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NATE ROESE



Capstone Proposal:
Training, Competitive and Recovery Footwear Design for Elite Male High Jumpers

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Spring 2020

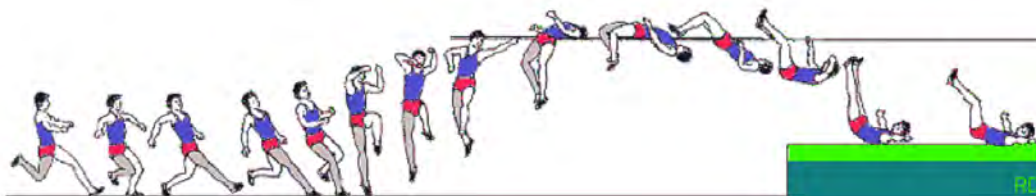
History of High Jump

The first recorded high jump competition was recorded during the early 19th century in Scotland (Dapena, 2002). Due to its popularity, it was incorporated into the first modern Olympics in 1896. Prior to high jump competition, it was first used as a physical training activity in Germany in the late 18th century (Dapena, 2002). It was realized during this time that the key factor to jumping high wasn't just to have power but to have proper technique. High jump techniques have gone through the most radical change over its lifetime in the field events for track and field.

The first technique used was called "legs up" which a person would simply lift their legs up when jumping to clear the bar (Dapena, 2002). The next evolutionary technique was created around 1876 and was called the scissors or the scissor kick (Dapena, 2002). This technique demands for the person lifts their legs over the bar in alteration which exponentially increased the height people jumped. This raised issues on landing, so now jumpers would land in sand or dirt to soften the fall. The scissors technique is still used today as a warm-up and training exercise for high jumpers. Following the scissors technique are the eastern cut off, the western roll, the straddle and few others with a little variation (Dapena, 2002). None were as revolutionary as the fosbury flop.

The fosbury flop was created by Dick Fosbury in the early 1960's ("Dick Fosbury", 2019). He started experimenting with new jumping techniques in high school because he was having trouble with the current straddle technique ("Dick Fosbury", 2019). With the new implementation of foam rubber landing pits, he was able to use a more unique jumping technique that didn't require that the jumper land on their feet. His junior year of high school is when he started officially using it, even though his coaches would encourage him to stick to traditional jumping techniques ("Dick Fosbury", 2019). That year he broke his high school record, and the following year he earned second at the state meet. He attended Oregon State University where he set the school record after his sophomore year. He went on to be the first high jumper to win consecutive NCAA high jump titles in 1967 and 1968 ("Dick Fosbury", 2019). After winning the NCAA's his senior year, he qualified for the Olympics in Mexico City. This was the international debut of the fosbury flop and Dick Fosbury showed the techniques full potential. He won the gold medal and set an Olympic high jump record of 2.24 meters ("Dick Fosbury", 2019). Since then, the fosbury flop is the most popular technique in the modern high jump.

The Fosbury Flop Technique:



(Yi Jen, n.d.)

Prior to the Fosbury Flop, high jumpers used the Straddle:

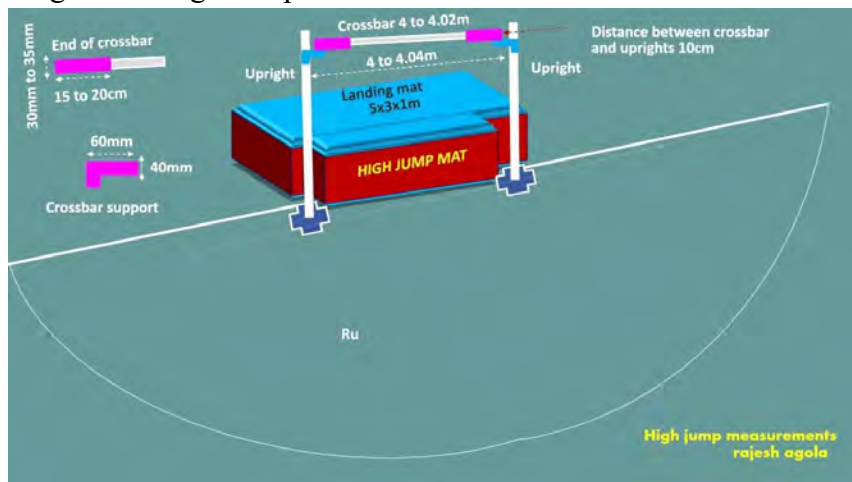


(Lopez, 2013)

Sports Playing Field

The high jump environment consists of 3 key elements, the landing pit, upright standard bars, and the crossbar. The function of the landing pit is to soften the landing of the high jumpers to reduce injury. The landing pit is made from foam and covered with a synthetic polyester and mesh. The size of the landing pit needs to be at least 5m long x 3m wide (Agola, 2016). The upright standard bars are usually made from either steel or aluminum to hold the crossbar at a certain height. The 4-meter long crossbar is what the high jumpers are jumping over. The crossbar is made from durable pultruded fiberglass and the ends sit on the height standard bars ("Gill Essentials", n.d.).

Diagram of High Jump Environment:



(Agola, 2016)

High Jump Rules and Success to Winning

Jumpers have 3 attempts at each bar height; if they fail to clear the height, they're out of the competition. If the bar falls off the upright standards in anyway during the jump, it will be considered a failed attempted. The jumpers are only allowed to jump off of one foot or they're disqualified. The jumper who has cleared the highest bar, wins the competition. If there is a tie, the judges will had the least amount of misses at the tying bar. If it's still a tie then the judges will see who had the least amount of misses overall.

The type of footwear a high jumper needs is very important to how successful they are. The shoes of jumpers cannot exceed 11 spikes with a length of 12 mm (IAAF, 2017). The thickness of the sole cannot exceed 13mm and the heel cannot exceed 19mm (IAAF, 2017). The shoes needs to be lightweight, durable, supportive, and they need to lock down the foot. The

necessary skills to be successful as a high jumper are speed, power, flexibility and aerial awareness. High jumpers need speed to gain forward momentum to convert into vertical momentum to jump high. Power is important because the high jumper needs to generate as much power as they can to launch themselves over the bar. Flexibility is important especially for the fosbury flop technique because it requires them to bend their backs while going over the bar. If the jumpers can increase the bend in their backs, the chances of them clearing the bar height increases. High jumpers also need aerial awareness when they're jumping so they don't hit the bar with their feet during their jump.

Showing power, flexibility and aerial awareness:



("Olympic High Jump", 2013)

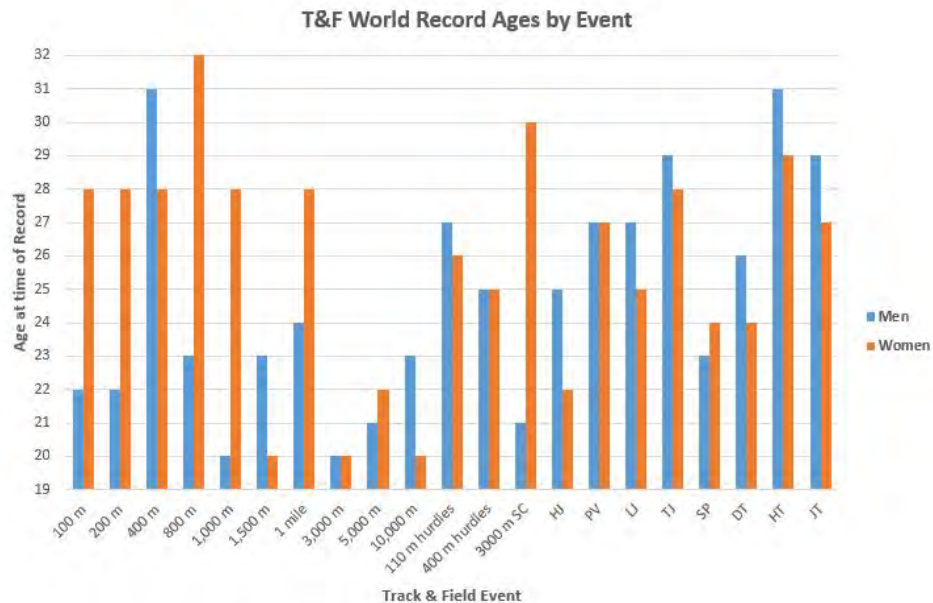
Athlete/ Consumer/ User Data and Market Size

Organized high jump starts in middle school and can continue all the way to the professional level. Athletes compete in high jump around the world, while a part of a club or school. There's no data to how many athletes participate in the high jump event, but according to World Athletics, in 2019 there were 5,198 recorded competitors of men and women. Elite male high jumpers will be the focus of the capstone research. Elite is considered to be collegiate and professional high jumpers who have jumped over 7 feet or 2.13 meters. World Athletics reported that in 2019, there have been around 800 professional male high jumpers who have competed.

There's a lot of discussion on the height and weight ratio in the high jump event. High jumpers are generally taller and leaner than most people which helps with propelling their bodies over the bar. Although, it's not necessary to be tall and/or lean; Stefan Holm's is a Swedish high jumper that broke that stereotype. At 5'9, he won an Olympic gold medal and was able to jump 59 centimeters over his own height (Maraviglia, 2019).

An interesting study done on the age of peak performance in track events showed high jump to have an early peak of athletic performance. Men's and women's high jump had the lowest average age of peak performance of all jumping events. The average is about 23.5 years

old, which indicates that maybe younger jumpers have more of an advantage ("Peak Age", 2013).



("Peak Age", 2013)

Event Positions

In high jump, there are two positions the jumper can start their approach from. The jumpers will either start on the right side if they're jumping off their left foot or the left side if they're jumping off their right foot. Once a side is picked, a set amount of steps is determined based on how advanced the jumper is. The number usually ranges from 8 to 12 steps. The first half of the steps should be upright long strides to accelerate the person and the last 4-5 should be shorter more powerful steps to transfer the horizontal momentum into vertical momentum.

Physiological and Biomechanical Needs for the Athletes

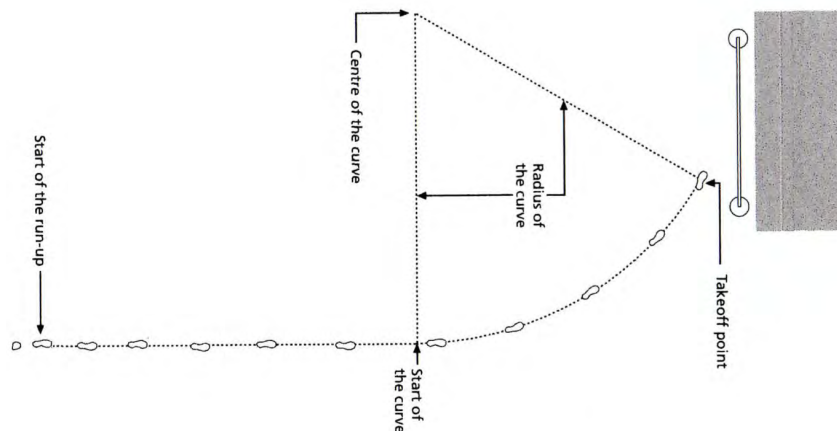
High jump training can vary depending on what coach the high jumper has but it will generally consist of weight training, sprinting intervals, plyometrics and event training. The athletes will be wearing training shoes for most of these workouts, except for event training; instead, they'll be wearing high jump spikes. Ph.D and assistant track and field coach for Harvard University, Paul Turner, wrote a paper on the training their high jumpers go through.

The suggested lifts in the paper for weight training includes bench press, power cleans, squats, leg press, heel raises, lunges, and step ups (Turner, n.d.). These lifts allow for the high jumper to build fundamental muscle groups to help them become stronger over the training block. These lifts, except for bench press, help build muscle in the jumpers quadriceps, hamstrings, calves and glutes (Lindberg, 2019). These muscles are the primary sources of where high jumpers get their power from to increase speed and vertical force. Bench press will build muscles in the chest, shoulders and triceps. These muscles also have a strong correlation to increasing speed and vertical force. The amount of sets and reps changes throughout the year whether the athletes is pre-season, during season, or off-season. Generally, the weight is going to be high, reps will range from 6 to 10, and sets will usually be around 3 or 4 (Turner, n.d.).

Sprinting intervals are important to developing speed so that the high jumper can gain enough horizontal velocity to convert into vertical velocity. Turner had his jumpers do various intervals from 4 sets of 400 meter strides (70% of maximal exertion) to 10 sets of 30 rows of stairs (Turner, n.d.). Another sprint interval he had assigned was 6-7 sets of 150 meter fast runs (85% of maximal exertion) (Turner, n.d.). All these workouts will increase in intensity as the season progresses. These workouts demand a lot from the body and the athletes must have proper gear to successfully complete the workout injury free. During sprinting, the jumpers are mostly using their mid-foot to forefoot area for landing and forefoot to push off. Having footwear that features cushioning, responsiveness, lightweight and energy return will be most helpful for these types of workouts.

Plyometrics are exercises that require muscles to exert maximal amount of force in short intervals ("Plyometrics", 2019). The goal of plyometrics is to build and strength fast twitch muscle fibers so the athlete can produce more power quicker. Turner had his high jumpers do a variety of plyometrics including squat jumps, split squat jumps, cycled split squat jumps, plyometric sit ups, double leg hops and bounding (Turner, n.d.). Plyometrics can work different muscles in the body, but in the case of high jump training, quadriceps, hamstrings, calves and glutes will be the primary muscles in use. Having footwear with a lot of stability, cushioning, responsiveness and lightweight materials will be beneficial for the jumper performing plyometrics.

The high jump event can be divided into 3 parts: the run up phase, the take off and the flight phase. The purpose of the run up phase is to gain speed and set up appropriate conditions for the take off phase. During the take off phase, the exertion of force from the athlete will determine the maximum height of the center of mass (COM) and the angular momentum in the air (Dapena, n.d.). Once in the flight phase, the athlete will be able to adjust the COM by lower parts of their body (feet and head) to raise other parts (hips) (Dapena, n.d.).



(Dapena, n.d.)

Horizontal and vertical velocity and the height of COM during the take off phase are extremely important biomechanically for the high jumper. During the beginning of the take off phase, the foot plants on the ground, causing the ground force to push back an equal and opposite force up the leg and body (Dapena, n.d.). This upward force is what transfers the energy from the horizontal velocity to the vertical velocity. The output of this determines how high the COM will go when the foot leaves the ground (Dapena, n.d.). A faster approach can increase the vertical velocity of the jumper, therefore increasing the bodies COM in the air (Dapena, n.d.).

Table 14.3 Height of the centre of mass (COM) at the start of the takeoff phase (h_{TD} , expressed in metres and also as a percentage of the standing height of the athlete), horizontal velocity in the last two steps of the run-up (v_{H2} and v_{H1}), horizontal velocity after takeoff (v_{H10}), change in horizontal velocity during the takeoff phase (Δv_H), vertical velocity at the start of the takeoff phase (v_{ZTD}), and vertical velocity at the end of the takeoff phase (v_{ZTO}).

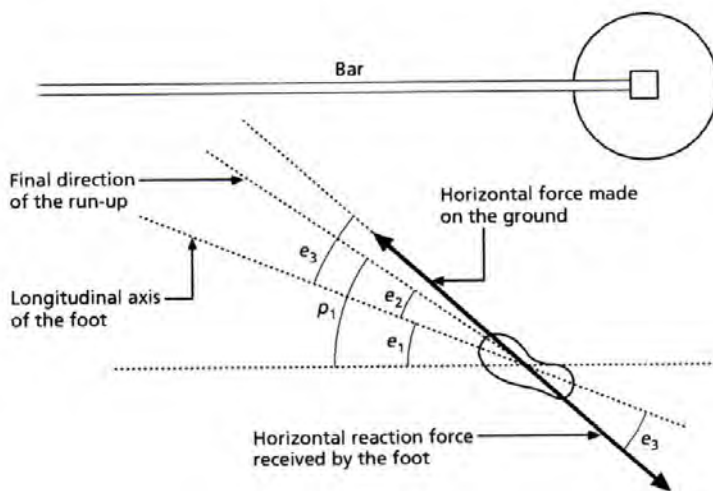
Athlete	h_{TD}		v_{H2} ($m \cdot s^{-1}$)	v_{H1} ($m \cdot s^{-1}$)	v_{H10} ($m \cdot s^{-1}$)	Δv_H ($m \cdot s^{-1}$)	v_{ZTD} ($m \cdot s^{-1}$)	v_{ZTO} ($m \cdot s^{-1}$)
	(m)	(%)						
<i>Men</i>								
Avdeyenko	0.92	45.5	8.1	7.9	3.7	-4.2	-0.3	4.50
Conway	0.78	42.5	7.4	7.4	3.4	-4.0	-0.6	4.65
Forsyth	0.95	48.5	7.2	7.3	3.8	-3.4	-0.6	4.55
Paklin	0.85	44.5	8.1	7.7	3.9	-3.9	-0.5	4.55
Partyka	0.93	48.5	7.6	7.4	4.1	-3.3	-0.6	4.50
Sjöberg	0.98	49.0	7.2	7.5	4.0	-3.5	-0.6	4.25
Sotomayor	0.89	46.0	-	8.0	4.0	-4.0	-0.7	4.60
Stones	0.92	47.0	7.0	7.1	3.5	-3.5	-0.4	4.40
Zvara	0.89	46.5	6.9	6.6	2.6	-4.0	-0.6	4.65
<i>Women</i>								
Acuff	0.92	49.0	6.3	6.3	3.5	-2.8	-0.2	3.80
Astafei	0.88	48.0	-	7.2	4.1	-3.1	-0.7	3.95
Beyer-Helm	0.86	48.0	6.9	7.2	3.8	-3.4	-0.5	4.00
Dragieva	0.81	47.5	6.9	7.2	3.5	-3.7	-0.8	4.10
Henkel	0.89	49.0	7.4	7.2	4.3	-2.9	-0.5	3.90
Kostadinova	0.90	50.0	7.5	7.3	4.2	-3.1	-0.5	4.00
Quintero	0.84	46.5	7.3	6.7	3.8	-2.9	-0.8	3.90
Sommer	0.87	49.5	6.9	7.1	4.3	-2.8	-0.6	3.85

Note: Some of the values in this table may not fit perfectly with each other, because of rounding off.

(Dapena, n.d.)

This table shows how a balance of a faster approach (horizontal velocity) and lower COM at the beginning of take off can increase the vertical velocity at the end of take off (Dapena, n.d.). COM should be in a lower position during the beginning of take off and higher at the end. Having the body at a lower position at the beginning of take off is hard for athletes because the body will need to be supported by a deeply flexed non take off leg (Dapena, n.d.). It's also difficult for the non take off leg to support body without losing velocity (Dapena, n.d.). Finding the optimum balance between COM at the beginning of take off and the horizontal velocity is different from jumper to jumper.

In regards to footwear, it's important to look at what's happening to the foot on a biomechanical level. When most high jumpers plant their foot for take off, the longitudinal axis is neither aligned with the final direction of the run up nor the horizontal force the athlete exerts (Dapena, n.d.).



(Dapena, n.d.)

This unalignment causes the foot to roll inwards (pronation of the ankle) (Dapena, n.d.). This means that the medial side of the foot is stretched and the lateral side is compressed.

Extreme pronation can cause injury to the ankle and foot. The sequence of images below show the ankle joint pronating while the foot plants during the take off phase.



(Dapena, n.d.)

The high jump event in general is utilizing most of the body. It's important the high jumper have strong legs, hips, shoulders and arms. The legs help you gain speed and give you the initial power to explode up during take off. Strong hips help the body rotate over the bar and to avoid hit the bar off. Shoulders and arms help control the body when running up for the approach and to gain vertical momentum.

When it comes to recovering muscles, what do athletes need in their footwear? A simple answer is increasing blood flow, which helps bring oxygen to their muscles and oxygen allows for the muscles to heal. On a more scientific level, the body needs nitric oxide to encourage the muscles to start healing (Bryan, 2019). Nitric Oxide is a molecule that tells blood vessels to improve oxygen and nutrients delivery which helps the regeneration process (Bryan, 2019).

There are natural ways of increasing nitric oxide in your body such as having a good diet high in vegetables and antioxidants. Important antioxidants include Vitamin C, Vitamin E, Polyphenols and Glutathione which all have their own benefits but collectively help form nitric oxide in the body (Van De Walle, 2018).

Another way of increasing recovery time is to use bioceramic material. Ceramic materials and mineral oxide are heated to 1700 Celsius, and once it's cooled, bioceramics is created (Alger, 2019). Bioceramics works by producing Far-Infrared (FIR) radiation when heated by the human body. FIR has been shown to increase blood circulation, reduce oxidative stress, reduce inflammation, and moderate sleep better (Alger, 2019). The image below is an example of how bioceramics can be printed onto clothing.



(Alger, 2019)

There's been studies done on FIR and it's health benefits. A study that used FIR in saunas helped decrease pain, stiffness and fatigue (Hall, 2017). Although this study was done on subjects that had arthritis pains. Bioceramics is still being studied for its potential benefits on far-infrared radiation but companies like Under Armour are already using it.

Under Armour has partnered with Celliant to incorporate bioceramics into sleepwear, originally made for Tom Brady. According to Celliant's website, use of their products with bioceramics in it are clinically proven to enhance tissue oxygen levels, improving athletic performance, sleep quality, health and wellness (Celliant, n.d.). According to their website, the

first step is to mix 13 proprietary thermo-reactive minerals and embed them into the core of polyester fibers. These embedded materials now have the ability to re-emit electromagnetic light energy emitted by the body. By altering the wavelengths of this energy back to your body, it triggers vasodilation in the capillary bed and increase the amount of oxygen available. This process increases tissue oxygenation by 7%, making the body use oxygen more efficiently ("How It Works-Celliant", n.d.).

