

Specialized Shoe Design Instructible

A research project done by: Sutherland McKelvey, Anthony Falletta, Maurice Peek, Sean McKinney, Matthew Stang



Sponsors and Special Thanks

The CLOVES Syndrome Community

The CLOVES Syndrome Community has sponsored this project in finances as well as project guidance. They have offered several resources that have been incorporated into the document's current process. The CLOVES Syndrome Community has also provided materials needed for testing and creating the initial prototype. Below is a link to their website.

<https://CLOVEssyndrome.org/>

The University of Akron

The University of Akron has provided this project with initial materials for testing and provided project coordination throughout the entirety of the project. This project was created for the “senior design” class that all mechanical engineering students must complete. The five students who created this project have worked together to showcase this as their final project.



The University of Akron

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Editor's Notes

This Instructible was created after a year long senior project for the University of Akron by five senior engineering students on path to graduation. This document encapsulates the findings and processes created by those students. The processes were utilized to assist a team member's nephew that has CLOVES Syndrome. The document contains the processes found and curated during the year that were used to create shoes for that individual. It should be noted that the processes are still under development and future renditions, versions, and types can and will be added in the future. This document was published to aid families in similar situations, providing resources, guides, and aid so that their shoe making journey may be assisted in some way. Everyone's needs are different, however documenting this process that worked for our specific case may help jumpstart other successful versions. The goal for the end of the project was to turn it over to the community to allow for continuous growth with families that find their own solution. If anyone has any input, questions, feedback, or ideas, Please email or reach out to the Author so that processes can be added for other people to use. It may help someone or generate further solutions.

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OVERVIEW

The general purpose of this resource is to aid families in creating affordable, quality shoes for individuals with complex foot conditions. This document is set up to be a step-by-step process with additional information to allow for an open platform for continued growth. In this document there will be several footwear solutions with modular differences to allow for variance in ease of production, and for engineering technicality. There will be technical language used throughout the document, so looking over the materials, terms, and other nuances will be addressed in the document as well. However, it is heavily recommended that a person does individual research to become as familiar as possible with custom shoes beforehand to increase the ease of the process and the quality of the final product. Each section has a general materials/tools list. For more complex materials, the appendix provides links to suggested sites to order the materials.

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Process breakdown

The majority of the content from this point will follow a step-by-step process assuming you have familiarized yourself with the document and have the necessary materials and tools to complete the shoes. It is recommended you check the appendix tools and materials section to ensure you are ready to begin. The Process is broken into two main sections: Sole creation, and upper creation. The Sole creation will have three ways to achieve a sole that is usable for different purposes. If a person is aiming to achieve a certain sole, they may only need to get some of the required materials. The upper creation will follow a singular process called the “AFA process”. This stands for the three basic steps to completion. Acquisition of materials and measurements, Format of the 2D patterns, and Assembly of the 3D upper and sole. This will be delved into deeper as the document continues. Creating the sole first is advised because the sole can help attain measurements for the upper to ensure that it is a flush fit.

Sole Creation

The sole is the foundation of the shoe. This document aims to provide 3 different solutions. These solutions are oriented at fulfilling different needs for soles.

The first sole described is the “assembly” option. This sole is inexpensive and easy to make. It may not last as long as the other options however it is great for young ones, and individuals can increase its lifetime by adding additional materials. An example of it can be seen to the right.

The second sole creation option is the “mold” option. This process uses a liquid polyurethane elastomer that must be molded. It is considerably more expensive, however tests have shown minimal wear with six months of daily use. This process also has an initial expense however after the process is set up, the only expense is the elastomer itself. This option is ideal for individuals looking for a high-quality sole that can be replicated when the foot has reached maturity and will not grow anymore. It can also be dyed to fit a variety of styles. An example of this sole can be seen to the right.

The final option is an outsourced 3D print option. It is slightly less expensive than the mold option and is created for you. The only work that must be done is a scan of an individual’s foot. This option is ideal for individuals that want a custom sole mail delivered to them that can be reordered and resized. An example can be seen to the right.



Option 1: Assembly Soles



Option 2: Mold Soles



Option 3: 3D Soles

EVA Foam Assembly Soles

Tools

Precision cutting utensil (razer blade)
Barge Cement (shoe glue) or Contact Cement
Masking Tape
Sandpaper (150-240 grit)
Scissors
Sharpie
Ruler
Measuring Tape
Cutting Board

Materials

EVA foam 5 mm
EVA foam 1mm
Vibram sheet (used for bottom tread) [optional]
Crepe Rubber (used as outsole shell) [optional]
Paper (18"x24") [may need a larger size]

Option 1: Tracing

1. Grab pencil and paper, place the paper on a solid flat surface
2. Place foot on paper and trace a close outline of the foot on the paper. Place their weight on the foot so it is in the condition under which they would be wearing shoes. Hold the marker perpendicular to the floor, this ensures a steady trace. Do not angle the marker at all.
3. Remove foot from paper and using a pencil, draw a smooth contour roughly 1 cm offset around the entire foot, (verify that this offset is large enough to encompass the entire foot with room for foot to grow. If not large enough, increase the offset distance).



Option 1: Tracing

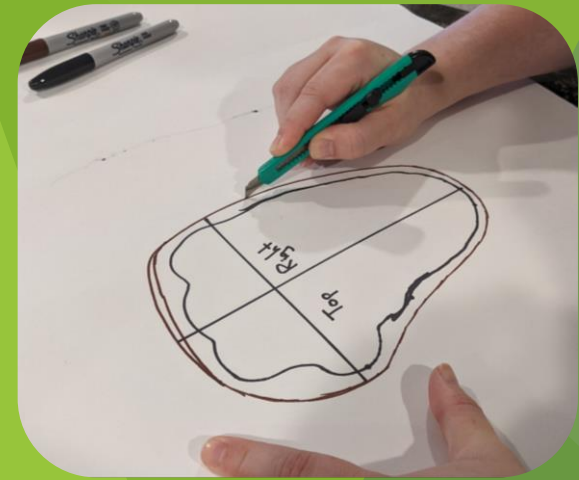
4. Using a ruler draw a vertical line from top of the foot to the heel
5. Next, taking ruler draw a straight line from the left most toe point to the right most toe point (this will create your toe box). The line should be perpendicular to the vertical line
6. Mark a note on the pattern saying, “Top (insert which side of the foot the pattern is). Example: “Top Left,” or “Top Right”



Option 1: Tracing

7. Using a pair scissors or boxcutter, cut out the outer most drawn pattern
8. Grab 10 mm EVA Foam and tape the paper pattern bottom onto the top of EVA foam to ensure it doesn't move (using two pieces of tape should be good enough).

(NOTE): EVA comes in a variety of thicknesses, depending on the person using different thicknesses may be ideal. EVA can also be stacked and glued together with contact cement



Option 1: Cutting

9. Using boxcutter, score the pattern into the EVA foam to create the outline of the pattern.
10. Once pattern is transferred onto the EVA foam, remove paper pattern to ensure it doesn't get damaged by cutting the EVA
11. Finish cutting out the EVA foam by making many straight and vertical passes to have a clean-cut line through all 10 mm of the foam (warning: do not tug on EVA foam to rip the pattern away from excess material, this could cause the EVA to be damaged).



Option 1: Cutting

12. Once the EVA pattern is finished and removed, place foot on top of the EVA again to make sure the offsets are still represented
13. Using rough sandpaper (150 grit), sand the rough edges of the EVA pattern to make it smoother (tip: place sandpaper on a hard flat surface or place a sturdy object like a block of wood behind the sandpaper in your hand to increase the effectiveness of the sanding). Don't spend a lot of time making the EVA edges smooth, the EVA just needs the major bumps and excess material removed.
14. Fit paper pattern on top of EVA pattern to ensure the correct orientation is showing. Mark a note on the EVA pattern using a silver sharpie or marker saying, "Top (insert which side of the foot the pattern is)". Example: "Top Left," or "Top Right"



Option 1: Assembly

15. Using a fabric tape measure, measure the rough circumference of the EVA foam and record it.

Note: if you have an in-step difference, measure that height difference and record it.

16. Using a ruler and a sharpie, draw a rectangle on the crepe rubber using the following as the dimensions:

Length: The circumference you recorded (add an extra 0.5 in. to the circumference length).

Height: Based on the in-step difference, measure out the in-step difference ensuring there is 1 cm of material above the top of the EVA foam and that the entire EVA foam is covered going down to the bottom of the shoe (This rectangle will serve as the feather line or Gum Band of the shoe).



(NOTE): Here we are making a band that will wrap around the sole. This will be a lip that can be sewn into. This material can also be used on the bottom of the sole to make it last longer. These steps can be optional

Option 1: Assembly

17. After ensuring that there is a 1cm lip created, the band is ready to be cut. Reference the second picture to see an example of the 1cm lip. If there is a height difference the EVA may be thicker (hence a thicker band)
18. Cut out the crepe rubber using scissors (warning: do not tug on rubber to rip the pattern away from excess material, this could cause the rubber to be damaged).
19. Once cut out, make sure the feather line crepe rubber band runs around the entire circumference of the EVA without gaps.

