd

- FSHD doesn't follow a uniform patten - muscles might be affected at different times.
- Weak hip abductor muscles can cause Trendelenburg gait - where a person shifts their body toward their affected leg when walking.
- Treatments:
    - Physical therapy
    - Surgery
    - Orthotics (shoe inserts) that help with walking and reduce the risk of falling
    - Other orthotic devices that support weak muscles

[3]

G. MD, “Facioscapulohumeral Dystrophy Treatment & Management: Medical Care, Surgical Care, Consultations,” Medscape.com, May 02, 2024. https://emedicine.medscape.com/article/1176126-treatment?form=fpf

https://emedicine.medscape.com/article/1176126-treatment?form=fpf

- Other treatment options:
    - Ankle foot orthosis can help patients with severe drop foot.
    - Floor reaction AFOs or knee AFO - these help individuals that have weakness in their knee extensor muscles.

Conclusions/action items:

FSHD impacts multiple muscle groups in ways that effects balance, gait and walking speed, often leading to drop foot and falls. While treatment options such as surgery exist, orthotics or AFOs should be explored as they help with improving dorsiflexion and overall ankle mobility.

2025/09/18 - Impact of Using AFOs on Gait

Aditi Singhdeo (singhdeo@wisc.edu) - Sep 18, 2025, 9:09 AM CDT

Title: Impact of Using AFOs on Gait

Date: 09/17/2025

Content by: Aditi Singhdeo

Present: N/A

Goals: To understand how AFOs affect gait asymmetry in patients with drop foot

Content:

https://jneuroengrehab.biomedcentral.com/articles/10.1186/s12984-023-01261-1

[1]
Weon Ho Shin *et al.*, “Ankle dorsiflexion assistance of patients with foot drop using a powered ankle-foot orthosis to improve the gait asymmetry,” *Journal of Neuroengineering and Rehabilitation*, vol. 20, no. 1, Oct. 2023, doi: https://doi.org/10.1186/s12984-023-01261-1.

Method:

- Developed an active AFO using pneumatic dorsiflexion assistance to correct gait asymmetry.
- Tested 10 patients in two conditions: barefoot and wearing the AFO.
- Patients walked multiple laps, their joint kinematics and distance and pace of steps were recorded.

Results and conclusion:

- The AFO increased ankle dorsiflexion angle during the gait cycle.
- Kinematic asymmetry decreased for ankle and knee joints, the hip joint remained unaffected.
- Some patients had improvement in asymmetry of swing speed, but there was no noticeable improvement across the group.
- Results demonstrate efficiency of AFO in improving gait asymmetry.

https://www.jyi.org/2016-november/2017/2/18/pulley-optimization-for-a-walking-engine-actuated-active-ankle-foot-orthosis

[2]
D. H. Kuettel, “Journal of Young Investigators,” *Journal of Young Investigators*, vol. 31, no. 5, Nov. 2016, Accessed: Sep. 18, 2025. [Online]. Available: https://www.jyi.org/2016-november/2017/2/18/pulley-optimization-for-a-walking-engine-actuated-active-ankle-foot-orthosis

Figure 1: Passive vs. Active Ankle-Foot Orthosis. This figure shows a comparison of a passive (A) and active (B) AFO. Passive AFOs simply immobilize the ankle and foot while active AFOs assist the ankle and foot to replicating human gait (Blackwell, Lucas, & Clarke, 2014).

Design A is a passive AFO and design B is an active AFO incorporating a pneumatic walking engine. The study above shows a strong improvement in gait asymmetry with using and active AFO that supports dorsiflexion, however, by looking at design B, we can see that the AFO is quite bulky which is unsuitable for our patient, Maggie, who wants an inconspicuous AFO.

Conclusions/action items:

Although active AFOs are more effective in improving asymmetry in gait, we would still chose to design a passive AFO as it can be more inconspicuous. We could create a two layer design which could provide a bit of a spring in Maggie's step while also supporting for dorsiflexion through elastic materials that would hold up the ankle. The cross design in figure A could be implemented in our design to provide more distributed support while allowing the ankle to also be at rest while the patient is sitting down or relaxing around the house., a criteria that our client had mentioned she would want for the AFO. When we carry out our testing to measure the effectiveness of the AFO we could consider similar parameters such as joint kinematics and spatiotemporal gait.

2025/09/10 - Types of AFOs

Aditi Singhdeo (singhdeo@wisc.edu) - Sep 11, 2025, 2:04 PM CDT

Title: Different types of AFOs

Date: 10/09/2025

Content by: Aditi Singhdeo

Present:

Goals: Understanding the different shapes of AFOs and the that are typically materials used

Content:

[1]

Y. J. Choo and M. C. Chang, “Commonly Used Types and Recent Development of Ankle-Foot Orthosis: A Narrative Review,” *Healthcare*, vol. 9, no. 8, p. 1046, Aug. 2021, doi: https://doi.org/10.3390/healthcare9081046.

https://pmc.ncbi.nlm.nih.gov/articles/PMC8392067/

Plastic AFO:

- Most commonly used orthosis because it is inexpensive, easy to clean and easy to remove.
- It is normally made by taking a plaster of the patient's leg and then molding the plastic over the cast to create a custom brace.
- Consists of a shank shell, foot plate, velcro straps and hinges.
- Solid AFO - fully limits ankle mobility, best for patients with drop foot, weak dorsiflexion or plantarflexion, ligament injuries, etc.
- Posterior leaf AFO - has a trimline behind the ankle, therefore it is more flexible than a solid AFO, has leaf shaped creases which act like a spring and it permits for slight dorsiflexion while walking.
- Hinged AFO - allows for some ankle mobility, made with hinges that connect the shank shell to the foot plate, usually at the malleolus. It also allows for limited dorsiflexion making it easier to walk on uneven surfaces. It is not recommended for individuals with mediolateral (side to side) ankle instability.

UD-Flex AFO:

- Worn at the front of the foot with a open heel.
- Allows for ankle bending.
- Allows for a more natural gait and walking pattern since there is more ground reaction feedback.

Carbon fiber AFO:

- Lightweight, high tensile strength, stiff, heat resistant.
- Expensive
- The shell is thin which reduces the pressure on the user.
- Improves plantarflexion and energy efficiency which leads to improved walking ability.
- Looks more natural and better performance compared to plastic AFO.

Conclusions/action items:

Plastic AFOs seem to be the most commonly used, however, Maggie wants an AFO that is a inconspicuous as possible, therefore I believe that using a Carbon fiber AFOs. We could consider using carbon fiber to design a shape similar to a UD flex AFO, this might be help with the goal of having our AFO be discrete. If we would want to mimmic a UD flex design, we would have to understand the severity of Maggie's condition and see if her ankle is strong enough to have a open heel. We could also consider adding hinges to the AFO however, that might be uncomfortable and put more strain on the knee.

2025/09/25- User centered needs with AFOs

Aditi Singhdeo (singhdeo@wisc.edu) - Sep 25, 2025, 4:07 PM CDT

Title: User centered needs with AFOs

Date: 09/25/2025

Content by: Aditi Singhdeo

Present:

Goals: Understand the factors that make younger patients more likely to use their AFO to help with designing the AFO.

Content:

https://www.mdpi.com/2673-1592/7/1/11

[1]
P. Dabnichki and T. Y. Pang, “User-Centered Design Framework for Personalized Ankle–Foot Orthoses,” *Prosthesis*, vol. 7, no. 1, pp. 11–11, Jan. 2025, doi: https://doi.org/10.3390/prosthesis7010011.

22% of patients did not use their AFO and 27% of patients stopped using their AFO early. The main reasons for this were:

- Discomfort and pain - the AFOs caused skin reddening and had pressure points that caused pain when used.
- Psychosocial: the AFO attracted unwanted attention from other kids. Peer influence and social acceptance impact how often patients used their AFO.
- Functional limitation: The AFO was too bulky or heavy, it was difficult to put on and take off.

Because of this even successfully designed AFO can fail due to inconsistent use and refusal to wear the device.

A few aspects to consider when designing the AFO to balance user preferences with safety and functionality would be:

- Having 90% accuracy in the fit of the AFO for the specific patient - this would be done by an orthotist.
- The AFO should not exceed a weight of 900g.
- Users should be able to walk pain free for at least 30 minutes and there should be ventilation channels for the bulkier AFOs.
- It should take users no more than 1 minute to put on and take off and a total of 5 minutes or less to fully assemble the AFO.
- The AFO should have allow for some unrestricted ankle rotation while having drop-foot prevention by supporting the foot during swing phases.

For material selection using Nylon should be considered because of its high strength, elasticity and low density. Moreover, when prototyping and testing the AFO team members should test how the AFO feels when putting it on and taking it off, walking up the stairs and see if the AFO is able to withstand deformation after being used repeadtly.

Conclusions/action items:

For the design matrix criteria, other than dorsiflexion and mediolateral support it would be important to evaluate comfort, durability and ease of user assembly for each of the potential designs. Ideally, we would want get our patient, Maggie, to Madison to test the AFO in person. This would allow us to assess how the AFO fits her foot, weather her skin reacts to the chosen materials or if she experiences any discomfort during use. In addition, Maggie would be able to test the durability of the AFO relative the the severity for her drop foot.

2014/11/03-Finite Element Model

Aditi Singhdeo (singhdeo@wisc.edu) - Oct 02, 2025, 5:53 PM CDT

Title: Finite element model

Date: 10/02/2025

Content by: Aditi

Present:

Goals: To understand how an FEA works for testing 3D printed AFOs and if it would be an effective form of testing.

Content:

[1]
Y. H. Cha *et al.*, “Ankle-Foot Orthosis Made by 3D Printing Technique and Automated Design Software,” *Applied Bionics and Biomechanics*, vol. 2017, pp. 1–6, 2017, doi: https://doi.org/10.1155/2017/9610468.

Building the FEA model from a real AFO:

- A polypropylene AFO was vacuum-formed around a patient cast. It was then trimmed to make it slightly flexible for gait and other movement.
- The AFO was then 3D optically scanned to create a solid model.

Bench test on the real AFO:

- The AFO was mounted with round dummies at each end of the device and a bench test was then carried out.
- Loads were applied where the straps attach via hanging weights to reach forces from 4 - 34 N going up in increments of 10N.
- Then the antero-posterior discplacement was measured at each load.

Testing through the finite element model:

- The scanned model was broken up into smaller pieces and set to linear elastic polypropylene.
- The same loads, mount and strap locations were used.
- The FEA displacements matched the bench test closely, demonstrating that an FEA can be effective when testing for stiffness.

Conclusions/action items:

We should consider carrying out a finite element analysis, especially to test the durability and stiffness of different strap materials. This would provide beneficial information for deciding what materials to use. I would also want to research how and FEA can be used to test the overall durability of the AFO, and if it is an applicable test to carry out.

2025/10/02- Resources available for 3D motion capture

Aditi Singhdeo (singhdeo@wisc.edu) - Oct 02, 2025, 9:26 PM CDT

Title: Equipment Available For Motion Capture

Date: 10/02/25

Content by: Aditi Singhdeo

Present:

Goals: To understand what resources on campus are available for motion capture testing

Content:

[1]
Facilities, “Facilities,” *UW BADGER Lab*, 2024. https://uwbadgerlab.engr.wisc.edu/facilities/ (accessed Oct. 03, 2025).

UW BADGER Lab

- 12 camera OptiTrack - Captures 3D kinematics for gait and movement analysis
- Two Bertec force plates - Measures ground reaction forces and center of pressure, helps detect heel strike
- Wearable inertial sensors - motion tracking (good for getting spatiotemporal gait metrics) for clinical settings
- Test Resources materials testing machine - quantifies stiffness, strength and basic fatigue of materials by performing compression, bending and tension tests

Conclusions/action items:

The two bertec force plates might be a good form of testing we could carry out, one the healthy and "unhealthy" leg when the patient comes down to Madison.

2025/10/07- FEA Testing

Aditi Singhdeo (singhdeo@wisc.edu) - Oct 16, 2025, 4:40 PM CDT

Title: How FEA works and is conducted

Date: 10/07/2025

Content by: Aditi Singhdeo

Present:

Goals: To understand how to carry out a FEA on solidworks, information will be used for the preliminary report

Content:

https://enterfea.com/fundamentals-of-fea-beginners-guide/

[1]
Ł. S. Ph.D, “Fundamentals of Finite Element Analysis: Complete Beginners Guide,” *Enterfea*, Nov. 18, 2019. https://enterfea.com/fundamentals-of-fea-beginners-guide/

Steps to carry out FEA for our AFO model:

1. Modeling: Start by deciding if you want to use 2D or 3D elements depending on how much detail is needed. And decide what details are relevant to include.
2. Properties and thickness: each element is assigned a thickness and material.
3. Meshing: breakdown the models element into small finite elements and nodes. Use smaller meshes in regions oh high stress gradients.
4. Model constraints: model the restraints to mimic reality, for the AFO we could have supports at both ends of the model to resemble a foot being in the AFO.
    - You can also use supports to approximate "contact" of the AFO with the foot, this is done if the interface doesn't have the contact capability.
5. Loads: apply the appropriate loads in areas that reflect real use of the AFO.
6. Run the FEA and optionally we can run a buckling analysis to check for stability.