Current/ Competitive Product Research

There are a variety of brands that make high jump spikes. Nike and Adidas make the most popular spikes that jumpers wear. I'll be analyzing 5 different high jump spikes that are currently offered on the market.

Nike's unisex spikes are called the High Jump Elite with a price point of \$125. According to Nike's website, it features a mesh upper with synthetic skin for a lightweight and breathable fit. A light Pebax plate for a more explosive push-off and a midfoot strap to help support and lock down the foot. This high jump spike also features a midfoot strap to keep the foot locked down. Reviews for this spike were good, everyone seemed to have positive things to say about them. They fit well, are durable and comfortable, but some complaints were about the color.

Nike High Jump Elite:



Adidas's spikes are called the adiZero HJ spikes with a price point of \$110. Adidas didn't have the spikes listed on their website, so I retrieved my information from Eastbay. According to Eastbay, the upper is made with a stitchless upper covered in a Sprintweb overlay for lightweight support and lockdown. Lining is made with a sweat wicking yarn to keep the jumper dry, fresh and focused. EVA midsole offers lightweight cushioning and with a rigid Pebax plate. The outsole is covered in a sharkskin traction pattern for grip. The reviews for this spike were high with no complaints. Users felt like they were comfortable and durable, and really liked the midfoot strap.

Adidas adiZero HJ:



Asics's men's high jump spike is called the High Jump Pro Track Shoe with a price point of \$120. According to their website, the upper is made with faux leather and textile lining. The midsole is made from their cushioning technology called Solyte and the outsole has SharkDuo technology for grip. The pair of spikes are asymmetrical and are made for a left foot take off. Reviews for the Asics high jump spike were average. A lot of users felt like these were an improvement from previous models and liked them for the left foot focused take off design. Other users felt that they fit incorrectly but that was the only negative.

Asics High Jump Pro:



The Saucony Uplift HJ 2 spikes are listed at a \$100 price point. According to their website, the upper is designed with Saucony's Isofit stretch mesh with Flexfilm overlays for lightweight support. It offers a removable foam insole for adjustability, and padded tongue and collar. The midsole is made with an EVA foam for impact absorption and a rigid 11 spike plate with energy return for a powerful take-off. Reviews for these were 4 stars, the pros of them that they were comfortable and lightweight and cons were that they weren't durable.

Saucony Uplift HJ 2:



The Puma Men's evoSPEED High Jump 5 spike is listed at \$135. Puma didn't have the spikes on their website, so information was taken from Eastbay. According to Eastbay, the upper is made from synthetic materials that comfortably wrap around the foot for a secure feeling. The midsole strap helps to lock down the foot and the adjustability of it helps to personalize the fit.

The Pebax plate and the shark skin outsole offers an aggressive grip for maximum speed and propulsion. There were no reviews online for the Puma evoSPEED high jump spikes.

Puma evoSPEED High Jump 5:



High jumpers also use normal running shoes for their training and some athletes will use recovery shoes for after their workout and competition. I'll be analyzing Nike, Adidas and Puma training shoes and Oofos, Hoka One One, and New Balance recovery shoes. There are no training and recovery shoes specific for high jumpers but the shoes being looked at seem to be a popular and relevant choice for them.

Training Shoes: Nike, Puma, and Adidas



According to Nike's website, the \$120 Nike Air Zoom Structure 22 is made with flywire cables to secure the foot, engineered mesh for ventilation and targeted support, and a partial bootie that wraps the foot for a snug and secure fit. An air zoom unit is incorporated into the Nike zoom foam midsole. The shoe also has an offset of 10mm (12mm forefoot; 22mm heel). The reviews for the Nike Structures are around 4 stars. The users felt like they were comfortable, fit well and stabilize the foot. Negative comments included durability issues, tread wearing down too fast, and lack of innovation between older models.

According to Puma's website, the \$130 Puma SPEED Orbiter running shoe is made from the engineered knit for a sock-like fit. The midsole is created with Puma's Hybrid foam, a combination of 2 separate foams for cushioning and responsiveness. Inside the midsole, there is a propulsion plate that helps the runners toe-off faster. The outsole is made from Puma's DIN40 performance rubber for traction and durability. The offset is 12mm, no specification on forefoot or heel height. There are very few reviews for Puma Orbiter but the reviews are positive with a 5 star rating. Positive remarks were that the shoe is very comfortable and fit well. The only negative comments are that they are a bit too heavy.

According to Adidas's website, the \$160 Adidas Solarboost 19 is made with an air mesh upper that has tailored fiber placement for midfoot support. The shoe incorporates a fitcounter heel for heel lockdown, propulsion rail for guiding the foot and a stabilizing torsion system. The midsole is made with Boost foam for a responsive feel. The shoe has a 10 mm offset (22mm forefoot; 32mm heel). The reviews for the Adidas Solarboost are a 4.3 / 5. Positive comments are made on how comfortable, lightweight and supportive the running shoes are. Negative comments included being expensive, forefoot tightness and causing blisters.

Recovery Shoes: Oofos, Hoka One One, and New Balance



According to Oofos's website, the \$80 Oofos Ooahh Sport Flex Sandals features their Oofoam that absorbs 37% more impact than traditional footwear foams to reduce stress on the feet and joints. The sandal is made with a velcro strap to secure the foot down for optimal fit. It's machine washable along with moisture and bacteria resistant. Reviews for the Oofos are a 4.5 / 5. Users thought they were very comfortable and they have helped alleviate pain in the heels. Negative comments were about the velcro size and not being safe to wear around.

According to Hoka One One's website, the \$80 Hoka One One Ora Recovery Shoe is made with a flexible lightweight mesh upper for breathability and comfort with easy entry. EVA foam in the midsole for stability, durability and support along with groove placements for optimal comfort and grip. This shoe also has an offset of 5mm. Reviews for the Hoka One One are a 4.2 / 5. The main positive feedback is that they are lightweight, comfortable and good cushioning. Negative comments are that they too narrow and tight, uncomfortable and they have poor arch support.

According to New Balance's website, the \$70 New Balance RCVRY Shoe is made with a breathable mesh upper and is machine washable. The Midsole is made from CUSH+ foam and the footbed "massages" foot to help restore blood flow to the area. Reviews for the New Balance RCVRY are a 4.4 / 5. Users felt like they were comfortable, lightweight and flexible. Negative comments were that they don't have any arch support, there are holes going through the midsole and that they run small so fit is a problem.

Anatomy of Typical State of the Art Products

Looking at the product landscape above, there are some common features from all the spikes. All the high jump spikes have a strap that goes over the top of the upper which supports and locks down the foot. It's an adjustable strap with velcro so the jumper can decide how tight they want to strap their foot down. High jump generates a lot of force, especially on the foot and spike, so adding a lockdown mechanism is important so the foot can stay in place.

The next common feature is the shark skin outsole which goes wraps up onto the upper. All the spikes have this except for the Nike pair, but their previous model did. This benefit of the shark skin is for grip and traction but there's no explanation on why it wraps up so high. An educated guess is that the spike deforms during the take off phase but the shark skin wrap still allows traction even when not on the bottom of the spike. Another common feature that benefits traction and grip are the 11 spikes on the bottom. All spikes have exactly 4 on the heel and 7 on the forefoot.



Common features of the training shoes include having a certain type of engineered mesh or knit for the upper. It's important for the upper to be breathable and fit well, so an engineered mesh allows for both. An offset of about 10mm to 12mm is common which allows more cushioning under the heel. All the running shoes looked at are designed for a heel to toe striking pattern of the foot.



The recovery shoes are all focused on cushioning and the midsole technology. The uppers are breathable and lightweight, and made from mesh unless it's a sandal. The main goal of the recovery shoes or sandals are to be comfortable and help relax the foot. Easy insertion of the foot seems to be in mind when designing these shoes whether it's a laceless design or a sandal.



State of the Art Materials of Current Relevant Products

The upper of the high jump spike consists of a synthetic polyester overlaid with TPU film. This allows for the upper to be lightweight and supportive. EVA foam or a companies specialized foam is incorporated into the midsole for cushioning. The plate in a high jump spike is designed by Pebax which is made from thermoplastic elastomers (TPE). It's lighter and stronger than typical TPU (Pebax®, 2019). This plate allows the high jumper to run faster and jump higher.

Training shoes are made with an engineered mesh or knit; the material is usually a polyester. This allows for durability, lightweight and breathability. Using durable bemis on the upper helps make the upper more durable and offer an option for graphics. The midsole technology varies from company to company with some using Zoom and Boost or a combination such as Ignite foam and NRGY beads. All these give a certain amount of cushioning and responsiveness. High end shoes have carbon fiber plates incorporated into the midsole for better energy return. Outsole tread technology is all made from rubber.

Recovery shoes are made with mesh or breathable polyester for the upper. If it's a sandal silhouette then a polyester wrap or foam with be used to secure the foot. The wrap will be connected at the top of the foot using velcro. The foam technology varies from company to company. Hoka uses regular EVA foam but increase the amount used, Oofos use their signature Ofoam, and New Balance uses their super soft Cush+ foam.

State of the Art Manufacturing of Current Relevant Products

Engineered wovens are less wasteful than traditional manufacturing processes (Cobb, 2019). An engineered woven is sewn together by a jacquard flat knit machine to make the exact upper pattern piece. This also allows the sewing machine to strategically place support or breathable parts into the upper. The midsole foam begins in the form of small pellets and goes through a process called reaction injection molding to heat up the pellets and expands it to the shape of the midsole. Another manufacturing process of this is to 3D print the midsole. A company called Carbon 3D printed the Adidas Futurecraft midsole using a process they call, Digital Light Synthesis (DLS) (Carbon Lattice Innovation, n.d.). A benefit of 3D printing is that businesses can get their hands on the prototype or product faster. They also have a lot of flexibility in customizing a certain product if they so choose (Carbon Lattice Innovation, n.d.). In the case of a midsole, a company can customize the type of support or cushioning a customer needs. In the future, the customization of midsole/ insoles will be commercialized for all footwear. Once the upper is sewn together with the strobel and the midsole and outsole are created and attached, they can be glued together with barge.

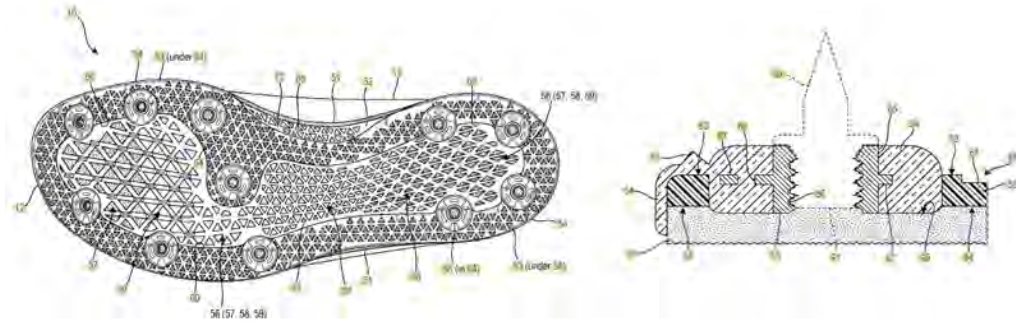
Manufacturing Process: Engineered Woven, Reaction Injection Molding, 3D Printing, and Gluing Upper and Midsole.



Utility Patent Landscape or Protection of the Products Intellectual Property

Nike's Unisex High Jump Spike Plate Patent: "Footwear with Rimmed Sole Structure"

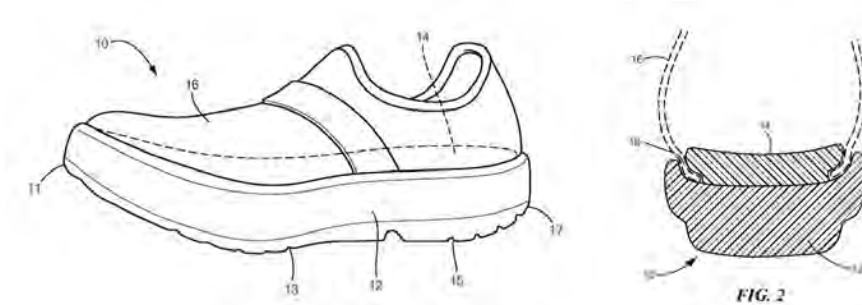
The patent identifies Nike's new design of a high jump plate. The plate is split into 2 layers, the outer layer which wraps up towards the upper and the inner layer which interlays between the footbed and outer layer (Cook, 2015). This new design is to create a lighter Pebax plate while creating better lift off ("Nike High Jump Elite", 2019).



(Cook, 2015)

Oofos 00mg Low Shoe Overlapping Midsole Patent: "Insole and Outsole Two-Piece Shoe"

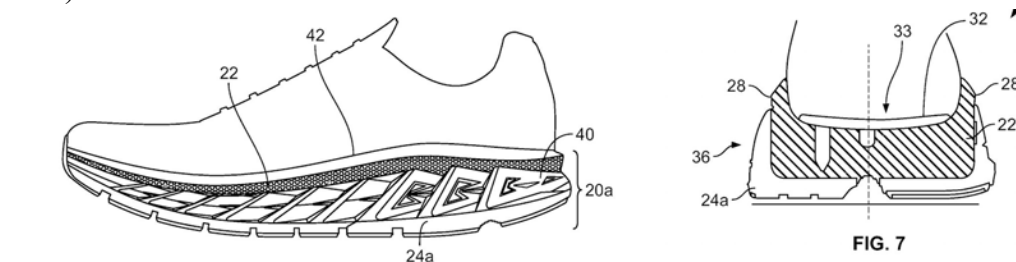
This patent identifies Oofos durometer range of between 28 and 38 on the Asker C scale, for the midsole and outsole (Brown & Diaz, 2017). The patent also goes over the sandwiching of the upper pattern with the midsole and outsole pieces (Brown & Diaz, 2017).



(Brown & Diaz, 2017)

Hoka One One Midsole Technology Patent: "Footwear Including A Stabilizing Sole"

This patent identifies stabilizing features in Hoka One One running shoes. Side walls extend along the medial and lateral side of the footbed, specifically of the heel. This structure provides stability to the wearers foot while aligning with the shape of the foot (Hillyer, Paris, & Pulli, 2016).



(Hillyer, Paris, & Pulli, 2016)

Graphic, Logo and Color Application on Current Product Space

High jump spike graphics include TPU film decals pressed on top of the upper fabric. Fast and sharp diagonal lines are used to portray the spike to be fast and agile. There is also a common theme of using mesh as both functional and aesthetics on the upper. The same principles apply to the training shoes. The graphics on the recovery shoes/ sandals are a lot less refined. There is still use of diagonal sharp lines and angles and also gradation is used as a graphic.



Logos for the trainers, spikes and recovery shoe are shown mostly on the lateral side side of the shoe as well as the bottom. Nike's logo tends to move up towards the vamp or toe box of the shoe. Puma's logo is placed in a way to be used as a functional piece for lateral reinforcement on the foot.



The colors on high jump spikes seem to start with a base of white or black and then hints of energetic colors such as yellow, green and orange. Sometimes the base won't be a majority of either black or white but one of the energetic colors (yellow, green and orange). The colors of the training shoes vary a lot more, but usually start with base color of black or white as well. Energetic colors are still seen in the training shoe color scheme but they're grouped with other colors. The recovery shoes have a lack of color compared to the spikes and trainers. The colors are usually black and white, which gives off a simple and less energetic feel to them. This research was based off of the brands websites which gave the colorways of the shoes that were analyzed.

Create a SWOT Analysis of Current Product Landscape

Training Shoes

<p>Strengths:</p> <ul style="list-style-type: none"> - A lot of cushioning - Variety of different features and 	<p>Weaknesses:</p> <ul style="list-style-type: none"> - Non specific for high jump training or jumping in general
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<p>benefits</p> <ul style="list-style-type: none"> - High quality materials - A lot of biomechanical testing 	<ul style="list-style-type: none"> - Made for running straight - Forefoot cushioning for landing and take off
<p>Opportunities:</p> <ul style="list-style-type: none"> - High jump / long jump specific training shoe - Plyometric inspired training shoe - Less injury on the foot - Allow athletes to jump higher and train more efficient - New silhouette 	<p>Threats:</p> <ul style="list-style-type: none"> - Too niche of a topic - Testing proposed design - Functionality of new design - New design/ silhouette causes new problems

Spikes

<p>Strengths:</p> <ul style="list-style-type: none"> - Designed for high jump - Lightweight and breathable - Biomechanical testing done - High quality materials - Spike and "sharkskin" traction - Lockdown of foot with strap 	<p>Weaknesses:</p> <ul style="list-style-type: none"> - No revolutionary design change - Uncomfortable - Relatively simple shoe for complex foot movement - Generally not designed for the take off foot
<p>Opportunities:</p> <ul style="list-style-type: none"> - New silhouette or foam technology - Design new plate - Allows athletes to jump higher - Design specific for the take off foot - Slanted insole for better curve running and center of mass (COM) during take off 	<p>Threats:</p> <ul style="list-style-type: none"> - Comfortability of slanted insole/ midsole - Testing/ convincing that slant will work - Possible injury

Recovery Shoes

<p>Strengths:</p> <ul style="list-style-type: none"> - Focus on cushioning - Breathability and moisture-wicking - Washable - Comfortable - Exploring ways to increase blood flow 	<p>Weaknesses:</p> <ul style="list-style-type: none"> - Medium - low-quality material - Lack of a variety of materials - Innovation
<p>Opportunities:</p> <ul style="list-style-type: none"> - Specific for athletes/ jumpers flying the night or morning after their 	<p>Threats:</p> <ul style="list-style-type: none"> - Too blue sky idea - Gathering information about the body

<p>competition</p> <ul style="list-style-type: none"> - Bioceramic materials for increase blood flow - 37.5 technology for cooling the foot - Reflexology inspired insole and/ or midsole - High top/ knee-high compression for calf recovery - Overall faster and better recovery so athletes/ jumpers can feel better faster. 	<p>during air travel</p> <ul style="list-style-type: none"> - Testing proposed design solutions will be hard
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Nate's Core Strengths

Nate studied graphic design at the University of Minnesota where he also ran Division 1 track and field. Being surrounded by track and field and sports most of his life, he's become a fanatic of athletics and competition. Nate's currently studying to get his masters of science in sports product design at the University of Oregon. This is where Nate has really developed as a product innovator. Having learned how to properly research, design and create products, he dreams of becoming a footwear designer to assist track and field athletes to achieve their goals.

So far as a product innovator, Nate's core strengths include research, pushing design boundaries, and prototyping/ making. Nate will tackle a design problem through research, whether it's analyzing the current product market, listening to athlete insight or through a biomechanical lens. He's recently been introduced to the world of sports biomechanics but has found it very useful in guiding his design and ideation direction. With the help of biomechanics, Nate can look at a sports product problem and generally understand the biomechanical needs for the solution. This type of design process helps legitimize his design solution.

Nate also finds that athletes give some of the best design advice for the products they use. Having been surrounded by athletes, trainers, and coaches his whole life, he has many connections in the sports world, especially in track and field. By also being an elite athlete, he better understands their needs in terms of products.

Nate's strengths will help support new innovation in high jump footwear. He is looking at a collection of shoes that are worn through the whole training and competition process. Specifically, he's looking at a high jump specific training shoe, high jump spikes and recovery shoe.

How Nate's Strengths Will Support New Innovation for High Jump

There are no training shoes specific for high jump so looking at the biomechanical needs of this shoe will be important. Understanding how the current shoes are being used and worn down will give a good indicator to what needs to be updated and designed with more durable material. High jumpers do a lot of sprints and plyometrics so taking these types of activities into account will be necessary. A lot of shoes that high jumpers currently wear for training are shoes designed for distance running. If there's a way to incorporate better jumping, landing and sprinting features in the shoe, it could help high jumpers train better and reduce the chance of injuries.

Understanding the physics and biomechanics behind high jump is crucial to designing an improved pair of new high jump spikes. Nate's biomechanical interest will play a big role in his ideation process and ultimately his new design. Designing spikes for high jump is challenging because there is so much going on with the body and the feet. Nate will have to look at video analysis of high jumpers during their jump to better understand what is happening to the body and the foot. He will use his knowledge in biomechanics to identify the direction of forces, gait cycle, foot pressure mapping and more. By understanding these, he can better design a spike that not only makes the athletes jump higher but reduce the amount of stress of their foot. With the connections Nate has with track and field, he is able to receive the athlete insight he needs on high jump. Using this insight will be very useful in product directions and concerns that the users have on current products. In the end, all this information will help Nate make proper design solutions and make a shoe that high jumpers will like noticeably better than previous products.

Nate will tackle the recovery shoe in the same way as the training shoe and spikes, by using athlete insight and biomechanics. The recovery shoe will be tailored towards high jumpers but Nate will be using other athletes that have used recovery shoes for their opinions and advice. The recovery shoe is looking specifically into the traveling aspect of the athlete and how that can affect their recovery. College and professional athletes will travel the same day or the morning after they compete and this can cause extra strain on their muscles and recovery time. Nate will look at what muscles high jumpers mainly use and see if he can tend to those areas. He will also look into if the effects of air travel on muscles and ways a recovery shoe can combat those effects. By making a successful recovery shoe, the athlete/ high jumper will need less time to recover so they can feel better and start training again. Nate will also design this shoe for injury prevention in mind so high jumpers can focus on training and not on healing their body.

How Does This Body of Work Supports Nate's Career in the Industry

Nate plans on having a career in the athletic footwear industry. More specifically he would like to design for running and track and field athletes. This project encompasses not only the product space he wants to work in but also the sport and activities. Nate also would like to work in the innovation for footwear and this project allows him to show off his skills. Each one of Nate's products he's making demonstrates certain skills that will support him to get into the career he wants.