Note: For the remainder of the instructible, we used a different model, to show you different color options, but all steps are the same regardless of the model change.



Option 1: Assembly

20. Using Barge cement, coat the bottom half of the crepe rubber feather line entirely and also coat the entire rough edge of the EVA foam. Let both sit for 5 minutes.



21. Attach the crepe rubber to the EVA foam and hold for 5 minutes shaping it around the EVA to ensure a good fit. (Make sure the edge of the crepe rubber is flush with the bottom of the EVA foam. Let sit for 30 minutes).



Option 1: Cutting

22. Using Tape, secure the EVA bottom onto more crepe rubber (two pieces of tape should be ok).

23. Using a sharpie trace the EVA with added band onto the crepe rubber

24. Using a pair scissors, cut out the drawn pattern

(NOTE): here we are making the bottom of the Assembly sole by adding a rubber tread. This will add traction and make the shoe last longer. This step is optional but recommended.

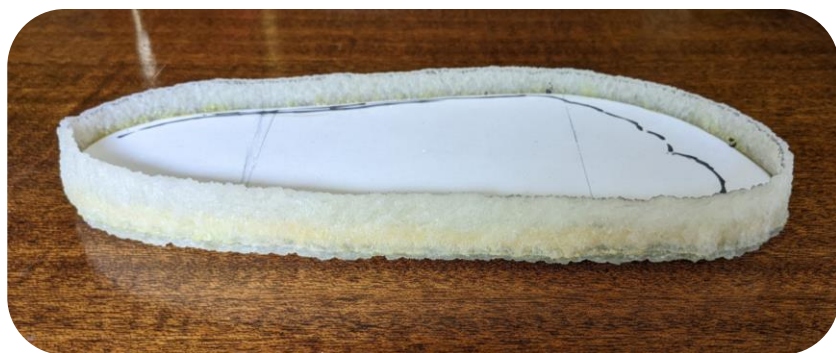


Option 1: Tracing

25. Mark a note on the top of the crepe pattern saying, “Top (insert which side of the foot the pattern is) Outsole. Example: “Top Left Outsole,” or “Top Right Outsole”
26. Place EVA foam bottom on top of the crepe rubber pattern to verify they are flush.
27. Using barge cement, coat the entire bottom of the EVA and the entire top of the crepe rubber. Let sit for 5 minutes.
28. After waiting 5 minutes, attach both halves and shape to make sure all edges line up. Hold for 5 minutes. Then let finished assembly sit for 30 minutes.



Option 1: Tracing



Cast Sole Using Silicon Molds

Tools

Paper (18"x24")

Sharpie

Ruler

Jigsaw or wood cutting tool

Hot Iron

Hot Glue / Hot Glue Gun

Mold Station Box (plastic shoe bin)

Paint brush

Materials

Cardboard (from cereal box or similar material)

Corrugated cardboard

$\frac{3}{4}$ " plywood or similar stiff working material

Wood Veneer edge banding (approx. 1")

Silicon kit

Polyurethane Elastomer kit

Release Agent

Water based polyurethane finish

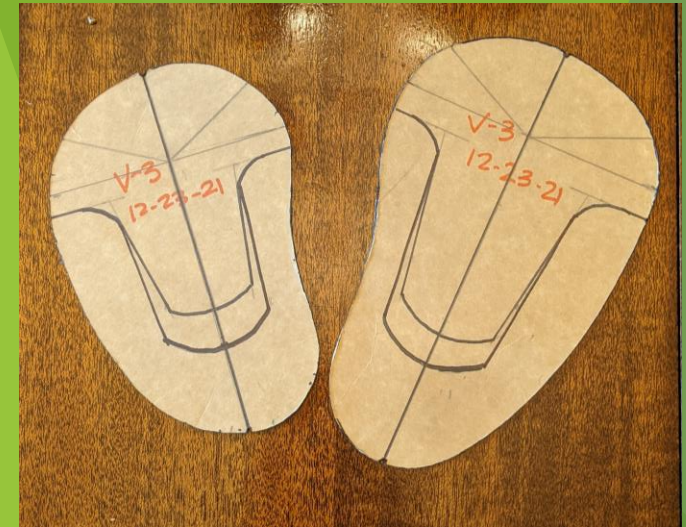
Option 2: Molding

1. Begin by laying a sheet of paper on the floor and tracing the individual's foot with a permanent marker. Hold the marker 90 degrees perpendicular to the ground.
2. When the tracing is complete for both feet. Allow a tolerance smoothing line to slightly increase the perimeter of the foot. This step allows for the shoe sole to be slightly bigger than the foot. This also accounts for materials that would take up space such as the material added from the upper.



Option 2: Molding

3. Cut out the tolerated foot sheet pattern and transfer that to a thin cardboard such as cereal box cardboard and cut out a “standard”. This pattern can be used many times and it is better to work with.
4. Now begins the molding setup. For the next step you will want to create a mock shoe sole. Our team utilized wood however any building material can be used. To create the wooden mock shoe sole, place the cardboard pattern on the mock material (in our case wood) and trace the cutout onto the wood.



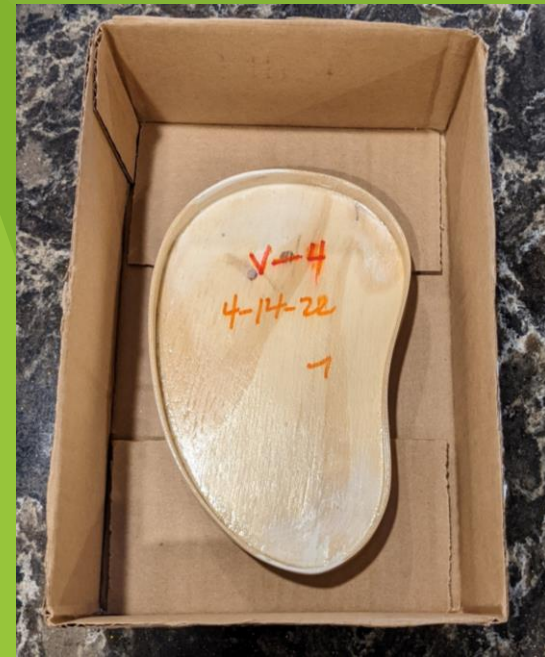
Option 2: Molding

5. With the mock base traced onto the wood, cutout the shape. Our team used $\frac{3}{4}$ inch plywood to create the sole base, the flat bottom of the shoe. If someone has an instep (foot height disparity) each shoe should be made independently to account for the difference.
6. Now it is time to add the lip to the shoe sole. The team used birch wooden veneer that can be ironed on to the sides. Measure the perimeter of the shoe sole flat and cut out a section of veneer to that length. Iron on the veneer to the sides.



Option 2: Molding

7. With the lip attached, the mock shoe sole is completed, this should fit the individual's foot, and be in the dimensions desired. Now it is time to create the mold station where the elastomer will be poured. To begin, create or use a box that encapsulates the shoe mock sole completely. We used cardboard because it was cheap and easy to make a box that fit the mold. Just be sure to waterproof it with tape and hot glue.
8. Coat the wood in the polyurethane varnish and spray the mold release agent on the wood. These steps will aid in removing the wood
9. Mix silicon by following the instructions provided in the product. Mount the shoe mock sole facing up on the bottom of the container. Fixate the shoe sole with glue and pour the silicon over the entire shoe sole, fill the container until there is a half inch in excess. It is recommended to use containers you will not use again.



Option 2: Molding

9. Allow the silicon to dry completely. Remove the entire silicon mold from the container by either breaking the box or using a knife to unstick the edges. Remove the mock sole from the silicon by bending and digging the wood from the material until it slides out and the sole mold is created, this can be used many times and will work for the polyurethane elastomer selected.
10. Mix the polyurethane as directed according to the instructions sent with the product. Pour the liquid into the silicon mold along with any color additives one may want. Allow to dry and then remove the polyurethane mold the same way the mock sole was removed.