Conclusions/action items:

This information is used to decide what testing we should carry out for the preliminary report. FEA seems like an efficient test to ensure the AFO won't break like it did last semester. However, from my knowledge, the team last semester did carry out an FEA and both prototypes had passed the test, therefore we might need to explore an alternative.

2025/10/16 - Stress Test Research

Aditi Singhdeo (singhdeo@wisc.edu) - Oct 17, 2025, 10:49 AM CDT

Title: Researching and brainstorming ideas for test apparatus

Date: 15/10/2025

Content by: Aditi Singhdeo

Present:

Goals: Start looking at what we can do for testing the polyester and TPU Filament

Content:

[1]
S. Wang, S. Tang, C. He, and Q. Wang, “Cyclic Deformation and Fatigue Failure Mechanisms of Thermoplastic Polyurethane in High Cycle Fatigue,” *Polymers*, vol. 15, no. 4, p. 899, Feb. 2023, doi: https://doi.org/10.3390/polym15040899.

https://pmc.ncbi.nlm.nih.gov/articles/PMC9958809/

- The study above looked at high cycle fatigue (large loading cycle 10^4 - 10^6+)behavior of thermoplastic polyurethane (TPU) under tension-tension loading.
- Conditions: sinusoidal load cycles at 5 Hz, stress ratio of 0.1, room temperature, spanning 10^3 - 10^7 cycles, the TPU was a flat rectangular strip.
- The article demonstrates that cyclic loading causes material softening and cyclic creep - cracks begin from the micropores on the surface.
- Primary failure would be the TPU fracturing
- Signs of damage would be whitening at the bend point and cracks at the surface

[2]
M. C. Iacob, D. Popescu, D. Petcu, and R. Marinescu, “Assessment of the Flexural Fatigue Performance of 3D-Printed Foot Orthoses Made from Different Thermoplastic Polyurethanes,” *Applied Sciences*, vol. 13, no. 22, p. 12149, Jan. 2023, doi: https://doi.org/10.3390/app132212149.

https://www.mdpi.com/2076-3417/13/22/12149

- For testing methods in this paper, they created a custom, low cost flexural fatigue testing apparatus using a DC motor and 3D printed parts to cyclically bend TPU samples at a 45 degree angle.
- The study created a bending ring that repeatedly flexes the insole where the toes bend. They set it to 250 cycles/min, aiming for 700,000 cycles (to mimic 2.5+ months of walking).
- They did blocks of 7,000 cycles with rests and repeated that 100 time.
- They observed 120 steps/min in normal walking and doubled the pace in lab to obtain results faster.

Conclusions/action items:

For the test apparatus, I think we should use a radial bend to avoid concentrating stress at a specific point, this will also help mimic the strap bending during use rather than only bending in half. We should cycle at a fixed rate and ensure temperature is kept constant since TPU cycling creep is rate and temperature dependent.

2025/10/16-Continuing Test Apparatus Research

Aditi Singhdeo (singhdeo@wisc.edu) - Oct 17, 2025, 10:49 AM CDT

Title: Research for Test Apparatus Design

Date: 16/10/2025

Content by: Aditi

Present:

Goals:

Content:

[1]
“DeMattia Crack Growth Testing: Pierced VS Non-Pierced Methods,” *MonTech USA*, Aug. 14, 2024. https://www.montechusa.com/demattia-crack-growth-testing (accessed Oct. 17, 2025).

https://www.montechusa.com/demattia-crack-growth-testing

- This article summarises a flex fatigue method for elastomers to study crack initiation and crack growth under cyclic loading
- There were two test conditions:
    - Pre-cut DeMattia: you start with a small slit then measure crack growth rate as the slit that grows under loading.
    - Non cut DeMattia: Used to see when and how cracks first appear (natural initiation) and then grow.

[2]
nltest, “Bend and Flexural Testing,” *nl-test.com*. https://nl-test.com/news/flexural-testing

https://nl-test.com/news/flexural-testing

- Flexural testing/ transverse beam testing loads a bent sample to assess flexural strength, modulus of rupture, toughness and overall behaviour under tension and compression - it is a common test used for polymers.
- 3 point bend test
    - Consists of two supports and an anvil in the center
    - Concentrates stress at a central point
    - Ideal for less flexible materials
- 4 point bend test
    - Consists of two supports and two anvils to create a uniform-moment region
    - Ideal for more flexible materials
    - Helps measure bending modulus (material's stiffness or its resistance to bending)
- Uses a UTM frame
- Capacity: low forces - 2,000 kN for 3 and 4 point bend tests

[3]

“Fatigue Testing | Polymer Material Testing,” *Smithers*. https://www.smithers.com/industries/materials/polymer/physical-testing/material-properties-testing/fatigue-testing

https://www.smithers.com/industries/materials/polymer/physical-testing/material-properties-testing/fatigue-testing

- Design and run fatigue programs for rubber, plastic and composites to assess durability
    - Perform cycles until failure, S-N curves, crack initiation and growth
- They can run compression, tension - tension, flexural and torsion cycling
- The programs include crack initiation and crack growth methods for elastomers.

Conclusions/action items:

The articles above have provided a good starting point for components I could add to the test apparatus. Polymer durability depends on time, temperature and stress, so when testing we need to control the angle, frequency, environment and radius. We can also look at examining cycles to first sign of damage and cycles to failure.

2025/10/18 - Testing Apparatus

Aditi Singhdeo (singhdeo@wisc.edu) - Oct 18, 2025, 7:18 PM CDT

Title: Testing Apparatus

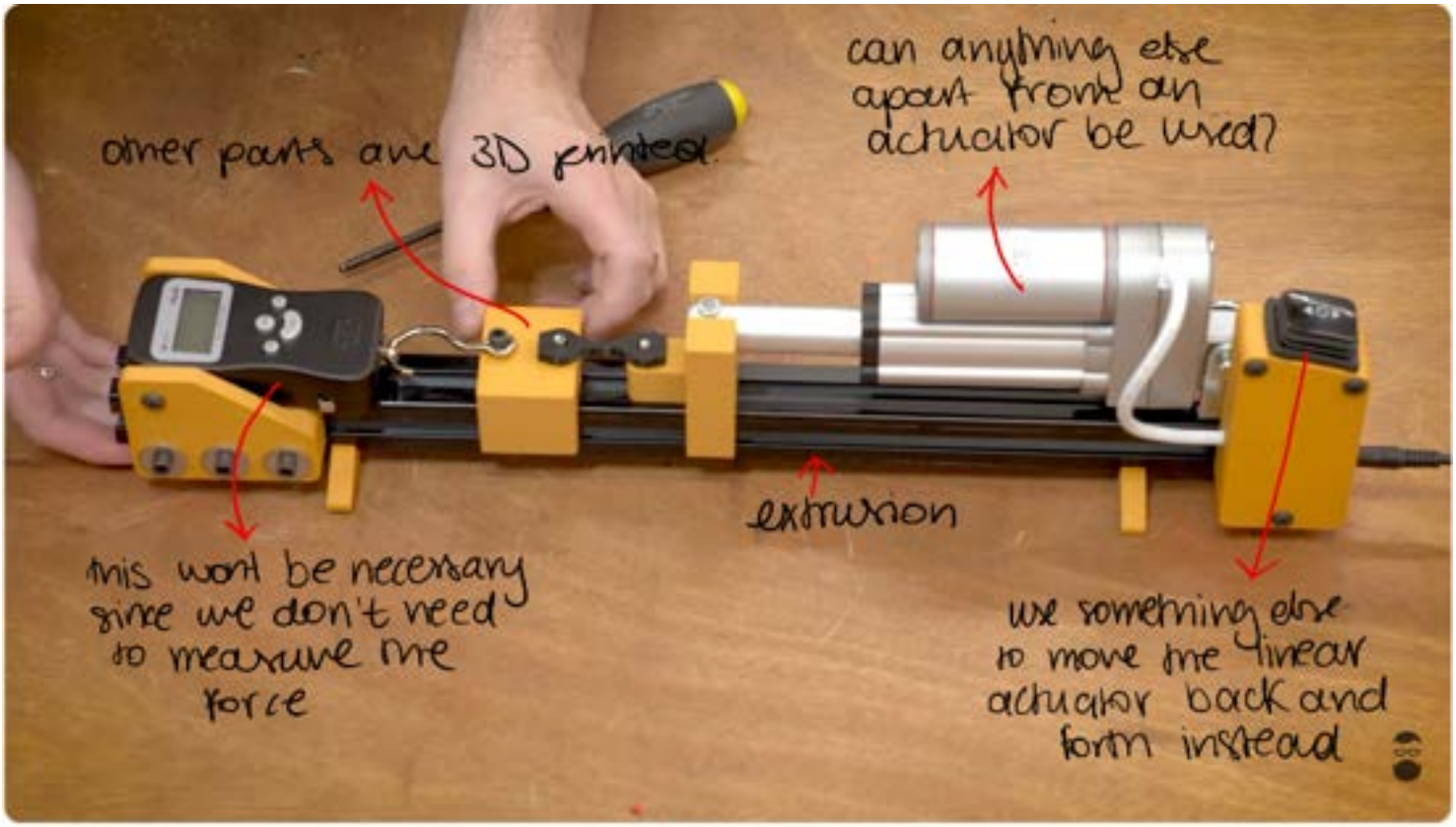
Date: 10/18/2025

Content by: Aditi

Present:

Goals: Design for the test apparatus

Content:



[1]
Robert Cowan, “Simple Tensile Strength Tester - Easy to Build!,” *YouTube*, May 26, 2024. https://www.youtube.com/watch?v=EZ391YmRlb8 (accessed Oct. 07, 2024).

Conclusions/action items:

This is from a video that was creating a tensile test apparatus but I think we could make a few modifications to have this move back and forth to better fit our test. I need to research if there are more suitable motors or if we could alter the speed of the actuator instead.

2025/09/18 - Design Idea

Aditi Singhdeo (singhdeo@wisc.edu) - Sep 18, 2025, 4:45 PM CDT

Title: Design Idea for AFO

Date: 09/18/2025

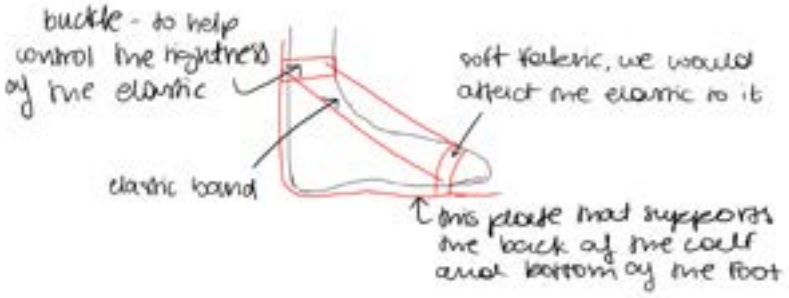
Content by: Aditi

Present:

Goals: Come up with potential design ideas

Content:

The base would be a thin plate that goes from the toes to the back of the back of the calf. There would also be a strap of fabric close to the toes and a leather buckle places near the Achilles (slightly higher for comfort). This will allow Maggie to have control over how much elasticity and dorsiflexion support she would like. The plate would also have indents around the heel to allow for some flexibility of the ankle.



Conclusions/action items:

This design does not provide as much support for ankle inversion. To address this, we could add reinforcements to the side. Another option would be to have a custom sole, instead of the plate being completely flat, we could elevate one side to counteract unwanted pronation or supination and reduce the likelihood of ankle inversion.

16/10/15 OSHA Chemical Safety and Biosafety training

Aditi Singhdeo (singhdeo@wisc.edu) - Oct 16, 2025, 2:03 PM CDT

Download

Screenshot_2025-10-16_at_2.01.39_PM.png (148 kB)

12/08/2025 - Intro to Machning

Aditi Singhdeo (singhdeo@wisc.edu) - Dec 08, 2025, 4:38 PM CST

Download

Screenshot_2025-12-08_at_4.38.05_PM.png (277 kB)

09/26/2025- BPAG Meeting Notes

Aditi Singhdeo (singhdeo@wisc.edu) - Dec 08, 2025, 4:32 PM CST

Title: BPAG Meeting

Date: 09/26/2025

Content by: Aditi Singhdeo

Present: All BME 200/300 BPAGs

Goals: To learn and fully understand how to carry out my role as BPAG

Content:

- Get you client to buy stuff - purchases need to be approved by client
- Need a prop for the presentation
- Anything over $1000 needs to be approved by the department
- All original receipts and table of expenses need to be in the notebook (and progress report - for the table of expenses)

- Our client has no affiliation with UW?
  - But our department is funding it?
  - Design course fund - submit a request for funding
- BPAG makes all the purchases
  - You can't shop shop uw - you need to go to each vendor separately, and if its not available you need to show that in the notebook and then you can buy it off amazon
  - $50 budget per team for makerspace - Account name: BMEDesign
  - Design innovation lab @ ecb
  - Random thingsL woodworking, screws, pipe fittings etc
  - Tool crip: have to use it in the lab downstairs
- Reimbursement: just don't do this
- Needs original receipts, not a screenshot - the original invoice
  - For our purchasing, reach out to Nhia Vang or Dr. P
  - For the notebook and poster - we pay, just split it
- Goal of the template is that someone can go to the template and buy everything and remake the prototype
  - Manufacture cart number and vendor cart number can be different
- For the funding through BME department send proposal before wednesday
- If you're gifted something or find materials from 1080 - document it, try to find where you can buy it from (you can put free in it)

Conclusions/action items:

Ask if we have already requested for funding formally, if not, request for funding. Request directions are on the BME design website.

