

PROCESS DOCUMENT  
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# Flywave

ENDURANCE PARKOUR SHOE





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Parkour is an activity where athletes traverse an environment and go from a starting point to an end point. These athletes need to have spatial awareness and be precise with their movements in order to safely and successfully move around. **The primary way they connect with obstacles in the environment is through their feet making contact with surfaces.** In these instances technique and foot placement are crucial for success.

When shoes that are not optimal for the activity are worn, it may hinder technique and increase the chances of injury. I intend to focus my capstone on creating a parkour shoe that's more durable and less susceptible to deformation after extensive use by the athlete. Ideally the shoe would have materials and features that improve durability, safety and aid in performance. This process document includes research, ideation and development of the shoe.

Being an avid parkour athlete, I thoroughly enjoy being able to maneuver my body and interact with obstacles in the environment in ways that I never thought were possible. That being said, **having more ways to move around also means that there more ways to get hurt** during the process.

One day while training, I attempted to perform a vertical wall run and ended up sustaining an injury. Reflecting back on the experience I was able to determine that it was a combination of inadequate shoes and poor technique which led to my injury. However I am not the only one. According to the World Freerunning and Parkour Federation, these are the most common injuries that can occur while participating in the activity:



Knee & Ankle Sprains

Knee Capitations

Shin Hits

Bruised Hands & Feet



How could a parkour shoe could be designed to be more durable & last longer?

Since my intent is to design a shoe, it was necessary for me to get familiar with the different parts of a shoe.

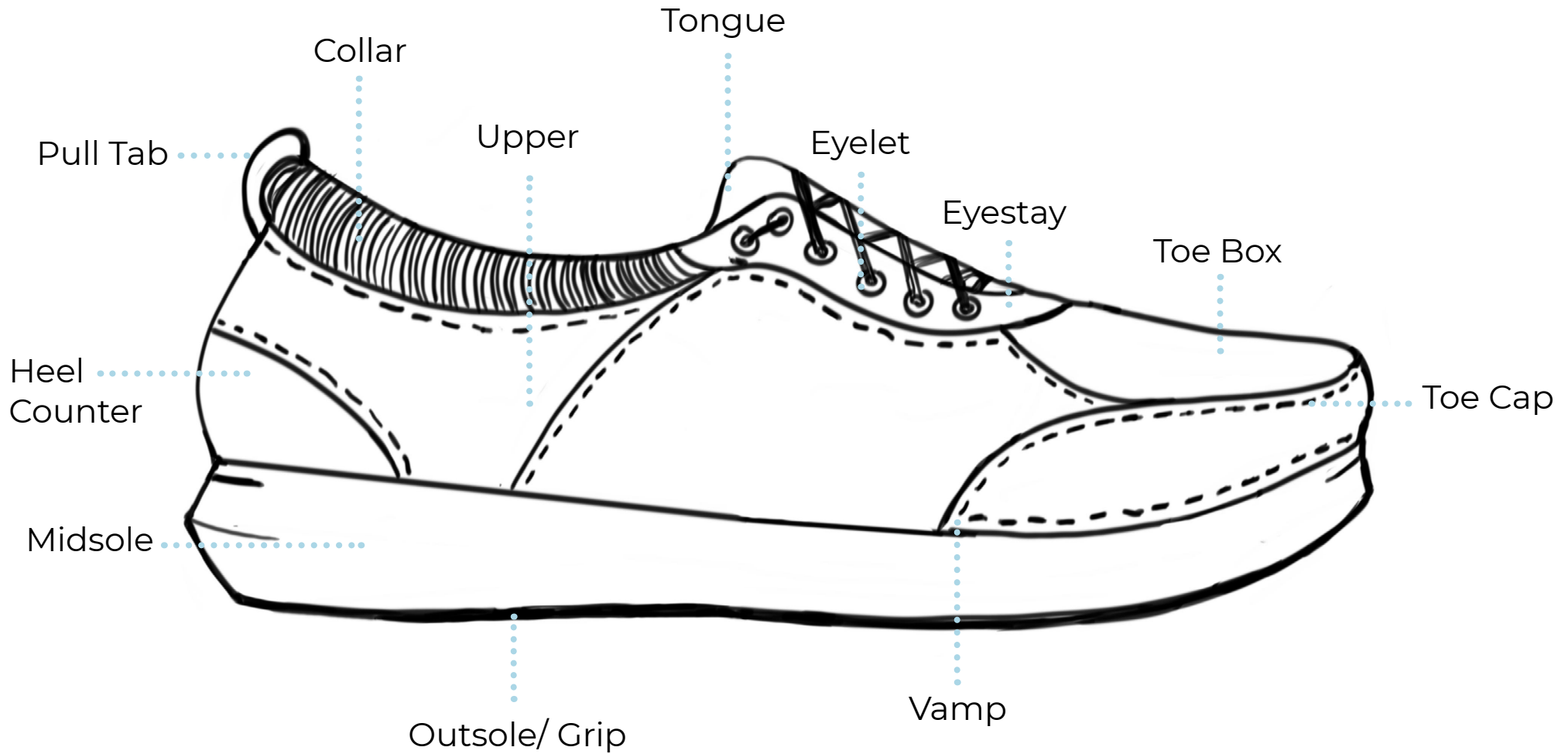


Figure 1: Anatomy of a Shoe [Sketch : Devya Patel]



Research was first conducted in the form of interviews to better understand what shoes are being used by parkour athletes and why. Interviews took place as brief conversations with experienced parkour athletes who were training at Play Project. An indoor parkour gym in Burlington, Ontario. They were asked the following questions:

1. What shoes do you use for parkour?
2. What features make them good for the activity?
3. Where are they wearing out?
4. How frequently do you replace them?
5. What's the most important quality you look for in a shoe?
6. What extra features you would like to see in your shoes?

### ***Parkour Athlete # 1***

1. Men's Puma Cabana Racers.
2. They have one piece of **rubber on the bottom** which means they have a good grip.
3. There are some small **rips around the toes**.
4. I change pairs about once a year.
5. It would have to be the grip.
6. If the shoes could be made to be more breathable and light weight that would be nice. Also if they had a better fit, my foot tends to slide around in them a little.

### ***Parkour Athlete # 3***

1. Men's Ollos.
2. **Rubber bottoms** are probably the most important quality.
3. The curved bit at the **front of the shoe near the toes**, and the bottom of the sole, under the toes.
4. Grip and comfort.
5. It depends on how fast they wear out, which varies alot.
6. If the rubber sole could connect to the top near the toes, that would be cool.

### ***Parkour Athlete # 2***

1. Tempest Parkour shoes.
2. They got a **flat and thin sole with rubber**.
3. The sole started to **peel at the front of the toes** and there are holes in the side near the toes.
4. Comfort and fit.
5. On a yearly basis.
6. Honestly, I would like them even more if they had leather. and looked cooler.

### ***Parkour Athlete # 4***

1. Onitsuka Tigers.
2. **A thin rubber sole** thats one piece.
3. On the sole, the area underneath toes.
4. Fit and color. I don't really care about what kind of brand they are.
5. If possible, I will try to fix the shoe. If that's not possible, I will get new ones.
6. If the shoes were more breathable around the toes and around the bottom of the arch.



### ***Parkour Athlete # 5***

1. Vans Ultra Ranges.
2. One **solid rubber sole**.
3. Around the **front of the toes**.
4. Size. My feet are size 15, so I will order shoes from what ever place has my size in stock.
5. I change them when they start to get holes, so about once a year.
6. A more durable material at the front of the shoe so things don't poke through.

### **Insights**

From conversing with the parkour athletes it was apparent that there are common features found in shoes that are used for parkour. **The first being a thin sole and flat rubber grip.** This is required to allow the athletes to be able to feel and grip the terrain they are interacting with. Secondly, it would have minimal cushioning to absorb some of the impact exerted on the body. Also the shoe would have to be low cut and promote a good range of motion for the ankle. There were also mentions of improving breathability, weight, style and durability. It was made apparent that the shoes experience **excessive wear and tear in certain areas.** These are illustrated on the following pages.

## Toe Box Area

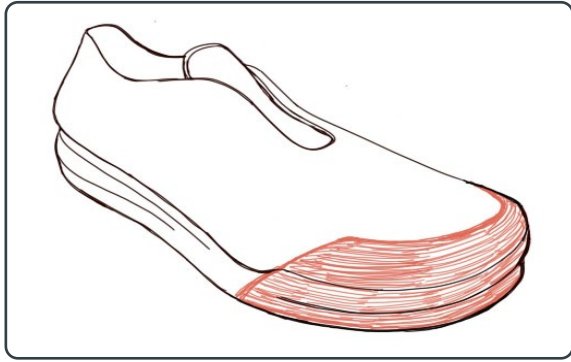


Figure 2: Toe Box Area [Sketch: Devya Patel]



Figure 3: Tempest Toe Box [Photo : Devya Patel]



Figure 4: Farang Elevate Lite Toe Box [Photo : Devya Patel]



Figure 5: Ollo Toe Box [Photo : Devya Patel]



### Vamp Area

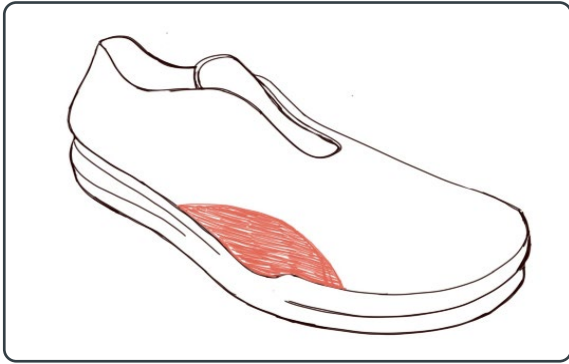


Figure 6: Vamp Area [Sketch: Devya Patel]



Figure 7: Tempest Vamp [Photo : Devya Patel]



Figure 8: Vans Ultra Ranges Vamp [Photo : Devya Patel]



Figure 9: Puma Cabana Racer Vamp [Photo : Devya Patel]

### Outsole & Grip

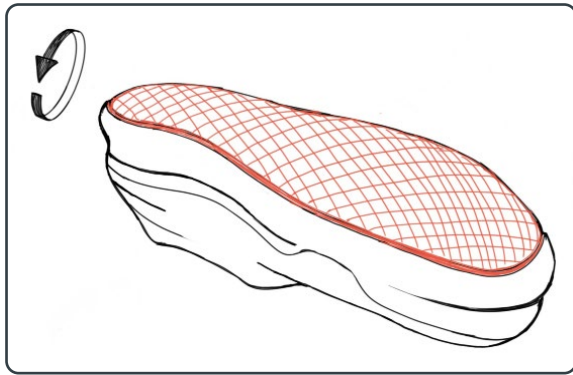


Figure 10: Outsole & Grip [Sketch: Devya Patel]



Figure 11: Vans Ultra Range Outsole / Grip



Figure 12: Puma Cabana Racer Grip [Photo : Devya Patel]