Option 2: Molding



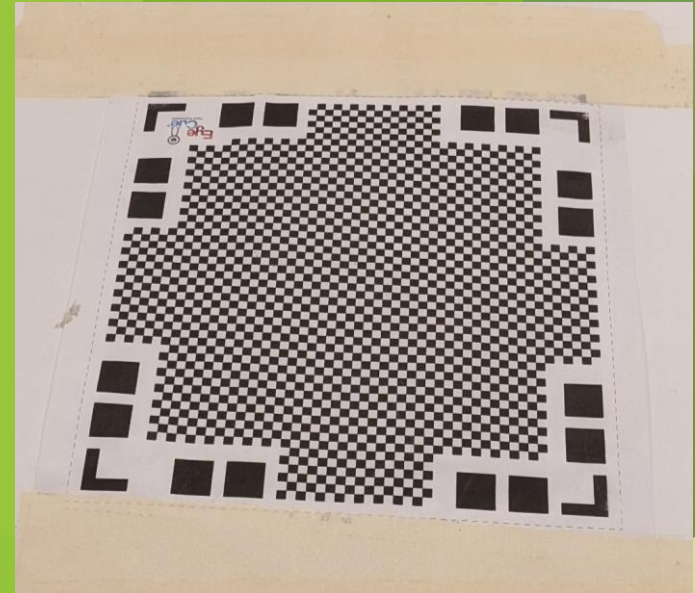
3D Printed Soles

Tools

iPhone 12 (smartphone with LIDAR scanner)

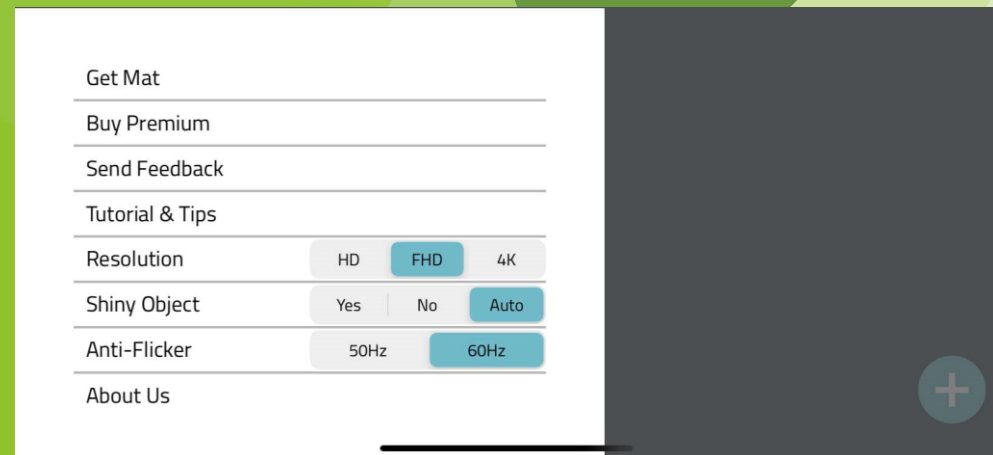
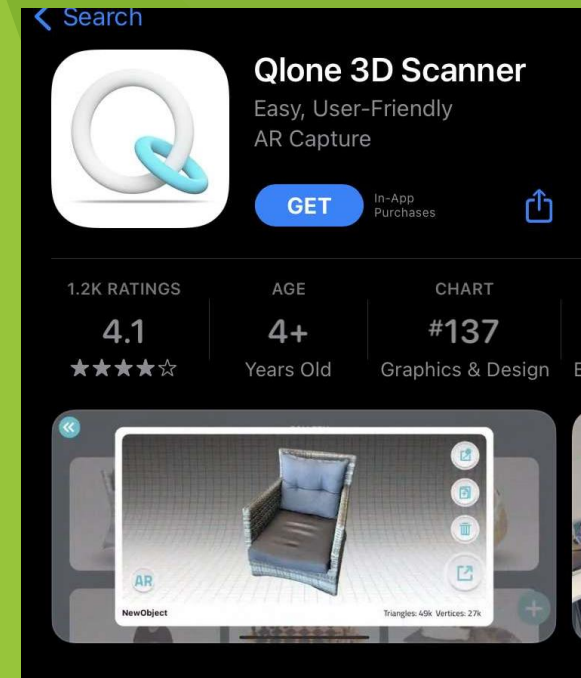
Materials

3D mat (if using qclone app on apple store)



Option 3: 3D Printing

1. Begin by downloading the Qlone app found on the Apple App Store. **(Note):** This method uses LIDAR technology that is only installed in Recent iPhones and certain androids. Check your phones capabilities before continuing this route. For this method we used an iPhone 12*
2. When the application is downloaded, you will need to print the scanning mat that will assist in capturing the scan of a person's foot. This can be seen in the tabs section. It is recommended that you print this in a 14"x18" paper so that the QR sheet will cover the entire foot.



Option 3: 3D Printing

3. It is important to note that purchasing the premium version through the app is necessary to obtain an “STL” of the scan. This will be used by the engineer to create the shoe. The team used a disposable visa card and put 20\$ to utilize the app features.
4. When the Sheet (mat) is ready, place it on the floor. Through the app click on the plus sign to begin a new scan and select that you will be using the mat. The app has an in-depth set up guide it will show you before you begin scanning. Use a flat hard surface and tape the edges down. Have the individual stand on the mat either barefoot or in a tight-fitting sock. It is ideal to wear shorts so that there is no pants draping over the ankle or upper shin.



Option 3: 3D Printing

5. Scan the foot following the app AR (augmented reality) sphere until it is a complete scan. It may take a few tries to get a scan that is accurate. As long as the individual does not move, it is possible to do multiple scans and compile them together through the app. It does not need to be completely accurate, however it needs to have a good overall relation to the foot so that the engineer can tolerance a shoe sole from it.
6. Export the scan as an STL and email the file to sutherland.mckelvey17@gmail.com.
(Note): An initial email to the engineer is heavily recommended so that business can be ensured and at a time that is relevant to both parties.

Option 3: 3D Printing

7. After contacting Sutherland, send the scan to him so that he can create a shoe sole from the measurements.
8. When Sutherland is done with the 3D model, He will send a photo and after confirmation he will print the sole. Optionally he can also print a “last”, which is a 3D model of a person’s foot. The team found lasts very helpful in the creation of the upper. A picture of the last can be seen to the right as well as the printed sole.



Option 3: 3D Printing

9. Sutherland will email the models to an engineering 3D printing company that will print the soles and other potential products. When the prints are completed, a final photo will be sent and the products will be mailed to the individual. This will be the last step in the sole process creation. When the soles arrive, they are completed and the upper can be created.



Upper Creation

The upper is defined in this document as the fabric material above the sole. For the upper creation process, a streamlined linear setup has been demonstrated following three main stages defined earlier in the document, the AFA process. This setup is meant to be used as a guide that can be shifted by the individual based on what they are looking for in the final product. One may want to familiarize themselves with the materials list and read the through the process entirely before beginning. For the upper, it is heavily recommended to use a sewing machine for multiple reasons. A sewing machine will look more aesthetic, it will hasten the process, and it will ensure a good quality sew line. Before beginning double check that all tools and materials are accounted for. These can be referenced in the appendix, a person does not need to buy every material, just an outer layer, cushion layer (also acts as insulation), and inner layer is recommended.

Upper Creation

Tools

Measuring Tape
Writing Utensil
Sharpie
Sewing pins
Razer Blade
Scissors
Needle
Sewing Machine (optional, but recommended)
Barge Cement
Sewing Awl

Materials

Masking Tape
Printable measurement tool sheet
Premade Sole
Paper (18"x24") (larger may be needed)
Cutting Board
Interior fabric (reference appendix for ideas)
Exterior fabric (reference appendix for ideas)
Cushioning middle fabric (reference appendix)
Nylon thread
Zippers

Acquisition

The goal of the acquisition stage of the upper creation is to retrieve key measurements utilizing the foot documentation sheets in the appendix. It is presumed that a completed sole is done as it is helpful to create a good fit for the entire shoe. Below are the steps found to create the dimensions for the shoe

Upper Creation: Acquisition

1. Right Foot

- a. Using the *Shoe Foot Documentation Sheet*, measure the easternmost toe point to the westernmost toe point across the EVA foam. Record that dimension in slot 1 on the right foot.
- b. Measure the northernmost toe point to the southernmost heel point across the EVA foam. Record that dimension in slot 2 on the right foot.
- c. Measure the perimeter distance from the easternmost toe point to the westernmost toe point. Record that dimension in slot 3 on the right foot.



Upper Creation: Acquisition

1. Right Foot

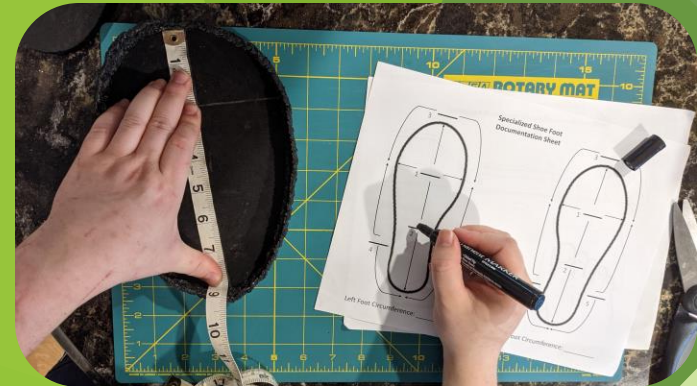
- d. Measure the perimeter from the westernmost toe point to the heel. Record that dimension in slot 4 on the right foot.
- e. Measure the perimeter from the easternmost toe point to the heel. Record that dimension in slot 5 on the right foot.
- f. Record the EVA foam circumference on the circumference line



Upper Creation: Acquisition

1. Left Foot

- a. Using the *Shoe Foot Documentation Sheet*, measure the easternmost toe point to the westernmost toe point across the EVA foam. Record that dimension in slot 1 on the left foot.
- b. Measure the Northernmost toe point to the southernmost heel point across the EVA foam. Record that dimension in slot 2 on the left foot.
- c. Measure the perimeter distance from the easternmost toe point to the westernmost toe point. Record that dimension in slot 3 on the left foot.