2025/09/08- Analysis of Lower Leg Muscles affected by FSHD

Celia Oslakovic - Sep 11, 2025, 4:52 PM CDT

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

Title: Analysis of Lower Leg Muscles affected by FSHD
Date: 09/11/2025
Content by: Celia Oslakovic
Present: Celia Oslakovic
Goals: Understand FSHD further and pinpoint which joints in the foot area it affects the most.
Content:
Facioscapulohumeral Muscular Dystrophy, or FSHD, directly affects skeletal muscle tissue in affected individuals. It affects areas of the face, shoulder girdle, and the lower extremities. It usually first affects the face and then progresses to other muscle groups. FSHD is one of the most prevalent types of muscular dystrophy currently known. FSHD affects the distal-most muscles first, primarily the gastrocnemius (flexing of the knee and foot, located at back of the lower leg) and tibialis anterior (primary dorsiflexor of the ankle).

Gastrocnemius
-> The main plantarflexor of the ankle joint, and a secondary knee flexor
-> Provides propulsive force when running, jumping, or walking.
-> A shortened gastrocnemius can cause dysfunction of hip movement and decrease anteversion.

The gastrocnemius is highlighted in green in the above picture^

Tibialis anterior

-> Primary dorsiflexor of the ankle

-> Pain along the path of the Tibialis anterior is often known as "Shin splints"

-> When the tibialis anterior is inhibited or underactive, these synergistic muscles become overactive: extensor hallicus longus, extensor digitorium longus and peroneous tertius.

-> People with inhibited or weak tibialis anterior will have an abnormality in the APA phase during gait initiation. Meaning that they will have difficulty shifting weight from the heel to the ball of the foot before taking the next step.

The tibialis anterior is highlighted in red in the above picture^

Conclusions/action items: The affect of FSHD on the tibialis anterior is most likely why Maggie is having difficulty with dorsiflexion of her ankles. It would be beneficial for our device to have support for the tibialis anterior, or something that could act as that tendon just on the outside of her calves.

Citations:

[1] C. Fecek, “Facioscapulohumeral muscular dystrophy,” StatPearls [Internet]., https://www.ncbi.nlm.nih.gov/books/NBK559028/ (accessed Sep. 11, 2025).

[2] Gastrocnemius - physiopedia, https://www.physio-pedia.com/Gastrocnemius (accessed Sep. 11, 2025).

[3] Tibialis anterior - physiopedia, https://www.physio-pedia.com/Tibialis_Anterior (accessed Sep. 11, 2025).

2025/10/02- Foot Drop Research

Celia Oslakovic - Oct 02, 2025, 3:52 PM CDT

Title: Foot Drop Research

Date: 10/2/2025

Content by: Celia Oslakovic

Present: Celia Oslakovic

Goals: Research the mechanics of Foot Drop and determine how to best combat that in our design. Also, to better understand the normal gait cycle versus the gait cycle of foot drop.

Content:

Foot Drop is the weakness or paralysis of dorsiflexor muscles. This makes it difficult for those suffering with foot drop to lift the forefoot during gait, and results in a walking pattern with abnormally high step counts.

For Maggie, this foot drop was brought on by her FSHD, which makes sense because the condition can be a result of a variety of neurodegenerative, compressive, or psychological disorders.

Foot drop is tested through mainly observation of the patient performing functional movements. This includes deep knee bending, standing on the toes and standing on the heels. Pinprick testing is also performed to assess sensory function.

Normal Gait Cycle -> 60% stance phase 40% swing phase. While on foot is in swing the other is in stance

Gait cycle begins with heel strike and concludes with heel strike on the same side. As the heel strike, the foot is in dorsiflexion preparing for the stance phase. Without functioning dorsiflexors, the foot stays in plantar flexion throughout the stance phase, this results in patients dragging their toes or lifting their foot higher to prevent foot dragging.

Conclusions/action items: Dorsiflexors are essential in order to prevent foot dragging and engage in the stance phase correctly. In our design, we are mainly focusing on maintaining dorsiflexion, however, we cannot neglect plantar flexion. Ideally, our design should primarily support dorsiflexion, but it should also allow for some plantar flexion. Since plantar flexion is the default for Maggie, it should be feasible to have an elastic that provides resistance to plantar flexion for her.

References:

[1]S. L. Nori and M. F. Stretanski, “Foot Drop,” Nih.gov, Feb. 12, 2024. https://www.ncbi.nlm.nih.gov/sites/books/NBK554393/

10/12/25- Patent Research

Celia Oslakovic - Oct 12, 2025, 5:03 PM CDT

Title: Patent Research

Date: 10/12/2025

Content by: Celia Oslakovic

Present: Celia Oslakovic

Goals: Learn more about the process of getting our design patented. Create a concrete plan of steps to take in order to apply for a patent.

Content:

We have to disclose an invention through WARF

Innovation Disclosure | Wisconsin Alumni Research Foundation (warf.org)

This is the link to disclosure the invention. We need to do this because it was university funded. We should submit to WARF soon. Once we send the invention disclosure, we will meet with a WARF Intellelectual Prepropety Manager to discuss

Patent process overview | USPTO

Conclusions/action items:

2025/09/19- Preliminary Design Idea

Celia Oslakovic - Sep 19, 2025, 12:49 PM CDT

Title: Preliminary Design Idea

Date: 09/19/25

Content by: Celia Oslakovic

Present: Celia Oslakovic

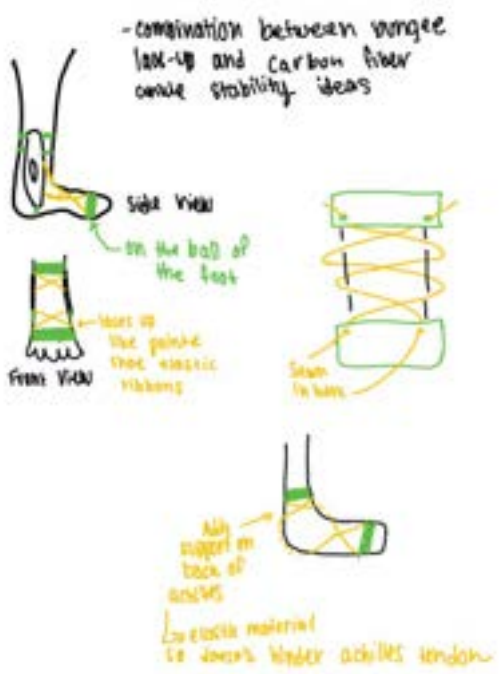
Goals: Come up with new design idea for the AFO and sketch it.

Content:

See attached image

Conclusions/action items: Go over design with whole group and determine which parts to use in future designs. See if design will move on to the design matrix.

Celia Oslakovic - Sep 19, 2025, 12:49 PM CDT



Download

Celia_Preliminary_Idea.pdf (457 kB)

2025/09/23- Design Matrix Design #1 Sketch w/ Labels

Celia Oslakovic - Sep 23, 2025, 8:29 PM CDT

Title: Preliminary Design Idea

Date: 09/19/25

Content by: Celia Oslakovic

Present: Celia Oslakovic

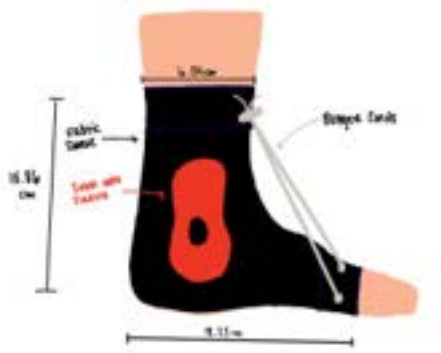
Goals: Sketched Design Idea #1 in the matrix with more detail than preliminary brainstorm. Added labels to flesh out the idea more.

Content:

See attached image

Conclusions/action items: Go over sketch and labels with whole group and determine if the sketch is good to use in the design matrix. Add sketch to matrix. Evaluate matrix to determine best fit design.

Celia Oslakovic - Sep 23, 2025, 8:29 PM CDT



Download

Design_1__24_x_25.pdf (1.13 MB)

2025/10/07- Biosafety Training Documentation

Celia Oslakovic - Oct 07, 2025, 3:23 PM CDT

Title: Biosafety Training Documentation

Date: 10/07/2025

Content by: Celia Oslakovic

Present: Celia Oslakovic

Goals: Complete biosafety training documentation so that I can do tasks in a wet lab setting safely.

Content:

See attached screenshot of completing in Bio-Arrow.

Conclusions/action items:

I still need to complete the milling training.

Celia Oslakovic - Oct 07, 2025, 3:23 PM CDT

Download

Screenshot_2025-10-07_at_3.19.23_PM.png (205 kB)

2025/10/09- Chemical Safety: The OSHA Lab Standard Training Documentation

Celia Oslakovic - Oct 09, 2025, 12:06 PM CDT

Title: Chemical Safety: The OSHA Lab Standard Training Documentation

Date: 10/09/2025

Content by: Celia Oslakovic

Present: Celia Oslakovic

Goals: Complete chemical safety training documentation so that I can work in a lab safely.

Content:

See attached screenshot of completing in Bio-Arrow.

Conclusions/action items:

I still need to complete the milling training.

Celia Oslakovic - Oct 09, 2025, 12:07 PM CDT

Download

Screenshot_2025-10-09_at_12.05.09_PM.png (136 kB)

2025/09/26 BPAG Meeting Notes

Aditi Singhdeo (singhdeo@wisc.edu) - Dec 08, 2025, 4:30 PM CST

Title: BPAG Meeting Notes

Date: 09/26/25

Content by: Celia Oslakovic

Present: All BME 200/300 BPAGs

Goals: The goal is to fully understand how purchasing and accounting will work for out project.

Content:

- Presentation needs a prop
- Have all expenses approved by your client prior to purchase
- All original receipts in the notebook
- Table of expenses -notebook progress report and report
- Our client has NO UW Affiliation
    - We are using UW funds to buy things though
    - If you buy something that is taxed UW will not reimburse taxes
    - Reimburse within 90 DAYS
    - If it is in the Shop UW+, you have to buy it through there
- We are a Rehab project
    - Submit request for BME funding
- ONLY BPAG will pay and get reimbursed. Reimbursement is a last resort
    - E-Reimbursement from UW-Clients
    - Takes 3+ weeks
- Design Innovation Lab @ Wendt
    - 3d printing and mini mart $50 budget there
        - If we exceed the $50, client can set up their own account
    - Account Name: BMEDesign
- @ ECB
    - Machining shop
- Contacts
    - Dr. P
    - Nhia Vang
- Non-Reimburable expenses
    - Notebook $15
    - Poster printing $50

- Make accounting table
    - Has ALL vital information
    - Goal to be able to remake our design w/ all same materials
    - Template is online
    - Shrink the links

Conclusions/action items:

Ask if we have already requested for funding formally, if not, request for funding. Request directions are on the BME design website.

09/11/2025 - Research: FSHD Society

Claire Matthai - Sep 11, 2025, 4:41 PM CDT

Title: FSHD Research

Date: 9/11/2025

Content by: Claire Matthai

Goals: Gain knowledge on our client's disorder (FSHD)

Content:

What is FSHD?

- Facioscapulohumeral muscular dystrophy
- A genetic disorder that causes weakening of skeletal muscles
- Typically begins in early teenage years with loss of muscles in face, shoulders, upper arms, legs or core, but can affect any muscle
- 70% of people with FSHD experience debilitating pain and fatigue
- No known cure
- Can take a long time to diagnose

Who does it affect?

- 1 in 8,000 individuals, or 870,000 people worldwide
- Affects men, women, and children of all races and ethnicities
- 10% develop symptoms before age 10
- 30% of cases show up in families with no prior history

Symptoms

- Symptoms vary widely in presentation and severity
- Common symptoms include muscle weakness in face, shoulders, and arms, as well as fatigue and pain
    - Makes everyday movements harder (including sipping through a straw, sit-ups and pull-ups, lifting arms above shoulder height, lifting the foot)
- Those affected may also experience feeling really tired, burning pain in muscles, sudden falls when legs give out, trouble breathing, hearing loss, Croats' disease, mild heart rhythm problems
- Doesn't affect all muscles at the same time or in the same way
    - Often causes uneven weakness (e.g. just one arm or one leg)

Diagnosis

- Tests to determine if one has FSHD include:
    - Blood tests - to measure levels of serum creatine kinase (enzyme released into bloodstream when muscle fibers are deteriorating) or serum aldolase (enzyme that helps break down sugars into energy)
    - Neurological tests - to rule out other nervous system disorders, identify patters of muscle weakness and wasting, test reflexes and coordination, and detect muscle contractures
    - Muscle biopsies - examining muscle tissue to look for abnormalities
    - Genetic testing - to confirm FSHD Type 1 or Type 2

Managing FSHD

- Although there is no cure, there are steps to manage FSHD such as physical therapy, resources for pain management, or adaptive tools like orthotics

Conclusions/action items:

FSHD (facioscapulohumeral muscular dystrophy) is a genetic disorder that causes weakening of skeletal muscles. FSHD can affect any muscles in the person affected, and in our patient, it primarily affects her right ankle, and it has started to spread to her arms as well. Symptoms vary among those affected, but Maggie's main symptoms are foot drop and difficulty raising arms. There are no cures at this time, so orthotics like the AFO we will be creating are a very valuable resource for those experiencing weakness in the legs.