Figure 13: Tempest Grip [Photo : Devya Patel]

## SHOES ON THE MARKET USED FOR PARKOUR

	Vans Ultra Ranges	Storror 10's	Adidas NMD	Asics Onitsu Tiger	Converse Chuck Taylors	Fievue	Nike Free Runners	Known Obstacles	New Balance 547	K SWISS Si - 18s	Vans Skate Shoes	La Flairs	
Cons/Area that wear out	<ul style="list-style-type: none"> <li>Bottom of sole after doing cat leaps</li> </ul>	<ul style="list-style-type: none"> <li>Tight around the toe box</li> </ul>	<ul style="list-style-type: none"> <li>Sole/heel not idea for wall running</li> </ul>	<ul style="list-style-type: none"> <li>Minimal Cushioning</li> </ul>	<ul style="list-style-type: none"> <li>Poor Cushioning</li> <li>No Flex</li> <li>High Cut</li> </ul>	<ul style="list-style-type: none"> <li>Grips - wear out quickly</li> </ul>	<ul style="list-style-type: none"> <li>Foam grip</li> <li>poor ankle support</li> </ul>	<ul style="list-style-type: none"> <li>Grip wears out quick</li> <li>toe box rips</li> </ul>	<ul style="list-style-type: none"> <li>Sole rips and pushes the foot forward</li> </ul>	<ul style="list-style-type: none"> <li>No longer produced</li> </ul>	<ul style="list-style-type: none"> <li>Falls off the foot easily</li> </ul>		La Flairs
Pros	<ul style="list-style-type: none"> <li>Light Weight</li> </ul>	<ul style="list-style-type: none"> <li>Relatively Cheap 60 (USD)</li> </ul>	<ul style="list-style-type: none"> <li>High Quality</li> </ul>	<ul style="list-style-type: none"> <li>Shoe Lasts Long</li> </ul>	<ul style="list-style-type: none"> <li>Grip</li> </ul>	<ul style="list-style-type: none"> <li>Cheap</li> <li>Flexible</li> </ul>	<ul style="list-style-type: none"> <li>Style</li> </ul>	<ul style="list-style-type: none"> <li>Grip Design</li> </ul>	<ul style="list-style-type: none"> <li>Profile</li> </ul>	<ul style="list-style-type: none"> <li>Grip</li> </ul>	<ul style="list-style-type: none"> <li>Grip</li> </ul>	<ul style="list-style-type: none"> <li>Sole</li> </ul>	

Figure 14: Matrix of other parkour shoes on the market Photo : Devya Patel]

A matrix was also created to include other shoes used by parkour athletes. This was done to gain further insight into the shoes that I wasn't able to observe first hand. These notes were condensed in a matrix based on feedback from the youtube channel titled "Not Too Ghetto". Who created a tier list based on the wide selection of shoes they use for parkour and ranked them from worst to best.

### Insights

From creating the matrix it was confirmed that **other shoes experience wear and tear in similar areas to the shoes observed first hand**. Finally an opportunity presented itself to make the shoes stylish. As there are several shoes used for the activity that aren't necessarily worn for their performance benefits but style instead.

Not Too Ghetto. (2021, May 11). Parkour shoe tier list [Video File]. Youtube. [https://www.youtube.com/watch?v=\\_mXOGIF7M0c](https://www.youtube.com/watch?v=_mXOGIF7M0c)



Interviews were also conducted with shoe fanatics and consumers who participate in physical activities besides parkour. This was done to better understand their mindset when purchasing and discarding shoes. They were asked the following questions:

- 1. What shoes do you currently wear?**
- 2. What qualities do you typically look for in a shoe?**
- 3. Do you gravitate towards any brands in particular?**
- 4. Do you use them for sports or any other physical activities?**
- 5. Do you try to repurpose your shoes when they get worn out?**

## ***Consumer # 1***

1. So currently I have been wearing Nike Runners, the Zoom Pegasus to be more specific.
2. Comfort and fit are the two most important qualities I look for in a shoe.
3. Nike. Since I know their sizing fits me well.
4. I use them for commuting and tennis occasionally.

## ***Consumer # 2***

1. Currently I wear New Balance Sneakers.
2. I prefer shoes that have good arch support.
3. I recently tried New Balance, I am liking them so far.
4. I use them for working out and when I go to the gym.

## ***Consumer # 3***

1. Currently I have be rotating through some Converse All Stars, New Balance 990's and some Doc Martins.
2. Comfort and style. I would say comfort more.
3. Converse cause they are cheap.
4. I used to work out and play basketball in Converse. I also have some Adidas Ultra Boosts I use for running.
5. In highschool, I used to turn worn out shoes into art pieces.

### **Consumer # 4**

1. Honestly, I like to mix it up every now and then. Currently, I have been digging Asics and New Balance Sneakers as lifestyle shoes.
2. Style, fit and comfort are the three qualities that qualities that I look for when purchasing a shoe.
3. Nike, Asicis and New Balance.
4. For athletic shoes, I run with Nikes.
5. Sometimes when I can't save or really clean the shoe, I will use them for gardening.

### **Consumer # 5**

1. Currently, I have a couple of shoes that I like to wear. I have some Stan Smiths, Yeezys, formal shoes, New Balances, Nike Vapors and some Air Maxs.
2. Color, I like to match my shoes with my clothes. Support and fit are also important qualities too.
3. Nike and Adidas.
4. I use the Nike Vapors for running.
5. When I wear out my sports shoes, I use them casually for walking or commuting.

### **Insights**

Conversing with consumers reinforced the notion of how personal the topic of footwear can be. **Creating a strong positive resonance between the shoe and consumer will be key.** As some consumers are loyal to a specific brand while others don't have a preference. Additionally some have a pair they like to use for everything while others have multiple shoes the use for different occasions.

From talking with employees and looking at online reviews, these shoes have features that could serve as inspiration for the ones I decide to intergrate into the parkour shoe. The Adidas Ultra Boost incorporates Continental tire rubber for the outsole which provides them with excellent grip. While the Brooks Adrenaline incoporates a midsole system that aids one in mainting their natural walking and running patterns.

## **Grip:** Adidas Ultra Boost    **Performance :** Brooks Adrenaline GTS



Figure 15: Ultra Boost [Photo : Devya Patel]



Figure 17: Adrenaline GTS 21 [Photo : Devya Patel]



Figure 16: Ultra Boost Grip [Photo : Devya Patel]



Figure 18: GTS Support [Photo : Devya Patel]



From the research conducted, the following conclusions can be made about parkour shoes:

1. The most important qualities of the shoe are its rubber sole, minimal cushioning, fit and weight.
2. They are prone to wearing and tearing around the toebox, vamp, sole and arch areas.
3. There is a demand to improve their breathability, durability and style.
4. People like to wear shoes that resonate with them on deep levels.

Design Proposal:

An opportunity has presented itself to create a parkour shoe that has features and materials that promote durability, performance and style. With the intent of creating a shoe that has a long lifespan and fits within the subculture of parkour.

Early sketches out of pen were created to get a better sense of shoe geometry and proportions from many perspectives.



Figure 19: Initial Concept Sketches [Sketches : Devya Patel]

A storyboard was created to highlight the shoe used in a parkour obstacle course.

Parkour Shoe Storyboard



Figure 20: Drawn Storyboard [Sketch : Devya Patel]



Digital sketches were created to add colour and call outs which helped with the developing of the first set of focused shoe concepts.