Upper Creation: Acquisition

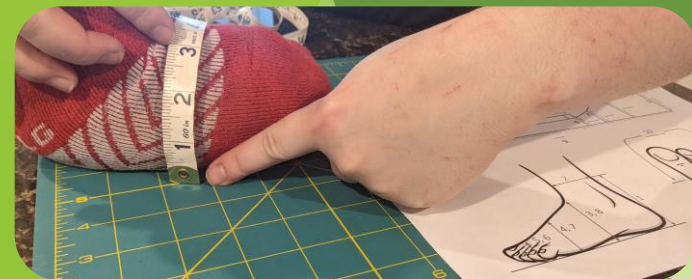
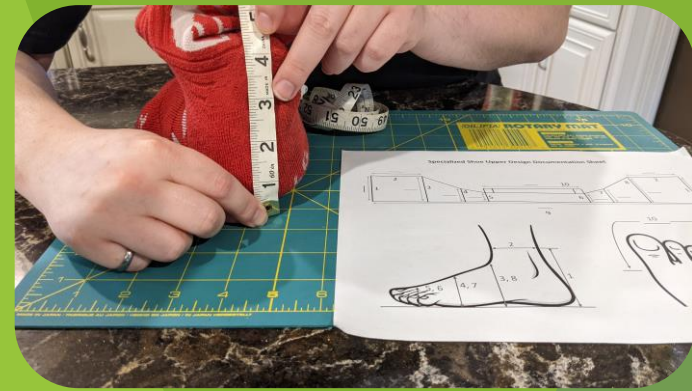
1. Left Foot

- d. Measure the perimeter from the westernmost toe point to the heel. Record that dimension in slot 4 on the left foot.
- e. Measure the perimeter from the easternmost toe point to the heel. Record that dimension in slot 5 on the left foot.
- f. Record the EVA foam circumference on the circumference line



Upper Creation: Acquisition

1. Pattern Creation of Right Shoe Upper
 - a. Using the *Shoe Upper Design Documentation Sheet*, measure the height from where the heel touches the ground to where on the ankle you would like the ankle hole of the shoe to be. Record that dimension in both sections labeled 1 on the Shoe Upper Design Documentation Sheet.
 - b. Measure the circumference of the ankle at the height you just chose on the ankle. Record that dimension in both sections labeled 2 on the Shoe Upper Design Documentation Sheet.
 - c. Measure the height from the bottom of the foot to the top of the foot at the locations on both sides of the foot labeled “3 and 8.” Record the corresponding dimensions in the sections labeled 3 and 8 respectively.



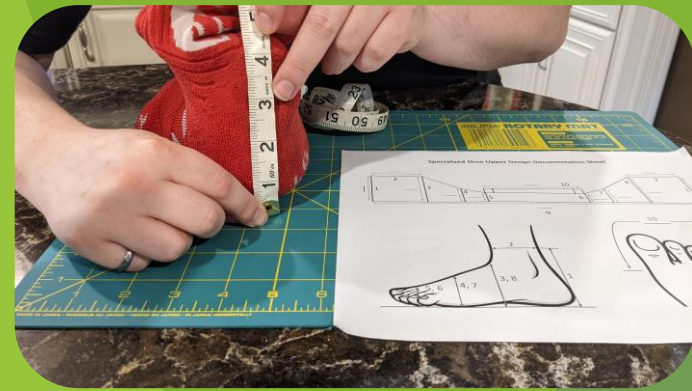
Upper Creation: Acquisition

1. Pattern Creation of Right Shoe Upper
 - d. Measure the height from the bottom of the foot to the top of the foot at the locations on both sides of the foot labeled “4 and 7.” Record the corresponding dimensions in the sections labeled 4 and 7 respectively.
 - e. Measure the height from the bottom of the foot to the top of the foot at the locations on both sides of the foot labeled “5 and 6.” Record the corresponding dimensions in the sections labeled 5 and 6 respectively.
 - f. Copy measurement 3 from the right foot on the Specialized Shoe Foot Documentation Sheet and record that dimension in location 10.



Upper Creation: Acquisition

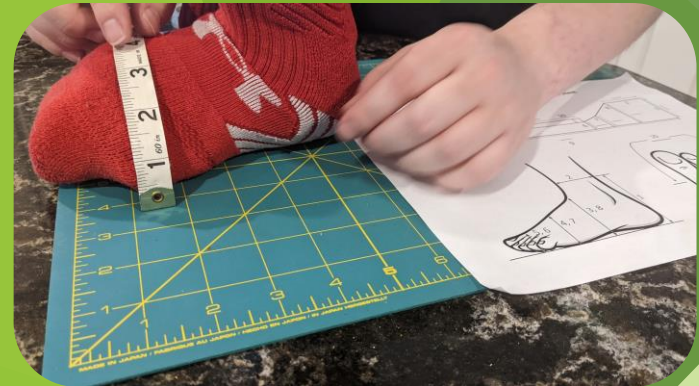
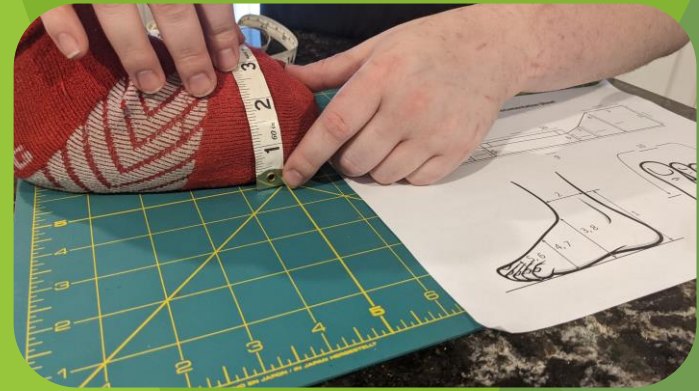
1. Pattern Creation of Left Shoe Upper
 - a. Using the *Shoe Upper Design Documentation Sheet*, measure the height from where the heel touches the ground to where on the ankle you would like the ankle hole of the shoe to be. Record that dimension in both sections labeled 1 on the Shoe Upper Design Documentation Sheet.
 - b. Measure the circumference of the ankle at the height you just chose on the ankle. Record that dimension in both sections labeled 2 on the Shoe Upper Design Documentation Sheet.
 - c. Measure the height from the bottom of the foot to the top of the foot at the locations on both sides of the foot labeled “3 and 8.” Record the corresponding dimensions in the sections labeled 3 and 8 respectively.



Upper Creation: Acquisition

1. Pattern Creation of Left Shoe Upper

- d. Measure the height from the bottom of the foot to the top of the foot at the locations on both sides of the foot labeled “4 and 7.” Record the corresponding dimensions in the sections labeled 4 and 7 respectively.
- e. Measure the height from the bottom of the foot to the top of the foot at the locations on both sides of the foot labeled “5 and 6.” Record the corresponding dimensions in the sections labeled 5 and 6 respectively.
- f. Copy measurement 3 from the left foot on the Specialized Shoe Foot documentation sheet and record that dimension in location 10.



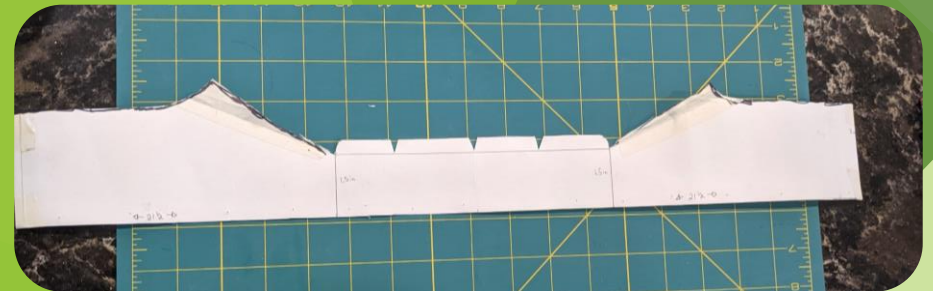
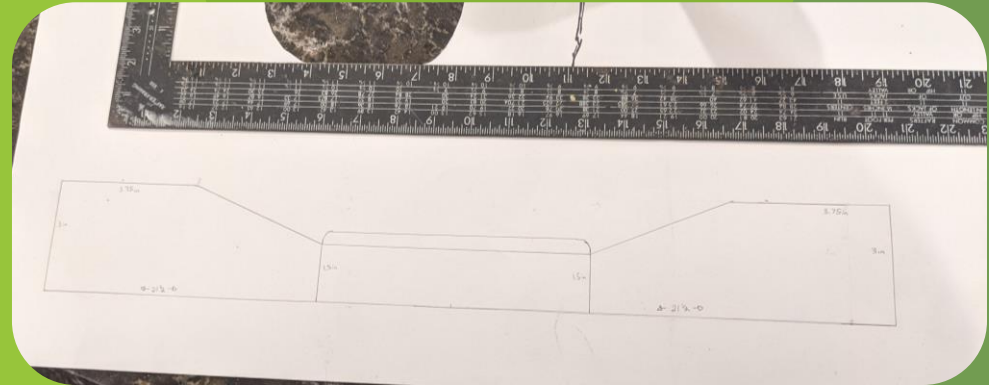
Formatting

The formatting stage of the upper assembly pertains to the usage of the acquired measurements to format the skeleton of the shoe. This involves creating the standards for the shoes, a 2D paper pattern that will be used later. It is essential to ensure this pattern is optimized for the foot by checking how it wraps around the foot and by checking how it fits in the shoe sole. Below are the steps to check that the fit is acceptable.