Link: https://www.fshdsociety.org/living-with-fshd/understanding-fshd/genetic-testing/

Citation:

09/11/2025 - Research: AFO Types and Uses

Claire Matthai - Sep 11, 2025, 3:54 PM CDT

Title: AFO Types And Uses | Comprehensive Guide

Date: 9/11/2025

Content by: Claire Matthai

Goals: Learn about the different types of AFOs and connect what I learn to our client's wants and needs

Content:

What are AFOs?

- AFOs (Ankle-Foot Orthoses) are medical devices designed to support the ankle and foot - they play a role in rehabilitation and mobility for individuals with various conditions that affect their lower limbs
- Can be custom-fitted or prefabricated
- Commonly prescribed for conditions such as cerebral palsy, multiple sclerosis, stroke recovery, and post-surgical rehabilitation
- AFOs help with:
    - Ankle joint stabilization
    - Improving gait patterns
    - Preventing complications associated with immobility

Types of AFOs

1. Solid AFO

- Rigid device, provides maximum control over foot and ankle
- Make from thermoplastic materials (durability and support)
- Used by patients that require significant immobilization due to severe weakness or spasticity
- Prevents:
    - Unwanted movement at ankle joint
- Allows:
    - Flexion at the toe while walking
- Patient conditions: cerebral palsy; stroke

2. Hinged AFO

- Incorporate a hinge mechanism at the ankle joint
- Allows controlled movement while still providing support
- Enables more natural gait dynamics compared to solid AFOs
- Used by patients that have some voluntary control over their ankle but still need assistance to prevent excessive motion
    - Used in rehab scenarios where regaining strength and mobility is a priority
- Patient conditions: mild hemiplegia; post-fracture recovery

3. Dynamic AFO

- Promote natural movement while providing necessary support
- Feature flexible components that allow for dorsiflexion and plantarflexion during walking

- Encourage active participation in walking by allowing a degree of freedom while still offering stability
    - Used for children w/ developmental delays or adults recovering from injuries where mobility restoration is a main goal
- Patient conditions: cerebral palsy; muscular dystrophy

4. Posterior Leaf Spring AFO

- Lightweight devices that provide minimal support to maintain optimal foot position without overly restricting movement
- Made from thermoplastic materials that curve around the back of the leg
- Useful for individuals with mild foot drop but still have some muscle strength in their legs
- Patient conditions: mild hemiplegia; multiple sclerosis

5. Custom-Fabricated AFO

- Tailored specifically to an individual's anatomy and functional needs
- Combine features from other AFOs
- Crafted using casts or digital scans of the patient's foot and leg, ensuring a precise fit
- Patient conditions: diverse conditions requiring personalized solutions

Materials Used in AFO Construction

- The type of material used in constructing an AFO can impact performance, comfort, and durability
- Regardless of material used, a proper fit is essential when it comes to the effectiveness of an AFO
    - An ill-fitting device can cause further complications like discomfort, skin irritation, pressure sores, or impaired circulation

1. Thermoplastics (e.g. polypropylene, polyethylene)

- Lightweight and easy to mold into specific shapes
- Balance between rigidity and flexibility

2. Carbon Fiber

- High strength to weight ratio
- Increasingly used in modern dynamic AFO designs
- Lightweight nature allows greater mobility without compromising structural integrity

3. Neoprene and Soft Liners

- Enhance comfort by reducing friction against the skin during wear
- Additional cushioning can be especially beneficial during long-term use

Benefits of Using AFOs

1. Enhanced Mobility - allows users to walk more confidently and independently

2. Prevention of Deformities - help maintain proper alignment of the foot and ankle joints

3. Increased Independence - mobility = independence in daily activities = greater self-esteem

Physical Therapy with AFO Use

- Strengthening exercises, gait training, pain management, and user education all significantly enhance outcomes for patients

Caring for Your AFO

- Regular cleaning, avoiding excessive heat, shoe compatibility, and regular follow-ups ensure the longevity and maximize the effectiveness of AFOs

Conclusions/action items:

This article explored 5 main types of AFOs along with the types of materials and their application in AFOs.

Link: https://wellwisp.com/afo-types-and-uses/

Citation:

09/15/2025 - Research: Study Establishes AFO Thickness Threshold

Claire Matthai - Dec 06, 2025, 5:34 PM CST

Title: Study Establishes AFO Thickness Threshold

Date: 9/15/2025

Content by: Claire Matthai

Goals: Gain knowledge on the most successful features in an AFO

Content:

- Rigid AFOs should deform only minimally to meet clinical goals.

- Material thickness and reinforcement design strongly influence rigidity, but choices have historically been anecdotal.

- Stiffness is maximized when reinforcements are placed as far anteriorly as possible.

- Additional stiffening occurs when reinforcements extend from the footplate to at least two-thirds of the AFO height.

- There is a minimum thickness threshold required to prevent buckling under load.

- Standard lateral/medial ribbing produced stiffness of 4.4 ± 0.1 Nm/degree.

- Moving ribbing to a more anterior position increased stiffness by 22%.

Link: Study Establishes AFO Thickness Threshold - The O&P EDGE Magazine

Citation: Study Establishes AFO Thickness Threshold - The O&P EDGE Magazine.” Accessed: Sep. 14, 2025. [Online]. Available: https://opedge.com/study-establishes-afo-thickness-threshold/

10/07/2025 - Research: Experimental and computational analysis of composite ankle-foot orthosis

Claire Matthai - Dec 04, 2025, 1:39 PM CST

Title: Experimental and computational analysis of composite ankle-foot orthosis

Date: 10/7/2025

Content by: Claire Matthai

Goals: Gain knowledge on AFOs

Content:

What was studied:

- The authors evaluated a composite (carbon-fiber) ankle-foot orthosis (AFO) — i.e. a brace used to support the ankle/foot.
- They used both experimental tests and computational modeling (simulations) to assess the mechanical performance of the AFO.

What they did:

- The authors evaluated a composite (carbon-fiber) ankle-foot orthosis (AFO) — i.e. a brace used to support the ankle/foot.
- They tested the AFO under conditions simulating real-world loads (as when walking) to see how it behaves mechanically.
- Performed computational (finite-element or similar) analysis to predict stress, deformation, and durability under repeated use.

Main Findings:

- The composite (carbon-fiber) AFO was effective in providing ankle-foot support: it could support loads relevant to walking and resist deformation under expected stresses.
- The modeling and experimental data aligned, meaning the computational analysis could reliably predict how the AFO would behave under realistic conditions.
- The results suggest that composite AFOs (e.g. carbon-fiber) can be mechanically sound and appropriate for use as ankle-foot support devices — potentially offering a lighter, durable alternative to more traditional AFO materials.

Why this matters:

- For people needing ankle-foot support (e.g. muscle weakness, neurological conditions, foot drop), composite AFOs present a viable — and possibly superior — option: strong support + durability + lighter weight.
- Computational modeling can help design and pre-test AFOs before manufacturing, reducing trial-and-error — saving time, resources, and improving safety.
- Supports further development of custom or patient-specific AFOs built from advanced materials (like carbon-fiber), possibly improving comfort and compliance compared to bulkier, heavier designs.

Link: Experimental and computational analysis of composite ankle-foot orthosis - PMC

Citation: D. Zou et al., “Experimental and computational analysis of composite ankle-foot orthosis,” Journal of Rehabilitation Research and Development, vol. 51, no. 10, pp. 1525–1536, 2014, doi: https://doi.org/10.1682/jrrd.2014-02-0046. Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5976490/

10/07/2025 - Pros and Cons of Polyester Fabric

Claire Matthai - Dec 06, 2025, 5:21 PM CST

Title: What Are The Pros and Cons of Polyester Fabric?

Date: 10/7/2025

Content by: Claire Matthai

Goals: Gain knowledge on polyester fabric and determine the possibility of its application in our AFO

Content:

Pros of polyester:

- Very durable – resists wear, abrasion, and repeated washing
- Moisture-wicking – absorbs sweat but dries quickly
- Fast drying compared to fabrics like cotton
- Stain-resistant because it absorbs less liquid
- Lightweight, ideal for activewear
- Wrinkle- and shrink-resistant – holds its shape well
- Inexpensive and more price-stable than natural fibers
- Easy to care for – machine washable/dryable, low ironing, dry-clean safe
- Versatile – can be blended with cotton, rayon, spandex, etc.
- Recyclable (though quality degrades with repeated recycling)

Cons of polyester:

- Less breathable, not ideal for bedding or hot climates
- Moderately flammable and can melt/stick to skin when burned
- Not eco-friendly – doesn’t biodegrade and contributes to landfill waste
- Temperature-sensitive – can melt or scorch under high heat
- Rougher texture than natural fabrics like cotton, may irritate sensitive skin

Link: Experimental and computational analysis of composite ankle-foot orthosis - PMC

Citation: Sanders, W. (n.d.). What are the pros and cons of polyester fabric? Https://Www.palmgear.com/. https://www.palmgear.com/what-are-the-pros-and-cons-of-polyester-fabric/

10/07/2025 - TPU Material Research

Claire Matthai - Dec 06, 2025, 5:27 PM CST

Title: The Properties of Flexible TPU Filament, How to Work with it, and Best Brands

Date: 10/7/2025

Content by: Claire Matthai

Goals: Gain knowledge on TPU and determine the possibility of its application in our AFO

Content:

Material Overview

- TPU = flexible, rubber-like thermoplastic filament
- Evolution of TPE (Thermoplastic Elastomer) → firmer and easier to print
- Combines soft + hard polymer segments → balance of elasticity and strength

Key Properties

- Rubber-like elasticity and flexibility
- Abrasion resistant
- Resistant to oils, greases, and solvents
- Performs well at low temperatures
- Excellent layer-to-layer adhesion
- More rigid and easier to print than TPE

Common Applications

- Sporting goods
- Footwear
- Medical devices
- Phone cases
- Inflatable products (rafts, seals)
- Automotive interior components (instrument panels)

Advantages vs PLA/ABS

- Flexible (bends and compresses without cracking)
- Higher impact resistance
- Better durability for moving/impact parts

Limitations

- Harder to print than PLA/ABS

- Harder to print than PLA/ABS
- Can cause stringing and blobs (poor bridging)
- Not ideal for detailed bridging over gaps
- Cannot be easily post-processed (doesn't dissolve like ABS in acetone)
- Depends heavily on correct tuning

Summary Insight

- TPU is best for flexible, impact-resistant, and durable functional parts
- More difficult to print than PLA/ABS, but improved over older TPE materials

Link: TPU Filament: Properties, How to Use It, and Best Brands - 3D Insider

Citation:

1. Flynt, J. (2018, March 29). The Properties of Flexible TPU Filament, How to Work with it, and Best Brands. 3D Insider. https://3dinsider.com/tpu-filament/#google_vignette

10/21/2025 - Ballistic Nylon Research

Claire Matthai - Dec 06, 2025, 5:30 PM CST

Title: Ballistic Nylon

Date: 10/21/2025

Content by: Claire Matthai

Goals: Gain knowledge on ballistic nylon and determine the possibility of its application in our AFO

Content:

Material Overview

- Originally developed for military use
- Now used mainly for durability and abrasion resistance

Key Characteristics

- Extremely tough and durable
- High abrasion resistance
- Designed for repetitive wear and heavy use
- Single-layer fabric (not true “ballistic” protection anymore)

Weave & Structure

- Uses a 2×2 basket (ballistic) weave
- Tight, dense weave improves:
    - Tear resistance in all directions
    - Overall durability
- Made from high-denier nylon fibers

Coatings & Performance

- Often polyurethane-coated
- Water-repellent
- Mildew-resistant

Common Applications

- Luggage and duffel bags
- Briefcases and backpacks
- Pet beds
- Workwear and reinforced apparel zones

- Chairs, covers, and custom cases
- Horse blankets

Best Use Cases

- Products needing:
  - Reinforced high-wear areas
  - Resistance to abrasion and tearing
  - High load durability

Link: Ballistic Nylon - What Is It? | Learn About Its Uses & History

Citation:

1. “Ballistic Nylon - What Is It?: Learn about Its Uses & History.” *Canvas ETC*, 26 Nov. 2022, www.canvasetc.com/ballistic-nylon/.