The high jump training shoe demonstrates Nate's ability to make a product look aesthetically pleasing but also functional in its own unique way. This product will show his skills in research, design and especially making. The high jump spike will demonstrate Nate's ability to use his knowledge and resources in biomechanics to make a revolutionary product in the high jump space. This product will show his skills in designing, making and especially researching. The high jump recovery shoe will demonstrate Nate's ability in research, biomechanics, and physiology, and incorporating it into a shoe. This product will show his skills in making and especially in designing and researching.

Field Work

The type of research for the project consisted of athlete research, footwear performance, and gathering foot data research. Athlete research was to learn about certain insights athletes, coaches and trainers had on training, competition, and recovery for the high jump. Footwear performance research was to look closer at how the current shoes are actually functioning during

activity. Foot data research was to gather information on the feet, specifically pressure zones while training and competing. The fieldwork for this project took place at the University of Washington and the University of Minnesota. These universities gave me the opportunity to complete the research for the project and gave me better insight into problems rather than learning them online.

The University of Washington was the first destination between the two trips. I made contact with a University of Oregon high jumper prior to the meet to let him know that I was coming and would like to talk afterward. At the meet, I watched the high jumpers warm-up and observed the shoes that they were wearing to better understand the types of shoes they felt comfortable wearing. The shoe models ranged a lot for Nike, and Adidas athletes mostly wore the solar drives. When it came to the competition spikes, both old and new models of the Nike spikes were worn, and the current spikes for Adidas were worn.

The University of Minnesota (UMN) was the second trip I took for research where I covered all of my research goals. UMN was picked because it's a school that I have a lot of close connections and have a lot of good high jumpers. I was able to work closely with athletes to receive athlete, coach and trainer feedback and insight, capture footwear performance and gather foot pressure mapping.

One of the main goals of attending the track meets was to capture slow-motion videos of the last step of their approach (take-off foot). This would be the method of researching the footwear performance of the shoes. I brought a high-speed camera that captured 120 fps at 1080 resolution, and I also used my iPhone which captured 240 fps at 1080 resolution. The camera was able to capture high-quality close-ups of the take-off foot while the camera was able to capture better slow-motion videos of the take-off foot. I used both to gather as much data as possible and I also took continuous shots to get clear images of the take-off foot.

Research Questions and People I Talked To

I talked to multiple athletes both collegiate and professional, and had the chance to talk to a collegiate high jump coach, an athletic trainer, and sports scientists in the industry. The collegiate athletes I talked to were Nick Bachinski, Ben Gucinski, Danny Schiller, Michael Burke, and Ryan Lockard who have either competed or currently do compete for the University of Minnesota. All these Minnesota high jumpers have jumped over 7 feet, which I consider an elite high jumper. I also talked to Ben Milligan from the University of Oregon who is also a 7 foot plus high jumper. The professional athletes I talked to were Luca Wieland from Germany, Shelby McEwen and Kevin Schultz from the USA, and Adrijus Geblauskas from Lithuania. The high jump coach I talked to was Zach Seigmeier who coaches at the University of Minnesota and the athletic trainer I talked to was Katie Madden who works at the University of Minnesota as well. I talked to Daniel Schuster and Eric Holmes from Adidas who have backgrounds in biomechanics and product testing. I also talked to Brad Wilkins from Amp Performance who has a background in sports physiology. These are the questions I asked athletes:

1. What is your shoe size and what is your jump foot?
2. What shoes do you wear during training and workouts?
 - What are your likes and dislikes?
3. What spikes do you wear for competition?
 - What are your likes and dislikes?
4. What shoes do you wear post-workout/ competition and during travel?

- What are your likes and dislikes?
- 5. Have you had any injuries in the past from high jump?
 - What about small pains or chronic pains?
- 6. What muscles are usually sore after training and competition?
- 7. What does an average day of training look like?
- 8. What has been your longest travel trip in terms of flight time?
- 9. Have you ever felt more sore or tight after flying or after a long bus ride?
 - Where did you feel this soreness or pain?
- 10. If you were to design a trainer, a spike and a recovery shoe specifically for you, what would the key features be in each one?

Questions for the high jump coach:

1. What's the most important part of the high jump approach?
2. What role does footwear play in the approach? How is it helpful?
3. What muscles are used the most during high jump/ what are the most important muscles for high jump?
4. What have been the most common injuries or pains you've seen in high jump? Explain why you think these injuries and pains are happening?
5. What's the most important part of training for high jumpers? What does an average day look like?
6. What is the role that training shoes for high jumpers during workouts?
7. How can training shoes or features of a training shoe enhance training for high jumpers?
8. What do high jumpers do to recover after workouts and competitions?
9. If you were to design a trainer, a spike and a recovery shoe specifically for you, what would the key features be in each one?

Questions for the athletic trainer:

1. What injuries or pains do high jumpers come in with the most for treatment? Explain why this is and possible ways to prevent this.
2. How do you treat these injuries or pains? Also, explain taping techniques for these injuries, specifically ankle taping.
3. Do you think the current training shoes given to high jumpers are optimal for their training (plyometrics and sprint intervals)? Could there be improvements? What improvements would you make?
4. How does air travel affect the muscles of athletes the night or morning after the competition?
5. What are the ways to increase blood flow to parts of the body?
6. What are features in a shoe that could help athletes post-workout and post-competition to recover faster?
7. Certain solutions proposed by athletes and sports scientists have been to look into a high top silhouette for ankle stability and a lateral to medial sole gradation for stabilizing the foot on take off. What are your thoughts on these solutions?
8. If you were to design a trainer, a spike and a recovery shoe specifically for you, what would the key features be in each one?

Questions for Daniel Schuster and Eric Holmes:

1. What are the benefits of a zero drop shoe compared to an average offset shoe?
2. Should there be energy-returning properties in a shoe using a carbon fiber plate? Or does that defeat the purpose of a training shoe?
3. What are the benefits and drawbacks to a lateral to medial sole incline?
4. How would you tackle the distortion of the high jump spike on take-off? What do you think is the major problem?
5. What are your thoughts on an insole with a heel to toe incline to help stretch the calf muscles?
6. Have you done anything in either footwear or apparel that helps increase blood flow to areas of the body?
7. Any recommendations on either the trainer, spike or recovery shoe?

Questions for Brad Wilkins:

1. How does air travel affect the muscles of athletes the night or morning after the competition?
2. What are the ways to increase blood flow to the parts of the body?
3. What are the things I should know about compression? Does it really work and how can I make it work the best for my problem?
4. If you were to design a trainer, a spike and a recovery shoe specifically for you, what would the key features be in each one?
5. Here are other proposed solutions to some of the shoes, what are your thoughts?

What I Learned

I'll be breaking down what I learned into the 3 methods of research I mentioned above, footwear performance, foot data, and athlete research. As explained above I used a high-speed camera and iPhone to capture the take-off step to better observe the function of the shoes. I not only looked at the competition aspect of high jump but also recorded and observed the training and warm-ups the athletes did.

Starting with the athlete's warm-ups, they would go for a slow jog and then get into dynamic stretching. This would consist of a lot of continuous forefoot landing and pushing off. Skips, high knees, lateral shuffles, and more were all apart of the warm-up. Moving towards training which consists of plyometrics and sprint intervals, there was also a lot of forefoot landing and pushing off. Athletes used their forefoot to push forward in order to gain speed to sprint and would continue to land and push off from their midfoot/ forefoot. Heel striking would come into play when they would slow down or walk. Athletes during plyometrics would use their forefoot to push off the ground to jump but heel striking would come more into play when landing or when gathering momentum from running to jumping. Some athletes showed me the

bottom of their trainers to explain that the rubber wears down on the shoes really fast due to the amount of usage of the forefoot of the shoe.

Image of the wear pattern on the bottom of the training shoes:



Images of landing mechanics of shoes during sprint intervals and plyometrics:



For the observation of the high jump spikes, I set up my camera as close to the landing pit as possible to get enough of a detailed recording. From the beginning of the approach, the high jumpers would rock back and forth just before they push forward. Once they do, they are all on their forefoot. The first 5 to 6 steps are straight so the spikes seem to be working as functioned. Once the athletes start turning, the upper on the right foot will start to shift laterally because of the mediolateral forces. The curve takes about another 5 to 6 steps, but they are all shorter than the first 5 to 6 straight steps. The slow-motion video reveals that when the athlete plants on take-off, the foot rotates inward putting extra strain on the medial side of the foot, ankle and sometimes the knee. This inward rotation happens every time but some are more extreme than others. The more extreme rotations can cause distortion in the spikes which makes them nonoptimal to jump off. Taking a closer look at the take-off step, the spikes seem to twist, leaving the foot and ankle unsupported.

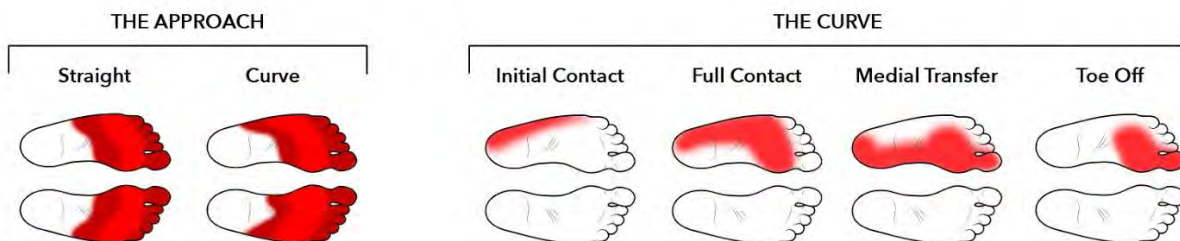
Images of inward rotation of the spike that causes distortion:



The next research method is to gather data on the foot, specifically pressure that the foot engages in when performing. Getting this data would be easier and more accurate with a pressure insole that could display the data into a pressure map, but I didn't have one. I resorted to how the high jumpers perceived the pressure and had them draw it out on a high jump approach template I made. After multiple athletes explained to me where they felt pressure on each step and drew it out, I put together an accumulated version. I broke up the approach into 2 parts, the straight away and the curve. The pressure maps for the straight away consisted of forefoot only contact since the athletes were running straight. The curve also consisted of forefoot pressure but with more variation between medial and lateral pressures. On the left foot, there was more medial pressure on the foot and on the right foot, there was more lateral pressure on the foot.

I broke up the take-off phase into 4 parts, the initial contact, full contact, medial transfer and toe-off. The initial contact is when the athlete first makes contact with the ground. The lateral heel is the first thing to strike the ground and has some of the highest pressure according to the high jumpers. The full-contact phase is when the foot has made full contact with the ground, creating a lot of pressure and force on the foot. The medial transfer phase is when force is transferring to the medial side of the foot, which can cause severe strain to the foot and ankle. The last phase which is the toe-off is the last push-off the athlete gets before taking off. The force by this point has mostly transferred to the medial MTP joints and toes.

Pressure map sequences of the approach and take-off foot:

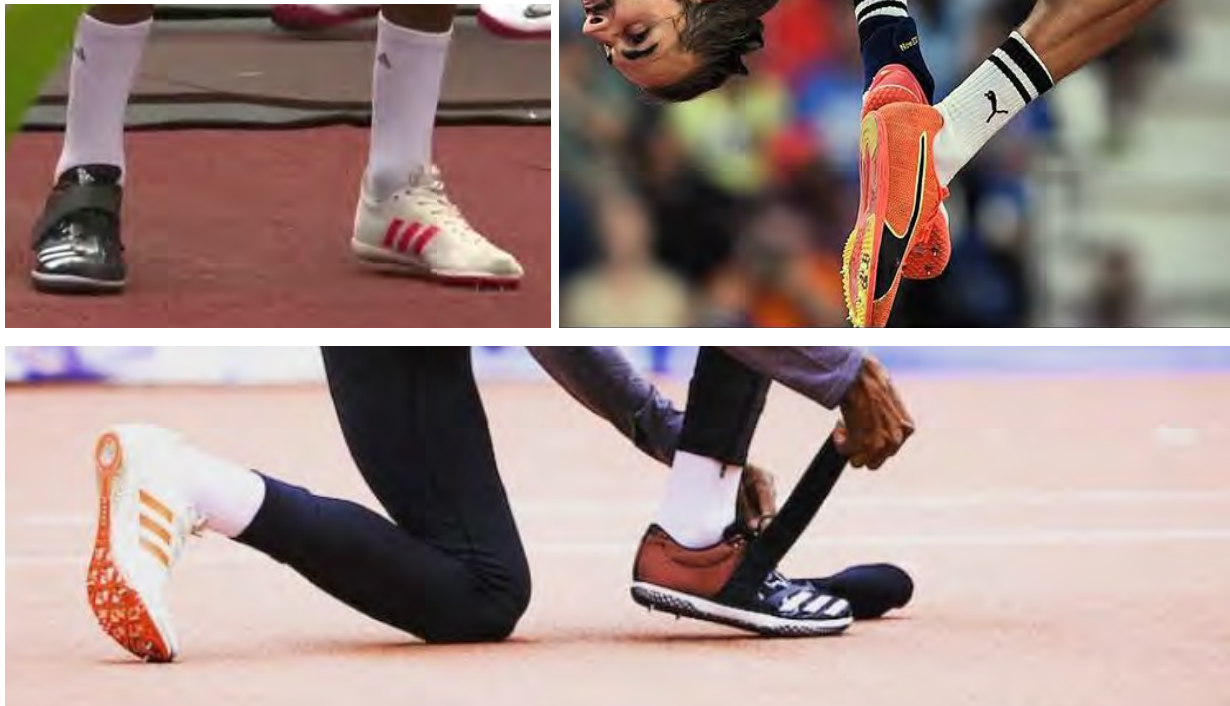


The last method was athlete research which gave me a lot of good insight. I talked to athletes both in-person and online to get feedback on questions. The first athlete that I talked to was Ben Milligan, some of his feedback was he likes the new plate on the Nike spikes but likes the rounded sole of the Adidas spikes. The next athletes I talked to were at the University of Minnesota. The high jumpers told me about their injuries and pains that affect them on a daily basis. These were shin splints, ankle pains, Achilles soreness and heel bruising which multiple athletes have felt before.

For their trainer, the athletes liked features such as lightweight, breathability, and comfortable. They disliked features such as forefoot cushioning, upper stability, and outsole durability. For their spikes, they liked features such as lightweight, heel support, and the plate. They disliked features such as ankle support, durability, and sharp edges on the plate. For the recovery, none of the athletes I talked to necessarily wore "recovery" shoes but rather old trainers, lifestyle/ casual shoes or sandals. When asked about their ideal recovery shoe, they noted that they would like them to have high cushioning, lightweight and comfortable.

Other notable remarks from the athletes were that some asked for a high top spike that could add support to their ankles on their take-off step. One of the athletes who asked has had ankle injury problems and thought that having a high top spike would help. Some athletes also noted that they really liked the older models of spikes because of the outsole rubber wrap and the rounded edges of the sole. They said it felt better to land on the older spikes because of these features. I also asked about the athletes' travel and flight times to understand how much traveling they're doing and what that experience is like. Some of the athletes would have flights that are 12 hours away, this specific case was for a Worlds Championship meet in Doha, a very important meet. After flights, these athletes experience a lot of muscle tightness. Muscles and tendons in the feet and ankle were noted as being tight with also calf muscles. High jumpers are generally tall and lanky so their height can cause extra discomfort on planes due to small legroom. A lot of athletes also get heel or calcaneus bruising due to the harsh pounding during the initial contact phase of the take-off. One athlete sent me a picture of their spikes that showed that they have taken the back 4 spikes out of the heel because they feel like they slow him down. This asymmetrical spike preference is not rare but rather common in a lot of high jumper upon further research. Some high jumpers will wear completely different spikes during a competition to help them run faster and be more aggressive around the curve in the approach. High jumpers will wear high jump spikes on their jump foot and sprint spikes or mid-distance spikes on their non-jump foot. The sprint spikes will give them more of an aggressive grip and keep them on their toes while the other spikes give them more cushioning so there's not an imbalance between sole height.

Images of athletes wearing 2 different spikes:



Design Priorities and Design Briefs

The collection is called the TCR Jump Collection and the design priorities are to make footwear that helps elite male high jumpers train better, jump higher and recover faster. The design priorities for the training shoe will be focusing on creating a shoe suited towards forefoot action instead of the traditional heel to toe shoe. The spikes design priorities will be to focus on how to better support the foot and stabilize the spike on take-off. The recovery shoe will focus on the specific injuries that high jumpers get during training and competition while taking into consideration their travel.

Using strong and lightweight materials will be essential to creating this collection. Materials such as polyester, dyneema, and heat bonded TPU overlay will be used throughout the collection. A carbon fiber plate and a pebax plates will be used to give the shoes high-performance features for running faster and jumping higher. The recovery shoe will be focusing on injuries by using Celliant technology that helps encourage blood circulation. The Celliant technology will be printed onto the inside of the recovery upper. Colors used for the collection will be a hyper blue, volt orange, off-black, and silver sky. The colors were inspired by the karman line, the imaginary line separating the earths atmosphere and outer space.

Training Shoe Design Brief and Product Direction:



Goal

Design training shoes for elite male high jumpers that focuses on forefoot cushioning and responsiveness while keeping the shoe comfortable and lightweight

Features & Benefits

Upper reinforcements for increase foot stability

Propulsive properties for a more responsive feel

Midssole plate for optimal energy return

Low foot drop for an optimal foot position

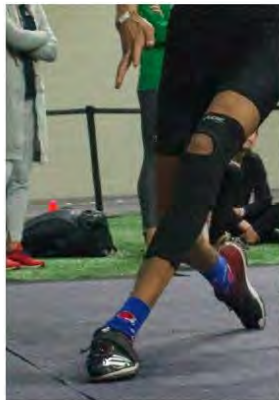


Polyester // Dyneema // TPU overlay
37.5 technology // Pebax foam
Graphene rubber // Carbon fiber plate

Engineered mesh upper
Injection molding for midssole
Vacuum form carbon fiber plate

Cooling Energy Palette
Sunrise Orange // Midnight Blue
Charcoal Black

Competition Spike Design Brief and Product Direction:



Goal

Design competition spikes for elite male high jumpers who jump off the left foot that increases propulsion on take off while locking down the foot and supporting the ankle

Features & Benefits

Insole configuration for increasing COM during take off

Midssole plate for optimal propulsive properties

Upper reinforcements on jump foot for foot lockdown

High top silhouette for ankle and foot stability



Polyester // Non woven // TPU overlay
Pebax foam and spike plate
37.5 Technology

Laser cut upper, heat press TPU
Injection molding for midssole
3D printed spike plate

Cooling Energy Palette
Sunrise Orange // Midnight Blue
Charcoal Black

Recovery Shoe Design Brief and Product Direction:



Goal

Design a recovery shoe for elite male high jumpers that aids in foot pains and injuries while being extremely comfortable, breathable and supportive

Features & Benefits

Upper technology to increase blood circulation to the feet

Sole incline to actively stretch calf muscles

Stimulating and cushioning sole to rejuvenate muscles and joints in the feet

Interchangeable insole for customizable fit and feel



Polyester knit upper // Elastane
Oofos Foam // Recycled rubber
37.5 Technology // Celliant

Industrial knitting machine
Injection molding for midssole
Heat press

Cooling Energy Palette
Sunrise Orange // Midnight Blue
Charcoal Black

Ideation Process

After research, I got into my ideation process. I started off by making a small chart for each shoe that helped organize the collection into different pieces of each shoe and how each piece can help improve the shoe. This helped me think about what pieces I wanted to focus on and what they could look like or how they can function.