Upper Creation: Formatting

1. Pattern Creation of Right Foot

- Using a pencil and ruler recreate the Upper pattern shape on paper. Use the measurements gathered on the Shoe Upper Design Documentation Sheet to create a 1:1 size model on the paper.
- After pattern is transferred, cut pattern out and insert into outsole.
- Use small pins to pin the upper pattern to the crepe rubber to hold pattern in place when foot is inserted (Warning: make sure points of pins point outward to ensure the foot isn't poked).
- Place foot into outsole, to verify fit with pattern (the pattern ends should line up perfectly at heel. If it doesn't, cut excess material away. Also, make sure line 5 and 6 line up with their perspective lines on the EVA top).



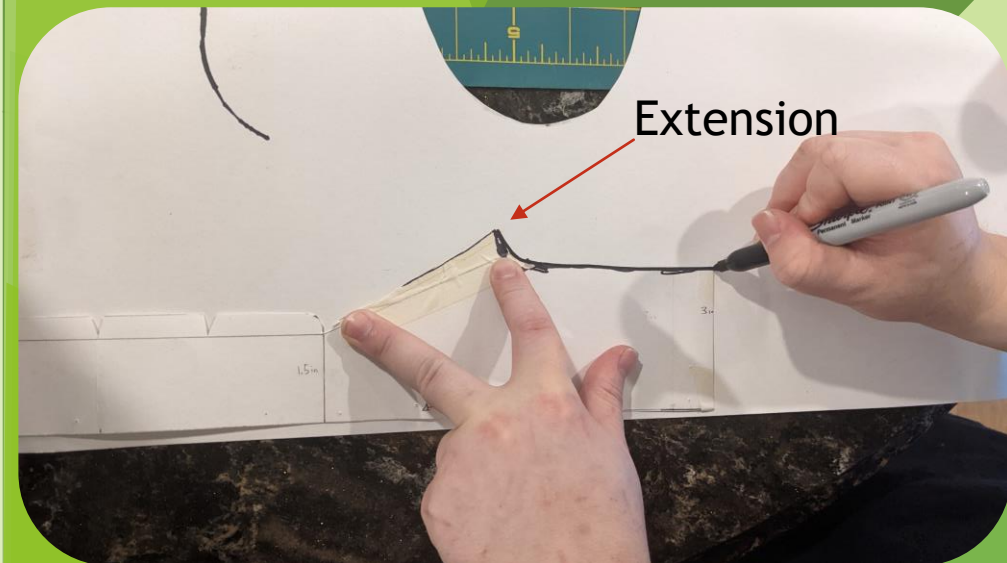
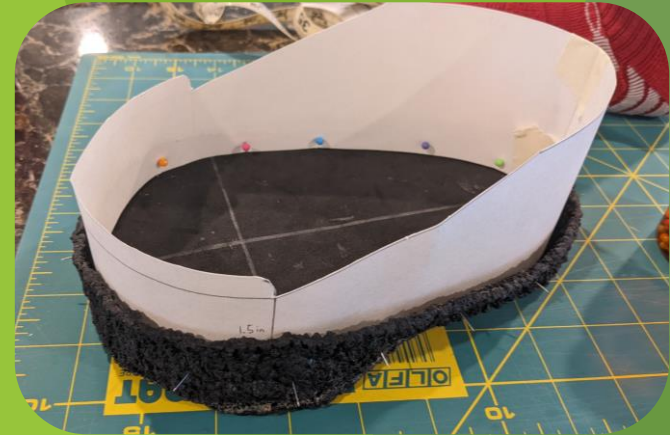
Upper Creation: Formatting

1. Pattern Creation of Right Foot

Note: Now the process of fine tuning the patterns begins. Modify the shoe pattern to meet your aesthetic appeal. Go to Index A for examples.

- d) When modifying shoe patterns there are two different modifications you can do; Extension (for adding more material to precut Standard), and/ or Cut (for removing material from precut Standard).
- e) For extensions, use tape to add more material. This will serve as a template for the creation of a new standard.
- f) For cuts, use scissors to cut material away from standard. This will help to finalize the new standard.

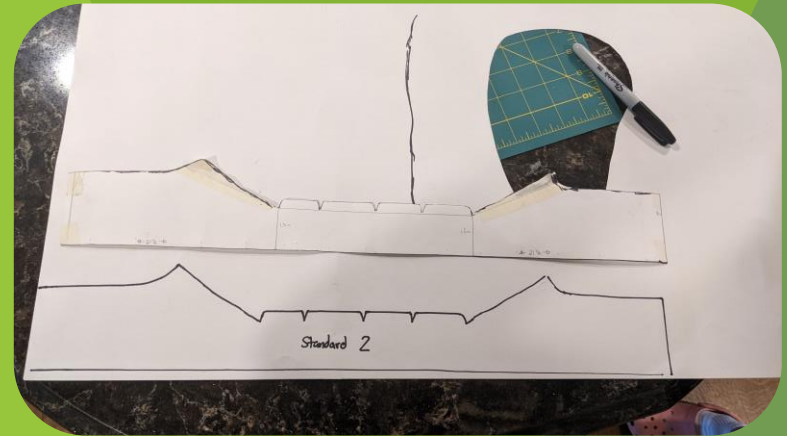
Note: do both extensions and cuts to the same pattern, so the least number of new standards need to be created.



Upper Creation: Formatting

1. Pattern Creation of Right Foot

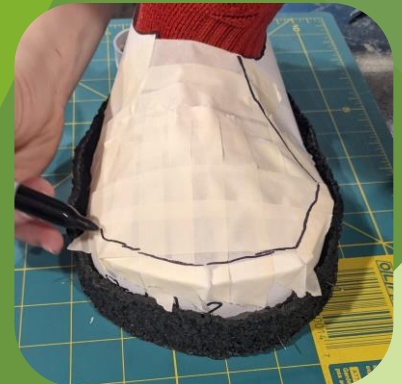
- d) Once all extensions are added with tape, then start cutting out material to get to desired shape.
- e) Once pattern is cut to desired shape, use that standard to retrace new standard.
- f) Then, cut out new standard.
- g) Repeat this process until you are satisfied with the look of the standard.



Upper Creation: formatting

1. Pattern Creation of Right Foot

- d) Now, put finished standard back into outsole and place foot inside standard. Using tape, tape over the standard, closing the gap above the toes and top of the foot (as you tape, form paper over the foot to get more form fitting shape).
- e) Go over the first layer of tape and put on a second layer to increase strength of tongue pattern.
- f) The using a sharpie, trace over the tape to create the shoe tongue pattern.
- g) Using a boxcutter and scissors, slightly score. Then, cut the paper to remove the tongue pattern from standard (Warning: be careful not to touch the foot with the blade).

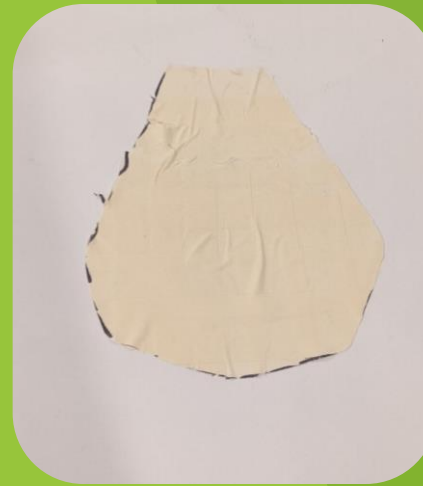


Upper Creation: formatting

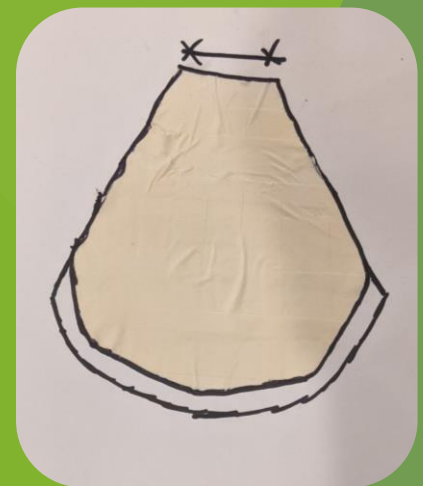
1. Pattern Creation of Right Foot

- d) Attach the taped tongue pattern to paper.
- e) Add a 1-centimeter offset to the front of the tongue where the toes will be (this offset will be used for the invisible sew line).
- f) Then cut out the pattern to create the tongue standard.