10/21/2025 - Mesh Fabric Research

Claire Matthai - Dec 06, 2025, 5:33 PM CST

Title: Athletic Mesh

Date: 10/21/2025

Content by: Claire Matthai

Goals: Gain knowledge on athletic mesh and determine the possibility of its application in our AFO

Content:

Material Overview

- Fabric: Athletic mesh
- Fiber: Polyester
- Construction: Warp-knit
- Category: Lightweight performance mesh (Tier 2/5)

Structure & Knit Properties

- Open mesh structure for ventilation
- Wales per inch: 8
- Courses per inch: 12
- Knit gauge: 24G

Physical Properties

- Weight: 100–200 gsm
- Thickness: 0.5–1.5 mm
- Typical width: 150 cm

Stretch & Fit

- Warp stretch: ~30%
- Weft stretch: ~20%
- Good elasticity and recovery
- Suitable for form-fitting garments

Key Performance Features

- Highly breathable
- Lightweight
- Quick-drying

- Effective moisture management

Common Finishes

- Moisture-wicking
- Antimicrobial
- DWR (Durable Water Repellent)

Typical Applications

- Sports jerseys
- Activewear
- Shorts
- Jacket linings
- Swimwear

Link: Athletic Mesh Fabric - Properties, Uses & Care Guide | Fabric Atlas

Citation:

1. Team, F. A. (2025, September 8). Athletic Mesh Fabric Guide - Fabric Atlas. Fabricatlas.com. https://www.fabricatlas.com/fabrics/athletic-mesh

09/25/2025 - Preliminary Design Idea

Claire Matthai - Sep 25, 2025, 4:18 PM CDT

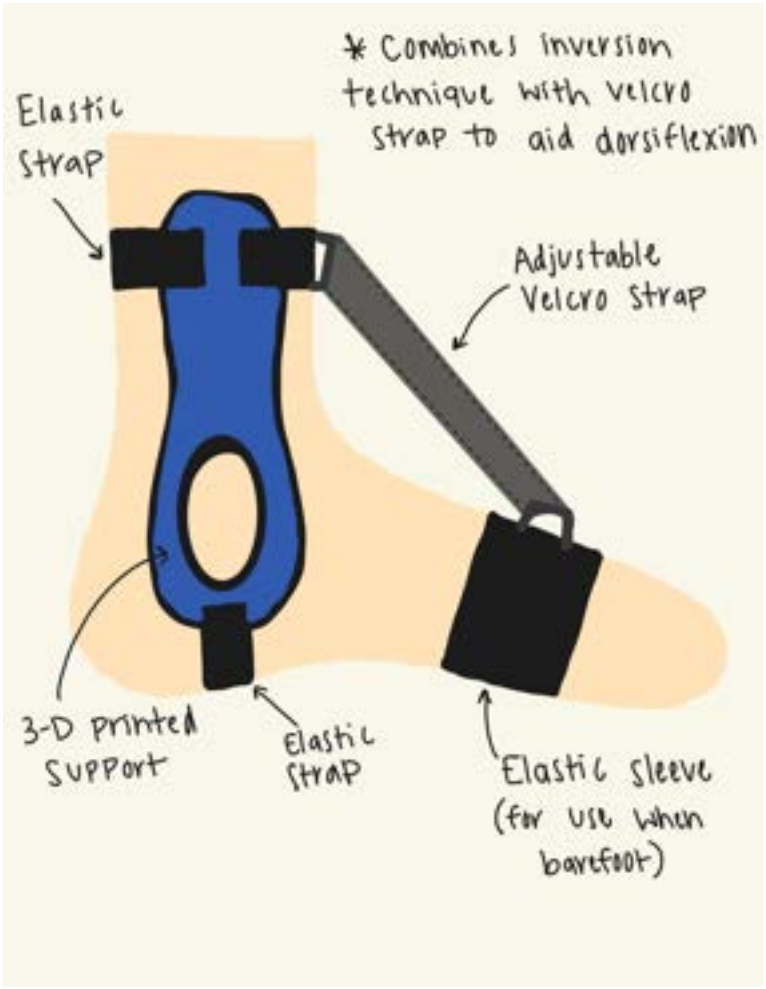
Title: Preliminary Design Idea

Date: 9/25/2025

Content by: Claire Matthai

Goals: Come up with a design idea for the AFO

Content:


* Combines inversion technique with velcro strap to aid dorsiflexion
Elastic strap
Adjustable Velcro strap
3-D printed support
Elastic strap
Elastic sleeve (for use when barefoot)

Conclusions/action items:

This design combines the inversion techniques from previous designs with an adjustable velcro strap to assist with dorsiflexion. This design would be compatible with and without shoes, but the velcro strap is not as inconspicuous as other bungee ideas. I will share my design idea with my group members and determine if this is one of the three designs we will include on our design matrix.

09/26/2025 - OSHA Chemical Safety Training Certificate

Claire Matthai - Sep 29, 2025, 3:37 PM CDT

Claire Matthai - Sep 29, 2025, 3:38 PM CDT

Download

cmatthai.pdf (111 kB) Chemical Safety Training Certificate

10/15/2025 - Biosafety Required Training

Claire Matthai - Oct 16, 2025, 10:50 PM CDT

Download

Screenshot_16-10-2025_225046_compliance.research.wisc.edu.jpeg (264 kB)

10/28/2025 - Intro to Machining

Claire Matthai - Oct 29, 2025, 9:38 AM CDT

Claire Matthai

ID Number: 9086981462

Eligibility: CoE Students

Profile

Program Registrations

Bookings

Memberships

My Memberships

Membership Type	Start Date	Expiry Date	Renew	Card Info
Machining	Wed, Aug 20 2025	Permanent	Not Renewable	N/A
Machining - Training Eligible	Wed, Aug 20 2025	Wed, Dec 31 3000	Not Renewable	N/A
CNC Mill I - Training Eligible	Wed, Aug 20 2025	Wed, Dec 31 3000	Not Renewable	N/A
Shop Tools	Tue, Aug 20 2024	Thu, Jan 2 3000	Not Renewable	N/A
Laser Cutter	Tue, Aug 20 2024	Thu, Jan 2 3000	Not Renewable	N/A
Lab Orientation	Tue, Aug 20 2024	Wed, Dec 31 3000	Not Renewable	N/A
Shop Tools - Training Eligible	Tue, Aug 20 2024	Wed, Dec 31 3000	Not Renewable	N/A
Laser Cutter - Training Eligible	Tue, Aug 20 2024	Wed, Dec 31 3000	Not Renewable	N/A

09/12/2025 - BSAC Meeting #1

Claire Matthai - Nov 30, 2025, 12:08 PM CST

Title: BSAC Meeting #1

Date: 9/12/2025

Content by: Claire Matthai

Goals: Meet with the other BSAC representatives and have a conversation about the following topics:

- Initial thoughts on the new “training throughout the curriculum”?
    - Anything you wish was different?
    - Has it been communicated well?
- How did project selection go? Any thoughts?
- What would you like to see more of from BSAC?
- 200s/300s
    - What questions do you have about BME design?
    - Do you feel like you have enough information on how a semester of BME design typically works (syllabus, requirements, schedule)?

Content:

- Thoughts on "training throughout the curriculum"
    - About 75% were not aware of this assignment, so communication needs to be improved in this area
    - We talked about having more flexibility on what training you could do - some ideas included: Altium, LabVIEW, Excel, etc.
- Project selection
    - One idea suggested was to add a feature to sort projects by active number of proposals
    - It was also difficult keeping track of what projects were still available or had already been suggested
        - Suggestions included making the website usable by more people at once
        - Having a break during project selection to allow people to gather their thoughts on what projects are still available and interests them

Conclusions/action items:

Major topics addressed during our first meeting include thoughts on "training throughout the curriculum" and ideas to improve project selection next year.

09/26/2025 - BSAC Meeting #2

Claire Matthai - Nov 30, 2025, 12:15 PM CST

Title: BSAC Meeting #2

Date: 9/26/2025

Content by: Claire Matthai

Goals:

- Discussion Reminders
- Faculty introductions
- Small Group Discussion
    - Students: name, year, track
    - How was the process of drafting and submitting the PDS?
    - How has client communication been? Has everyone met with their client?
    - At what stage of your project are you in? Prepared for design matrix/ideas
    - Are you and your advisor on the same page for lab archive expectations?
    - Thoughts on a suggestion form for BME “training throughout the curriculum”?
    - How to increase student awareness of BME advising resources/links?
    - Use the remaining time to ask faculty questions!
- Large Group Discussion
    - Each group summarizes their discussion and presents it to the large group
- BME Mentor Update

Content:

- Lab Archives
    - Variety in expectations among advisors
    - Faculty said that the notebook should serve to guide the conversation during advisor meetings, everything you do for the project belongs in the notebook. You should be spending 2 hours per credit of time outside of class (plus the class time) documenting your work.
- Training throughout the curriculum
    - A suggestion form was agreed upon to be a good way to get new training approved and added to the document
    - Many BSAC members favored the idea of creating a spreadsheet similar to the BME Track Recommendation spreadsheet, where trainings are sorted based on their application to a specific track
- Awareness of BME Advising Page
    - BSAC agreed to the idea of increasing the frequency of emails with mention of the BME Advising resource, similar to the progression email incoming sophomores get

Conclusions/action items:

Major conversations from this meeting include lab archives expectations and training throughout the curriculum and BME advising page awareness. We also got to speak with and hear from faculty members and get their insight on these topics.

10/10/2025 - BSAC Meeting #3

Claire Matthai - Nov 21, 2025, 12:05 PM CST

Title: BSAC Meeting #3

Date: 10/10/2025

Content by: Claire Matthai

Goals: Talk about responses from previous BSAC inquiries, discuss how preliminary presentations/reports went, determine if expectations are clear for Show and Tell.

Content:

Previous BSAC Inquiries

- Puccinelli is open to the idea of a BME 200 lecture, just needs to figure out logistics of taking out a credit somewhere to add to this class and timing of lecture. We said that an asynchronous option could be beneficial so that people can fit it around their schedule.

Group Discussions

- Preliminary Presentations
  - Many groups went over the time limit, so we may need to implement cut offs to ensure groups stay in this 10-minute limit
  - Some groups didn't get asked any questions, so we need a way to encourage others to ask questions
- Preliminary Reports
  - Would be good if reports could be due on Friday (or at least not on the same day as feedback fruits) because many of us had mid-week exams
- Advisor Expectations
  - Lots of discrepancies in advisor expectations - Some people are getting weekly notebook check grades; others don't have any grades put in
  - Would be good to have more consistency here and give advisors more guidance so they can best support us

Conclusions/action items:

At this BSAC meeting we talked about how preliminary presentations went and what changes we want to see next year. We also talked about preliminary reports and how we would prefer the deadline wasn't the same day as feedback fruits. Finally, we addressed discrepancies in advisor expectations and our hope to have clearer expectations made for next year.

10/24/2025 - BSAC Meeting #4

Claire Matthai - Nov 30, 2025, 12:28 PM CST

Title: BSAC Meeting #4

Date: 10/24/2025

Content by: Claire Matthai

Goals:

- Agenda
- Responses/overview from previous BSAC inquiries
- Training throughout the curriculum
- Mentor/Mentee Program Check in
- Small group introductions
- Small group discussion
- Large group discussion
- Reminders
    - **Tong Distinguished Lecture** right after this meeting (MANDATORY ATTENDANCE)
- Community Events/Involvement
- Schedule
- Attendance

Content:

- Material ordering
    - Some client confusion who is expected to order materials
    - A new funding system was discussed featuring a funding pool/strings collected at the start of the semester. This would work similarly to the BMEDesign Makerspace account.
    - Gave some general advice for material ordering
- Testing/equipment resources
    - Utilize Piazza for specific questions on what type of testing your team should conduct
    - RABBIT is a tool that allows you to search for subject matter experts on campus
    - Wisconsin Center for Nanoscale Technology (WCNT) (wcnt.wisc.edu) are shared instrumentation facilities providing equipment, facilities, and expertise in microelectronics, nano-fabrication technology, electron microscopy, micro-analysis and soft materials characterization.
        - Nanoscale Fabrication Center (NFC)
        - Soft Materials Characterization Laboratory (SMCL)
        - Nanoscale Imaging and Analysis Center (NIAC)
    - Research Cores Directory (resources.research.wisc.edu): equipment, cores, resources, and services for researchers

Conclusions/action items:

At this BSAC meeting, major points we talked about included advise for ordering materials and advise for determining the best resources for testing and equipment utilization.

11/21/2025 - BSAC Meeting #5

Claire Matthai - Nov 30, 2025, 12:19 PM CST

Title: BSAC Meeting #5

Date: 11/21/2025

Content by: Claire Matthai

Goals:

- Small Group Discussion
    - Design Project Progress:
        - What is your team’s plan for the remainder of the semester? (two weeks left until poster pres)
        - How has testing and data collection been going?
        - Are you ready for Final Poster Pres?
        - Expectations clear for completeness of project/prototype?
    - Client Questions:
        - How is communication w/client? Attending poster presentations?
        - Is your project continuing for next semester?
    - General Questions:
        - How did enrollment go? Are there any concerns?
- Large Group Discussion
    - Reminders
- BMES/ORG Announcements

Content:

- Talked about how our projects are going/where we're at and how communication with our clients have been
- Dr. Tracy Puccinelli gave input on patents and how to apply -- starts with an application online where you just describe your project and add advisors/clients/contributors
- Be concise on your poster - the more pictures, the better
- Look at PDS and make sure testing fulfills all the requirements you intended to meet -- analyzing testing is something you can do over break as turnaround before presentation week will be very quick
- There will be a feedback fruits assignment where you need to provide feedback on 3 other presentations
- Posters should be set up by 11:00 but you don't need to stand by the poster until 12:00
- Aim to print posters by Wednesday, December 3

Conclusions/action items:

At this BSAC meeting we had the opportunity to talk with advisors about how our projects are progressing, how class selection went, and what the expectations are for the final poster presentation.