Training Chart:

TRAINING	UPPER	COLLAR	INSOLE	MIDSOLE	PLATE	OUTSOLE
CUSHIONING	Heel counter & achilles cushioning and foam	Textured collar for a little extra padding	More dense foam in forefoot	Thin gel layer in forefoot Ergonomic design	Waved plate to allow cushioning but also return energy	Durable outsole to protect midsole cushioning
RESPONSIVE	Lightweight material Non intrusive design	Snug fit to keep heel in place	Energy returning foam	Energy return foam Firmer layer of foam	Optimized design and shape for forefoot push off	Graphene infused rubber for traction
DURABILITY	Forefoot reinforcements on both lateral and medial	Fabric with high strength	More dense foam in forefoot	High quality foam with a wall that covers the upper to protect upper from ripping	Carbon fiber plate	Graphene infused rubber for traction

Competition Chart:

COMPETITION	UPPER	COLLAR	INSOLE	MIDSOLE	PLATE	SPIKES
SUPPORT	High top ankle support with thicker / rigid materials	TPU support structure in lining to resist ankle eversion	Left foot medial wall cushioning	Slanted midsole to support foot on curve and take off	Slanted plate to encourage vertical force	Spike placement to allow better support
PROPULSION	Denser foam with energy return	Snug foam lining to keep foot in place	Denser foam with energy return	Energy return foam Firmer layer of foam	Optimized design and shape inspired by take off foot pressures	Graphene or nanotube spikes - really lightweight
LOCKDOWN	Left foot medial reinforcement Right foot lateral reinforcement Lightweight & non stretch around forefoot	Snug foam lining to keep foot in place	Curved insole to keep foot centered	Slanted midsole to keep foot on top of sole - better lockdown	Ergonomic shaped plate to help foot lay naturally	Spike placement to encourage foot to stay in place

Recovery Chart:

RECOVERY	UPPER	COLLAR	INSOLE	MIDSOLE	OUTSOLE
CIRCULATION	Compression upper to increase blood flow	Bioceramic infused lining	PR sole inspired bumps for stimulating the foot - ergonomic and interchangeable	Shaped to allow foot to lay in natural position	High traction to allow other parts of the shoe to work properly
COMFORT	Breathable and form fitting upper Knit/ Elastane	Soft and stretchy lining	High cushioning insole - interchangeable Ortholite foam	OOFOS cushioning for ultimate	Segmented outsole to allow midsole cushioning
SUPPORT	Midfoot support strap and high cushioning on heel	Foam in lining to have snug fit on heel	Cushioning insole to support foot in the best resting position	Structure midsole to support arches and natural foot position	Ultimate traction to keep foot where it's suppose to be

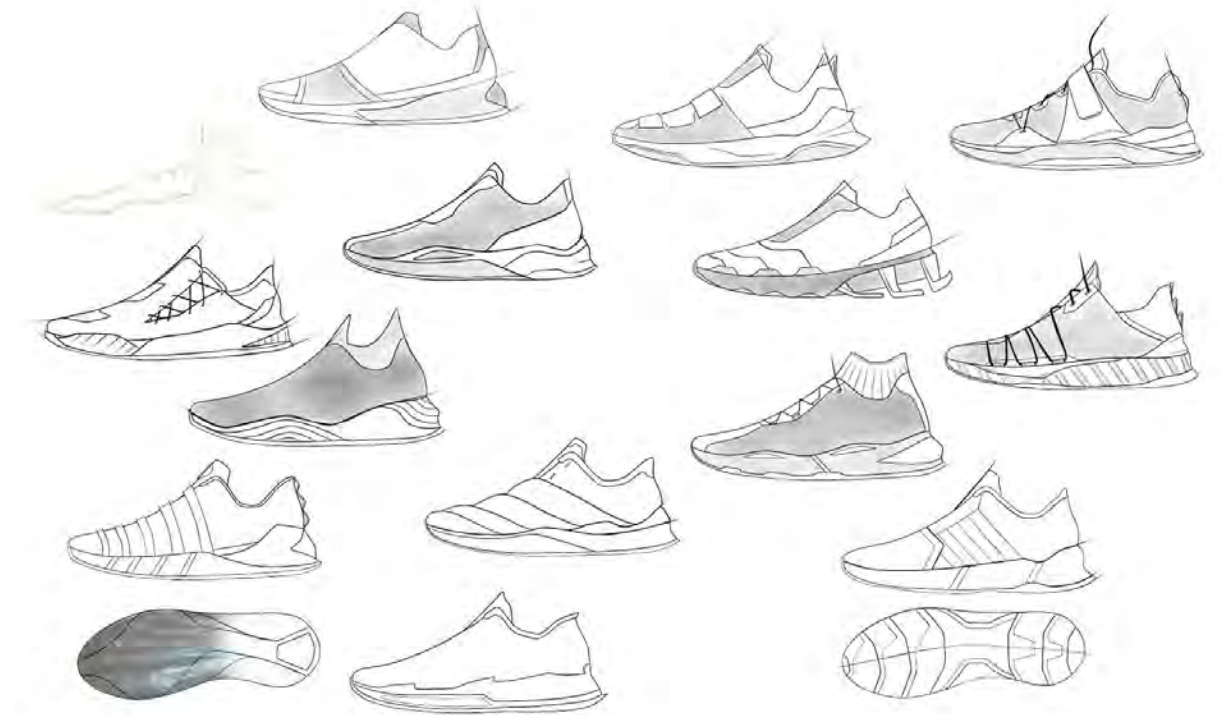
After gathering thoughts on the mindmap, I had a more clear direction moving forward. Then I began to gather images to help inspire each shoe and put them into a mood board.

Moodboards:



At this stage, I was ready to start sketching and ideating. I began sketching for the trainer and focused a lot of straps, ways of locking the foot down, and different midsole silhouettes. The straps would help the foot stay locked down and conform to the foot. This would help the slipping around of the MTP joints in the shoe when jumping and landing. I also looked at using tactical cables to hold the foot to the sole. The cables would run across the upper and could be tightened by the shoelaces. While looking at the midsole, I wanted to focus better technology for cushioning towards the forefoot and have lighter and cheaper technology at the heel. I also looked at different ways the cushioning would compress and how it could maximize energy return as much as possible.

Round 1 of Training Shoe Sketches:



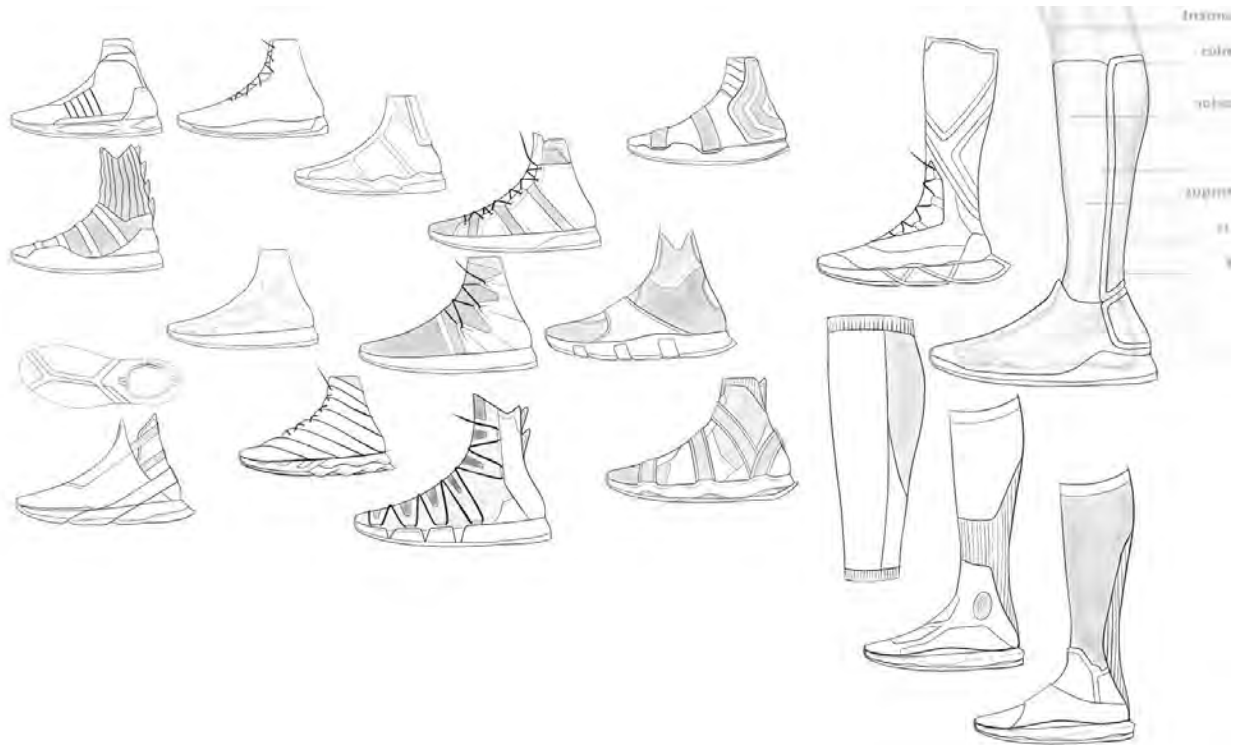
Next, I started sketching competition spikes and focused on a high top silhouette, ankle and medial stability, and plate technology. The high top silhouette would help wrap the ankle to give it some resistance from everting so much. The non-stretch fabric would also help keep the spike stay under the foot and not slide off. I also did a low cut spike for the non-jump foot so that it can be as mobile and fast as the athlete needs it to be. Similar to the trainers, I also looked at straps to help the foot stay locked down. Fabric overlays and TPU hotmelts were used to look at increased medial support. For the plate/ midsole technology, I was inspired by the Adidas Springblade shoe to use for the propulsion properties in the spikes. By using little blades to compress and expand when force is applied, the spike will be able to return energy in an upward direction. This would help the athlete jump higher to clear the bar. I also looked at segmenting the plate to allow bet foot movement and mechanics to reduce injury.

Round 1 of Competition Spikes Sketches:



Lastly, I started sketching the recovery shoe with a focus on fit, cushioning, and compression/ blood circulation. For fit, I used straps as a way to tackle this problem and since it's been used in my other shoes, this could be a unifying element. I wanted to use elastic banding to help mold around the foot and to keep the upper snug. I also want the upper to be compression which helps with blood flow. Since apart of the recovery shoes is looking at travel, compression will be a good choice for when feet swell up due to increased elevation. I also thought about how the foot is going to get into the shoe and easy ways of doing this. I added flaps with velcro around the ankle to allow easy access into the shoe because taking a long time to get a shoe will get annoying and the user won't wear it. I took inspiration from basic sandals since they are used a lot for post-workout and to wear comfortably. I used the dorsal flap that goes over the foot for some designs that gives the foot freedom but also keeps it in place. Lastly, the shoe eventually took on a new silhouette from a high top to a knee-high. This was to attend the calf muscles and the achilles tendon since according to athlete feedback, these areas get sore. The knee-high will be compression to alleviate the pains, tightness, and injuries.

Round 1 of Recovery Shoe Sketches:

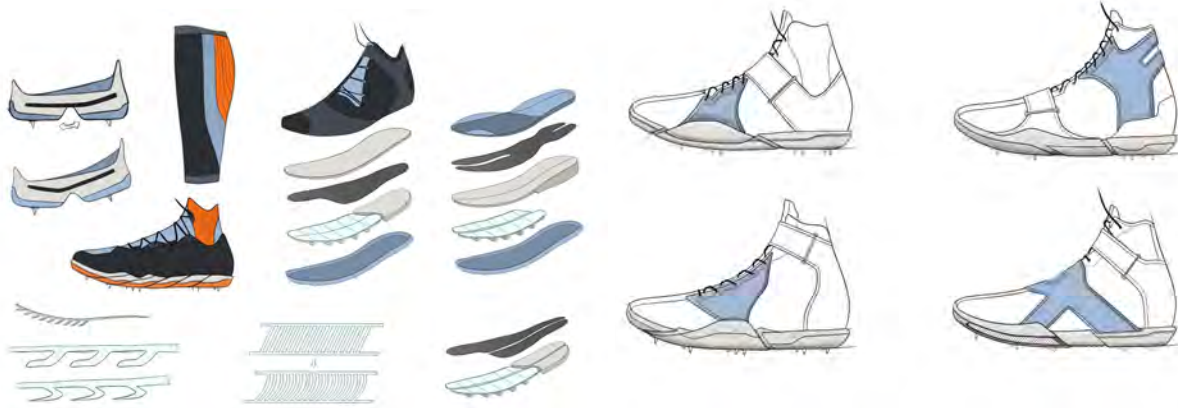


After feedback from initial sketches, I narrowed down ideas and certain looks to carry on. Strap systems carried on throughout the process in each shoe. I explored different shapes and forms of straps to see if any could be used for either one of the shoes. Segmented midsole developed to give the athlete flex grooves for movement and to also work as a design element with the upper. In the training shoe, I looked further into how to strap can wrap around the foot through the midsole to sandwich the foot. Sidewalls that extrude onto the upper to act as a reinforcement for the forefoot. The carbon fiber plate designs looked at looping the plate to provide a new innovative way to better improve the athletes' plyometrics and sprint intervals. The spike explored flexed grooves to guide energy to certain areas for propulsion and also looked at the bending of the plate to resist lateral medial distortion. Looking at exploded views of the sole to better understand how the plate and midsole technology work together helped me realize that the plates should be combined. Combining the plates makes the blade technology work better, makes it easier to model and creates fewer parts to make. The recovery shoe explored alternative options to the knee-high such as a calf sleeve but the designs eventually stuck with the knee-high design. A ribbing compression that follows the calf muscle and achilles tendon is a prominent design feature. The midsole is cut into 3 to offer natural foot mobility but also high cushioning.

The rest of ideation for the training shoe:



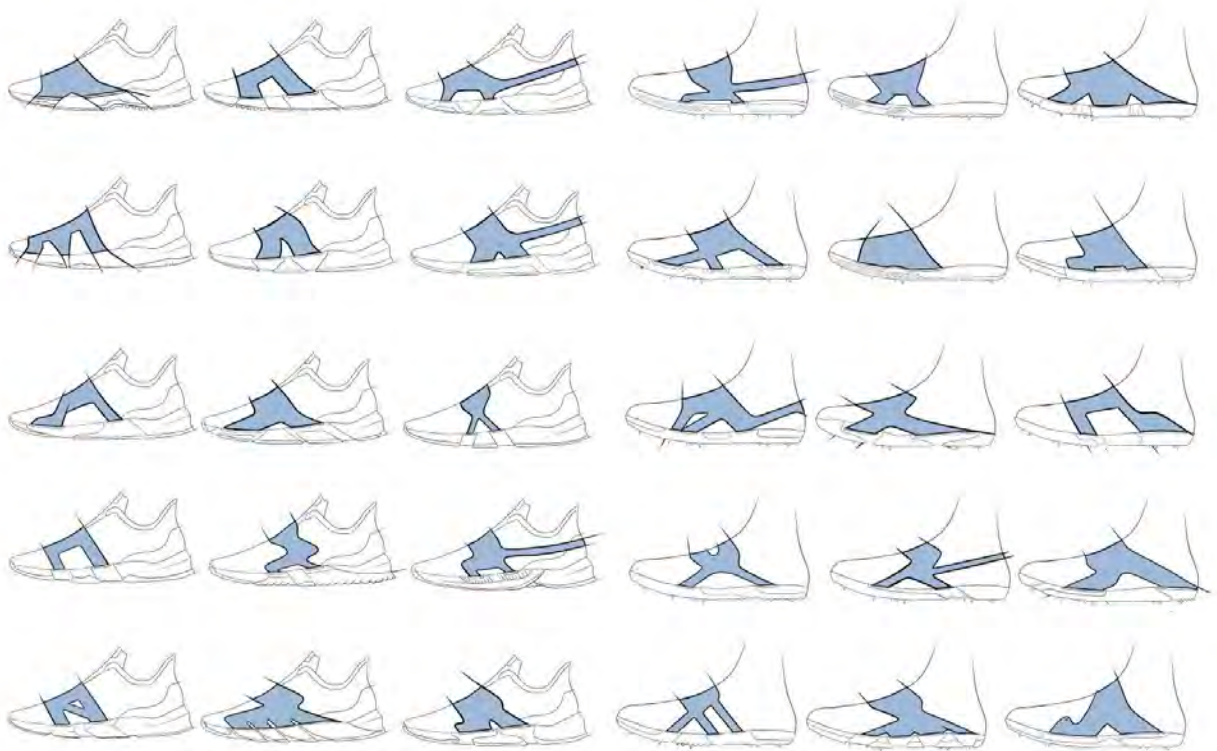
The rest of ideation for the competition spike:



The rest of ideation for the recovery shoe:



Exploration of strap form and shape:



Final direction for the TCR Jump Collection:



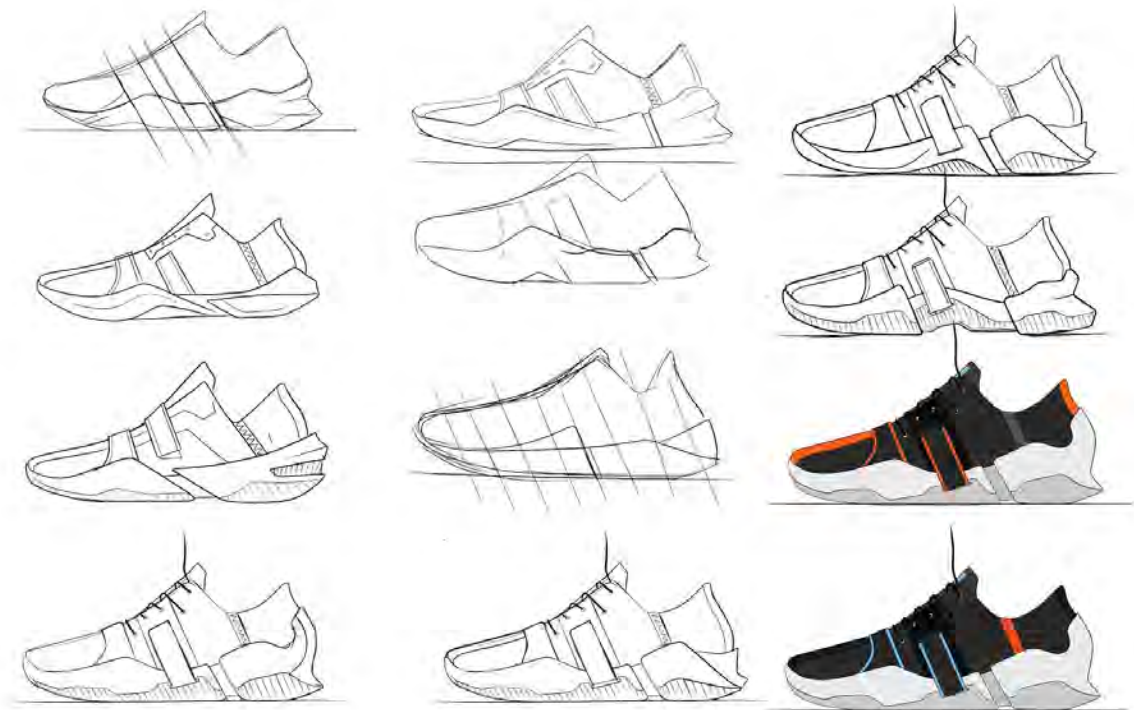
Major updates to the collection included a redesign of the trainer and minor tweaks to the competition spike and recovery boot. The updated concept direction of the trainer focused on

improved stability within the midsole, where I decided to eliminate the flex grooves and instead keep the forefoot as one integrated piece. By doing so, this increased forefoot surface area, which is important as the athlete's plyometric activities find them more on their toes than their heels. Additionally, this midfoot stability was supplemented by creating a midfoot lip around the medial and lateral MTP joints. This will better support the foot in the case of any inversion or eversion brought about by high impact exercises. Lastly, continuing off of the idea to improve stability, I integrated the heel counter into the midsole tooling. The purpose of this was to surround the heel with structured cushioning limiting shifting of the foot within the shoe.

When finalizing the concept direction for the spike prototype, I decided to simplify my plan of going about ankle support. Originally, I wanted to use a flexible 3D printed part to reinforce the ankle. When thinking about the comfort of the foot, I didn't want to cause any friction between the achilles tendon and the 3D printed part. The new concept instead brought support through material choices of the upper, which also helped decrease the weight of the spike. The material I chose to use was a heavy duty ripstop. This brought structure to the ankle without needing a rigid piece to do the same function.

The overall concept direction for the recovery boot remained nearly the same for this final iteration. The only change being the removal of an external heel cup. This was to improve comfort and reduce friction on the calcaneus, similar to the logic of the spike.

Updated trainer ideation:



Updated Final Concept:



Prototyping

Figuring out the final direction gave me the opportunity to start prototyping the shoes. I had previous upper patterns from another spike project I did, but I had to start from scratch for my training and recovery shoe. After taping the last and finalizing pattern pieces, I could start prototyping. I started with scrap materials with similar properties as what I imagined my final material to be. I also did material exploration with different textures and hot melt layering. This gives the material extra strength and leaves an interesting texture. I made about 10 different swatches that I could use for the upper of my shoes. I started with my trainer which I made from a basic mesh and I stitched an elastic strap to the strobel stitch. I played with TPU layering to help stabilize certain areas such as the toe box and heel. For the spike prototype, I used mesh and covered up the vamp stitch up the middle with bemis tape. I used the textured TPU layering for the medial side as reinforcements. I also stitched on elastic bands to the strobel stitching to act as the banding that wraps around the foot. For the recovery shoe, I started out by trying to make a last but ended up just using mannequins leg as a place holder. I used the trainer pattern pieces for the recovery shoe and then draped for the knee-high portion. I used mesh for the foot and a stretch woven paired with a polyester ribbing for the calf. For the over the foot strap, I took foam and heat pressed TPU hotmelt over it to capture the shape. I stitched the ends to the strobel stitching which helps conform and mold the foam strap around the foot.