D



E



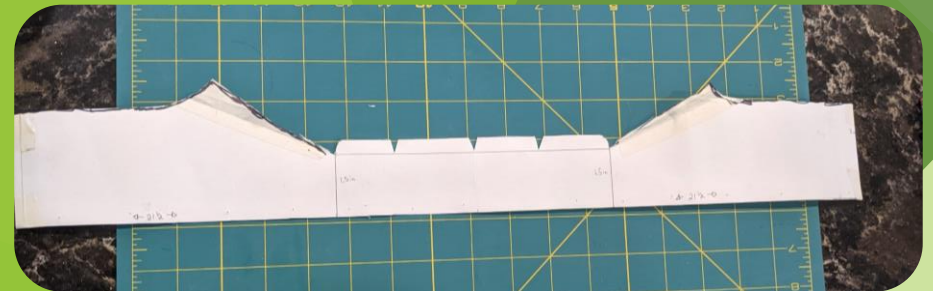
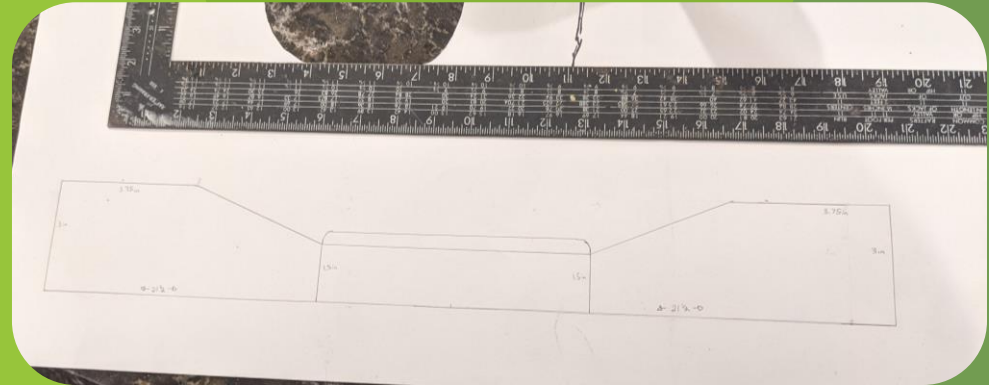
F



Upper Creation: Formatting

1. Pattern Creation of Left Foot

- Using a pencil and ruler recreate the Upper pattern shape on paper. Use the measurements gathered on the Shoe Upper Design Documentation Sheet to create a 1:1 size model on the paper.
- After pattern is transferred, cut pattern out and insert into outsole.
- Use small pins to secure the upper pattern to the crepe rubber to hold pattern in place when foot is inserted (Warning: make sure points of pins point outward to ensure the foot isn't poked).
- Place foot into outsole, to verify fit with pattern (the pattern ends should line up perfectly at heel. If it doesn't, cut excess material away. Also, make sure line 5 and 6 line up with their perspective lines on the EVA top).



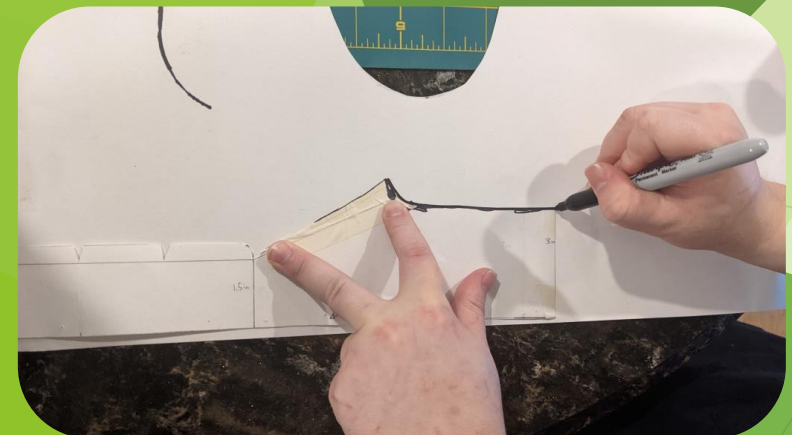
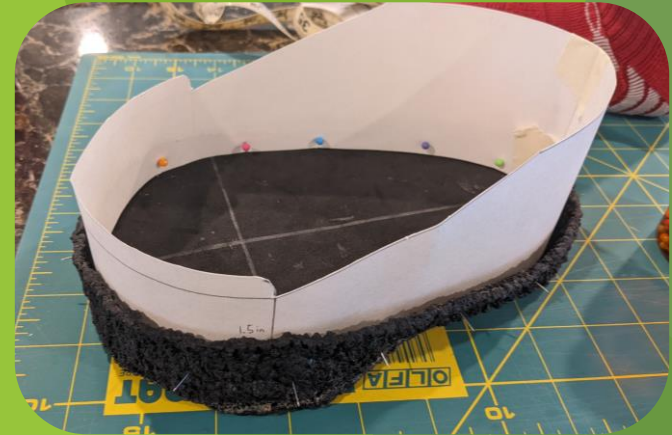
Upper Creation: Formatting

1. Pattern Creation of Left Foot

Note: Now the process of fine tuning the patterns begins. Modify the shoe pattern to meet your aesthetic appeal.

- d) When modifying shoe patterns there are two different modifications you can do; Extension (for adding more material to precut Standard), and/ or Cut (for removing material from precut Standard).
- e) For extensions, use tape to add more material. This will serve as a template for the creation of a new standard.
- f) For cuts, use scissors to cut material away from standard. This will help to finalize the new standard.

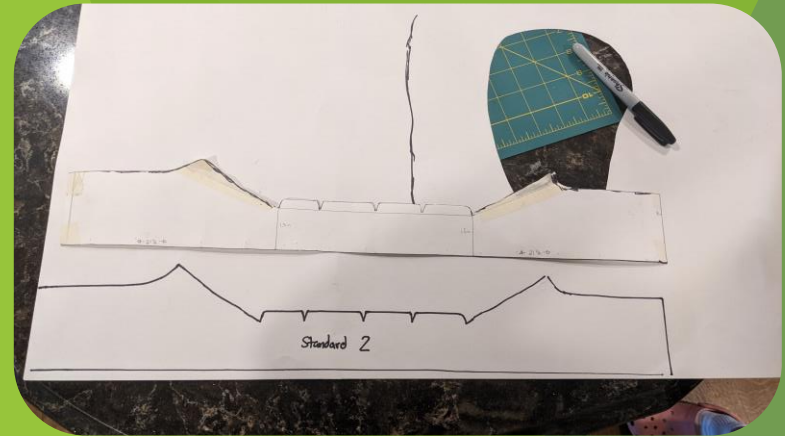
Note: do both extensions and cuts to the same pattern, so the least number of new standards need to be created.



Upper Creation: Formatting

1. Pattern Creation of Left Foot

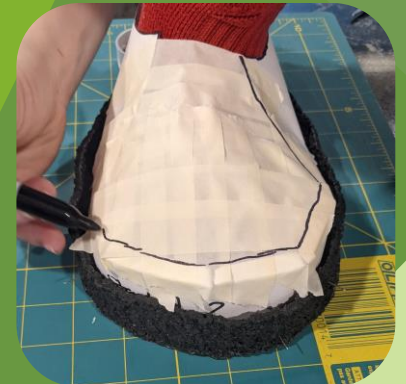
- d) Once all extensions are added with tape, then start cutting out material to get to desired shape.
- e) Once pattern is cut to desired shape, use that standard to retrace new standard.
- f) Then, cut out new standard.
- g) Repeat this process until you are satisfied with the look of the standard.



Upper Creation: Formatting

1. Pattern Creation of Left Foot

- d) Now, put finished standard back into outsole and place foot inside standard. Using tape, tape over the standard, closing the gap above the toes and top of the foot (as you tape, form paper over the foot to get more form fitting shape).
- e) Go over the first layer of tape and put on a second layer to increase strength of tongue pattern.
- f) The using a sharpie, trace over the tape to create the shoe tongue pattern.
- g) Using a boxcutter and scissors, slightly score. Then, cut the paper to remove the tongue pattern from standard (Warning: be careful not to touch the foot with the blade).

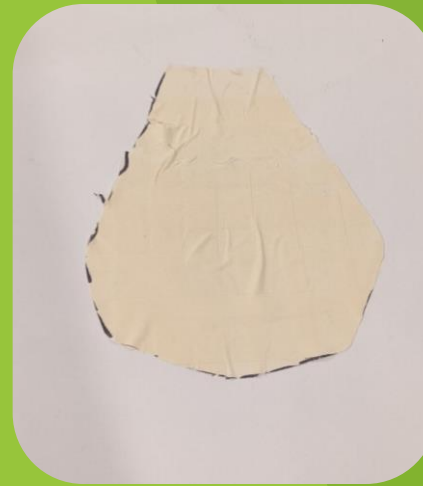


Upper Creation: Formatting

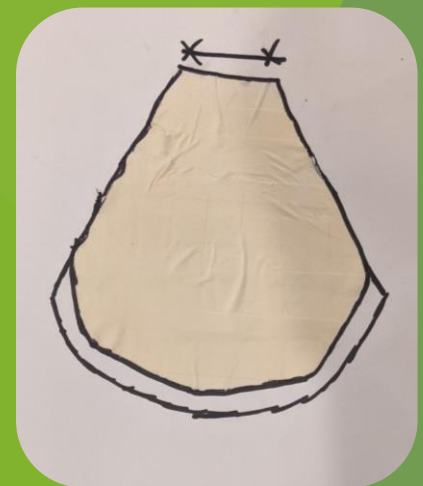
1. Pattern Creation of Left Foot

- d) Attach the taped tongue pattern to paper.
- e) Add a 1-centimeter offset to the front of the tongue where the toes will be (this offset will be used for the invisible sew line).
- f) Then cut out the pattern to create the tongue standard

D



E



F



Assembly

Assembly is the final step in the upper creation. By now, a person should have created standards based on foot measurements from the foot itself as well as the sole. The patterns should have been tweaked and checked so that they fit around the foot and are styled to the individuals liking. Assembly involves using that standard to cut out fabric into shapes and sewing/gluing them together. Below is a step process to finish the shoe.