Research - Dorsiflexion and Eccentric Contractions - 9/9/25

Sean CAREY - Sep 09, 2025, 7:04 PM CDT

Title: Dorsiflexion and Eccentric Contractions

Date: 9/9/25

Content by: Sean Carey

Present: Sean Carey

Goals: Learning about the movements that the client struggles with

Content:

The Client needs assistance with the dorsiflexion of the foot after lifting it during walking.

- Dorsiflexion is the raising of the foot towards the shin
- client struggles with lifting of the foot after lifting it to avoid tripping
- dorsiflexion is between 10 and 30 degrees
- Plantar flexion is the opposing movement to dorsiflexion

One of the goals is to prevent eccentric contractions during foot loading and to stop the foot from slapping the ground

- "During an eccentric contraction, muscles lengthen while still generating force,"
  - "downward phase of a bicep curl when lowering the weight back to the starting position"
- Eccentric contractions can cause greater damage to muscles
- "Eccentric contraction of plantarflexors" (calf muscles) during the loading phase of gait
- dont make the device so strong that the foot slaps the ground

[1] "Dorsiflexion: Injuries and mobility exercises." Accessed: Sep. 09, 2025. [Online]. Available: https://www.medicalnewstoday.com/articles/318930

[2] Dr. Praveen Kumar TK and Dr. A Mohammed Shafeek, "The power of eccentric contractions: Understanding muscle force during lengthening movements," *International Journal of Physiology, Health, and Physical Education*, pp. 90–92, Jul. 2024, doi: https://doi.org/10.33545/26647265.2024.v6.i2b.76.

Conclusions/action items:

Questions for the client:

How severe is the condition?

How much help is needed with the dorsiflexion of the foot?

Can the client resist the dorsiflexion of a device during walking?

Research - Muscles used when walking - 9/9/25

Sean CAREY - Sep 09, 2025, 7:27 PM CDT

Title: Muscles used when walking

Date: 9/9/25

Content by: Sean Carey

Present: Sean Carey

Goals: Learn about how we walk in relation to the ankle

Content:

Gait Phase	Key Muscles Active	Type of Contraction	Primary Action
Heel Strike	Tibialis anterior, Quadriceps, Gluteus maximus	Eccentric	Controls knee flexion, prevents foot slap
Foot Flat	Quadriceps, Gluteus medius, Tibialis anterior	Eccentric	Shock absorption, pelvic stabilization
Midstance	Plantar flexors (Gastrocnemius/Soleus)	Eccentric	Controls tibial advancement
Heel Off	Plantar flexors, Hamstrings	Concentric	Propels body forward
Toe Off	Iliopsoas, Plantar flexors	Concentric	Initiates swing phase
Swing Phase	Iliopsoas, Hamstrings, Tibialis anterior	Concentric	Leg advancement, foot clearance

Stance Phase

Heel Strike (Initial Contact)

- "Ankle moves from 0° neutral at initial contact to 5° of plantarflexion at foot flat"
- "Knee moves from 0° extension at initial contact to 15° flexion at foot flat"w

Foot Flat (Loading)

- "Ankle moves from 5° of plantarflexion during foot flat to 5° of dorsiflexion at midstance"
- "Knee moves from 15° flexion at foot flat to 5° flexion at midstance"

Midstance

- "Ankle moves from 5° dorsiflexion at midstance to 0° of dorsiflexion at heel off"
- "Knee moves from 5° flexion at midstance to 0° flexion at heel off"

Heel Off (Terminal Stance)

- "Ankle moves from 0° at heel off to 20° plantarflexion at toe off"
- "Knee moves from 0° at heel off to 30° flexion at toe off"

Toe Off (Pre-swing)

- "Ankle moves from 20° plantarflexion at toe off to 10° plantar flexion at early swing"
- "Knee moves from 30° flexion at toe off to 60° flexion at early swing"

Swing Phase

Early Swing

- "Ankle moves from 20° of plantarflexion at toe off to 10° of plantarflexion at early swing"
- "Knee moves from 30° flexion at toe off to 60° flexion at early swing"

Mid Swing

- "Ankle moves from 10° of plantarflexion at early swing to 0° of plantarflexion at mid-swing"
- "Knee moves from 60° flexion at early swing to 30° flexion at mid-swing"

Late Swing (Deacceleration)

- Ankle "maintains a neutral position"
- "Knee moves from 3o° flexion at mid-swing to o° flexion at late swing"

[1] S. S. Ekka, “Muscles Used in the Gait Cycle: Anatomy & Activity Explained (With,” PHYSIOSUNIT. Accessed: Sep. 09, 2025. [Online]. Available: https://physiosunit.com/gait-cycle-muscle-anatomy/

[2] “Muscle Activity During Gait,” Physiopedia. Accessed: Sep. 09, 2025. [Online]. Available: https://www.physiopedia.com/Muscle_Activity_During_Gait

Conclusions/action items:

There are two main phases of the gait to pay attention to. First of all, the swing phase, and keeping enough dorsiflexion so that there is no tripping. Second of all, the loading phase, and trying to minimize the eccentric contraction of the calf muscles while they walk. The angles will be useful during the testing and prototyping phases so that we can adjust the brace fit those constraints.

Research - Types of AFO's - 9/13/25

Sean CAREY - Sep 13, 2025, 11:09 PM CDT

Title: Types of Ankle Foot Orthoses

Date: 9/13/2025

Content by: Sean Carey

Present: Sean Carey

Goals: Learn about relevant types of AFOs that would be helpful for the client

Content:

TurboMed

- It is an AFO that attaches to the shoe and stores elastic energy during the gait to return dorsiflexion
- It is made of a highly durable plastic
- It is meant "for patients with weakened dorsiflexor, foot drop, hemiplegia, or peroneal nerve palsy caused by stroke, cerebral palsy, and multiple sclerosis. " [1]
- Less frequently used because of concerns about plastic being able to withstand the load

Articulated AFO's

- hinge at ankle
- lots of control over ankle and foot
- not good for those with severe muscle weakness/instability

Solid AFO's

- Rigid structure with lots of support
- completely restrict ankle movement

Ground Reaction AFO's

- focus on controlling knee and ankle movement
- mainly for knee hyperextension and instability
- very bulky

Posterior Leaf Spring AFO's

- semi-rigid and meant to assist with foot drop
- less stability than Solid AFO's so not meant for extremely unstable people

[1] Y. J. Choo and M. C. Chang, “Commonly Used Types and Recent Development of Ankle-Foot Orthosis: A Narrative Review,” *Healthcare (Basel)*, vol. 9, no. 8, p. 1046, Aug. 2021, doi: 10.3390/healthcare9081046.

[2] “Understanding the Different Types of Ankle Foot Orthoses (AFOs) - Align Clinic.” Accessed: Sept. 13, 2025. [Online]. Available: https://align-clinic.com/understanding-the-different-types-of-ankle-foot-orthoses-afos/

]

Conclusions/action items:

The two biggest findings were the TurboMed and the Posterior Leaf Spring AFO. Both are meant to help with dorsiflexion. The TurboMed is not widely used because of material strength concerns. The Posterior Leaf Spring AFO would be a good starting point, but would need to be improved because it mainly helps with passive dorsiflexion during the stance phase, but it does help with foot drop.

Research - Spring 2025 Semesters Design - 9/13/25

Sean CAREY - Sep 13, 2025, 11:43 PM CDT

Title: Spring 2025 Semesters Design

Date: 9/13/25

Content by: Sean Carey

Present: Sean Carey

Goals: Learn about previous work done for this project

Content:

- They looked into passive-dynamic AFO's like the leaf spring, but the client's case is too severe for that to work
- Client experiences ankle inversion (foot rolls to the side when lifted)
- They have equations for how much force the AFO needs to generate
- The final prototype is made of carbon fiber reinforced PLA
- The foot sleeve is made of nylon, polyester, and latex
- The final design was a compression sock with rigid supports for inversion and bungee cords for dorsiflexion
- performed MTS testing on the inversion supports, which passed
- performed force plate testing with the brace on a healthy subject under circumstances meant to replicate healthy and not healthy conditions
    - used this to choose between two inversion supports

- **They say inversion support needs to be improved (ineffective)**
- **It is hard to put on (a bigger problem now that the client's upper limb mobility is decreasing)**
- **Bracing causes pain on the medial side of the foot due to friction with the inversion support**
    - **suggest a lace-up enclosure instead of a compression sock**
- **The bungee cord system needs to be improved**
- **needs ergonomic refinements**
- **Need in-person testing**

Conclusions/action items:

They conducted a lot of different tests, but because the client was unable to come, they had to simulate the condition using a healthy subject, which is not preferred. The inversion support proved to be ineffective, and the brace was uncomfortable and hard to put on. Additionally, because the client's condition is worsening, the bungee needs to be improved to provide even more dorsiflexion.

Research - Fall 2024 Semester Design - 9/24/25

Sean CAREY - Sep 24, 2025, 12:20 PM CDT

Title: Fall 2024 design

Date: 9/24/25

Content by: Sean Carey

Present: Sean Carey

Goals: Research first-semester design

Content:

This is the semester where they developed the bungee design, and before they developed the support design.

- compression sock with gel pads at pressure points for comfort
- foot brace - nylon reinforced carbon fiber supports for stability
- bungee cord threaded through Locklace
    - adjustable strength
- does not fit in the shoe, but works for indoor use
- Testing showed that there was no negative or positive impact of the brace on healthy individuals
- unable to perform testing on the patient
- Recommend
    - replace compression sock for something slimmer
    - make support entirely carbon fiber
    - perform material testing
    - do testing with the patient

Conclusions/action items:

It seems that the bungee was not strong enough to add support for a healthy patient. They also only focused on dorsiflexion, so there was no increase in inversion support. This design needs to be improved to help more with dorsiflexion and incorporated with the next semester's inversion support.

Research - existing AFO materials - 9/24/25

Sean CAREY - Sep 24, 2025, 12:05 PM CDT

Title: Existing AFO materials

Date: 9/24/25

Content by: Sean Carey

Present: Sean Carey

Goals: Research materials used in existing AFOs

Content:

Important Material Factors: Strength, Stiffness, Hardness, Weight, Thickness, Durability, Formability, Moisture Resistance, and Biocompatibility

Material type	Advantages	Disadvantages
Polymers	Easily moldable	Can be nondegradable causing environmental pollution
	Short production time	Release of toxic gases during the manufacture of AFOs
	Poor heat and electricity conductor	Irritates the skin with prolonged use
	Corrosion resistant	Inflammable
	Lightweight	
	Aesthetically pleasing	
	Low metabolic cost of walking	
	Colorable	
Metals	High strength	Bulky and heavy
	Tear resistant	High production cost
	High stiffness/rigidity	Low cosmetic value
	Allows for thinner thickness orthoses	High metabolic cost of walking
		Excessive sweating and bad odor
		Easily corroded
		Joints require cleaning and lubrication
		Time-consuming design and

		manufacturing processes
		Needs specific equipment for manufacture
Polymer-based composites	High strength-to-weight ratio	High production cost
	Aesthetically pleasing	Not necessarily eco-friendly
	Corrosion resistant	Low recyclability
	Fatigue resistant	Time-consuming design and manufacturing processes
		Not economical for short-term users
		Needs specific equipment for manufacture
		Nonthermoformable for thermoset matrix composites
Leather	Dimensional stability	Harmful chemical waste
	Breathability and water vapor permeability	Bulky and heavy
	High moldability	Low cosmetic value
	Heat insulator	Excessive sweating and bad odor
	Tear resistant	
Textile fibers and fabrics	Renewability of raw materials for natural fibers	Low strength
	Lightweight	Low tear resistance
	Corrosion resistant	Low stiffness
	Cheap	May cause skin irritation and allergy

[1] A. Nouri, L. Wang, Y. Li, and C. Wen, “Materials and Manufacturing for Ankle–Foot Orthoses: A Review,” *Advanced Engineering Materials*, vol. 25, no. 20, p. 2300238, 2023, doi: 10.1002/adem.202300238.

Conclusions/action items:

There are many materials that AFOs can be made out of, and we will need to use a combination of materials. We will most likely use a 3D printed polymer for the inflexible parts. We will look into types of 3D printed polymers so that we can choose one that fits what we need. We will use fabrics for the casings to contain the 3D printed parts.

TPU Research - 10/15/25

Sean CAREY - Oct 15, 2025, 9:56 PM CDT

Title: TPU Filament Research

Date: 10/15/25

Content by: Sean Carey

Present: Sean Carey

Goals: Research the Filament we are using in the straps

Content:

- rubber-like flexibility
- High temperature resistance
- Can stretch
- typically difficult to rip or break a well-designed model
- Difficult to 3D print
- Shore hardness - ranges from soft to semi-rigid
- Standard tolerances are ± 0.6 mm (X/Y) for parts under 80 mm and ± 1.8 mm (Z)

[1] "TPU (THERMOPLASTIC POLYURETHANE)," TACTICAL CNC. Accessed: Oct. 15, 2025. [Online]. Available: https://tacticalcnc.com/tpu-thermoplastic-polyurethane/

[2] "TPU Filament Detailed Guide." Accessed: Oct. 15, 2025. [Online]. Available: https://3dpros.com/filament/tpu

[1] r3-D2, "Comprehensive Guide to TPU 3D Printing: Flexible Filament and Material Insights," 3D Mag. Accessed: Oct. 15, 2025. [Online]. Available: https://www.3dmag.com/3d-wikipedia/tpu-3d-printing-flexible-filament-material-guide/

Conclusions/action items:

It's difficult to print, but it has a wide range of uses due to its flexibility and heat resistance. Because of its flexibility and hardness, it's difficult to tear. There are a lot of different types of TPU filament that vary in hardness, so we will need to look into the specific properties of each one as we are conducting testing to choose which one will be best.