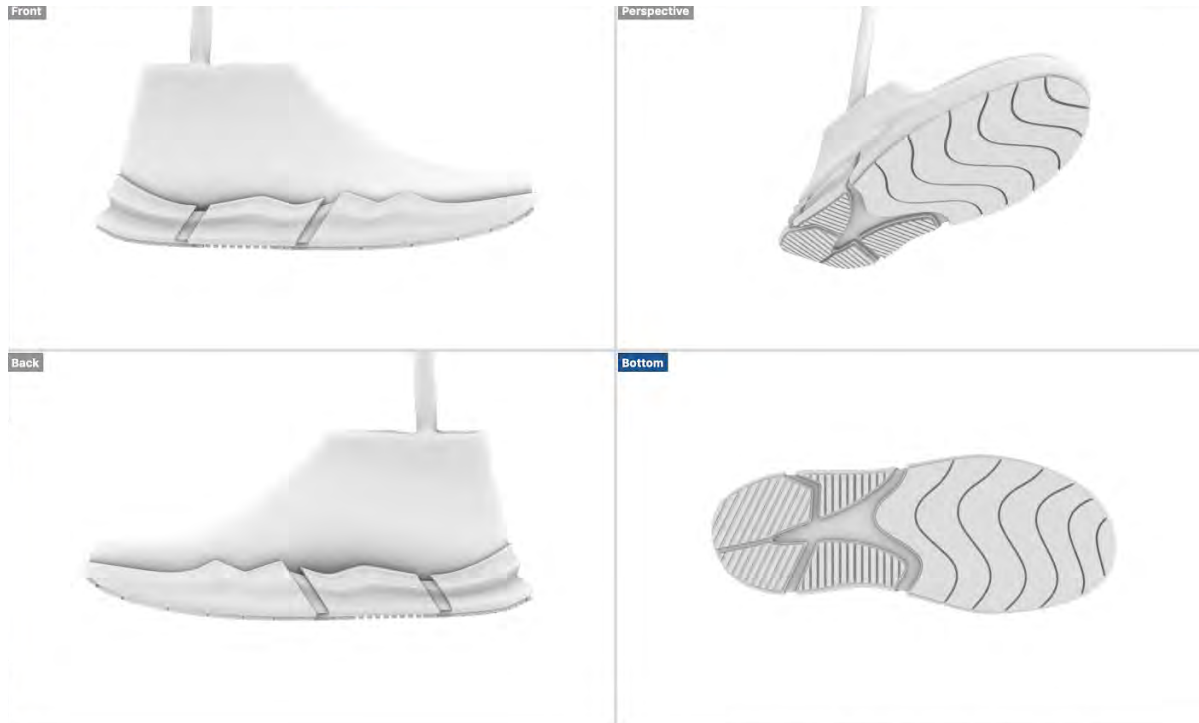
Images of the prototypes for the TCR Jump Collection:



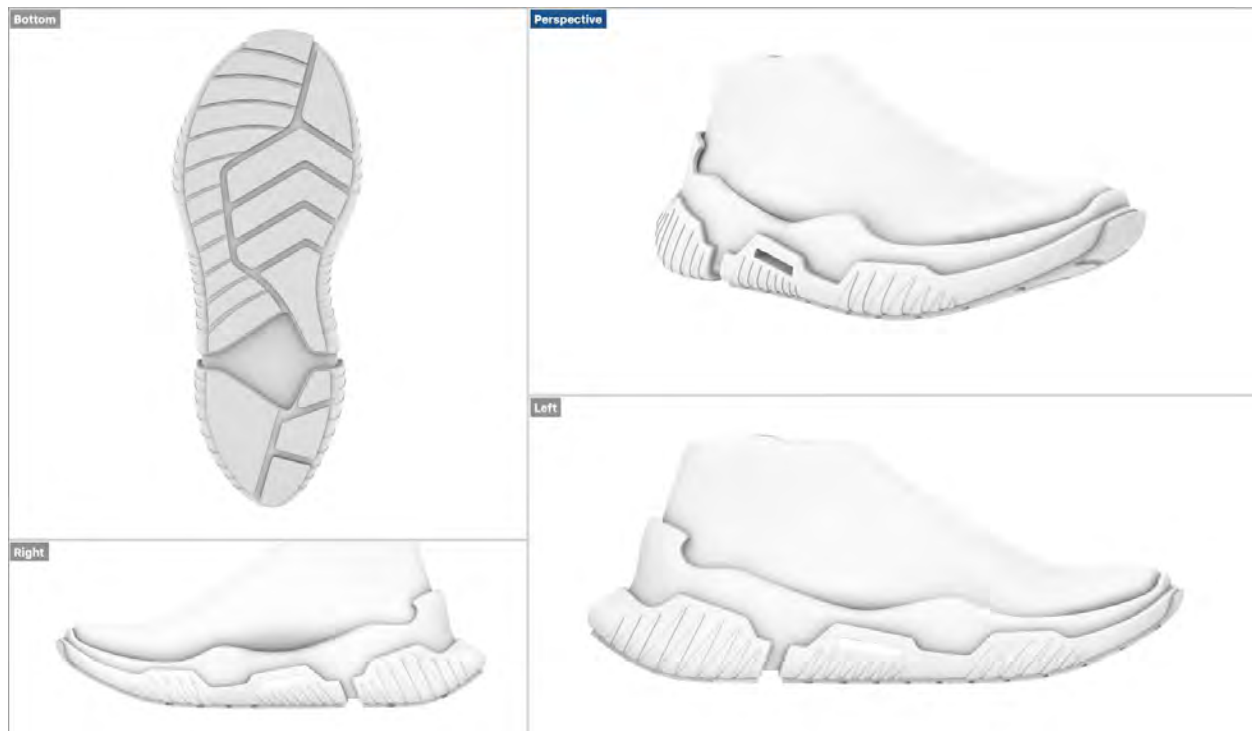
After creating the upper prototypes, next was to go into CAD, specifically Rhino software, to create the midsoles and plates. Throughout the collection, all the midsoles have a segmented look that portrays flexibility through the grooves while also following the design elements and principles of the upper. Each midsole utilizes this in different ways to ensure that the shoe is functioning to the best of its capabilities.

The trainer midsole is segmented into 3 segments, the heel, the midfoot and the forefoot. The heel segmented is made for the landing and grip. The crease line at the heel allows the midsole to bend slightly to allow better impact protection when landing. The midfoot segment acts as a stabilizing piece but allows for flexibility. The forefoot is the biggest segment because of how much use and force are applied to this section of the shoe. Having a bigger surface area allows more traction, more protection, and more stability while also still allowing flexibility. The sidewall of the forefoot segment extrudes up to help keep the foot from sliding. In regards to the traction, the key elements are lightweight, natural movement and grip. The traction is a graphene infused rubber and weighs the same as normal rubber, which is relatively heavy compared to other materials used in footwear. The heel and the midsole segment are designed to keep the shoe lighter by using slivers of the rubber instead of a continuous piece. The forefoot has thicker pieces of rubber to provide longevity of traction. The grooves are places to give the foot natural movement when bending the foot.

Images of the training midsole:



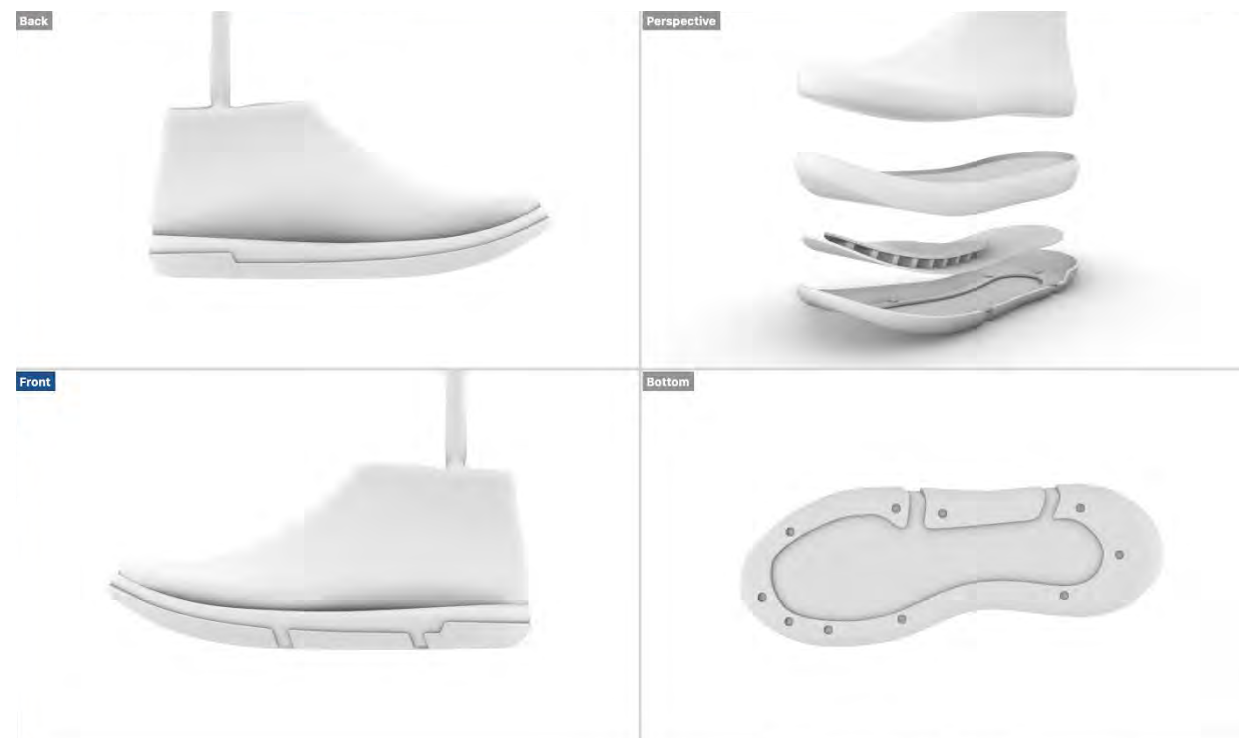
Updated training midsole:



The competition spike is split into a total of 2 segments, but visually still works within the collection because the heel wraps around to the forefoot to give it a 3 segmented look. The combination of the midsole and plate gives the spike better movement, cushioning and

propulsion. The segments or the outer wrap is made from high impact foam which acts as a better cushioning system to hit the ground first than a pebax plate. Athlete feedback showed that high jumpers liked the outer foam better but still like the propulsion and responsiveness of the plate. The outer foam allows the high jumper to plant their foot more comfortably compared to an outer plate. The foam outerwrap isn't segmented on the medial side because high jumpers roll over onto the medial side of the foot and want as much stability and cushioning during the phase. With the plate offset into the midsole, it's made to give high jumpers, even more, push off force than before. The added blades on the forefoot portion of the plate bends when enough force is applied and increase the amount of returned energy. Being made with pebax plastic is a big reason why the plate works, giving the plate high elasticity, rigidity and keeping it lightweight.

Images of the spike midsole and plate:



Updated spike midsole and plate:

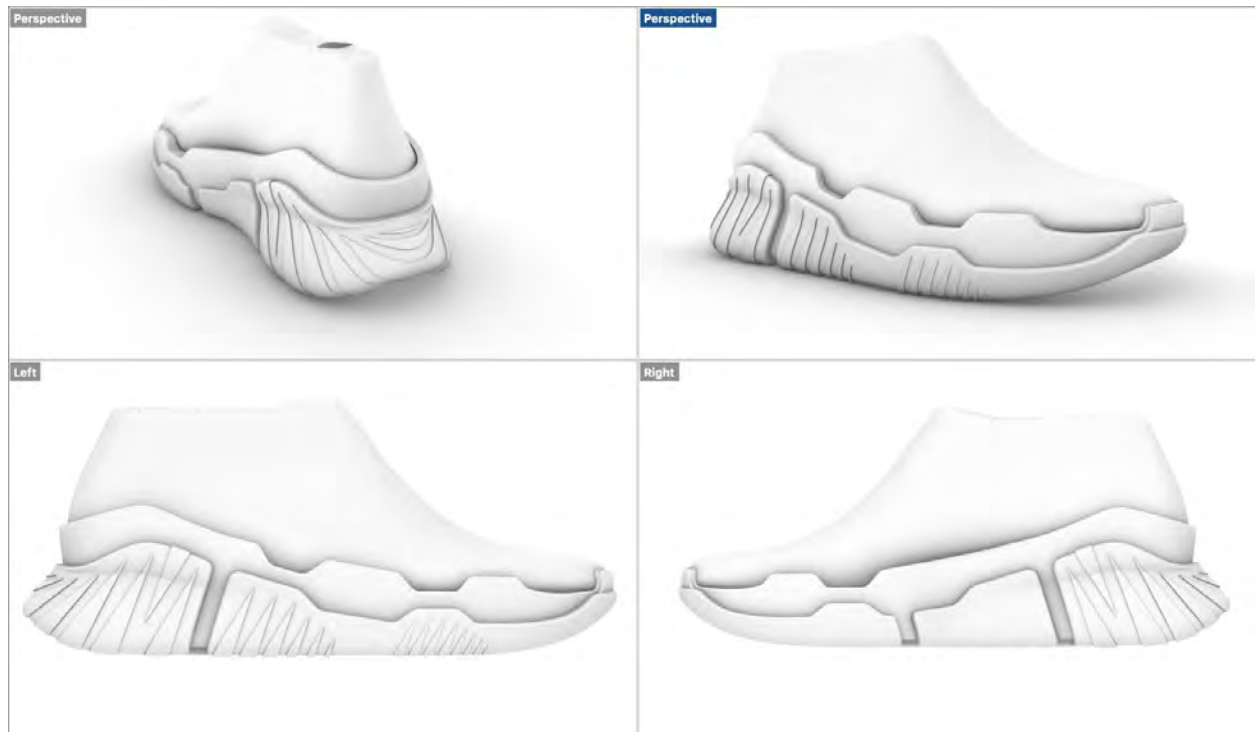


The recovery shoe has 2 segments on the lateral side and 3 segments on the medial side. The main purpose of the recovery shoe is to help relieve pains and aches in high jumpers after workouts and competitions. The recovery shoe is highlighted by its dual-density foam. The top layer is a softer and more cushioned foam to allow the foot to lay in a more natural and comfortable position. This layer helps for impact protection and slightly extrudes up to help stabilize the foot from moving too much. The bottom layer is a more classic footwear foam such as EVA that is used to help the top layer from moving too much and to help stabilize the shoe in general. This layer will also slightly add to the cushioning and impact protection properties of the midsole. This also gives the traction a solid surface to be placed to help it function better. The traction follows the grooves of the midsole lines help also represent the striking pattern of the foot.

Images of the recovery shoe midsole:



Updated Recovery midsole:



After finishing the 3D models of the midsole in Rhino, I printed them out so I could create a mold and cast them with foam. The process started with making a perimeter with foam core to

encapsulate the Smooth-On mold star 30 around the 3D printed midsole. After creating a 2 part mold and letting it dry for 6 hours, I was able to pour flexible polyurethane foam into the mold. This allowed me to create a functional midsole for my prototypes.

Pictures of the midsole process:



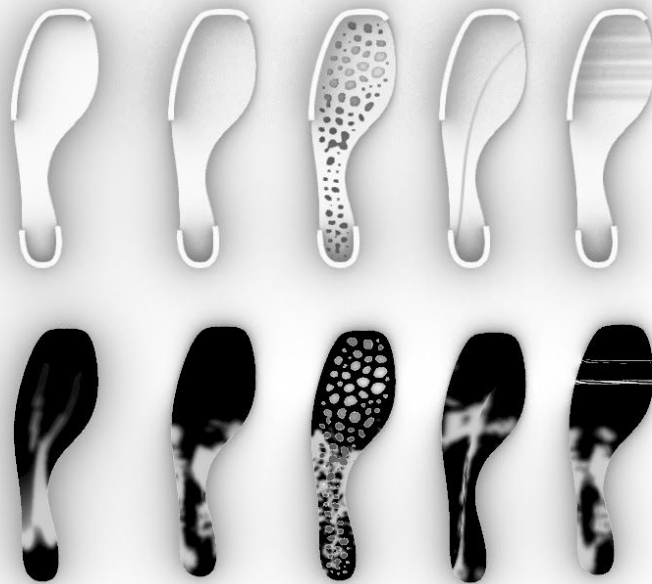
Validation Plan

The products must prove that the concepts work by giving validation in various ways. The training shoe must prove that the athlete feels more locked down compared to the other shoes they wear. This will be done by using common trainers used by athletes such as the Nike structures, Adidas solardrive, etc. and comparing them to my design. I will have 3 athletes partake in this test and have them walk around and do little jumps. I will ask them on a scale from 1 to 10 how stable their forefoot was when moving. The higher the score, the more secure the shoe is. Other features that are going to be tested are the lower drop sole and carbon fiber plate. The lower drop will be a perception test to see if they feel any difference between sole heights compared to the baseline and my design. I will have them walk around and do little jumps to get a better feel for the shoes. I will ask them what are the biggest differences between the shoes, is one more comfortable and can they feel the lower drop. The carbon fiber plate will be tested using the grasshopper plug-in, Millipede which can create stress on the plate to see where it is. This stress will indicate how much energy is being returned and where the energy is being guided. The more stress on the plate without breaking, the more efficient the plate is.

The competition spike will go through a similar testing process of having the same 3 athletes wear a common baseline spike and compare it to my design. My design must be able to make the athlete feel more locked down compared to the baseline which will be either the Nike Zoom HJ spikes or the Adidas HJ spikes. I will have the 3 athletes walk around and do little jumps and will ask them to rate each shoe on a scale from 1 to 10, 1 being absolutely no

lockdown and 10 being extreme lockdown. Other features being tested will be the slanted sole to see how the athlete feels walking straight and on a curve, and jumping around. The testing of this is to see if the slanted sole is uncomfortable, more uncomfortable or not noticeable. Perception feedback on the high top silhouette is also important because this is a feature asked for and is a new style. Lastly, the spike plate will be validated through the grasshopper plug-in, Millipede. The software will be able to map the stress on the plate to see generally how much of the plate is returning energy.

Example of results from the Millipede plug-in to show stress mapping; grey means there's stress and black means there's no stress:



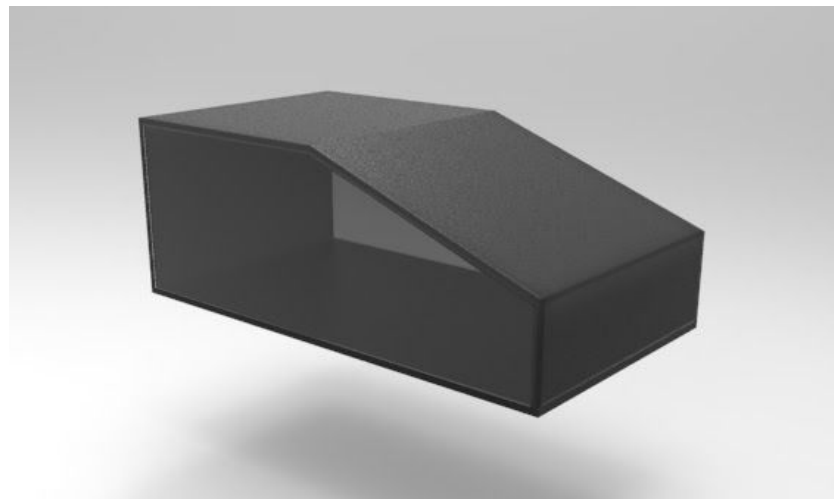
The validation plan for the recovery shoe will be a perception test to see how the athlete likes the cushioning, knee-high compression and any other small features. I'm currently talking to Celliant to see if I'm able to use some of their material for this shoe. With the coronavirus pandemic, communication is slow and getting the material might not work out. If I can get the material and use it for my recovery shoe, I would like to test it by either wearing it on a plane or giving it to someone to wear it while traveling. This would give me feedback on if the recovery shoe works in a traveling setting.

If I'm not able to get to athletes due to covid-19, I will set up a video conference with athletes back home from Minnesota to show them and ask them what they think of the collection. I'll go into detail about each shoe to best explain to them what they have to offer.

Packaging

I wanted to create a shoe box that resembled the lines and shapes in the collection. I also wanted to resemble the transparency of the spike plate with the packaging, because I want them to see the technology or see the shoe. When the box unrolls, it reveals graphics explaining each shoe and how it works. The sides are made with tinted transparent plastic while the rest of the box is made of cardboard. Having the box unroll reveals information about the shoe and collection that the athlete usually never receives or understands. It's important for the athlete to understand and trust in the product that they're wearing.

Example of packaging and trainer graphics on the inside of the box:



Spring Term Work Plan

Prototype Plan:

	Jobs To Be Done - Prototype
Week 1-2	Get midsoles printed so I can start to create a mold and cast them. I will have multiple parts to print including: spike plate, spike midsole, trainer midsole top and bottom, trainer carbon fiber mold, possibly the outsole. recovery midsole top and bottom. Continue perfecting the upper patterns with real materials. Bought from online and in-store (Mill End). Have working models for validation.
Week 3-4	Update shoes based on validation. Recut upper patterns, remake mold and cast if need to. Make double of everything to prep for presentation display.
Week 5-6	Should be finished with all the shoes. Finalized footwear complete. No more prototyping.
Week 7-8	Presentation
Week 9-10	Present

Validation Plan:

	Jobs To Be Done - Validation
Week 1-2	Prototypes prepped for validation
Week 3-4	Validate shoes with 3 athletes. Depending on virus, I would have to stay here and use athletes in the area or be able to go back to Minnesota. The athletes will go through a perception test to identify if they like everything. Also send CAD files of plates to Alex to test the stress map on them in the Millipede plug-in.
Week 5-6	Reach out to any of the other athletes online and send them pictures and updates on the project to get feedback. Once this step is done, you can update shoes.
Week 7-8	Presentation
Week 9-10	Present

Presentation:

	Jobs To Be Done - Presentation
Week 1-2	Prototypes
Week 3-4	Validation - Order presentations materials
Week 5-6	Validation/ Final Prototype - Start laying out packaging and prints for display, prep parts for exploded view
Week 7-8	Work fully on completing packaging, pamphlets and the exploded view. Have big prints for boards ready to print
Week 9-10	Finish up any loose ends and practice presentation.

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A high jumper is captured in mid-air, performing a Fosbury Flop over a bar. The athlete is wearing a green and blue uniform. The background shows a large stadium filled with spectators. In the foreground, there are banners for the IAAF Diamond League and AG Insurance. The scene is dimly lit, suggesting an evening or night event.