Upper Creation: Assembly

1. Pattern Creation

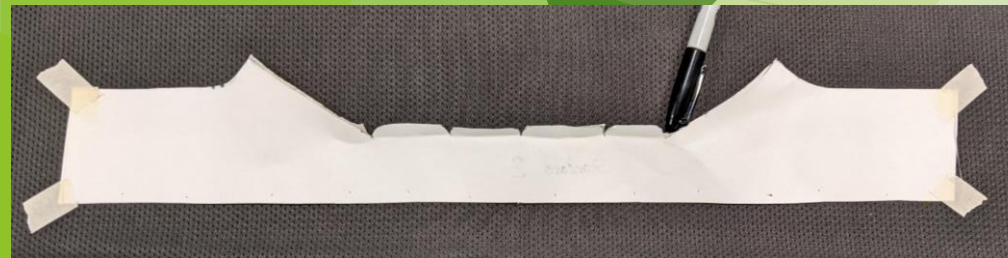
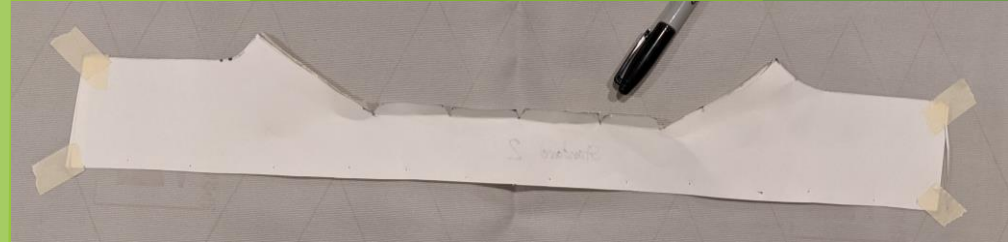
- d) Once both the Upper Standard and the Tongue Standard of both feet are finished, choose your materials for the upper.

Note: You will want to get a Ziplock bag to save your standards, so the next time you create a shoe, you have the patterns already made.

- d) You will want to choose your materials based on what you are looking for in a shoe. Note that there is a list of reference materials available in the appendix separated by layer.

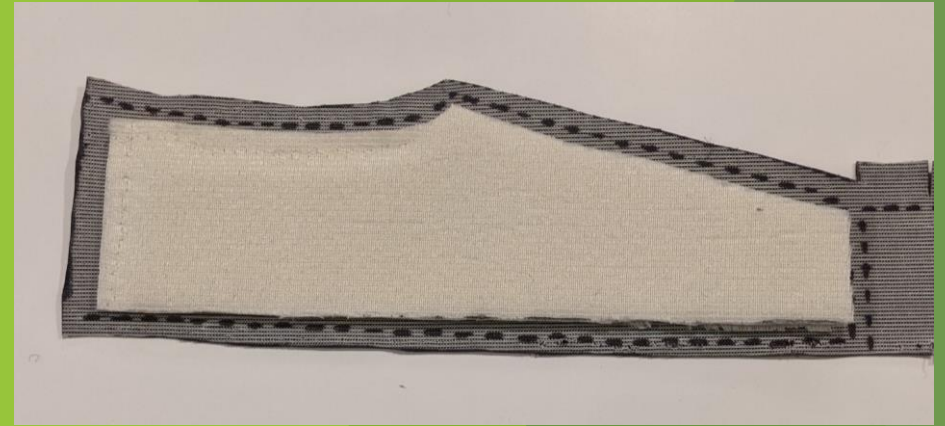
Upper Creation: Assembly

1. Begin by taking the standard and placing it upon your selected outside material. Example materials we used were marine vinyl leather, Authentic leather, and tricon. Make sure to denote which side you want to be the outside and ensure that the pattern is laid out in a manner that the material wraps around the way you want.
2. Secure the standard to the material by taping the edges down. Depending on the material it may be advisable to use either scissors or a razor blade. Cut out the outer material and set it aside for later use.
3. Do the same thing for the desired inner material. Examples of this would be wool, tricon, and neoprene. It should be spongey or soft, while breathable. Take care to ensure that if the material is different on one side to cut out the pattern in an orientation which has the inside wrapping around the foot.



Upper Creation: Assembly

4. Now it is time to create the middle layer. This is to add thickness to the upper, providing comfort and support. Examples of this would be foam, thermolam, or similar spongy materials. To add this to the material create inserts for in-between the inner and outer material. Use a 1.5 cm offset and trace the sides, front and top to add the middle layer.
5. When the outer, middle, and inner patterns are cut and acceptable, the overall look should start to come into view. For the shoes designed during the year, zippers were used as fasteners as they are easy to operate, replace, and for their aesthetic. They are to be sewn into the sloped angles on the sides of the shoe. For now just gather the materials so that sewing and following the final steps will be quicker.



Upper Creation: Assembly

7. Begin by laying out the outer and inner materials on top of each other. The materials should fit together over one another with symmetry. Begin by sewing the bottom line all the way across.
8. Insert the middle materials to the sides as well as the front, next sew the top middle heel area but be sure to stop as you approach the slope on the side of the shoe.
9. Sew the front of the shoe above where the insert was added. This will secure the middle layer in place.
10. Insert the zippers in-between the outer and inner layers and pin them to secure them. Sew them in so that they are in-between the layers.



Upper Creation: Assembly

11. Sew the zippers along the slope, tucking the sides of the fabric in-between the inner and outer material. the zippers themselves should be closed end zippers and have the tails cut so that they can be pushed all the way to the end of the slope.
12. After sewing the outer, inner, middle, and zippers together in the specified areas: try laying it around the sole to see the fit and check the work. Sew the end pieces together so that the upper is a continuous ring. The only piece missing should be the tongue.
13. Follow the same steps as the standard pattern to create the tongue. Take the tongue pattern and place it on the desired inner and outer materials. Tape the pattern down and cut out the shape. Create a 1.5 cm smaller insert out of foam.



Upper Creation: Assembly

14. Sew the bottom and top of the tongue so that the sides are still unsewn (this will be for the other zipper flaps to be inserted into).
15. When the bottom and top are sewn together and the insert is secured, it is time to sew the wide bottom portion to the front flaps in the front of the shoe.
16. An invisible sew line is advisable because of its low-profile aesthetic however any sew pattern can be done to secure the tongue to the front of the shoe.
17. Drape the tongue over the front of the shoe so that the outer materials are mated together. Sew the extension done on the tongue to the flaps protruding from the front of the shoe. The tongue should fold back creating a crease along the front of the shoe.



Upper Creation: Assembly

18. When the tongue is sewn into the front of the upper, the zippers must be sewn into the tongue in the same manner that they were to the sides of the shoe. Insert the sides of the zipper in-between in the inner and outer material on the tongue. Sew down each zipper, one at a time so that it is secured. Using sewing pins will greatly aid in maintaining the desired orientation.
19. With the zippers secured to the tongue, The upper is complete. One may consider adding additional features such as strips that will secure the upper into a circular shape. It should be sewn into the sides of the sole.



Upper Creation: Assembly



Appendix

Assembly materials.....65

Mold materials.....66

Upper outer materials.....67

Upper Inner materials.....68

Upper Middle materials.....69

Upper Miscellaneous materials.....70

Foot Documentation Sheets.....71

Materials

1. EVA foam 5 mm
2. EVA foam 2mm
3. Vibram sheet (used for bottom tread) [optional]
4. Crepe Rubber (used as outsole shell) [optional]
5. Barge Cement

Links

1. https://www.amazon.com/Sheets-Craft-Cosplay-Thickness-1-10mm/dp/B07BL1Z19L/ref=sr_1_7?crid=1TZ2QMFKT33DZ&keywords=eva%2B5mm&qid=1654195529&sprefix=eva%2B5m%2Caps%2C106&sr=8-7&th=1
2. https://www.amazon.com/Sheets-Craft-Cosplay-Thickness-1-10mm/dp/B07BL296HK/ref=sr_1_7?crid=1TZ2QMFKT33DZ&keywords=eva%2B5mm&qid=1654195529&sprefix=eva%2B5m%2Caps%2C106&sr=8-7&th=1
3. https://www.amazon.com/Repair-Rubber-Repairing-Material-Thickness/dp/B083KLM6YZ/ref=sr_1_9?crid=1QTD1LWAOCC T2&keywords=vibram+sheet&qid=1654195734&sprefix=vibra m+sheet%2Caps%2C110&sr=8-9
4. https://www.amazon.com/dp/B076FDQB2Y?ref=ppx_yo2o v_dt_b_product_details&th=1
5. https://www.amazon.com/Barge-All-Purpose-Cement-022721/dp/B0032YYOFS/ref=sr_1_2_sspa?crid=28OA6M9A2 Q1HR&keywords=barge%2Bcement&qid=1654196277&sprefi x=barge%2B%2Caps%2C168&sr=8-2- spon&smid=A2MI9QS56ZOCLV&spLa=ZW5jcnlwdGVkUXVhbG lmaWVyPUEzNDlGWTVDVjk5S1QyJmVuY3J5cHRlZElkPUEwMz c5MzQzMVBVOTthGRE9XWlpMOSZlbnNyeXB0ZWRBZElkPUEw ODk3MzkyMzZPN0tRUlIHRTdWVSZ3aWRnZXROYW1lPXNwX2F 0ZiZhY3Rpb249Y2xpY2tSZWRpcmVjdCZkb05vdExvZ0NsaWNr PXRydWU&th=1