Presentation Research and Prep - 10/02/2025

Sean CAREY - Oct 02, 2025, 8:29 PM CDT

Title: Presentation Prep

Date: 10/02/2025

Content by: Sean Carey

Present: Sean Carey

Goals: Prepare for Preliminary Design Presentation

Content:

Competing Designs Slide:

Four of the most relevant competing AFO designs are the PD-AFO, SMO, Jointed AFO, and the variable stiffness AFO.

The passive dynamic AFO is a non-mechanical AFO that is meant to assist with walking by storing energy in the AFO and returning it as you push off the ground. It acts as a kind of spring.

The Supramalleolar Orthosis is one of the simpler orthoses. It is made to be small and only barely go above the ankle. Its main purpose is to add stability and support to the foot and ankle as you are walking.

The jointed AFO is an AFO that is separated into two parts connected by a joint. This type of orthosis is meant to add stability to the ankle while still allowing dorsiflexion and plantar flexion. Additionally, it is intended to limit foot drop by keeping the angle between the foot and the ankle at approximately 90 degrees.

The variable stiffness orthosis is one of the more complicated AFOs. It is possible to adjust the condition of the leaf spring in the AFO, therefore affecting the stiffness. It is shown to assist with foot drop and reduce toe strike.

All of these AFOs have certain things that they help with, but we are looking to develop something that is more suited to the patient's needs (transition)

PDS Slides:

There are a lot of aspects that we need to keep in mind while designing the AFO. Starting off, it needs to be measured for the patient so that it is secure and works well. For the actual support, it needs to permit no more than 30 degrees of foot drop, which is something the patient has been struggling with. Additionally, it needs to assist in dorsiflexion of the foot and add some resistance to plantar flexion, which would also help with foot drop. It also needs to be safe and withstand the torsional forces of ankle inversion and daily use, while supporting the patient's weight. We also need to ensure that the AFO is equipped for daily use along with the patient's horseback riding. The Last factor is comfort. If it is not comfortable, the patient won't want to wear it, then it is not helping at all.

[1] F. M. Medical, “What is an SMO Brace?,” Forward Motion. Accessed: Oct. 02, 2025. [Online]. Available: https://www.fdmotion.com/blog/what-is-an-smo-brace
[2] “Variable Stiffness Orthosis – Neurobionics Lab.” Accessed: Oct. 02, 2025. [Online]. Available: https://neurobionics.robotics.umich.edu/research/wearable-robotics/variable-stiffness-orthosis/
[3] J. Feng, J. Weiss, A. Thompson, and J. E. Meeker, “Passive Dynamic Ankle Foot Orthoses Use in Civilian Patients with Arthritic Conditions of the Foot and Ankle,” *Foot Ankle Orthop*, vol. 8, no. 1, p. 24730114231157734, Mar. 2023, doi: 10.1177/24730114231157734.
[4] “Jointed AFOs,” Orthotics Plus Melbourne. Accessed: Oct. 02, 2025. [Online]. Available: https://orthoticsplus.com.au/orthotics/ankle-foot-orthoses-afo/jointed/
[5] “Gait Cycle: Phases & Biomechanics | OrthoFixar.” Accessed: Oct. 02, 2025. [Online]. Available: https://orthofixar.com/basic-science/gait-cycle/
[6] “Movement About Joints, Part 7: The Ankle.” Accessed: Oct. 02, 2025. [Online]. Available: https://www.crossfit.com/essentials/movement-about-joints-part-7-the-ankle

Conclusions/action items:

Present tommorow

Individual Brainstorming - 9/18/25

Sean CAREY - Nov 19, 2025, 12:47 AM CST

Title: Individual Brainstorming

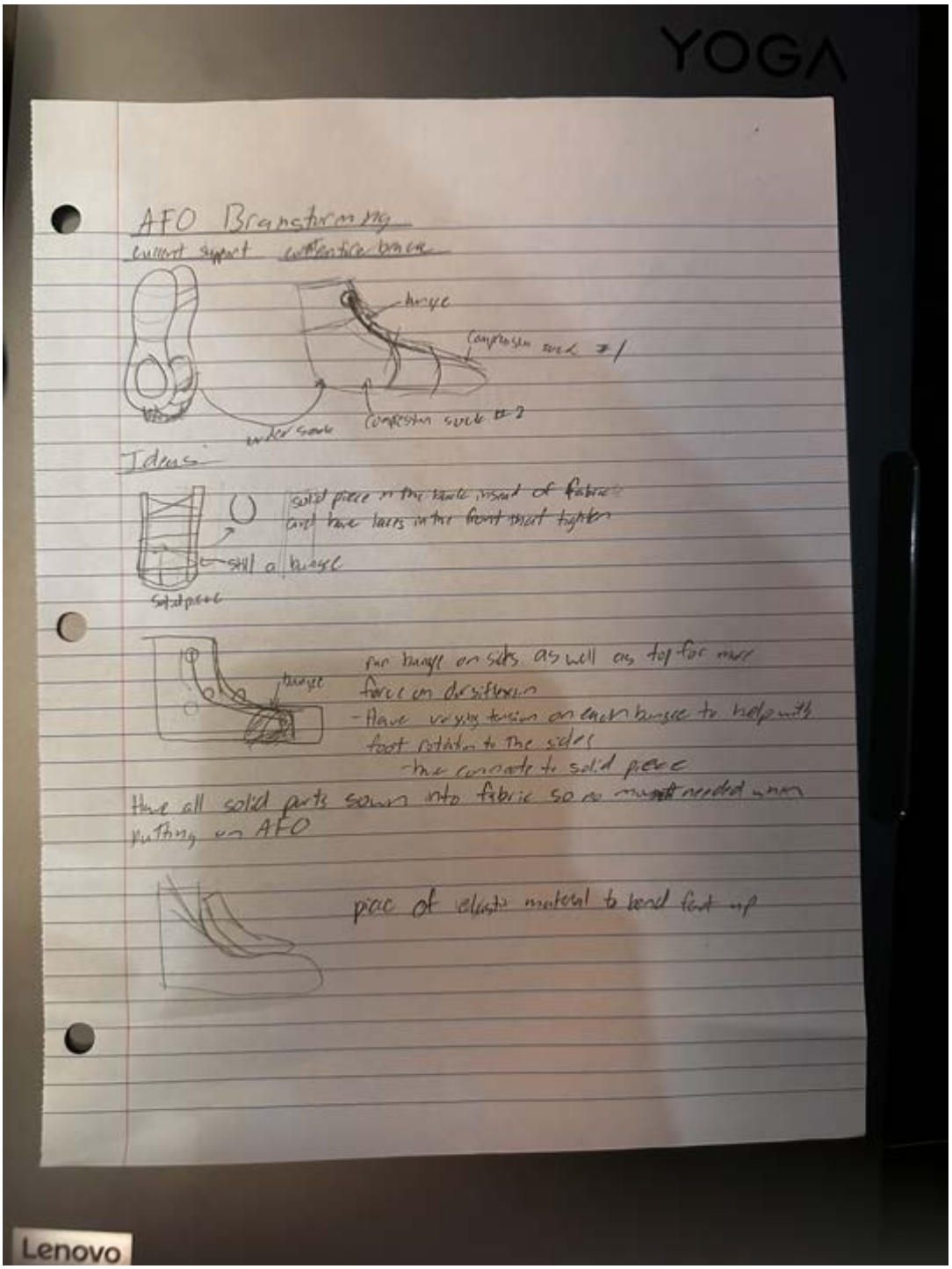
Date: 9/18/25

Content by: Sean Carey

Present: Sean Carey

Goals: Brainstorm ideas for AFO

Content:



AFO Brainstorming

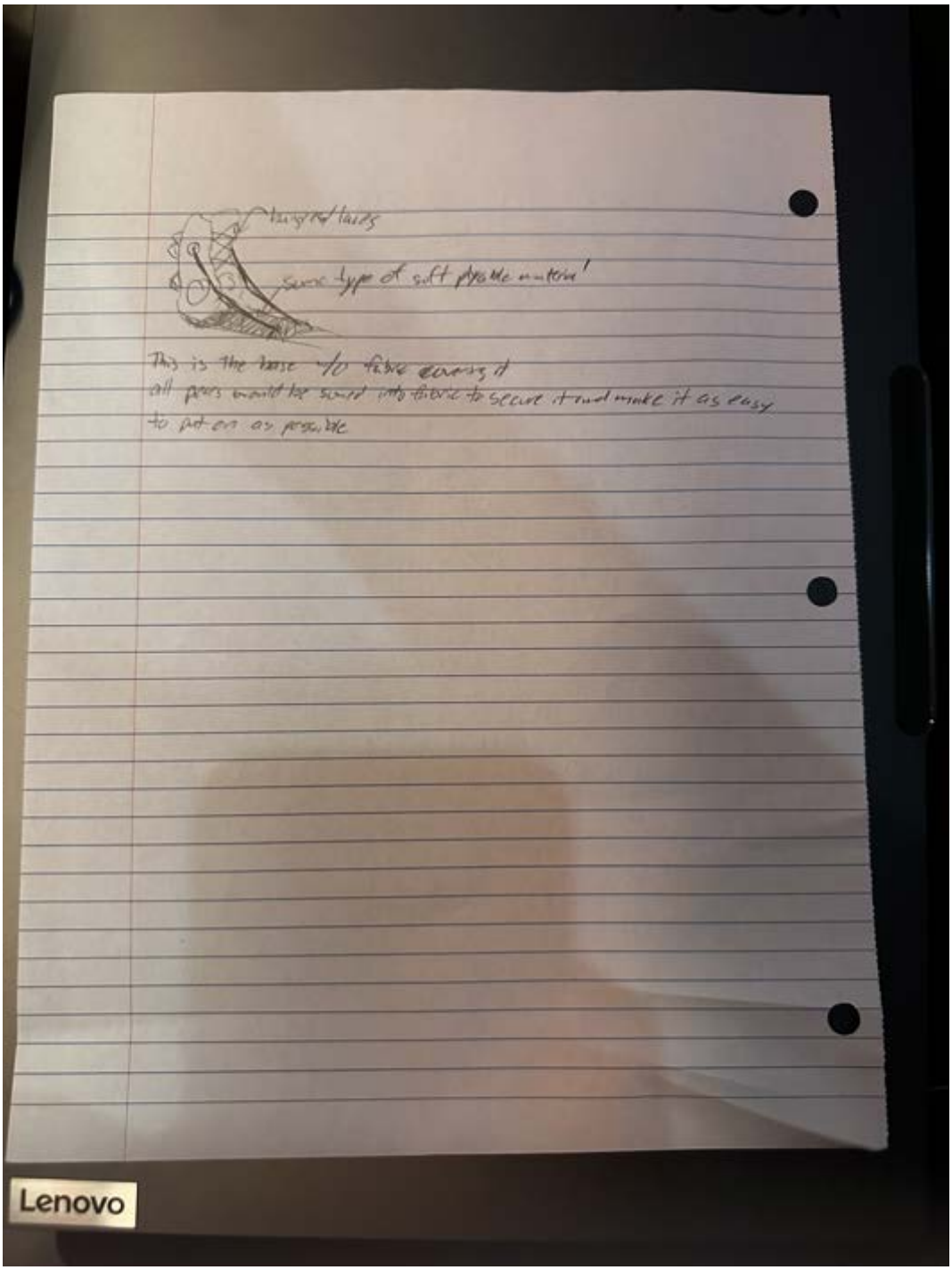
current support

Ideas

run straps on sides as well as top for more force on dorsiflexion
- Have varying tension on each buckle to help with foot rotation to the sides
- have connect to solid piece

Have all solid parts sewn into fabric so no ~~must~~ needed when putting on AFO

piece of elastic material to bend foot up



Conclusions/action items:

I think it would be beneficial to make the piece all one so that there is less complexity to put it on. The client is struggling more and more with arm mobility so it needs to be as simple as possible. We also don't want things moving around so that they need to be adjusted.