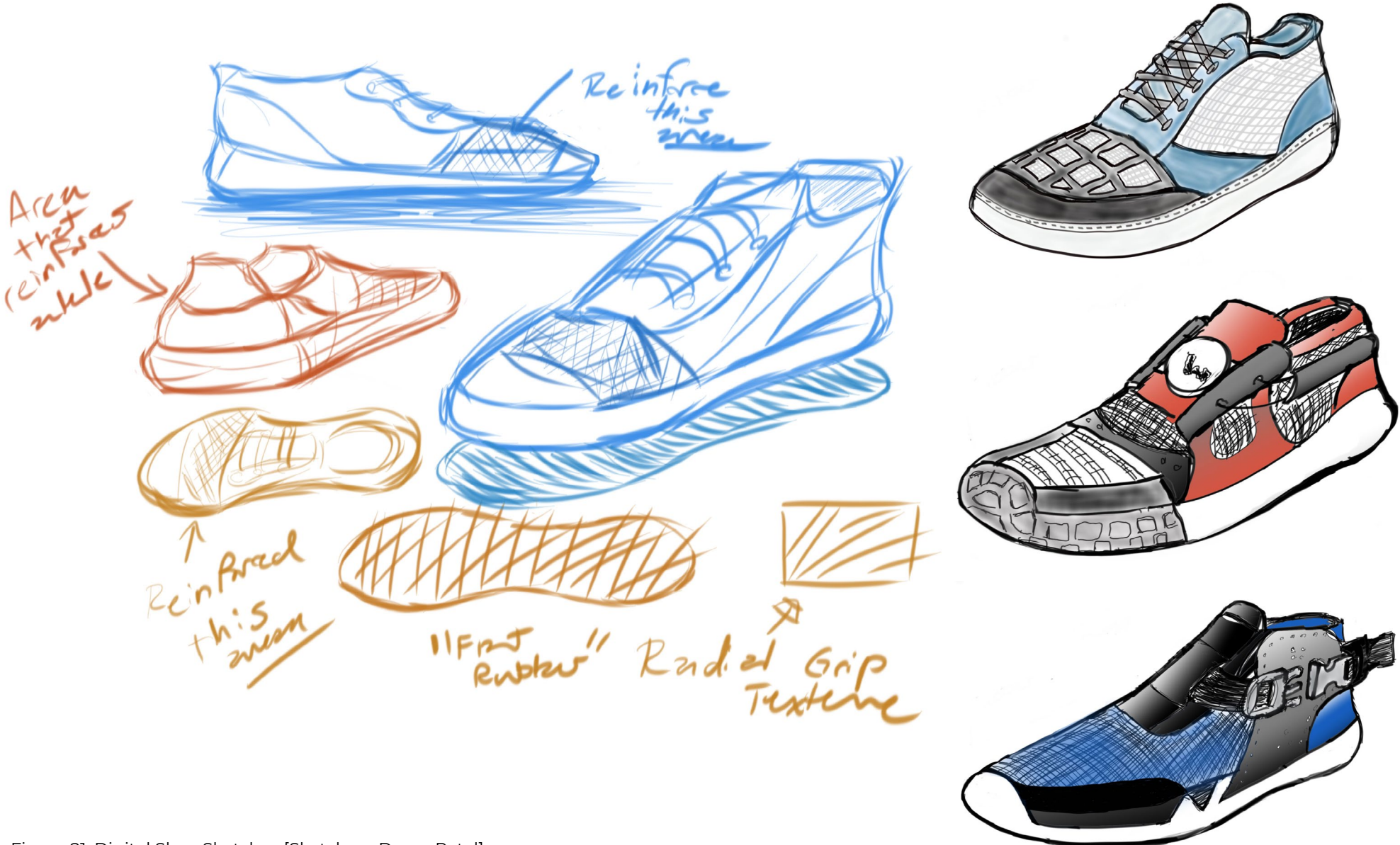
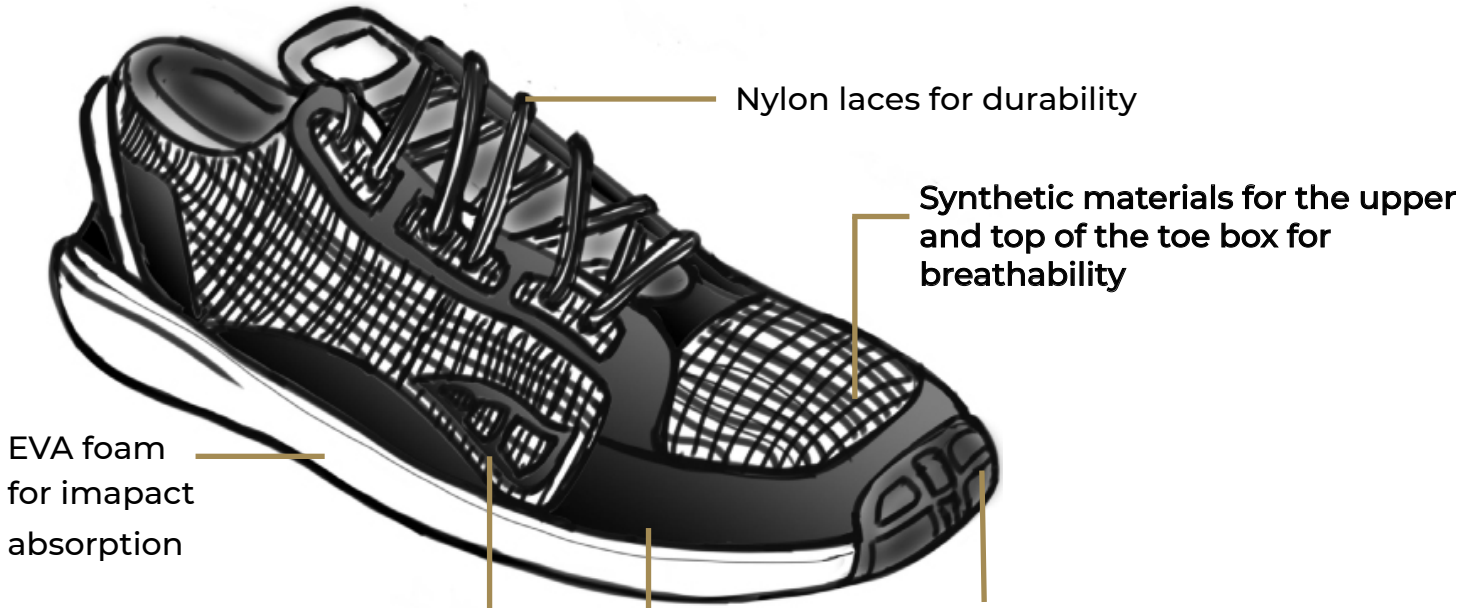
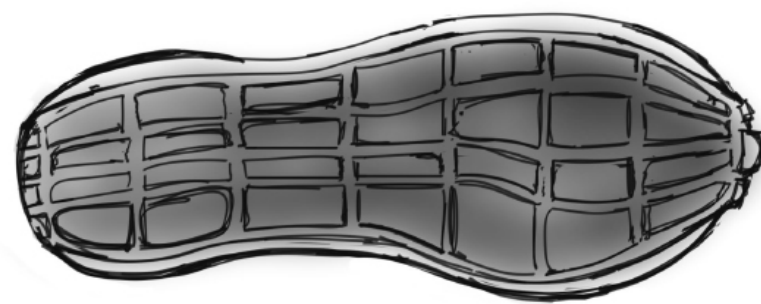
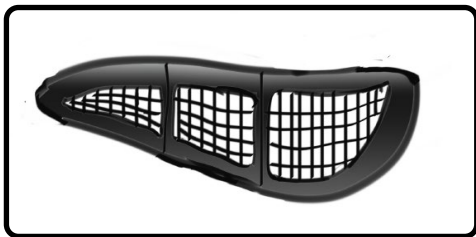


Figure 21: Digital Shoe Sketches [Sketches : Devya Patel]



Laminated PVC on the vamp provides extra support without restricting flexibility

PVC laminate around the toe box area and arches



Tire rubber compound used to improve the longevity of the grip



Figure 22: Shoe Concept # 1 [Sketch: Devya Patel]





EVA foam for impact absorption

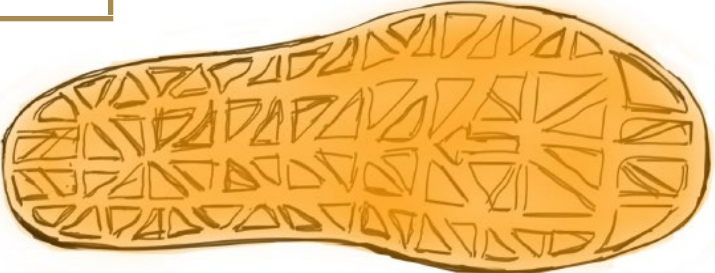
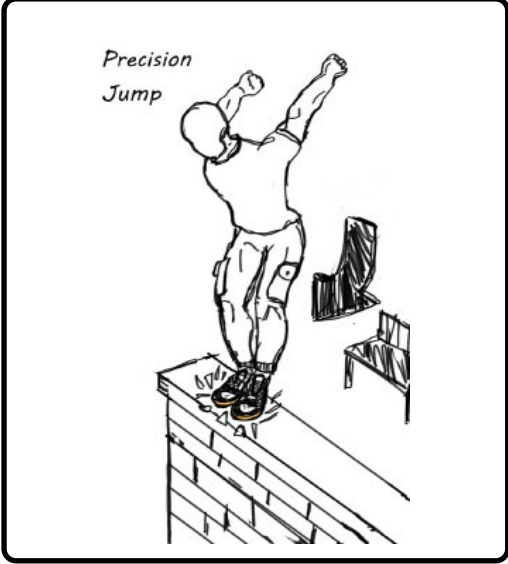
Synthetic materials and textiles for the upper

Reinforced and laminated TPU on the vamp provides extra support without restricting flexibility

Laminated thermoplastic polyurethane (TPU) webbing over toe box provides extra durability



TPU laminate around the toe box area and arches

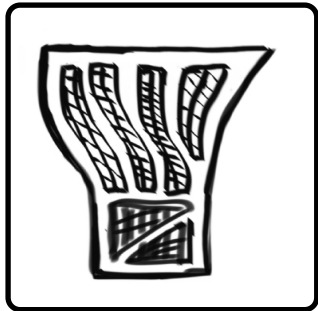
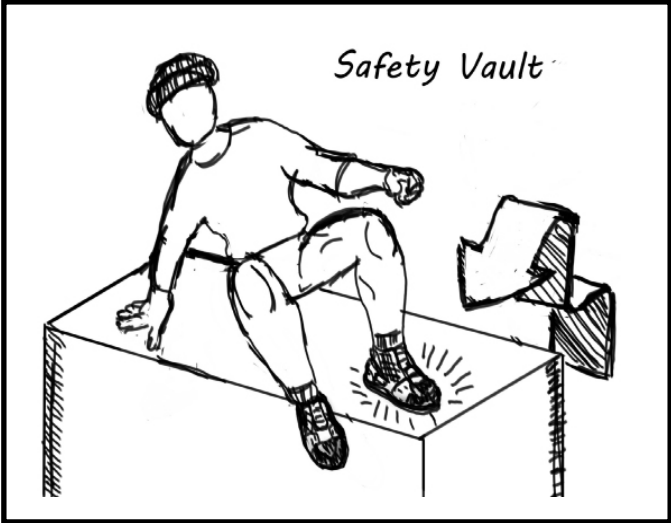
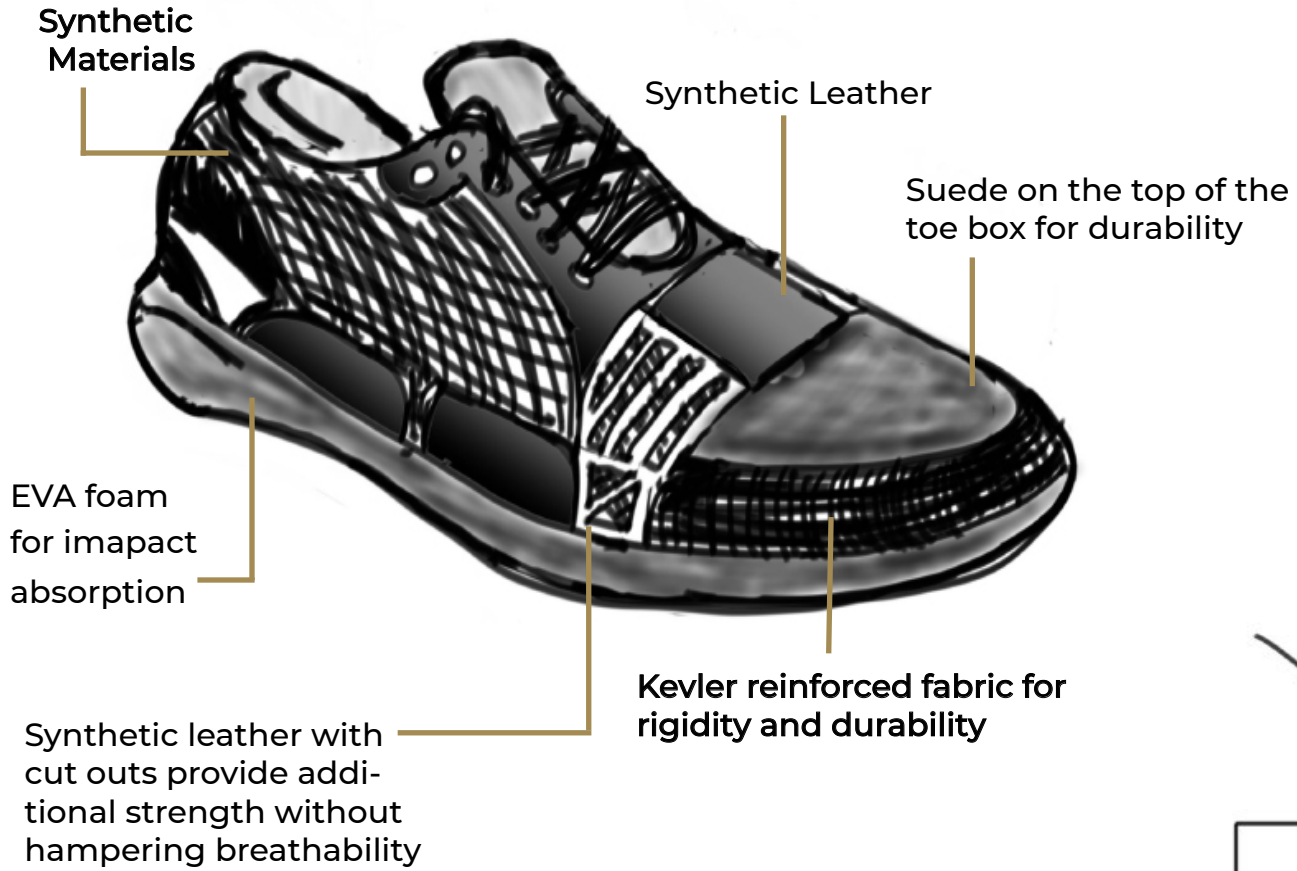