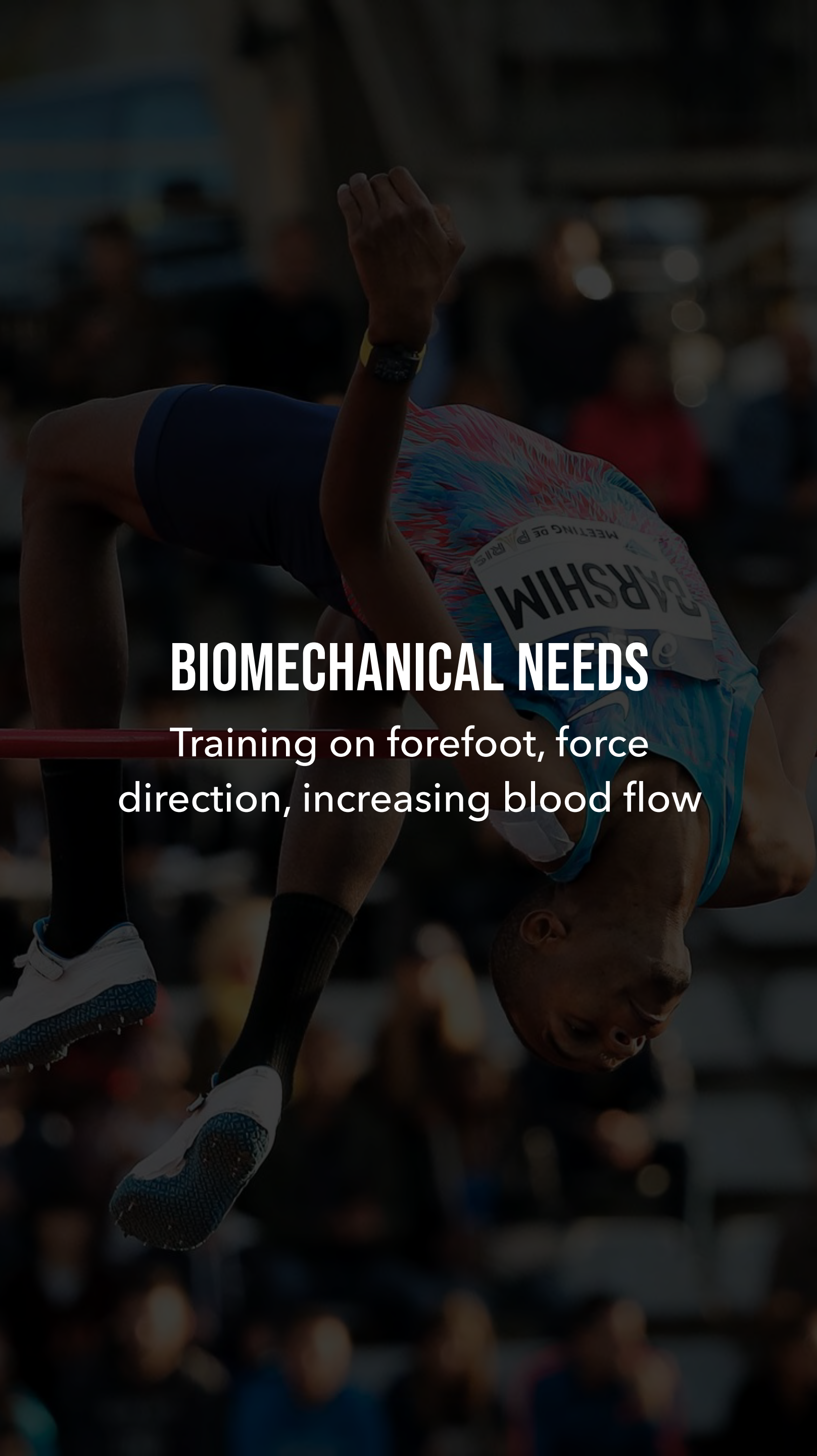
WINTER PROCESS 2019

NATE ROESE

A high jumper is captured in mid-air, performing a Fosbury Flop over a bar. The athlete is wearing a dark singlet and light-colored shorts. The background shows a large stadium filled with spectators under bright lights. The image is darkened to serve as a background for text.

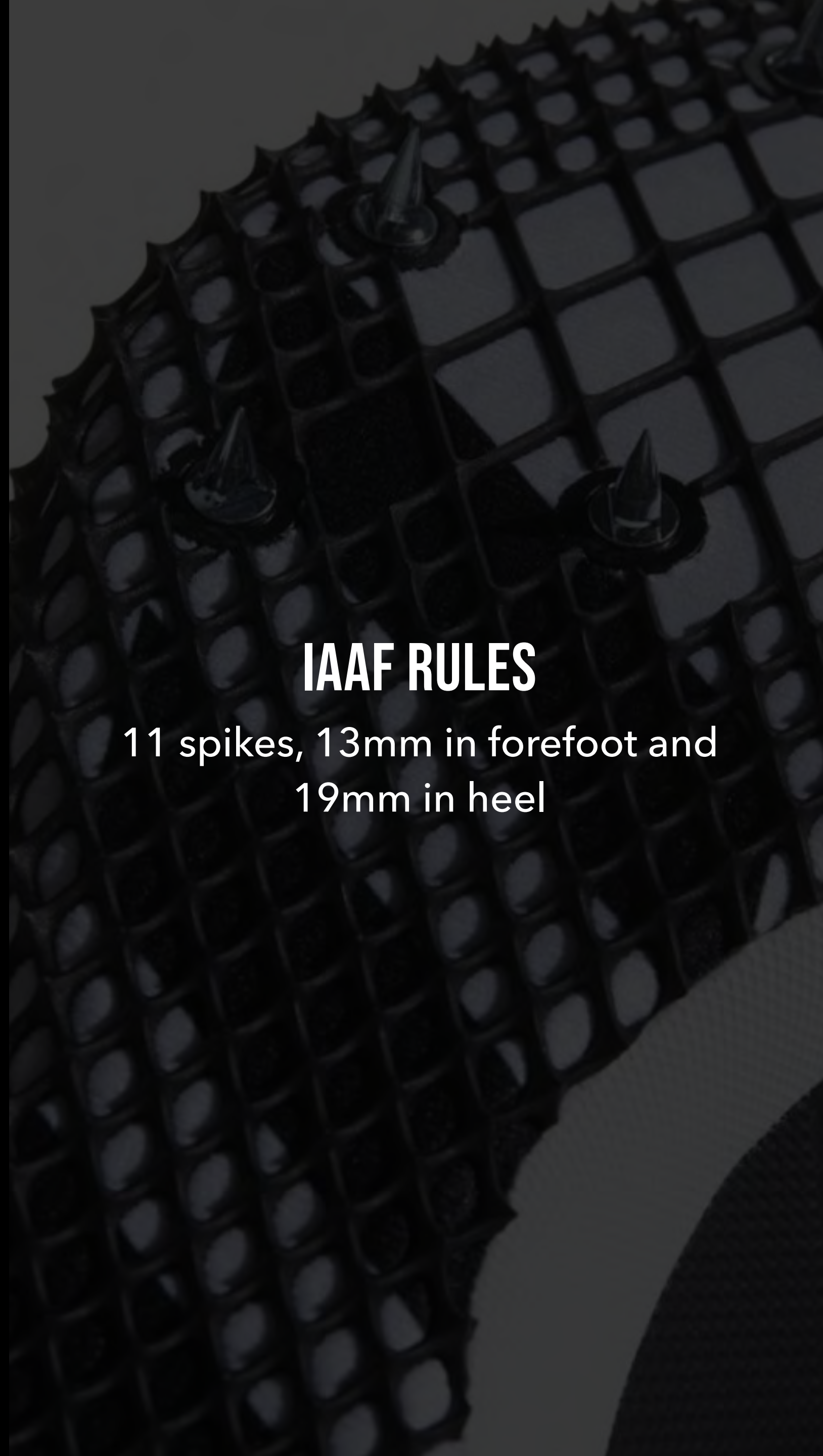
OVERVIEW

My capstone is a footwear collection that is tailored to the unique demands of elite high jumpers; from training, to competition through to recovery. This collection will better support the needs of the athlete in training, creating a shoe with improved stability and responsiveness at the forefoot, in competition, in the design of a spike with improved propulsive properties on push off, and recovery, with footwear designed to actively aid in foot strains and injuries.



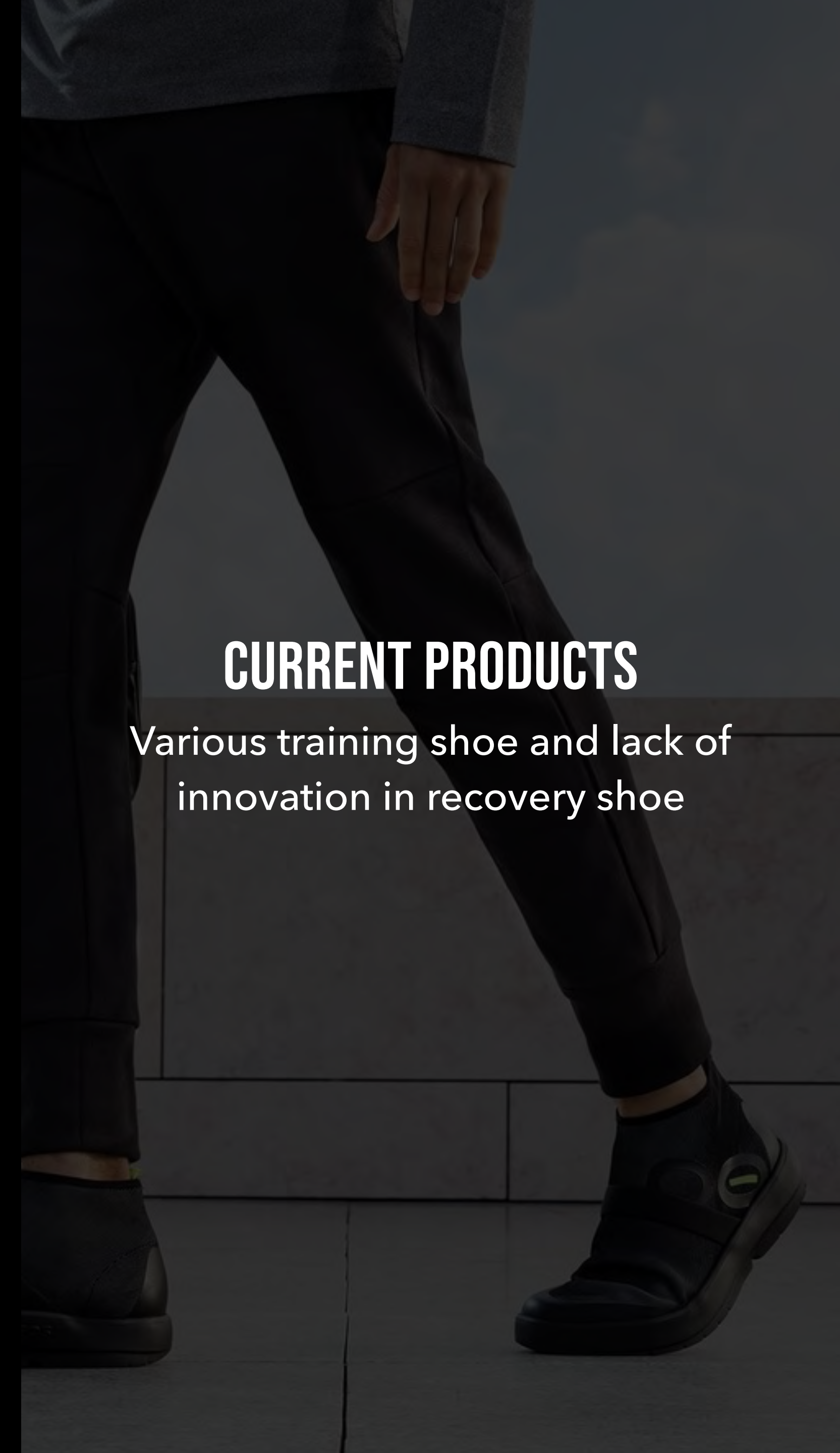
BIOMECHANICAL NEEDS

Training on forefoot, force direction, increasing blood flow



IAAF RULES

11 spikes, 13mm in forefoot and 19mm in heel



CURRENT PRODUCTS

Various training shoe and lack of innovation in recovery shoe



ATHLETE RESEARCH

Insights from coaches, trainers
and athletes



FOOTWEAR PERFORMANCE

See how well the footwear is
functioning during use



BIOMECHANICS RESEARCH

Specific footwear needs and
foot data

A person in a dark jacket and pants is performing a squat on a red running track. The background shows a grassy field and trees.

Q&A AND OBSERVATION

Watch warm ups, training, & recovery, and all the small details

A person wearing glasses and a headset is operating a professional video camera. The camera is pointed towards the left. In the background, there are other people and a green field.

SLOW MO VIDEO ANALYSIS

Capture video of the last step of the approach

A person is holding a white and black athletic shoe. Another person is standing next to them, looking at the shoe. The background shows an indoor setting with a white wall and a blue recycling bin.

BIOMECHANICS CONSULTING

Talk to sports biomechanists and get feedback on ideas

A photograph of two men walking on a track at dusk. The man on the left is wearing a yellow long-sleeved shirt and maroon pants. The man on the right is wearing a dark jacket and maroon shorts. They are walking away from the camera towards the left. The background shows stadium lights and bleachers under a dark sky.

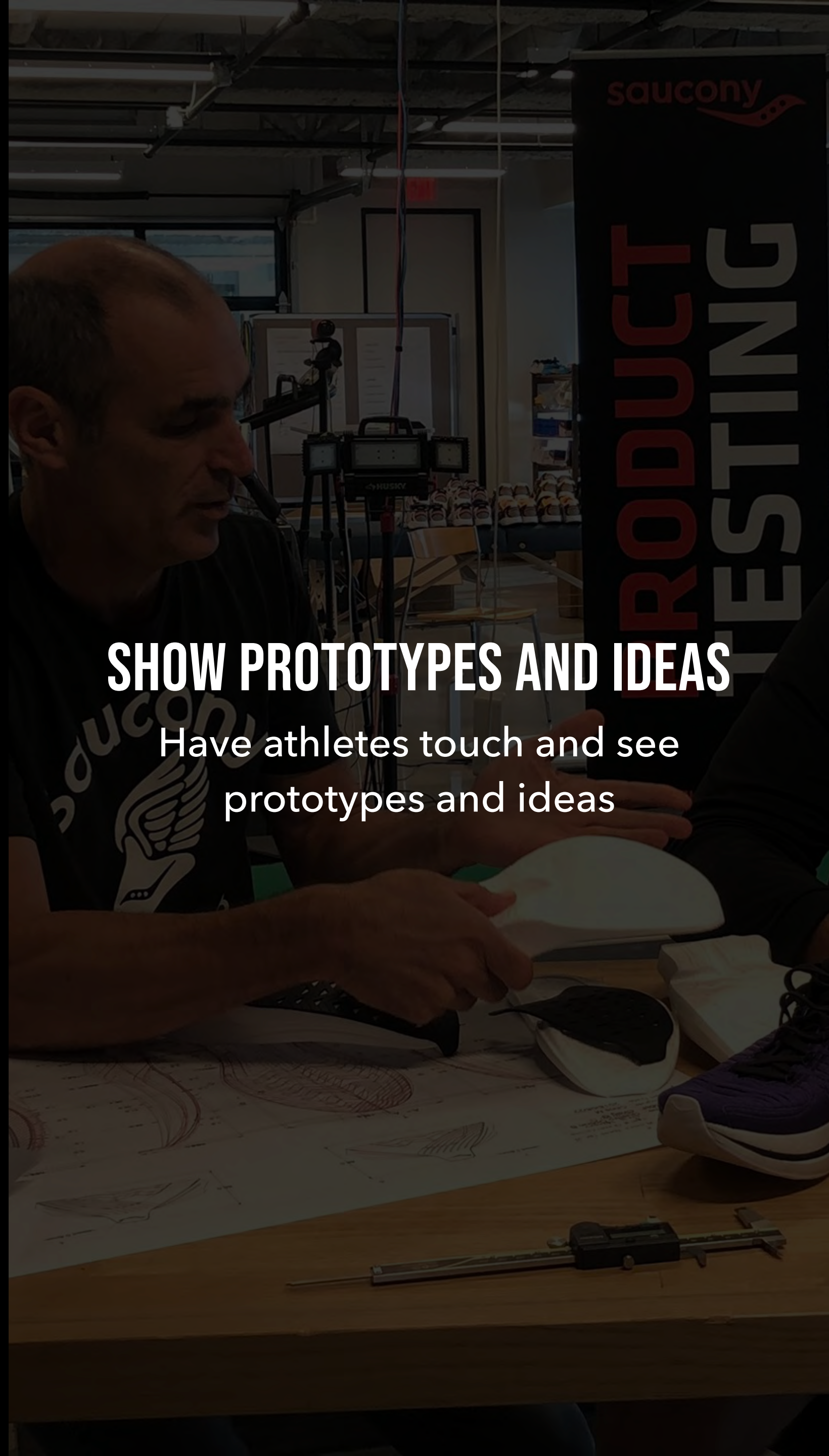
MEETING ATHLETES IN PERSON

Understand high jump better
and get more insightful info

A photograph of a high jumper in mid-air, performing a Fosbury Flop. The athlete is wearing a maroon singlet and shorts. The background is a blurred stadium with a red and blue structure.

RECORD ATHLETES JUMPING

Record my own data and get
live/ up to date footage

A photograph of a man sitting at a table in a workshop, working on shoe prototypes. He is wearing a dark t-shirt with the Saucony logo. On the table are several shoe prototypes, a pair of purple and white sneakers, and a caliper. In the background, there is a banner that says "saucony PRODUCT TESTING".

SHOW PROTOTYPES AND IDEAS

Have athletes touch and see
prototypes and ideas



MINNEAPOLIS, MN

1/29 - 2/2

Athlete insight and video footage of high jumpers at track meet. Meeting with high jump coach, trainers and 4 high jumpers



EUGENE, OR

Date pending

Meet with Mike Hahn, who works at the Bowerman SS Clinic, to discuss high jump biomechanics, footwear needs and ideas.



LUBBOCK, TX*

1/23 - 1/25 or 2/13 - 2/16

Considered one of the best high jump schools in the nation, retrieve coach and athlete insight and video footage of high jumpers.



ADIDAS FEEDBACK

Product Testing Managers:
Daniel Schuster and Eric Holmes

Offset: neutral vs. drop
Energy return in training shoes
Carbon fiber plate: restrictions on the foot
Mediolateral incline w/ side walls
Footwear references to look at
High top vs. low top
Effects of heel to toe incline
Blood flow & stimulation

The World's Fastest Man, Donovan Bailey, wears the adStar Sprint. See our complete new line of track & field spikes at www.adidas.com.



UW INDOOR PREVIEW

VIDEO ANALYSIS

A professional video camera, likely a Sony model, is mounted on a tripod. The camera is positioned on a green artificial turf field, with a dark, textured surface in the background. The camera's LCD screen is visible, showing a live feed of the scene.

ATHLETE INSIGHT

A high jumper in a green and yellow uniform is captured in mid-air, performing a jump over a bar. The athlete is wearing a green long-sleeved shirt and green pants with yellow accents. The background is a blurred crowd of spectators in a stadium.

SLOW MOTION VIDEO



TAKE OFF FOOT IMAGES



BEN MILLIGAN



PAINS, INJURIES, AND SORENESS:

ACL, LCL and meniscus tear (basketball). Strained soleus on jump leg. Shin splints on jump leg and some ankle pains. Most sore in the lower back. Hamstrings after training.

TRAINERS & SPIKES LIKES & DISLIKES:

Nike Pegasus 36: A little more cushioning in the forefoot. Wants it a little heavier and firmer cushioning so foot isn't moving so much. Likes that it is a dynamic shoe.

Nike Zoom HJ Elite Spikes: Upper feels stiff and not wide enough (flat feet). Slippage on take off phase, more secure feeling spike. Likes the flat outsole and is light. Favorite pair are the Adidas HJ spikes. rounded outsole is nice. Uses Nike Metcon for lifting.

TRAVEL & RECOVERY:

6-7 hour flight, whole day traveling wearing the same shoes. No extra soreness but just tired. Likes to wear Nike React for cushioning. Air max 95 and joyrides are also nice.