Materials

1. ¾" plywood or similar stiff working material
2. Wood Veneer edge banding (approx. 1")
3. Silicon kit
4. Polyurethane Elastomer kit (smooth on PMC-770)
5. Release Agent
6. Water based polyurethane finish

Links

1. <https://www.homedepot.com/p/Columbia-Forest-Products-3-4-in-x-2-ft-x-2-ft-PureBond-Red-Oak-Plywood-Project-Panel-Free-Custom-Cut-Available-2854/204771251>
2. <https://www.homedepot.com/p/EDGEMATE-13-16-in-x-25-ft-Birch-Edge-Tape-657608/202843396>
3. https://www.amazon.com/dp/B09CYYB311?psc=1&ref=pp_x_yo2ov_dt_b_product_details
4. <https://www.smooth-on.com/products/pmc-770/>
5. https://www.amazon.com/Silicone-Release-Spray-Agent-Aerosol/dp/B085CBSS5Y/ref=sr_1_1_sspa?crid=3VIHXHOYW N0BO&keywords=mold+release&qid=1654197547&sprefix=mold+release%2Caps%2C124&sr=8-1-spons&psc=1&spLa=ZW5jcnlwdGVkUXVhbGlmaWVyPUE4RTcxQktHOEtFUE4mZW5jcnlwdGVkSWQ9QTA0MjQzMDEwSE80RzLEQ0ExJmVuY3J5cHRlZEFkSWQ9QTAyNDU1NDhHWURXT0tKVllGN1Umd2lkZ2V0TmFtZT1zcF9hdGYmYWN0aW9uPWNsaWNrUmVkaXJlY3QmZG90b3Rmb2dDbGljaz10cnVl
6. https://www.amazon.com/Rust-Oleum-Varathane-200261H-Polyurethane-Water-Based/dp/B000LNW7ZM/ref=sr_1_5?keywords=water%2Bbased%2Bpolyurethane%2Bfinish&qid=1654197450&sr=8-5&th=1

Upper Outer Materials

Materials

Leather

Marine vinyl leather

Links

1. Visit Tandyleather - Use 3-4 oz for lighter leather and use 5-6 oz for heavier leather. There are different colors and styles so pick the option that is right for your needs.

2. <https://www.joann.com/marine-vinyl/prd23669.html>

Materials

Air Knit (Tricon)

Wool

Neoprene

Links

1. <https://www.joann.com/air-knit-pewter-utility-fabric/18919258.html>

2. https://www.amazon.com/Pieces-Canvas-Leather-Sewing-Handmade/dp/B089SHYLG9/ref=sr_1_16?keywords=sewing+awl&qid=1654816897&sr=8-16

3. <https://www.joann.com/stretch-scuba-neoprene--royal-blue/17687203.html>

Materials

Foam thermolam

Links

<https://www.joann.com/pellon-flex-foam--2-sided-fusible-interfacing-fabric-20/14896799.html>

<https://www.joann.com/pellon-thermolam-plus-interfacing/529404.html>

Upper Miscellaneous Materials

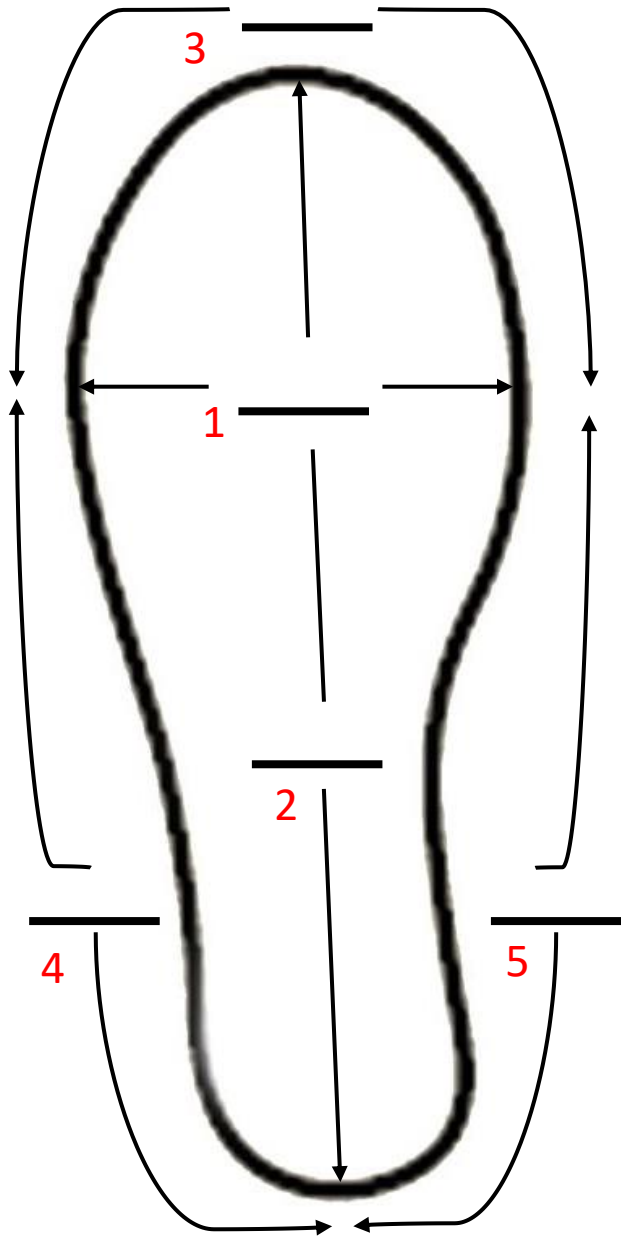
Materials

1. Sewing Awl

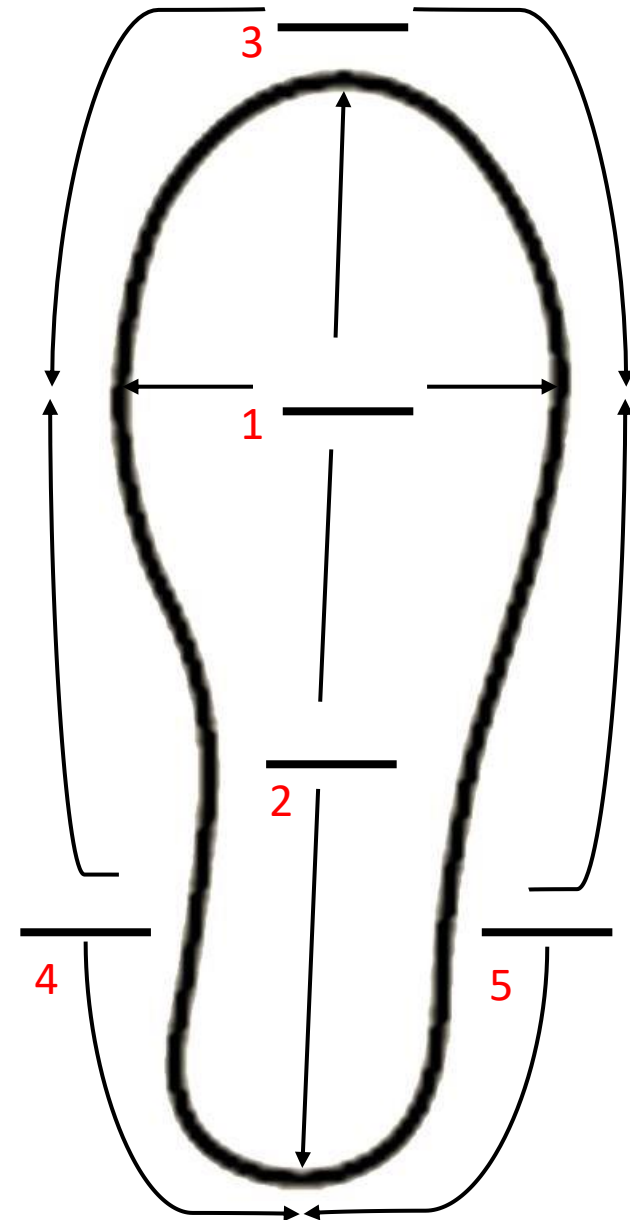
Links

1. https://www.amazon.com/Pieces-Canvas-Leather-Sewing-Handmade/dp/B089SHYLG9/ref=sr_1_16?keywords=sewing+awl&qid=1654816897&sr=8-16

Specialized Shoe Foot Documentation Sheet



Left Foot Circumference: _____



Right Foot Circumference: _____

Specialized Shoe Upper Design Documentation Sheet