Gum rubber sole with fine grip pattern allows for greater traction on a majority of surfaces



Figure 23: Shoe Concept # 2 [Sketch : Devya Patel]





Eva foam grip and texture

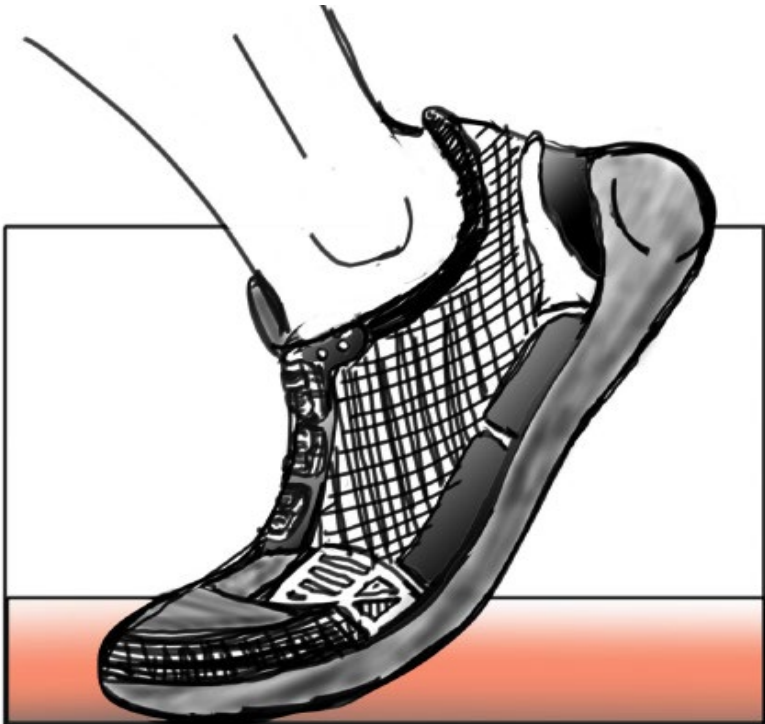


Figure 24: Shoe Concept # 3 [Sketch : Devya Patel]

This model was made with the intent to help facilitate the conceptualization of the shoe's design. In particular the translation of certain elements from 2D to 3D. It incorporates the most prominent elements from the previous three concepts into one.



Figure 25: 3/4 Model View [Photo : Devya Patel]



Figure 26: Medial Profile View of Model [Photo : Devya Patel]



Figure 27: Rear View [Photo : Devya Patel]

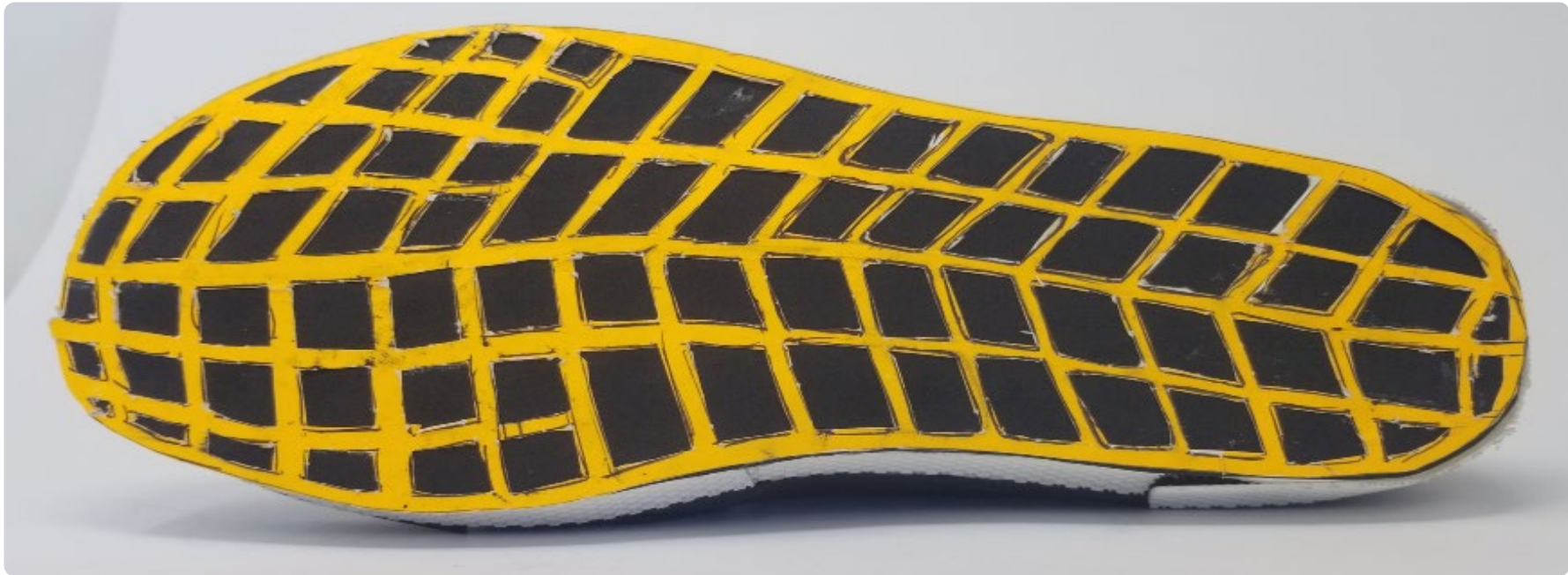


Figure 28: Tread Pattern of Model [Photo : Devya Patel]



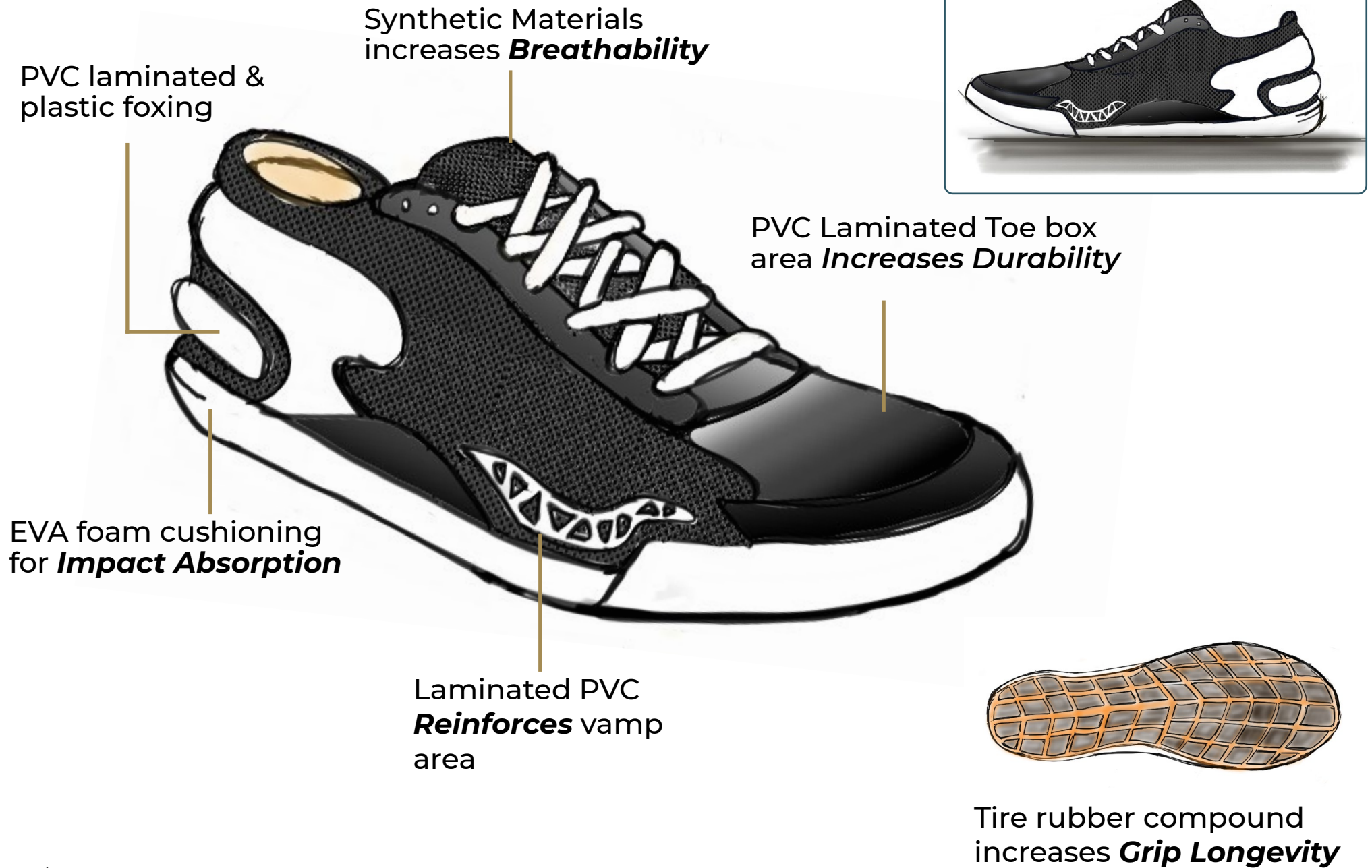


Figure 29: Focused Shoe Concept [Photo : Devya Patel]

Early attempts at 3D modelling the shoe in Fusion 360 proved to be difficult.