ATHLETE FEEDBACK

INJURIES

Shin splints
Achilles soreness
Ankle sprains
Heel bruising
Soleus soreness
Knee pain
Hamstring soreness

Reasons are from running tight turns, incorrect planting technique and competition in general

TRAINERS

Like:
Lightweight
Breathable
Durability
Comfortable

Dislike:
Forefoot cushioning
Upper stability
Fit
Bulky
Outsole durability

SPIKES

Like:
Lightweight
Heel support
Flat sole

Dislike:
Durability
Ankle Support
Cushioning
Outsole material
Dorsal/ Mid-foot Fit

RECOVERY

Flight Soreness:
Muscles in feet & ankle
Calf muscles
Knee & Hips

Ideal Shoe:
Cushioning
Lightweight
Comfortable
Breathable
Easy to get on

6-12 hour flight // whole day traveling wearing the same shoes

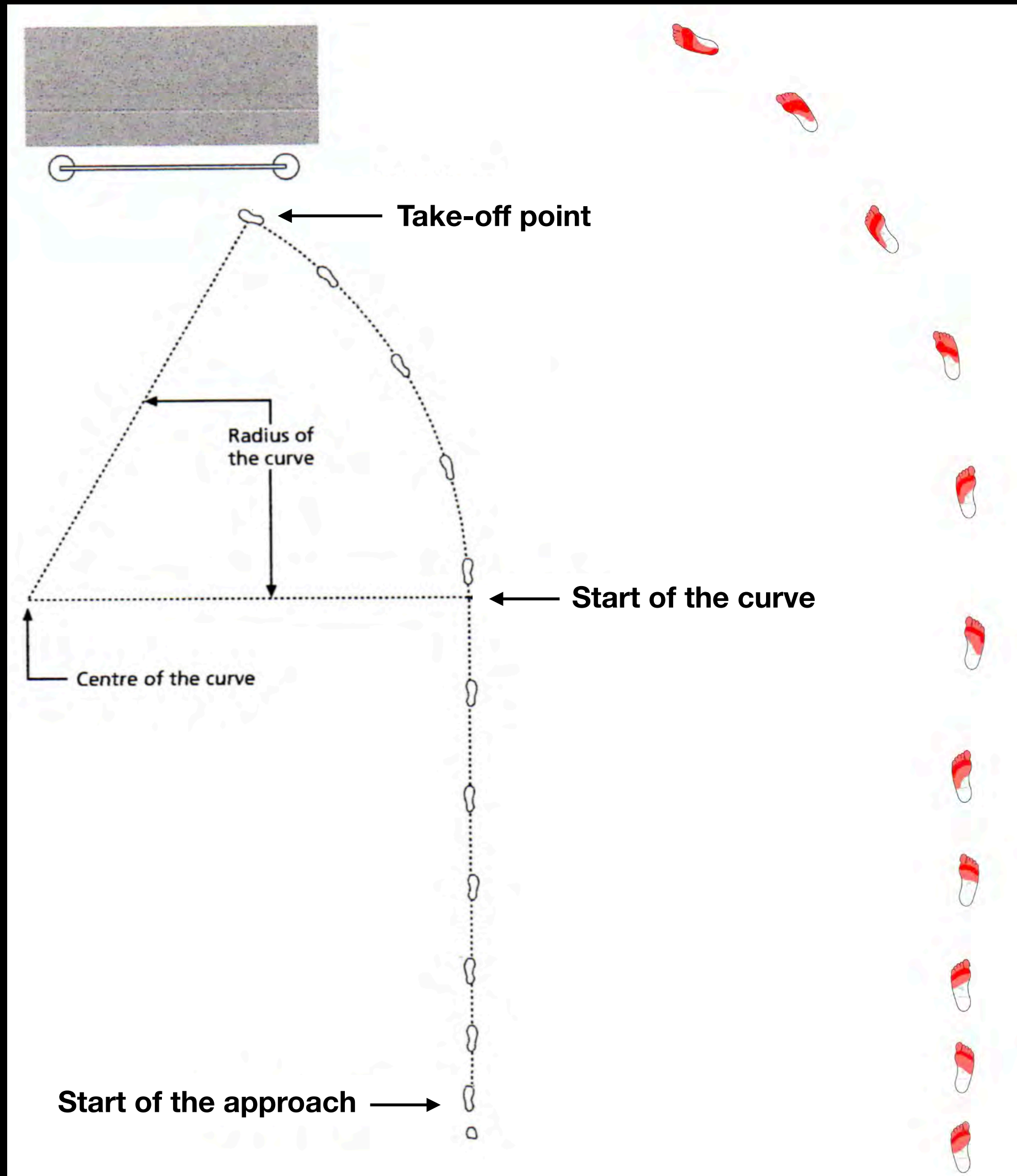
INSIGHT

The image displays five sequential screenshots from an iMessage thread. The participants are Shelby Dagreat (username: shelbydagreat_) and Kevin Schultz (username: thekevinschultz). The messages are as follows:

- Screenshot 1 (11:51 PM):** Shelby Dagreat lists:
 - 8. Legs being sore, just stiff at times so stretching is key after a long flight or just any flight
 - 9. Normally I cool off with no shoes
 - 10. Some key features I'd include because I want to have my own high jump spike one day eventually I'll make sure it's comfortably and protective for all high jumpers too where. I'll be sure to put the bottom pump back in on the bottom at a medium size bulk and and two straps for heel and ankle support and one across the top on the middle also a variety of colors to choose from and my own custom logo
- Screenshot 2 (11:51 PM):** Shelby Dagreat lists:
 - 5. Quads, Thighs, Hamis, Lower Back, Knee and Ankle at times same for training and competition
 - 6. Depends on the day a full training session and then weight room so normally last up to 2 hours depending how much we have on that particular day
 - 7. Doha, Qatar (14hr Flight)
 - 8. Legs being sore, just stiff at times so stretching is key after a long flight or just any flight
 - 9. Normally I cool off with no shoes
 - 10. Some key features I'd include because I want to have my own
- Screenshot 3 (11:51 PM):** Shelby Dagreat lists:
 - 1. Shoe Size 13 and my jump foot is my right leg
 - 2. I currently workout in the Nike peguses overall they are great I like them because they are comfortable they could make the back of them a little flatter
 - 3. I jump in those recent high jump nike shoes I like that they are light but I would prefer more support underneath the bottom like the old ones more bulky and thicker at the bottom
 - 4. Yes lower back pains, heel bruises, and shin pain I believe it came from planting foot wrong way or just hammering workouts down hard such as bounding which I don't do a lot of
 - 5. Quads, Thighs, Hamis, Lower
- Screenshot 4 (1:41 AM):** Kevin Schultz lists:
 - tulls, sprint workout in sprint spikes (300-500 meters worth), lift. An easy day can be as light as warmup and strides.
 - 7. Never left the States but been to both coasts for several meets, texas, Midwest.
 - 8. Personally no
 - 9. Either no shoes, casual wear, moccasins, or slides
 - 10. Training shoe:
 - a. Very lightweight, absorbs impact well (injury protection), looks cool
 - b. Spike: Very lightweight, NO HEEL SPIKES in the non-jump spike, back right of shoe insoles slightly lower rising at an incline plane toward big toe of jump foot. (slight)
 - c. Recovery: Comfy, protective
- Screenshot 5 (1:41 AM):** Kevin Schultz lists:
 - 1. Shoe size: 12, right foot
 - 2. Nike Pegasus 35s, I like the support they give for injury protection. I dislike how heavy they are and bulky. I prefer a lower cut, slimmer shoe but injury prevention is priority one.
 - 3. White nike zoom hj elite. I really like how lightweight they are, I like how they fit my foot, snug. No complaints.
 - 4. Have only had subtle injuries on the outside upper section of my foot. The pains were from running a fast tight curve and planting my foot parallel to the bar.
 - 5. Post jumping, I am usually sore from the top of my shins down if anything. They take a large number of the force
 - 6. Training on a large volume day would be, general warmup, 6-8 total jumps from hj drills or full sprint workout in sprint

The screenshots also show the iMessage interface with status bars at the top (AT&T, signal strength, Wi-Fi, battery, and time) and the bottom input area with a 'Message...' placeholder and icons for voice recording, photos, and emojis.

FOOT DATA RESEARCH



FOOT PRESSURE

THE APPROACH

TAKE OFF

Straight

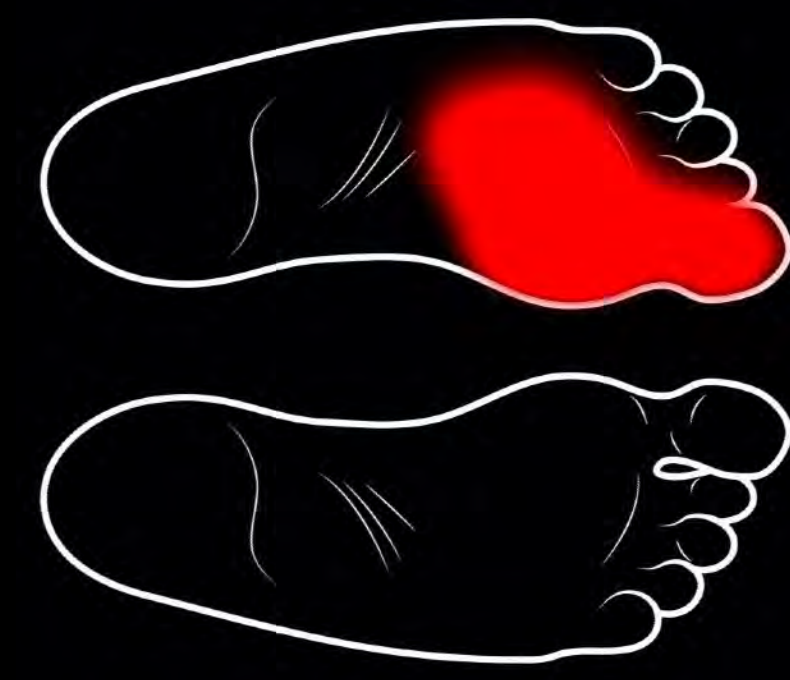
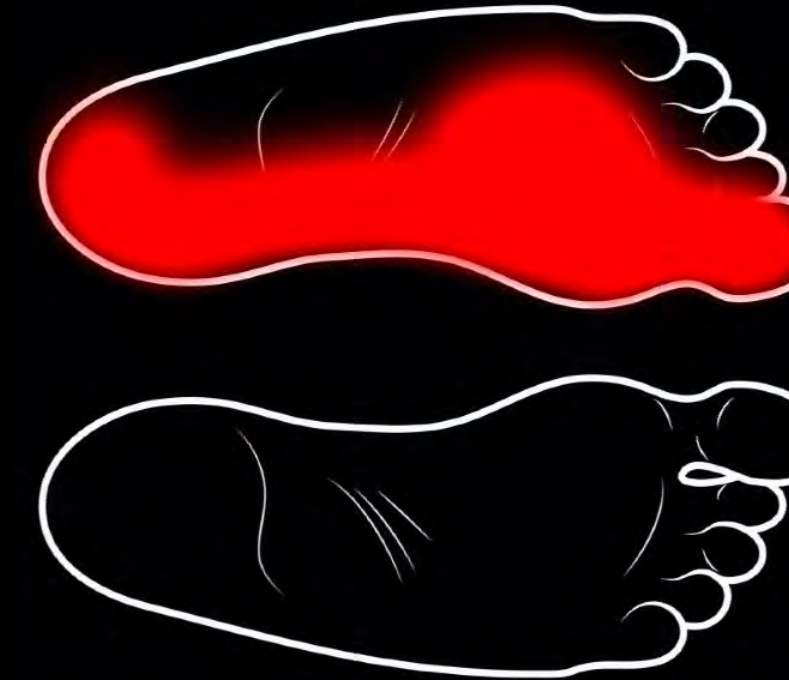
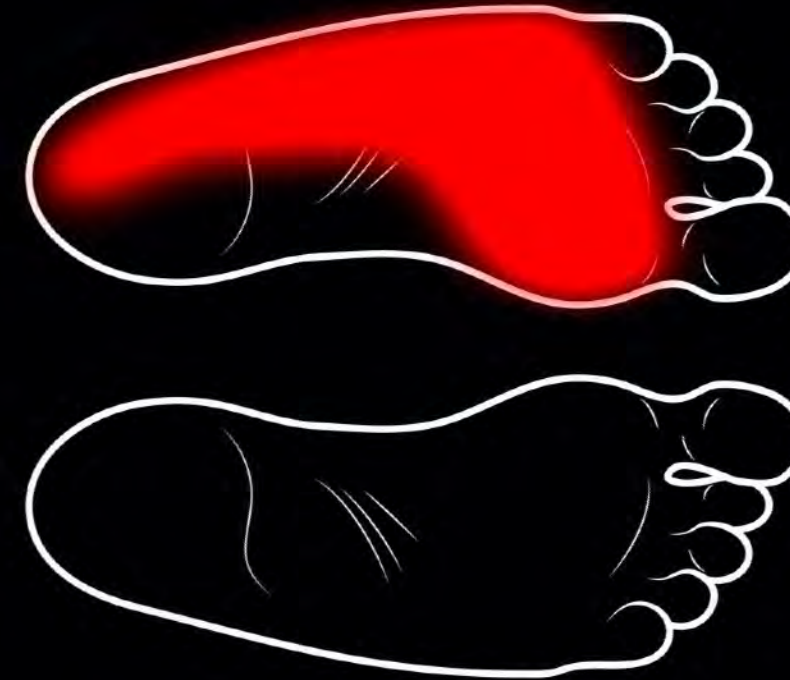
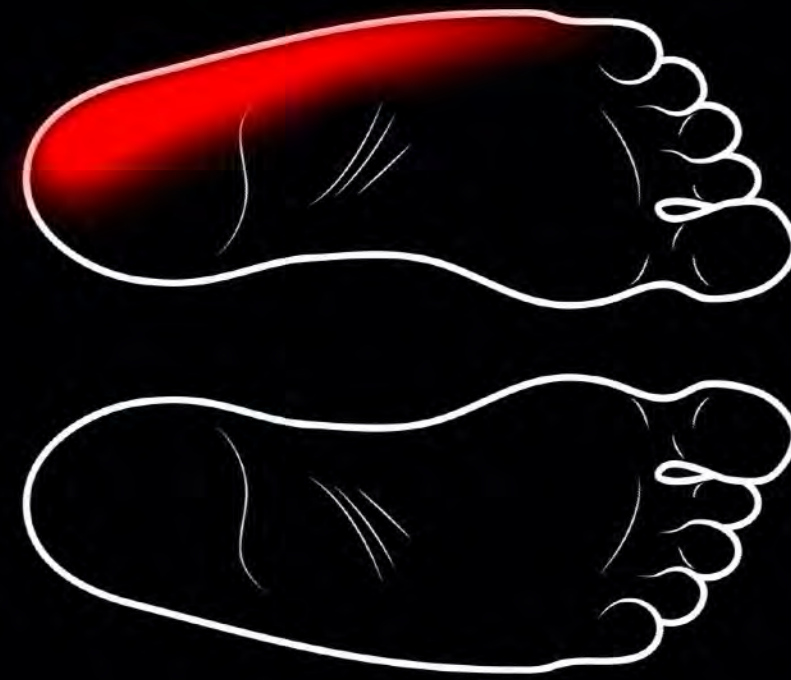
Curve