9/23/2025 - Design Matrix drawing 3

Sean CAREY - Sep 23, 2025, 11:03 PM CDT

Title: Design Matrix Drawing 3

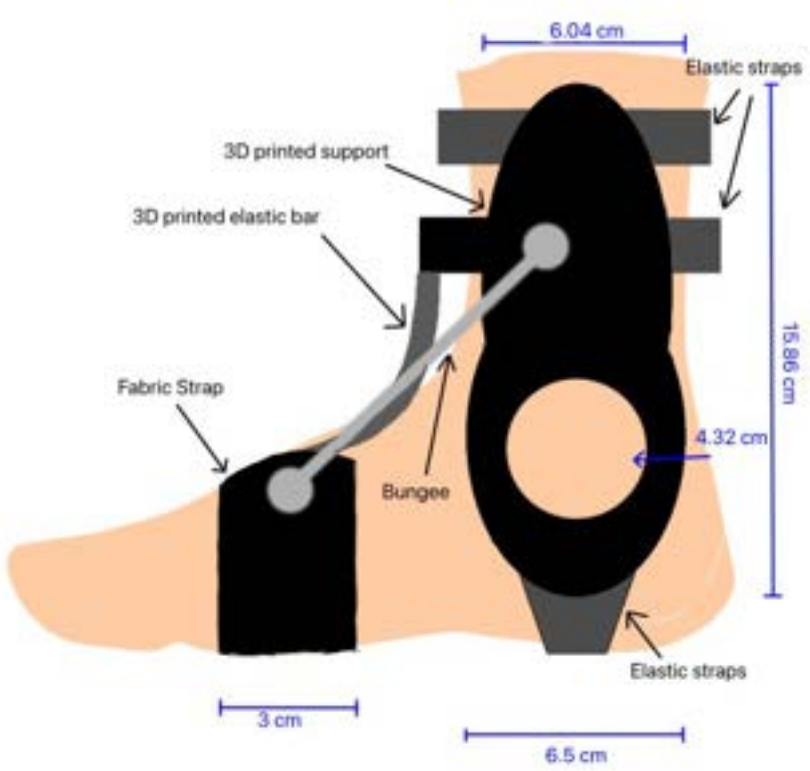
Date: 9/23/25

Content by: Entire team

Present: Sean Carey

Goals: Draw design 3 form design matrix, brainstormed by team

Content:



Conclusions/action items:

The design features the same inversion brace from the previous semester's design, which we will tweak to make it more comfortable and sturdier. It also keeps the bungee. This design adds an elastic bar that will be 3D printed in a way so that when it is in the brace, it is in a constant state of wanting to flex back to its original shape, which will move the foot up to support dorsiflexion.

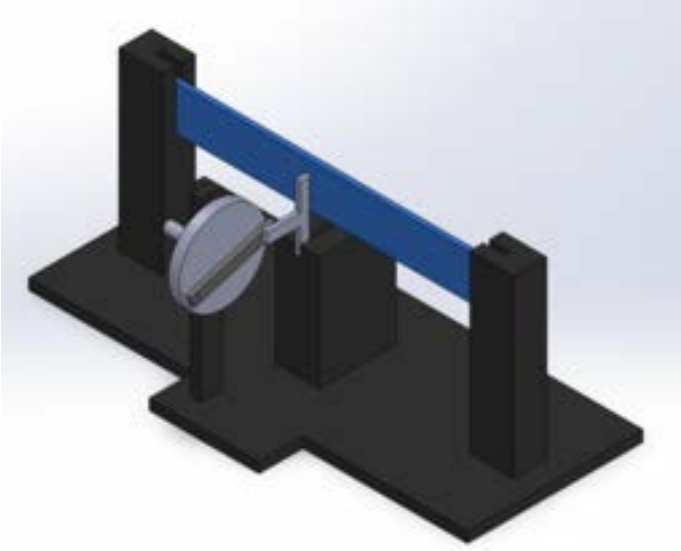
Testing device V1 - 10/11/25

Sean CAREY - Oct 15, 2025, 9:08 PM CDT

test piece - 1 x 8 in. - thickness - 1/8 or 1/16 in.

bend angle - 20 degrees

Sean CAREY - Oct 15, 2025, 9:15 PM CDT



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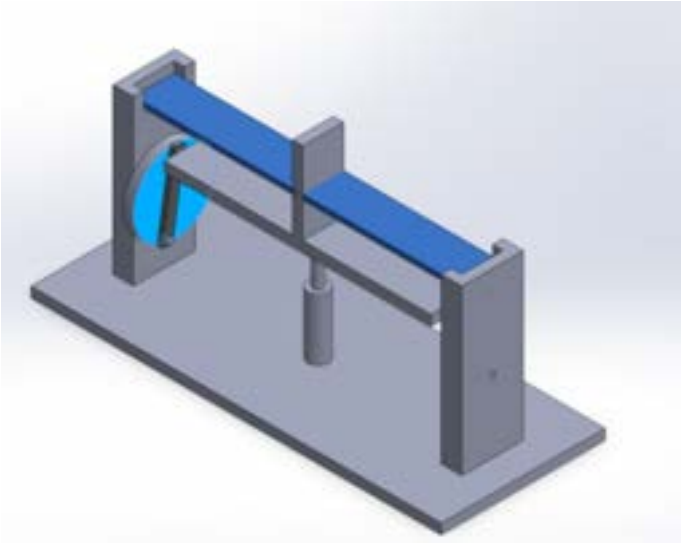
Testing device V2 - 10/16/25

Sean CAREY - Oct 16, 2025, 3:28 PM CDT



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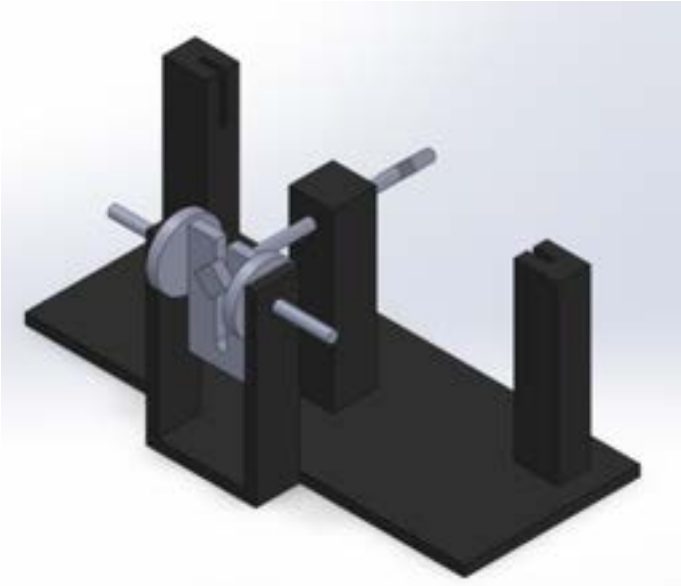
Testing device V3 - 10/16/25

Sean CAREY - Oct 16, 2025, 4:13 PM CDT



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Testing device semi-final - 10/20/25

Sean CAREY - Oct 20, 2025, 5:57 PM CDT

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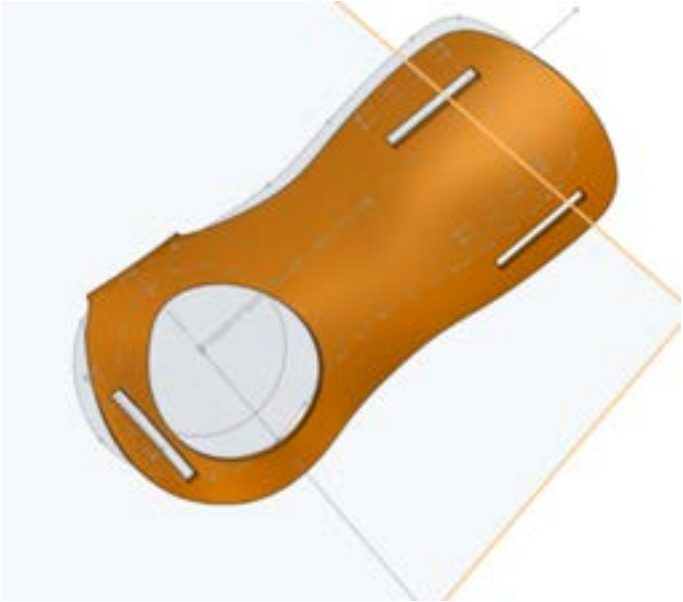
20251020_224114000_iOS.MOV (17.7 MB)

Lateral Brace V1

Sean CAREY - Oct 23, 2025, 5:08 PM CDT



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Lateral Brace V2 - 10/29/25

Sean CAREY - Oct 29, 2025, 7:39 PM CDT

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medial brace V1 - 10/29/25

Sean CAREY - Oct 29, 2025, 7:41 PM CDT

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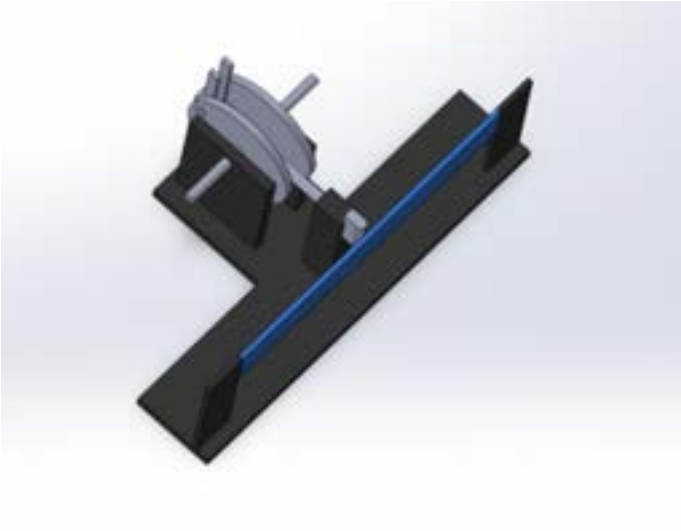
Testing device V4 - 10/29/25

Sean CAREY - Oct 29, 2025, 8:34 PM CDT



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Final Brace Design - 11/16/25

Sean CAREY - Nov 19, 2025, 12:55 AM CST

Title: Final Brace Design

Date: 11/16/25

Content by: Sean Carey

Present: Sean Carey

Goals: Finalize the brace design

Content:

After testing with the client, these are the updates that we decided need to be added:

1) Flatten out curves in the brace

2) make braces the same height

3) Change hole heights so that they are the same length

4) add a back strap

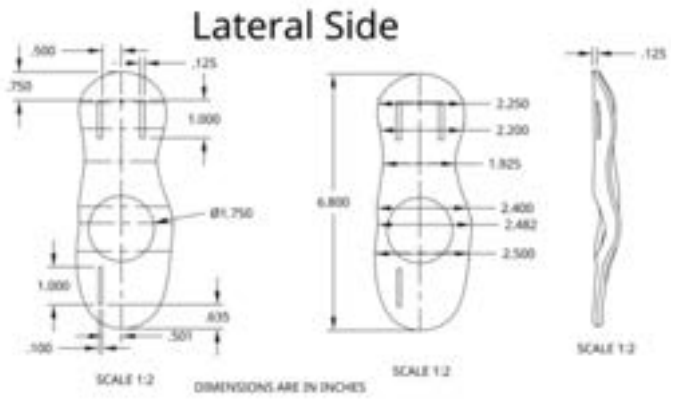
5) add a strap over from of the ankle (this will go through the big hole)

Conclusions/action items:

Final brace is ready to print

Final Brace Drawings

Sean CAREY - Nov 19, 2025, 12:56 AM CST



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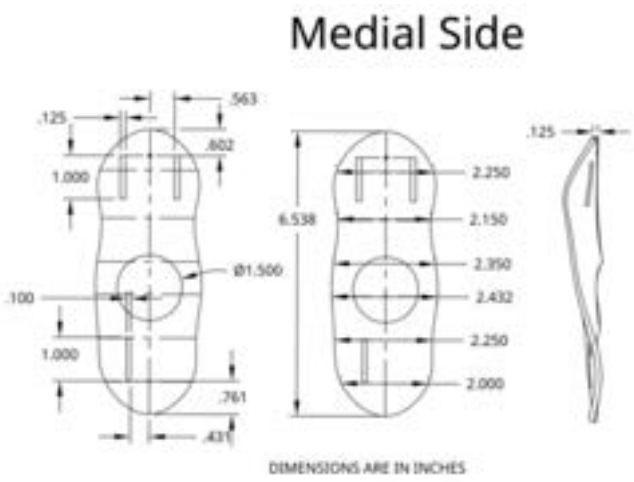
Sean CAREY - Nov 19, 2025, 12:56 AM CST



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OSHA Chemical Safety Training - 9/8/25

Sean CAREY - Sep 16, 2025, 4:00 PM CDT

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safety_training_certificate.pdf (111 kB)

Sean CAREY - Sep 16, 2025, 4:02 PM CDT

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Biosafety Required Training - 9/8/25

Sean CAREY - Sep 16, 2025, 4:03 PM CDT


This certifies that Sean Carey has completed training for the following course(s):

Course	Assignment	Completion	Expiration
Biosafety Required Training	Biosafety Required Training Quiz 2024-2025	9/8/2025	9/8/2999
Chemical Safety: The OSHA Lab Standard	Final Quiz	9/8/2025	

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Intro to Machining Training - 9/24/25

Sean CAREY - Sep 24, 2025, 12:29 PM CDT

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InterEGR 170 Training

Sean CAREY - Oct 09, 2025, 11:30 AM CDT

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09/10/2025 - Entry Template

Alex Conover - Sep 10, 2025, 11:50 PM CDT

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

Date: 9/5/2025

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 in IEEE format)

Conclusions/action items:

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

2014/11/03-Template

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

Title:

Date:

Content by:

Present:

Goals:

Content:

Conclusions/action items:

Spring 2025

Alex Conover - Sep 05, 2025, 2:11 PM CDT

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Alex Conover - Sep 05, 2025, 2:11 PM CDT

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