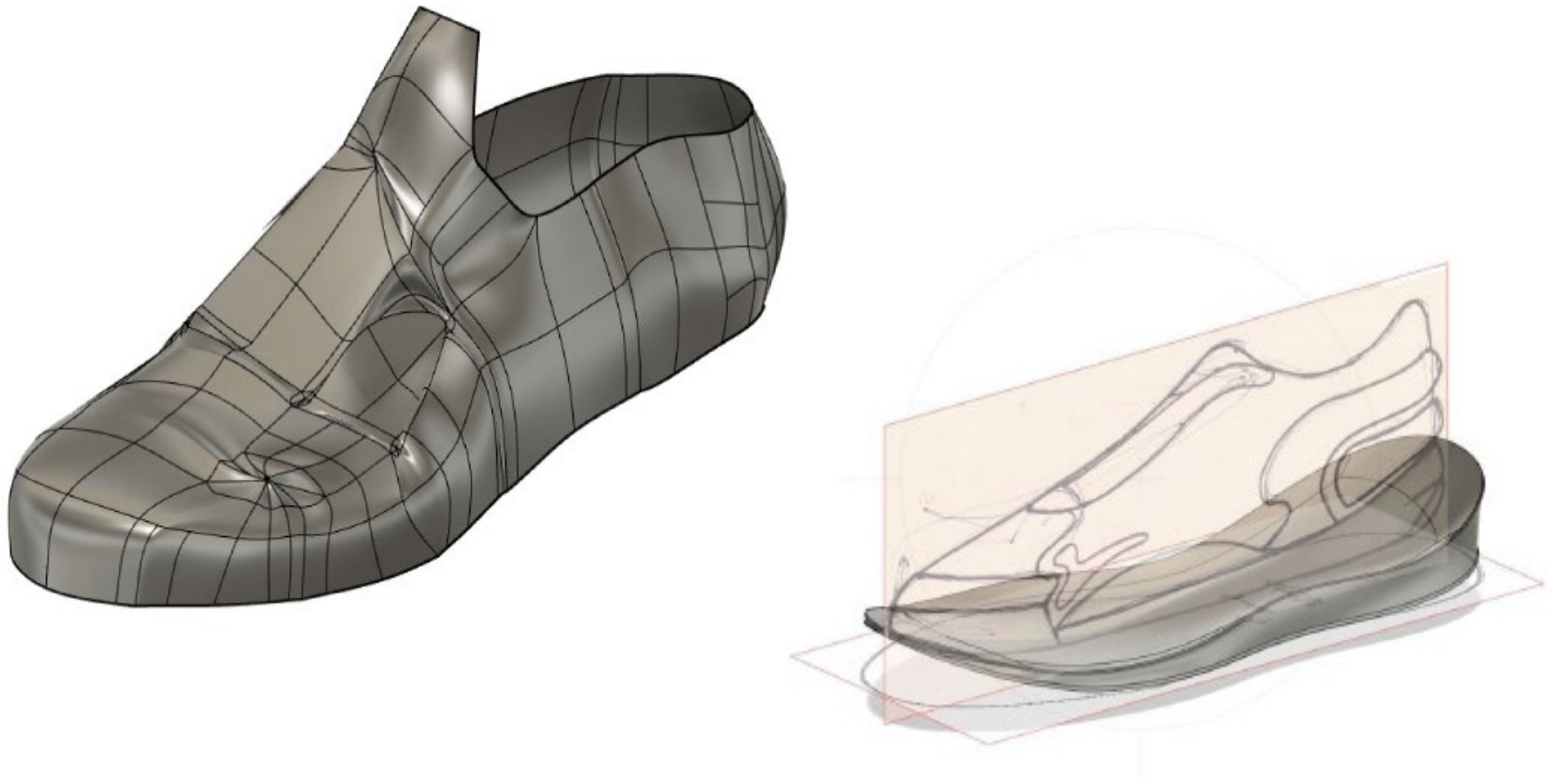


Figure 30: First Attempts at 3D Modeling [Photo : Devya Patel]

Midsole development began with designing and 3D printing a sole around a PLA shoe last. This was done in order to get a better understanding of how organic forms could be 3D printed. **Subsequently, prints were also made out of thermoplastic polyurethane (TPU) confirming that a part of the shoe and sole could be made out of a flexible material.**



PLA Sole

TPU Soles

Figure 31: Initial 3D Printed Soles [Photo : Devya Patel]



Figure 32 : TPU Sole w Gyroid Infill [Photo : Devya Patel]



TPU was also printed flat to indentify if it could behave like cloth and the results were fascinating. When printed in this orientation at a minimal thickness, the material became very difficult to rip and tear. This lead several peices of TPU being hand sewn to a pair of shoes to see if this would be a vialbe option for reinforcing the areas prone to degrading. These were then worn and tested in a parkour gym.



Figure 33: Shoes stitched with TPU reinforcements [Photo : Devya Patel]



1. Start of the course



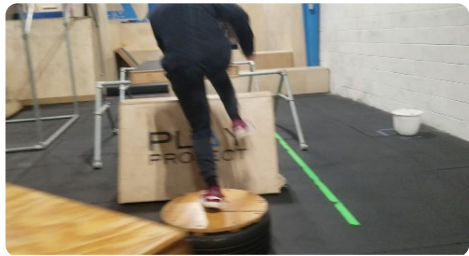
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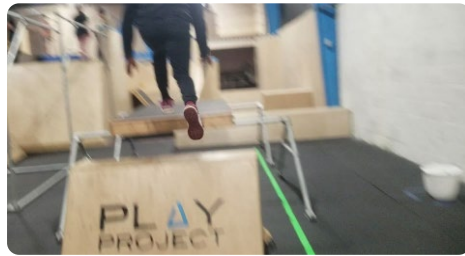
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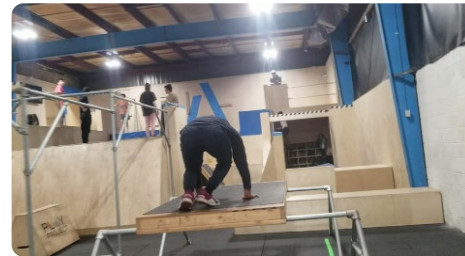
4.



5.



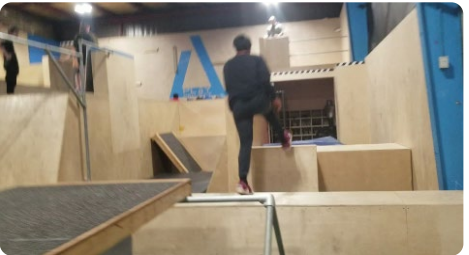
6.



7.



8.



9.



10.



11.



12.



13.



14.



15.



16. End of the course

Figure 34: Storyboard with validation model [Photo : Devya Patel]



Shoes with varying types of soles were tested to identify which style of mid/outsole would aid the athlete in performing precision jumps onto horizontal surfaces. As this is one of the most common movements performed in parkour. **Testing revealed that shoes with flatter soles provided the athlete with the greatest benefit. Since they were able to spread their toes and feel/grip the ground better.**

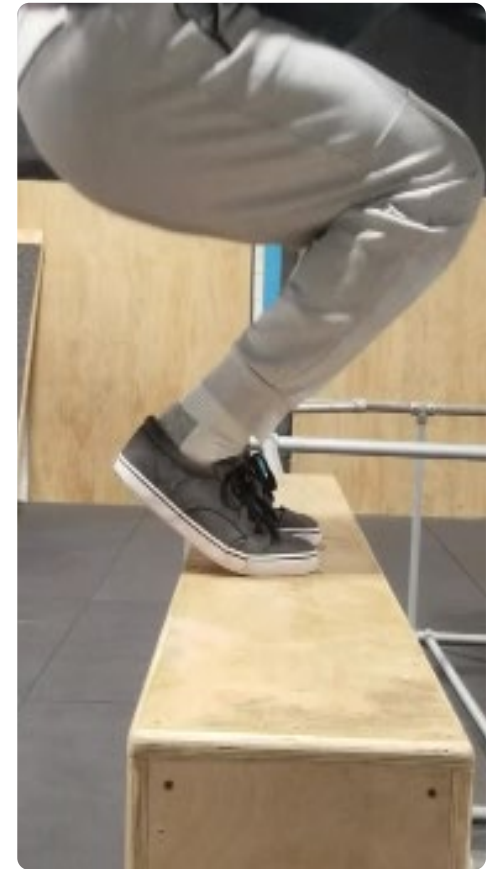


Figure 35: Precision jumps with different soles [Photo : Devya Patel]



The athlete also performed cat hangs on vertical surfaces as this is also another move that is performed in parkour. This time there was an emphasis on indentifying which sole would provide the most impact absorption without restricting technique. **Testing revealed that shoes with minimal cushioning and rounded edges were able to absorb more impact without impeding the athlete’s ability to feel and grip the wall.**



Figure 36: Cat hangs with different soles [Photo : Devya Patel]

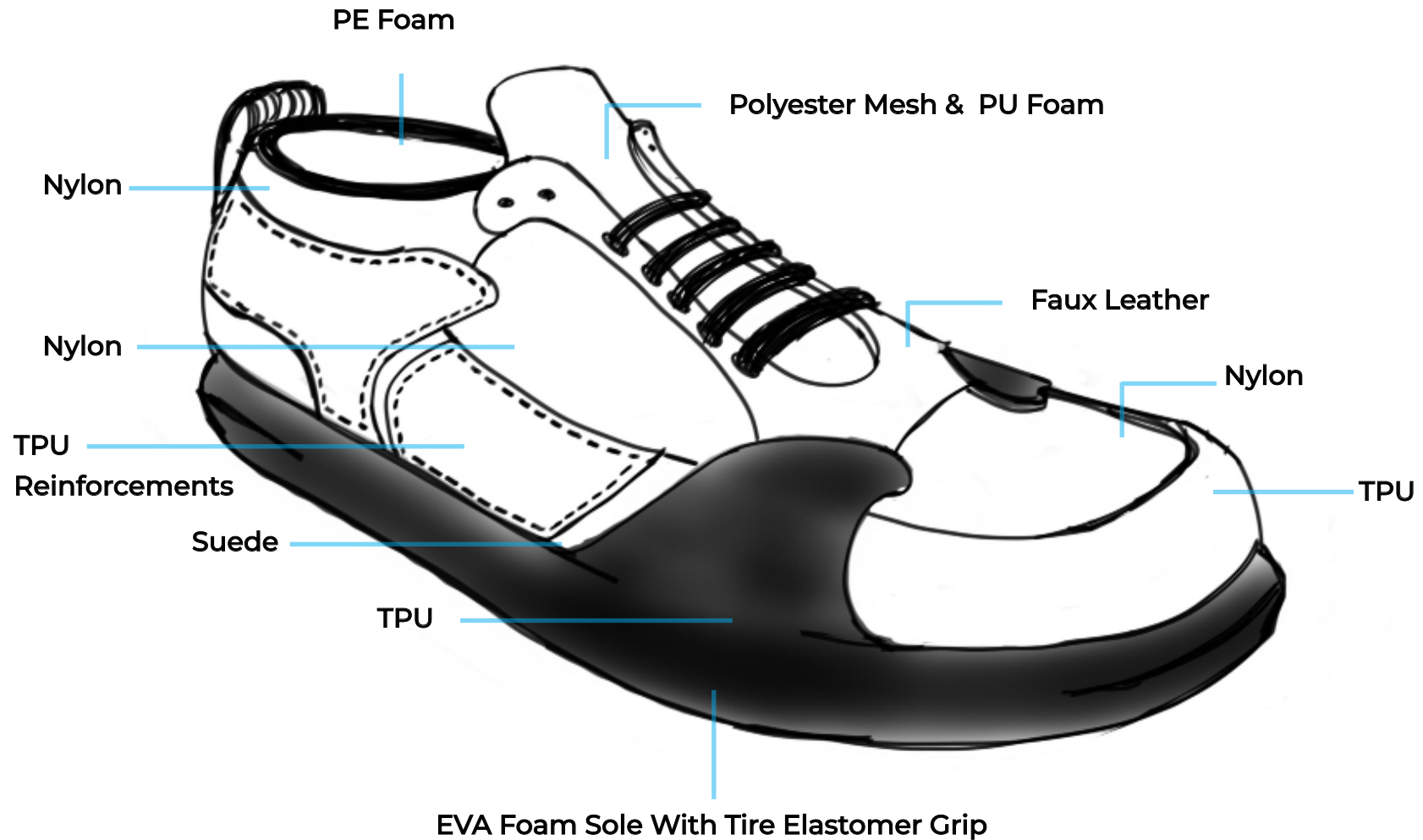
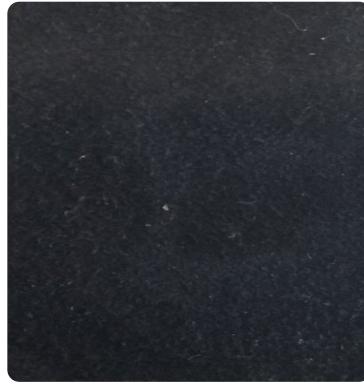


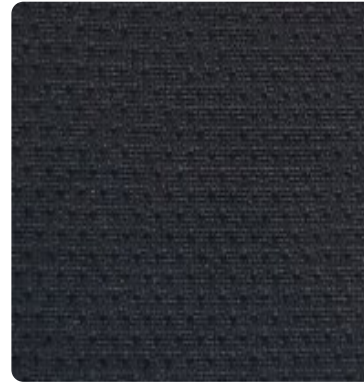
Figure 37: Refined Shoe Concept with features [Photo : Devya Patel]



**Thermoplastic Polyurethane (TPU)**



**Oxhide Suede**



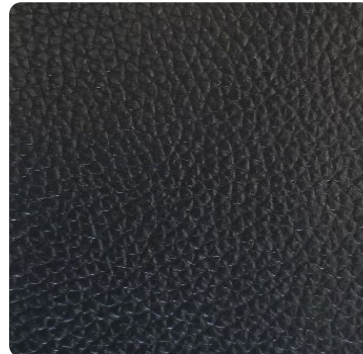
**100% Polyester Mesh**



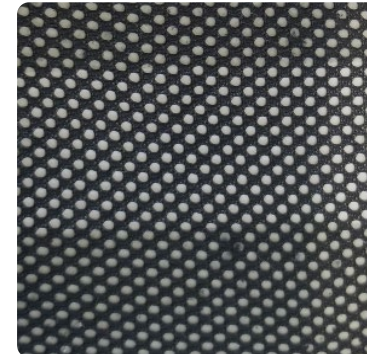
**EVA Foam**



**Nylon & Polyester Thread**



**Premium Oxhide Leather**



**100% Polyester Fine Sports Mesh**

### **Additional Materials**

**Polyethylene Foam (Internal Padding)\***

**Polyurethane Foam (Tounge & Collar)\***

**Nylon\***



Revisions to the 3D Printed soles were made based of the insights gathered from testing the various soles and several iterative changes that occurred through the development stage. Shoe lasts with alpha hinges were acquired to help with the fabrication of the sole as it served as the primary reference geometry/ form.

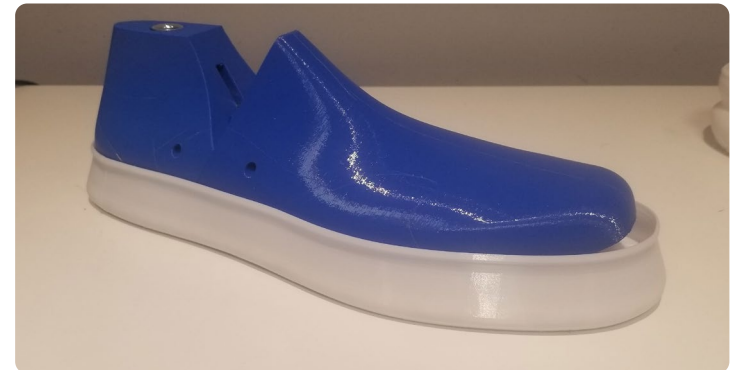


Figure 39: Sole Development [Photo : Devya Patel]

Newer versions of the sole included a raised perimeter that travels around the upper with the intent to provide additional protection to the foot on while offering a higher placement for a potential stitch line to be sewed along.

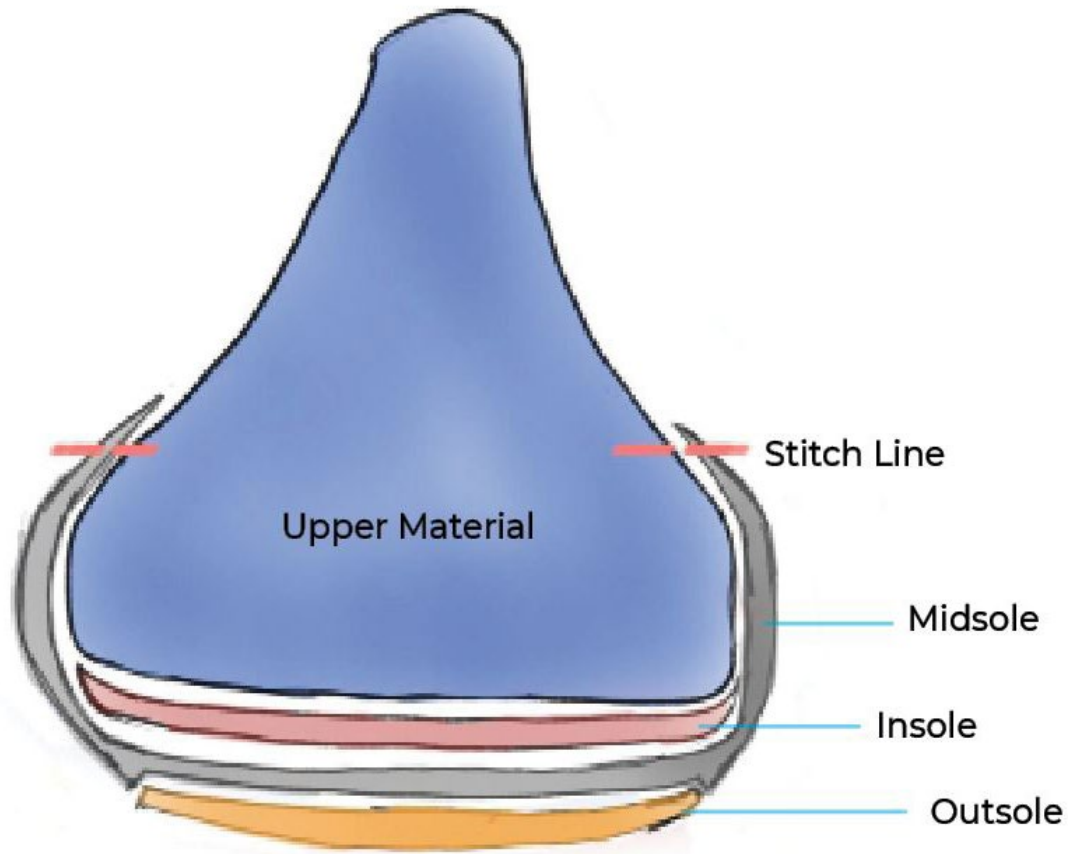


Figure 41: TPU/TPE Sole Swatches [Photo : Devya Patel]

Figure 40: Protective Perimeter with [Sketch : Devya Patel]

Incorporating a raised perimeter introduced a new challenge. When the sole was bent to simulate a precision landing position, the sole would flare out on both sides. Which would stress the stitching in vamp area possibly causing this area to fail quicker. To mitigate this issue a bending channel was intergrated into the newer version of the sole to provide some relief.



Figure 42: Bending Channel Development [Photo : Devya Patel]



To help with developing a potential pattern for the uppers of the shoe, the last was taped up and then drawn on to the divide the form into different segments.

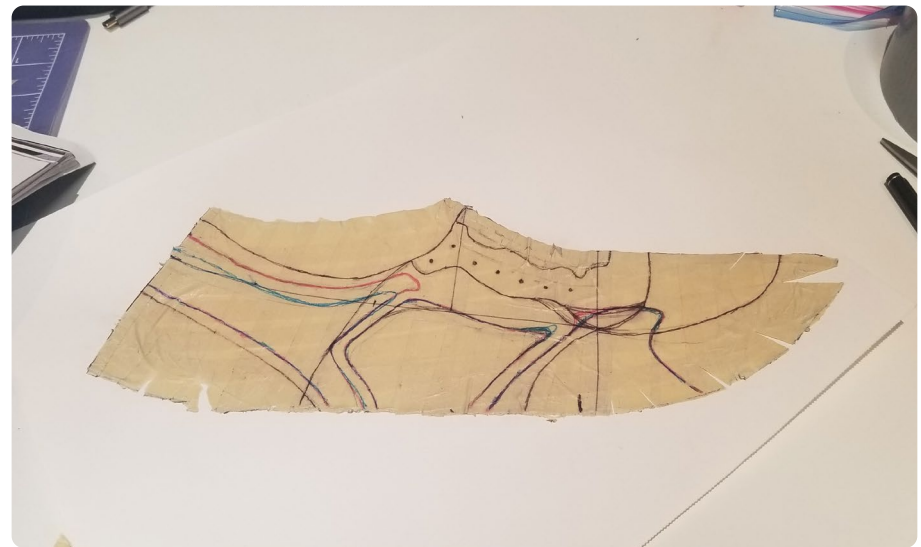


Figure 43: Pattern Drawing on the Last [Photo: Devya Patel]

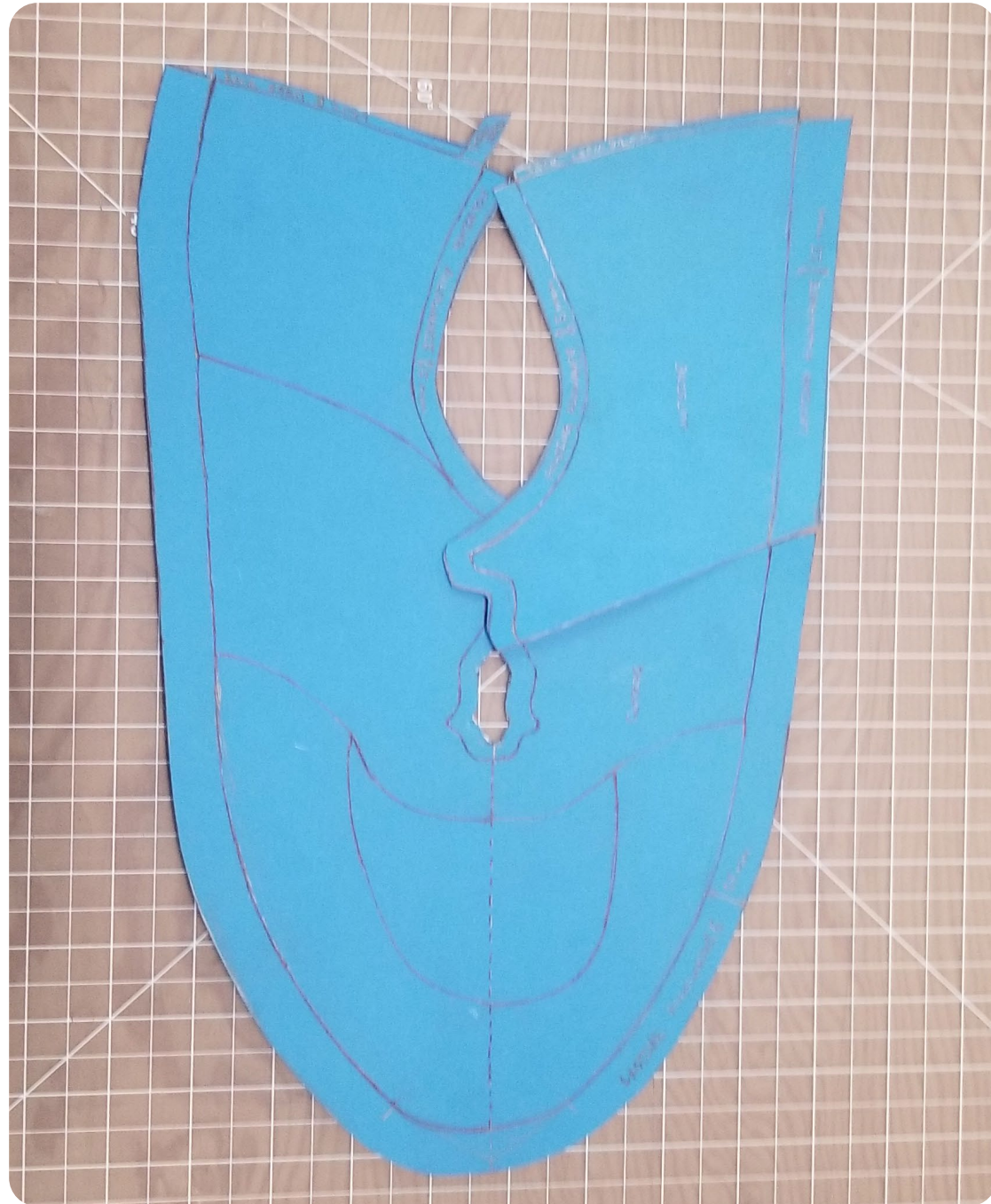


Figure 44: Conventional Pattern of a single layer of the shoe [Photo: Devya Patel]



Swatches of the upper pattern were 3D printed out of TPU to mimic traditional fabrics. This was achieved by extruding the prints without the top and bottom layers of filament, resulting in the infill patterns being exposed. Despite being cool, this option was not pursued further as the swatches were able to be torn easily with out the top and bottom layers.



Figure 45: 3D Printed Fabric Swatches [Photo : Devya Patel]



A rough version of the upper was made out perforated leather and staples to simulate stitching.



Figure 46: Upper Made out of perforated leather and staples [Photo : Devya Patel]

Using orthographic photos of the shoe lasts as references made it easier to model the shoe in Fusion 360.

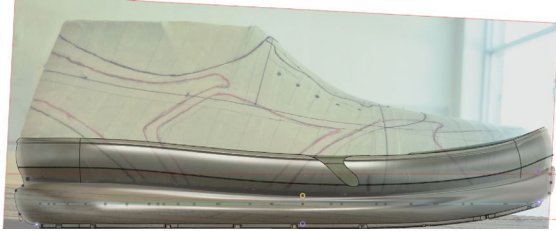


Figure 47: Advancements in 3D Modelling [Photo: Devya Patel]

Sketching continued to develop and create an authentic design for the profile of the shoe. Screenshots of the 3D shoe model were drawn on to help speed up the process and get a more accurate silhouette.

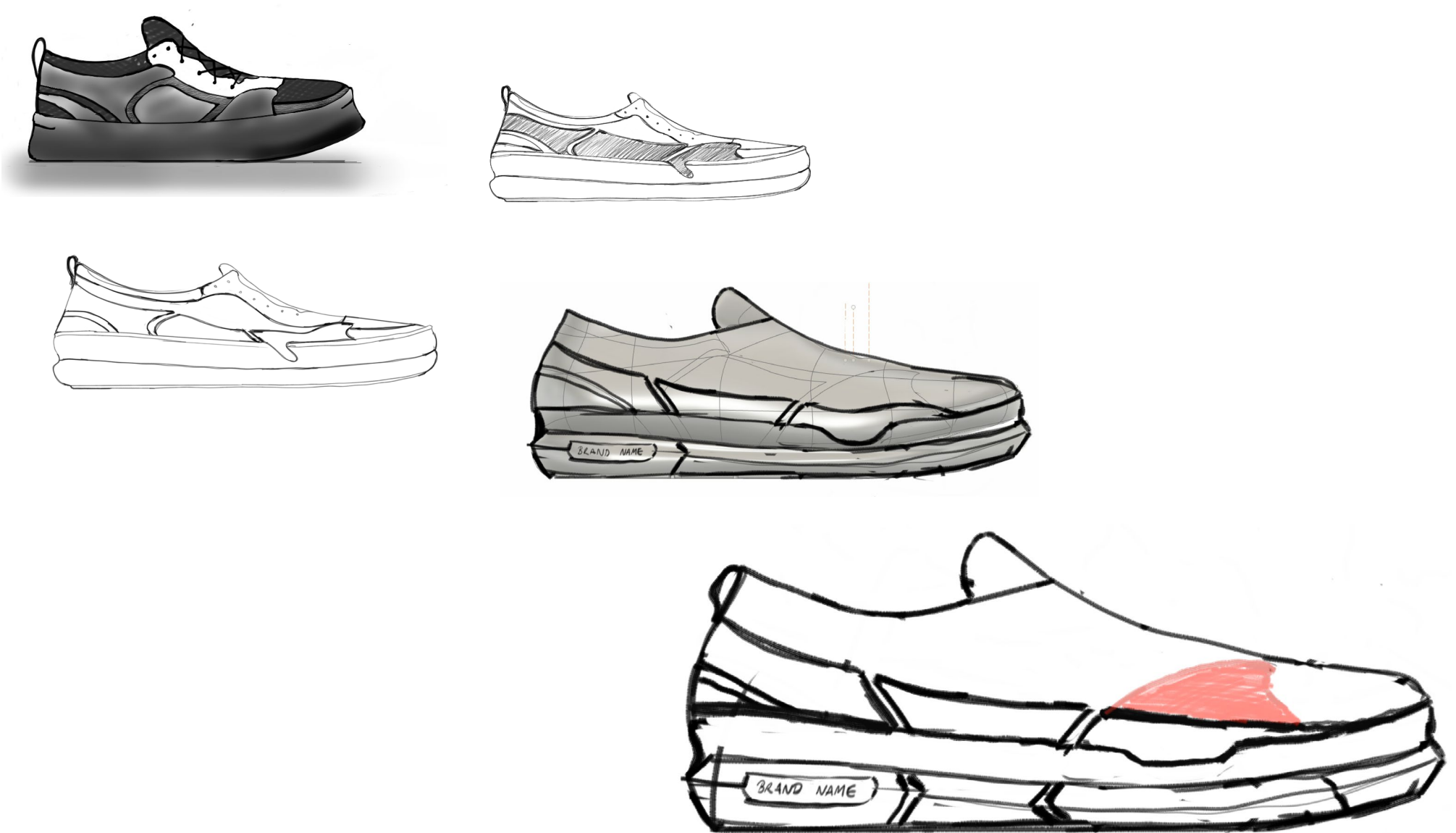


Figure 48: Advanced Profile Sketches [Sketches : Devya Patel]



An upper shell was printed out of TPU to identify if it could serve a base for the fabric to be stitched and adhered to.

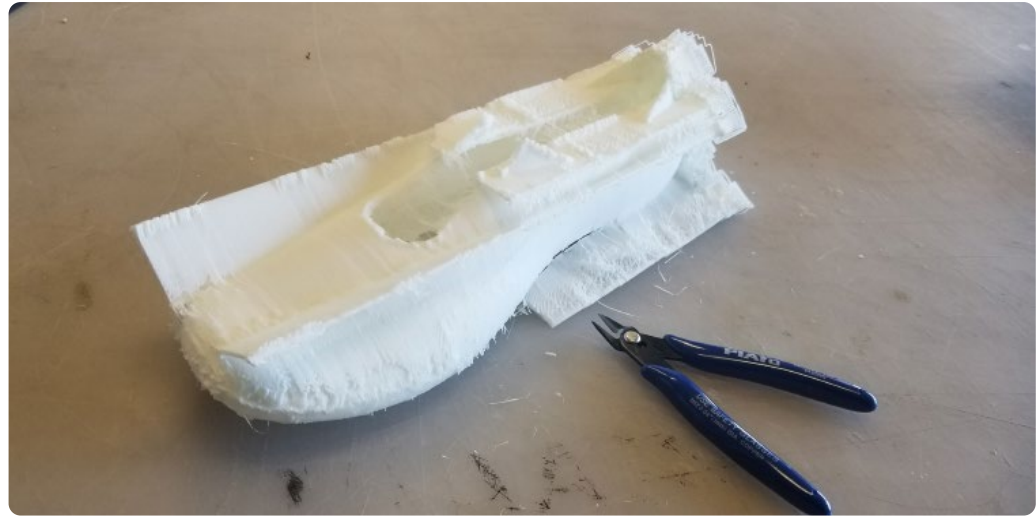
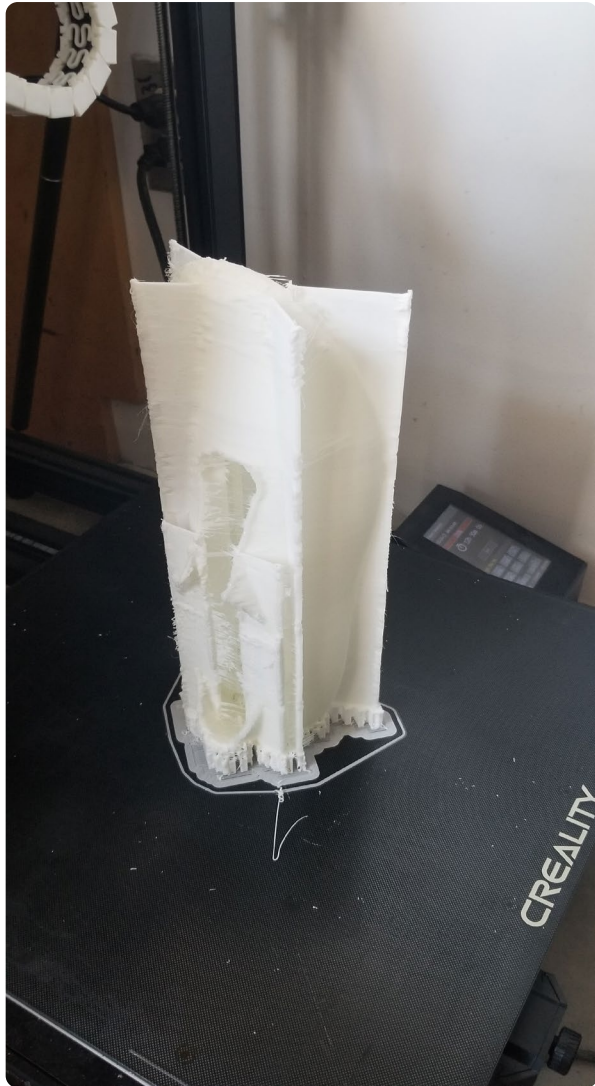


Figure 49: 3D Printed Uppers [Photo: Devya Patel]

Holes were punched out on the upper appromixately here the eyestay would be located. This allowed for laces to be intserted in the uppers for a fit test which proved to be quite successful.

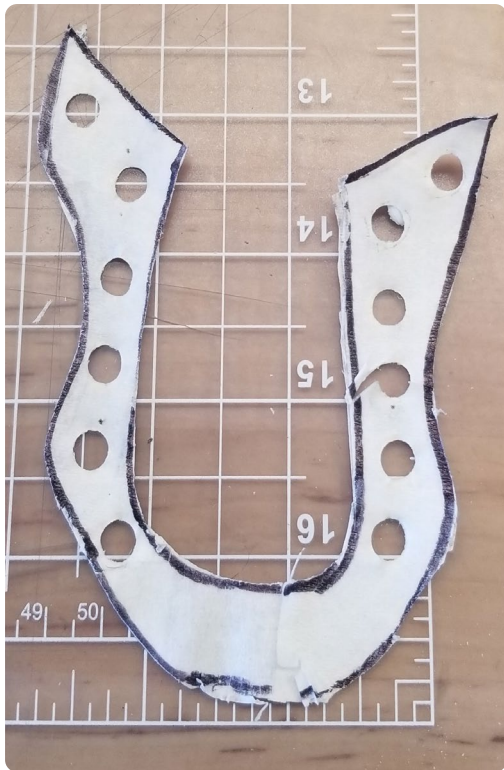


Figure 50: Eyestay Design & Fit Test [Photo : Devya Patel]



Attempts were made to sew fabric onto the uppers however the geometry of the 3D prints made it difficult maneuver the form around the sewing machine and create clean stitches.



Figure 51: Attempts to directly sew fabrics to the upper shell [Photo : Devya Patel]



A new fabric pattern of the shoe was created, sewn and then stretched over a 3D printed shell of the upper to identify if this would be a feasible method to represent the actual materials on a shoe like form. This was abandoned since the fabric wasn't able to follow the form without extensive wrinkles which resulted in the final result being unappealing.

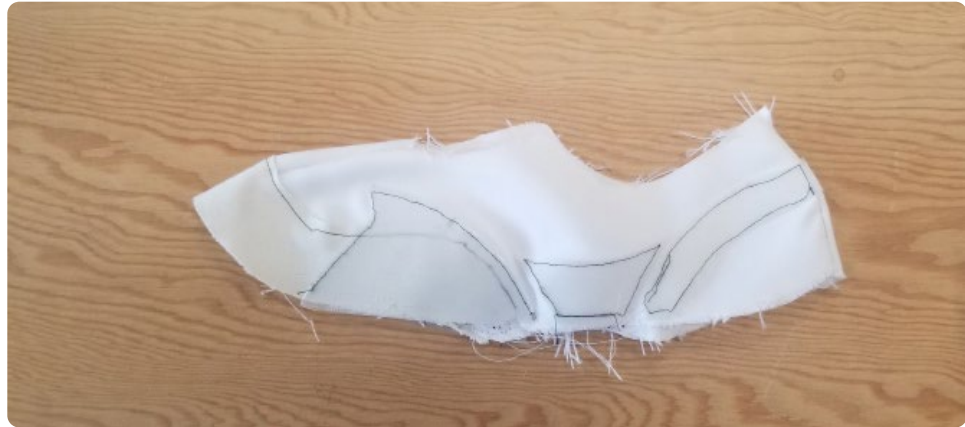


Figure 52: Attempts to add sewn fabrics to an upper shell [Photo : Devya Patel]

Ultimately it was decided that the uppers would be 3D printed out of ColourFabb's Varisohore TPU with the reinforcements raised on the form's surface. This decision was made since sewing fabric on the form proved to be difficult and resulted in it looking unappealing. The sole was also printed out of Varioshore filament since the material was able to replicate the properties of EVA foam when printed with certain settings.



Figure 53: Final upper and sole form [Photo : Devya Patel]

The tread of the shoe was 3D printed out of thermoplastic elastomer (TPE) filament to simulate the rubber used in vehicle tires. Additionally small cut outs for the logo were made in the tread and TPU pieces were added in the gaps for branding purposes.



Figure 54: 3D Printed Tread out of TPE [Photos : Devya Patel]



Dryfits of the shoe components were done before gluing to ensure that all the forms fit nicely together.



Figure 55: Dryfitting the shoe components [Photo : Devya Patel]

In order to determine which adhesive would work the best for gluing. Various swatch samples were created and glued together. Ultimately through testing it was revealed that Gorilla Glue worked the best for connecting the tread to the sole and Shoe Goo worked the best for connecting the upper to the sole.

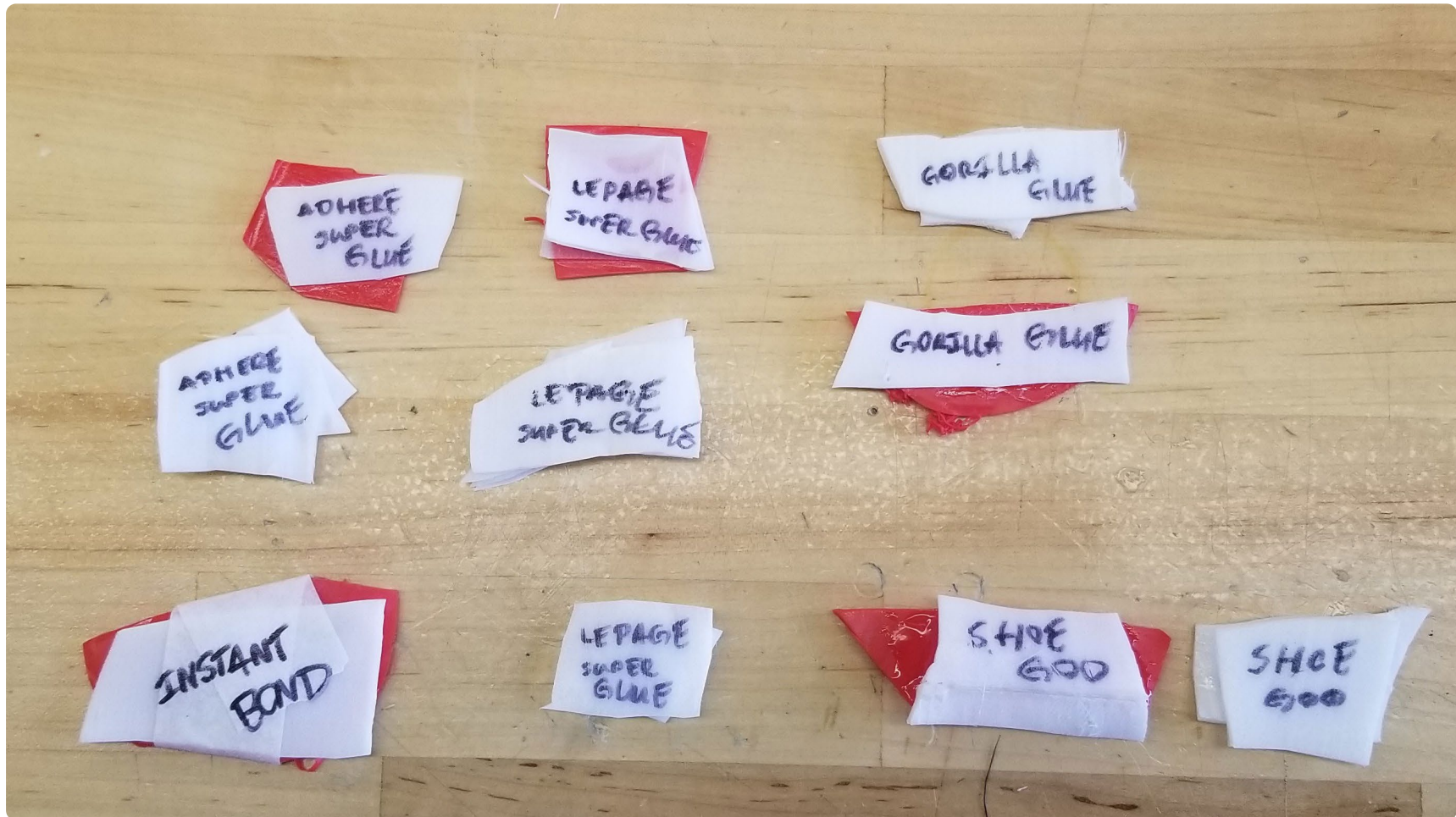


Figure 56: Adhesive Tests on Print Swatches [Photo : Devya Patel]



Down below are photos of the components being clamped together on the drying rack in the industrial design studio.



Figure 57: Components Clamped together and drying [Photo : Devya Patel]



TPU reinforcements in vamp, heel & arches increases durability

TPU Reinforced Eyestay

Breathable nylon mesh upper

TPU toe cap for extra protection



Figure 58: Plyowave Parkour Shoe Hero Shot [Photo : Devya Patel]

EVA foam for  
impact absorption



Tire elastomer grip provides  
traction & durability



Figure 59: Plyowave Parkour Shoe Rear View [Photo : Devya Patel]



Figure 60: Plyowave Parkour Shoe Alternative Color Ways [Photo : Devya Patel]





















# Reflection & Acknowledgements

Throughout this project I learned a ton about the shoe making process and have a new found respect for the amount of time, effort, designing and engineering that goes into making shoes. Going into this project I had very little knowledge and insight into how shoes were made.

From the beginning I knew that it would be challenging to make shoes in a conventional manner as that requires an extensive amount of resources, testing and time. All of which were limited. However through rapid and interative design, testing and using emerging manufacturing methods such as 3D printing flexible filaments, a couple pairs of wearable shoes were able to be constructed and I couldn't be happier.

I would like to thank my family, friends and faculty for helping and supporting me through out this project. I would also like to share a special thanks to Mickey Wang, the industrial design studio technician for assisting me with fabricating the 3D printed components of the project.



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