Initial Contact

Full Contact

Medial Transfer

Toe Off



FOOT SORENESS DATA

Left

Right

MTP & General
Forefoot Pain

Arch Pains



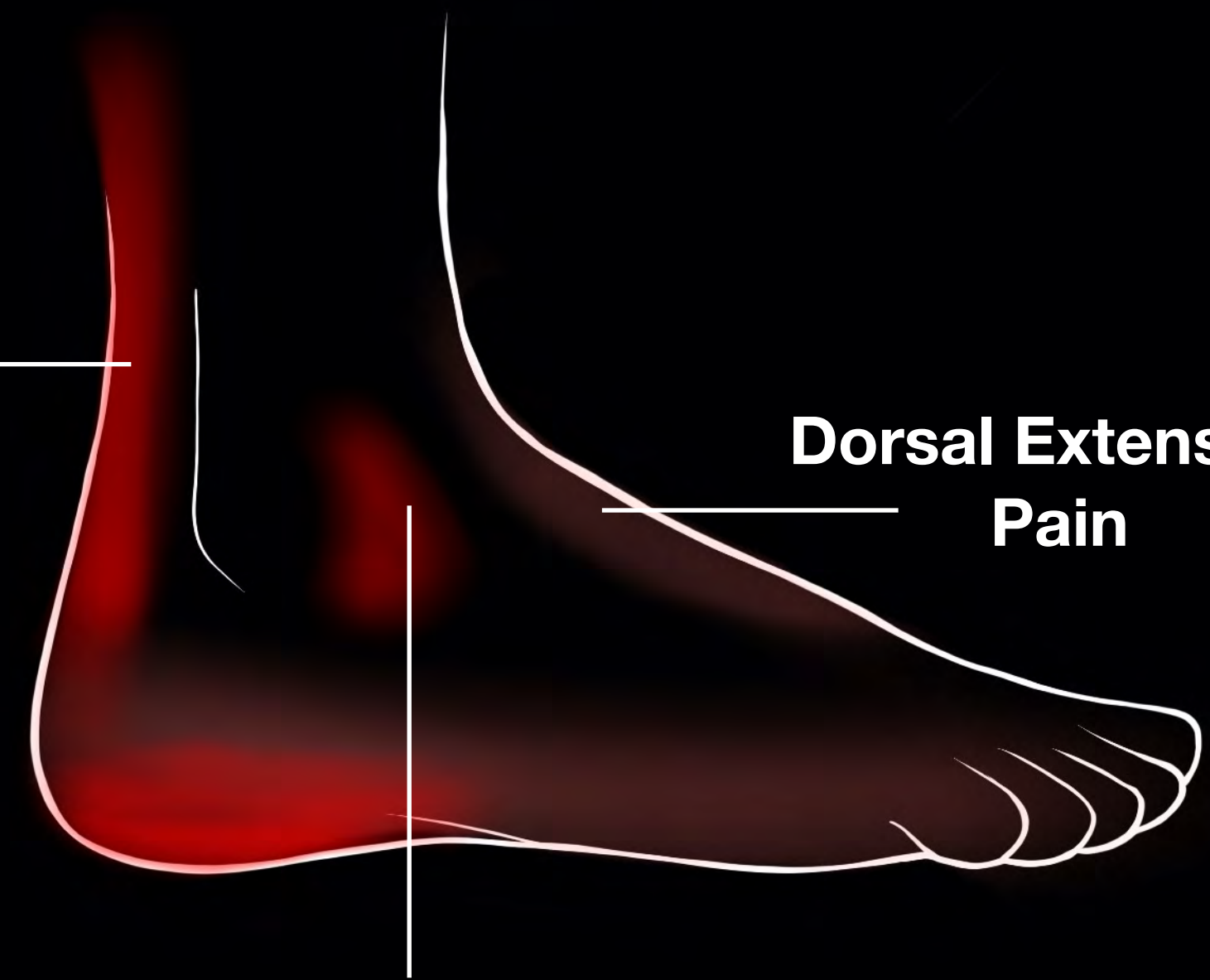
Calcaneus
Bruising

Jump Foot

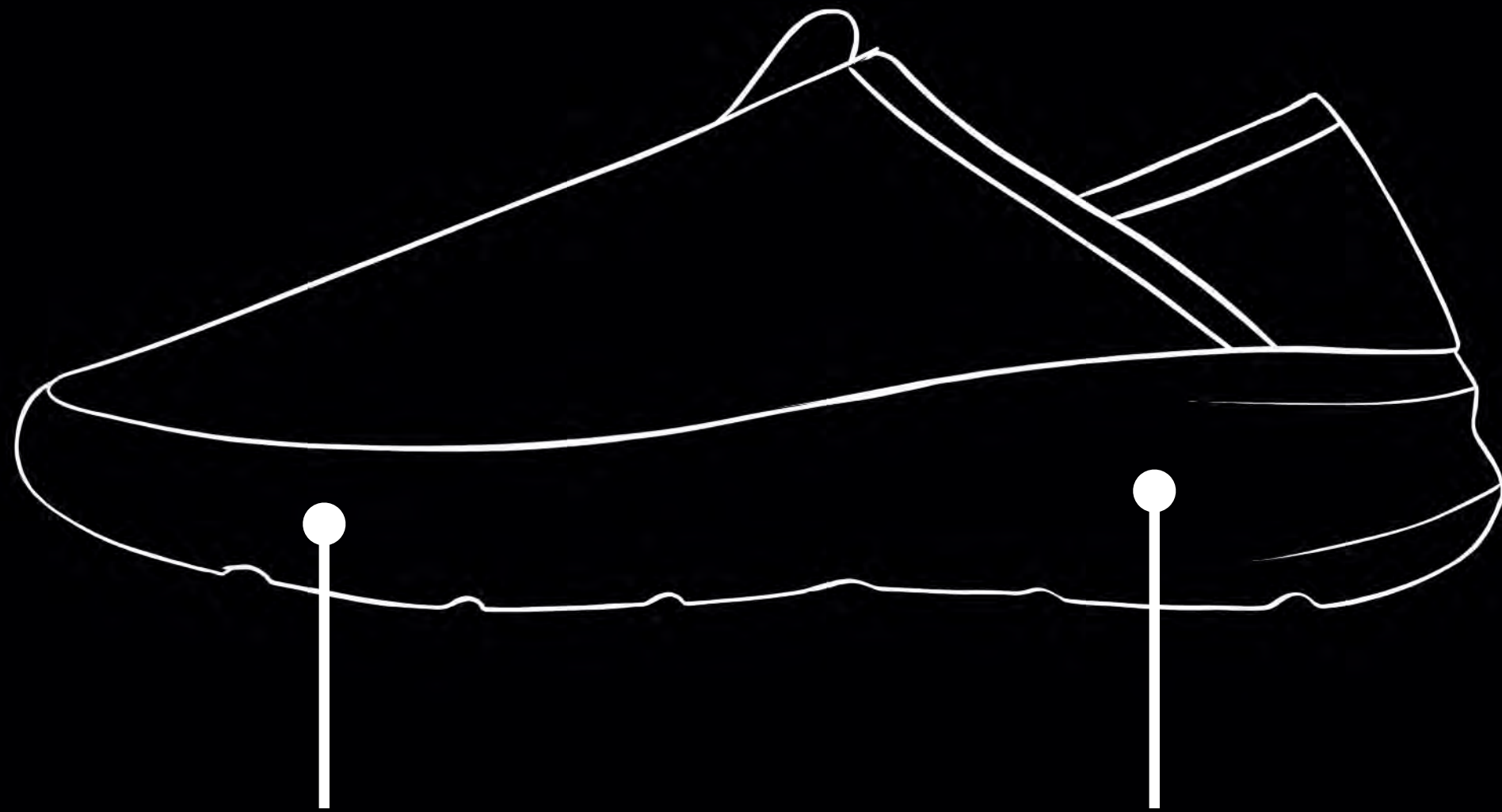
Achilles
Tendon

Dorsal Extensors
Pain

Anterior Talofibular
Ligament Strain

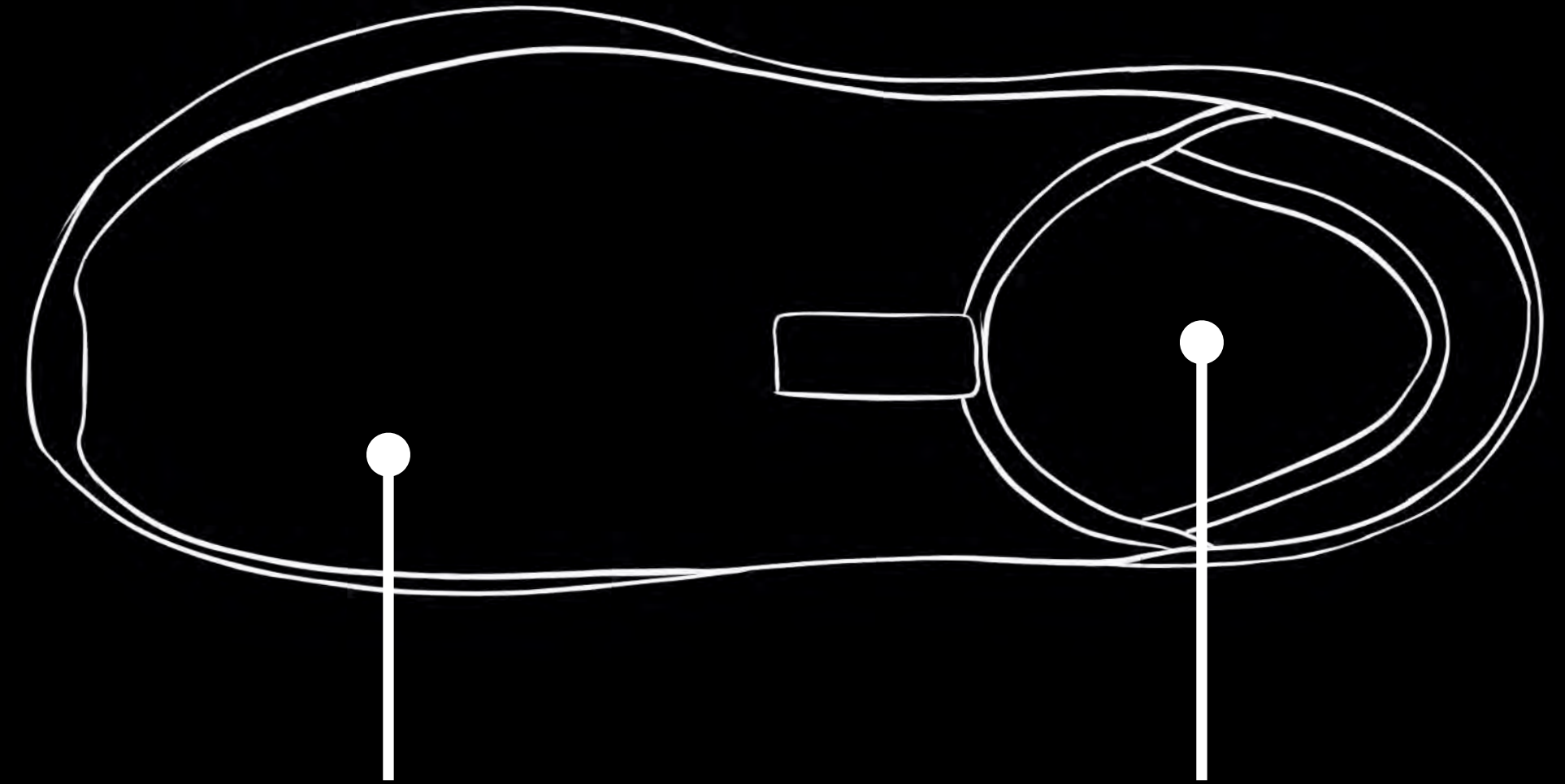


AREAS FOR IMPROVEMENT



Sole Formation

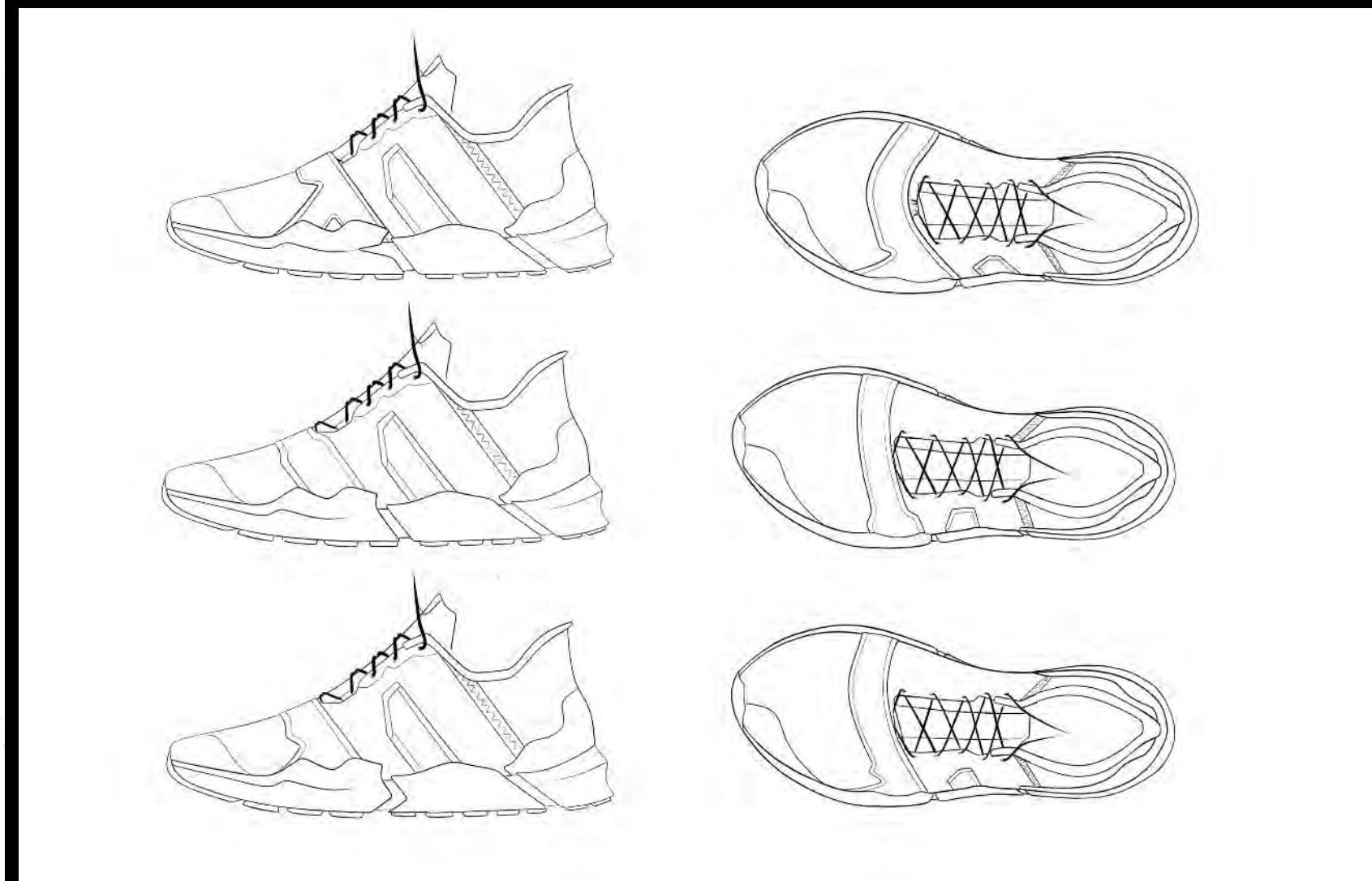
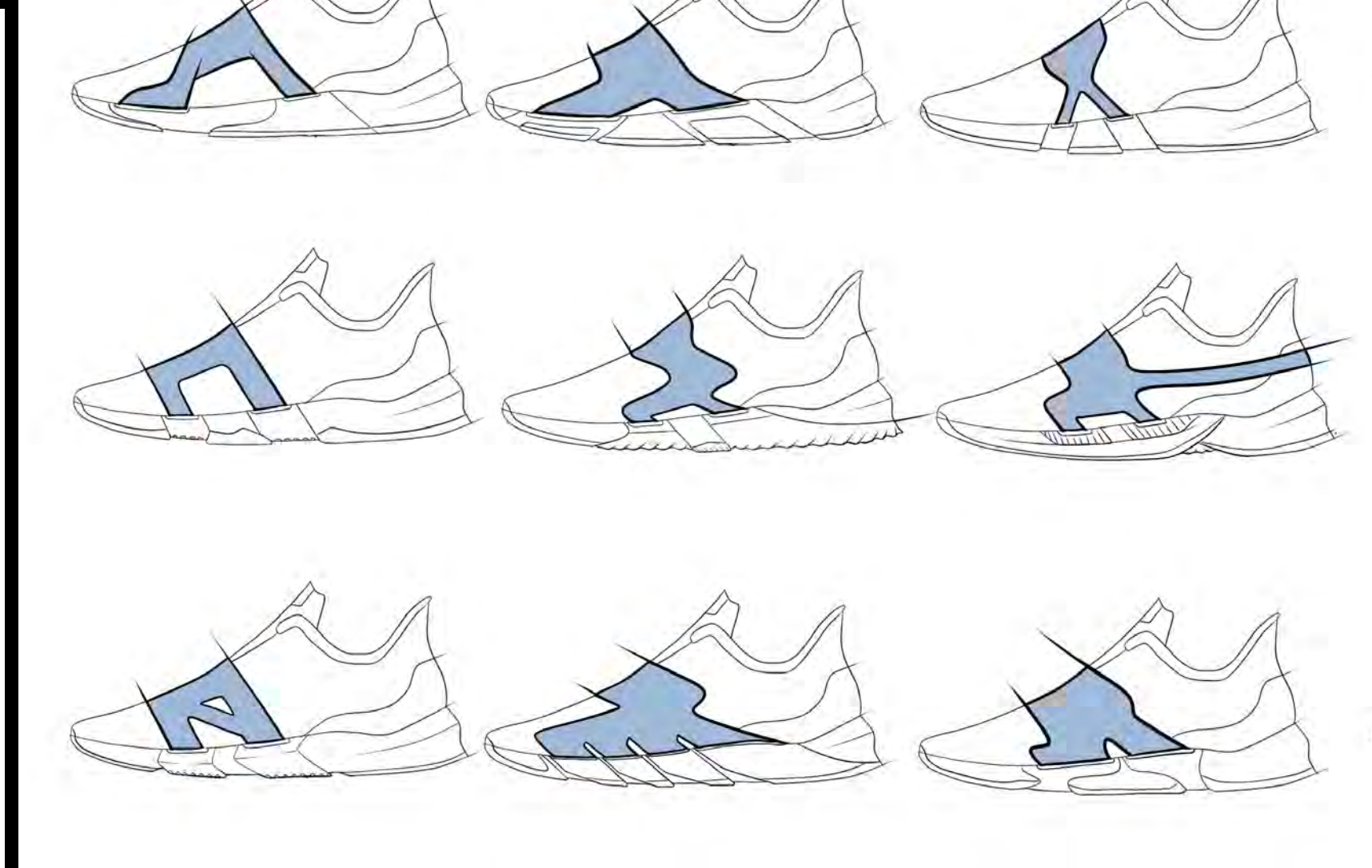
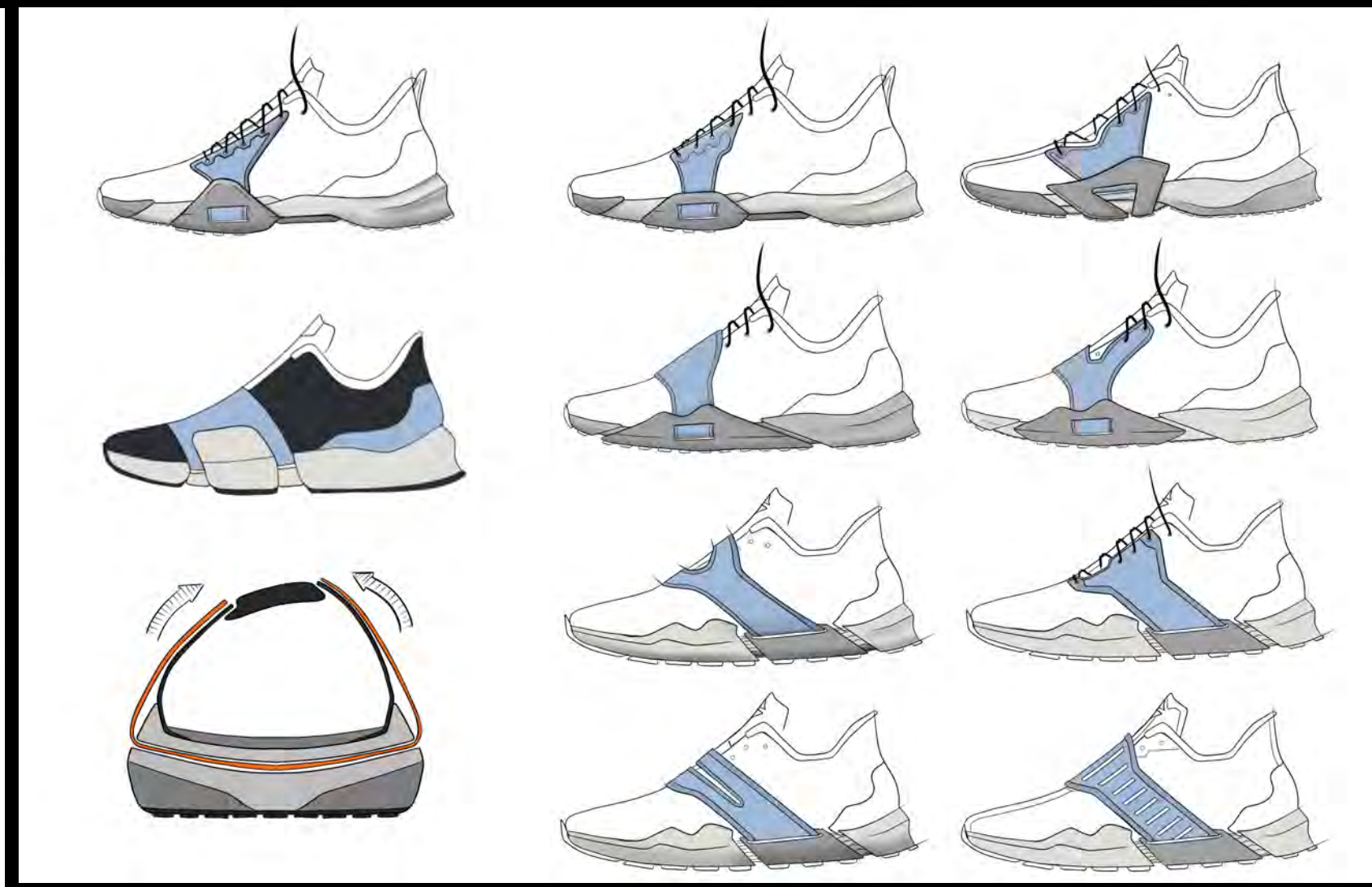
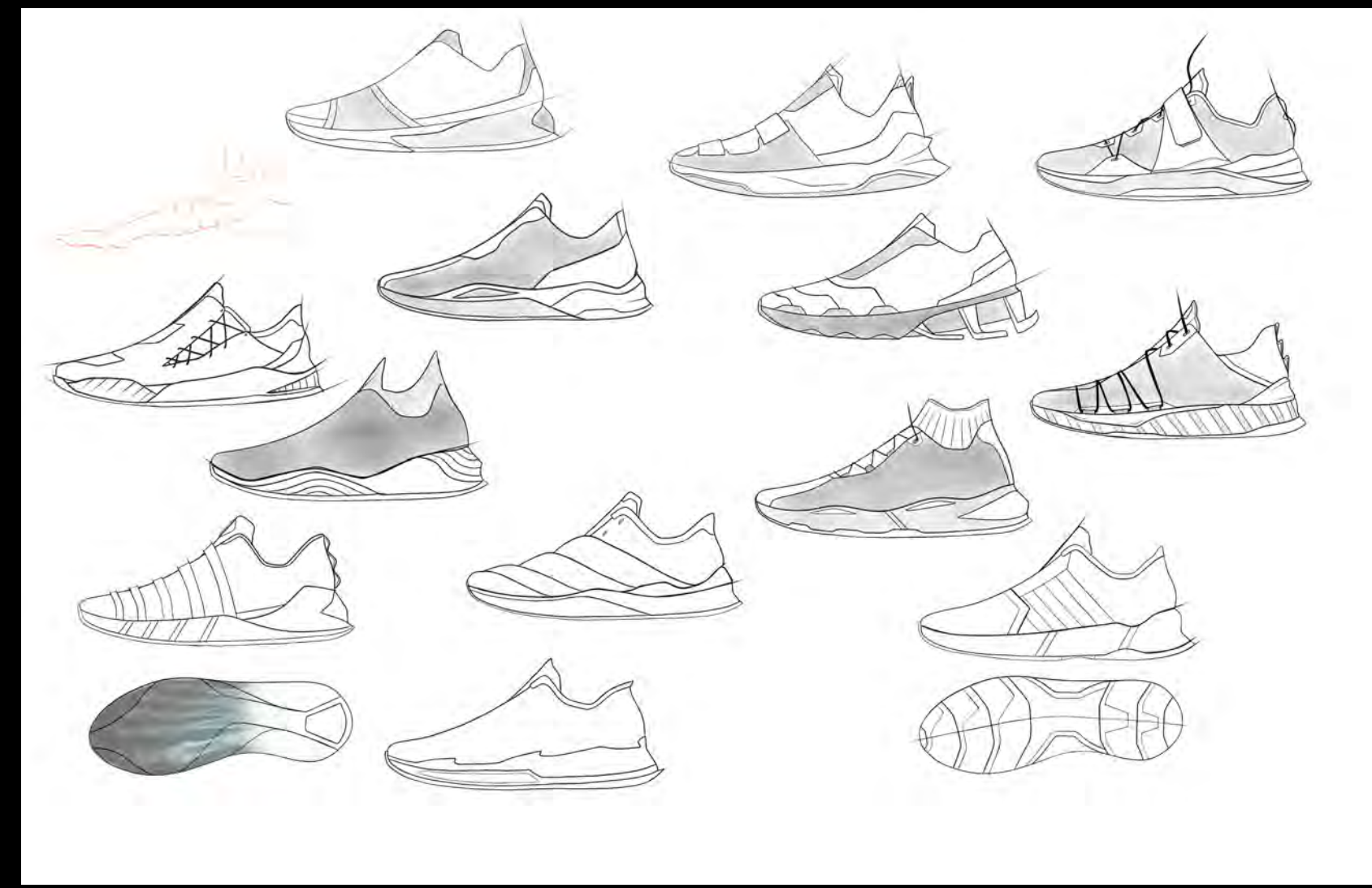
Adequate Heel Cushioning



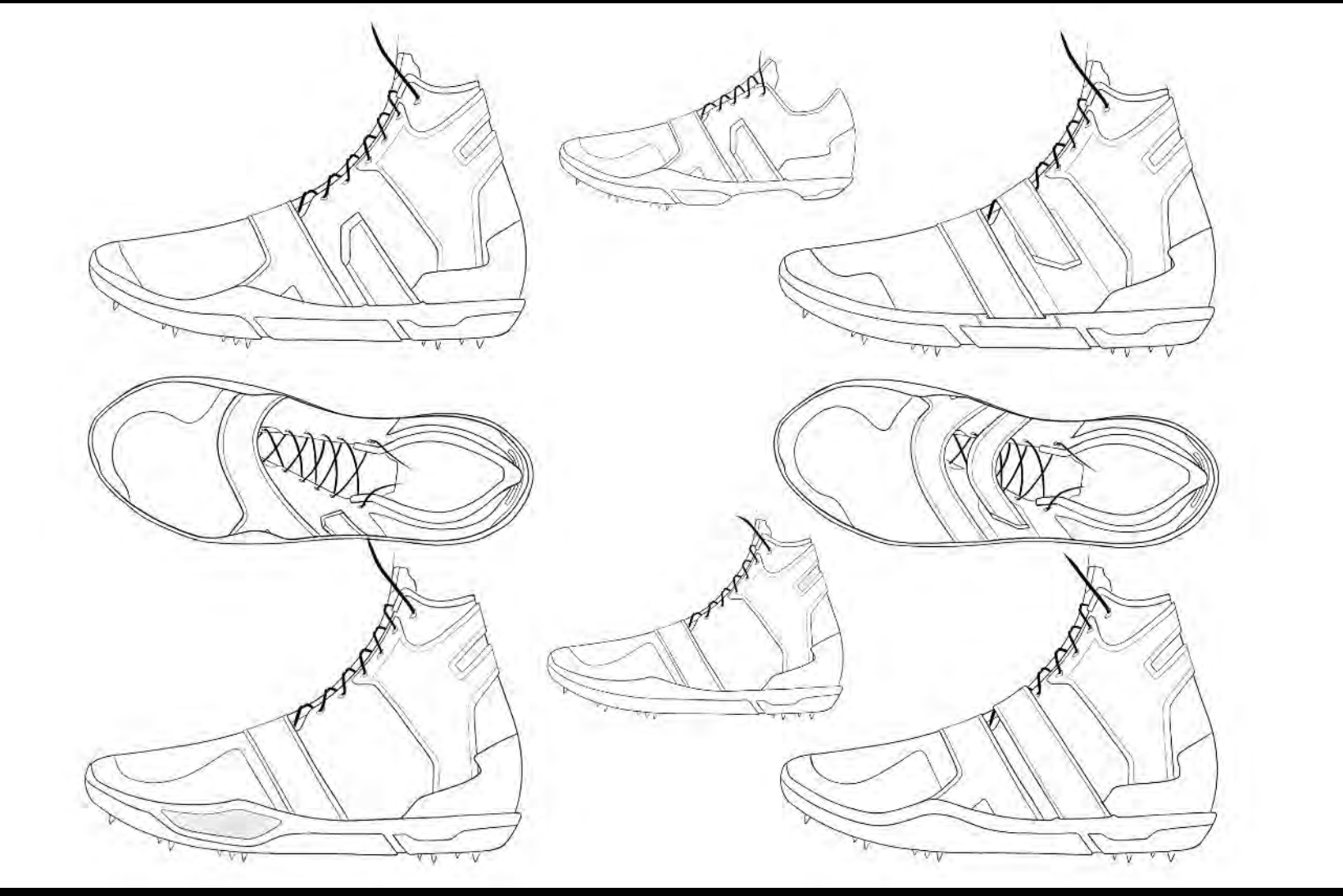
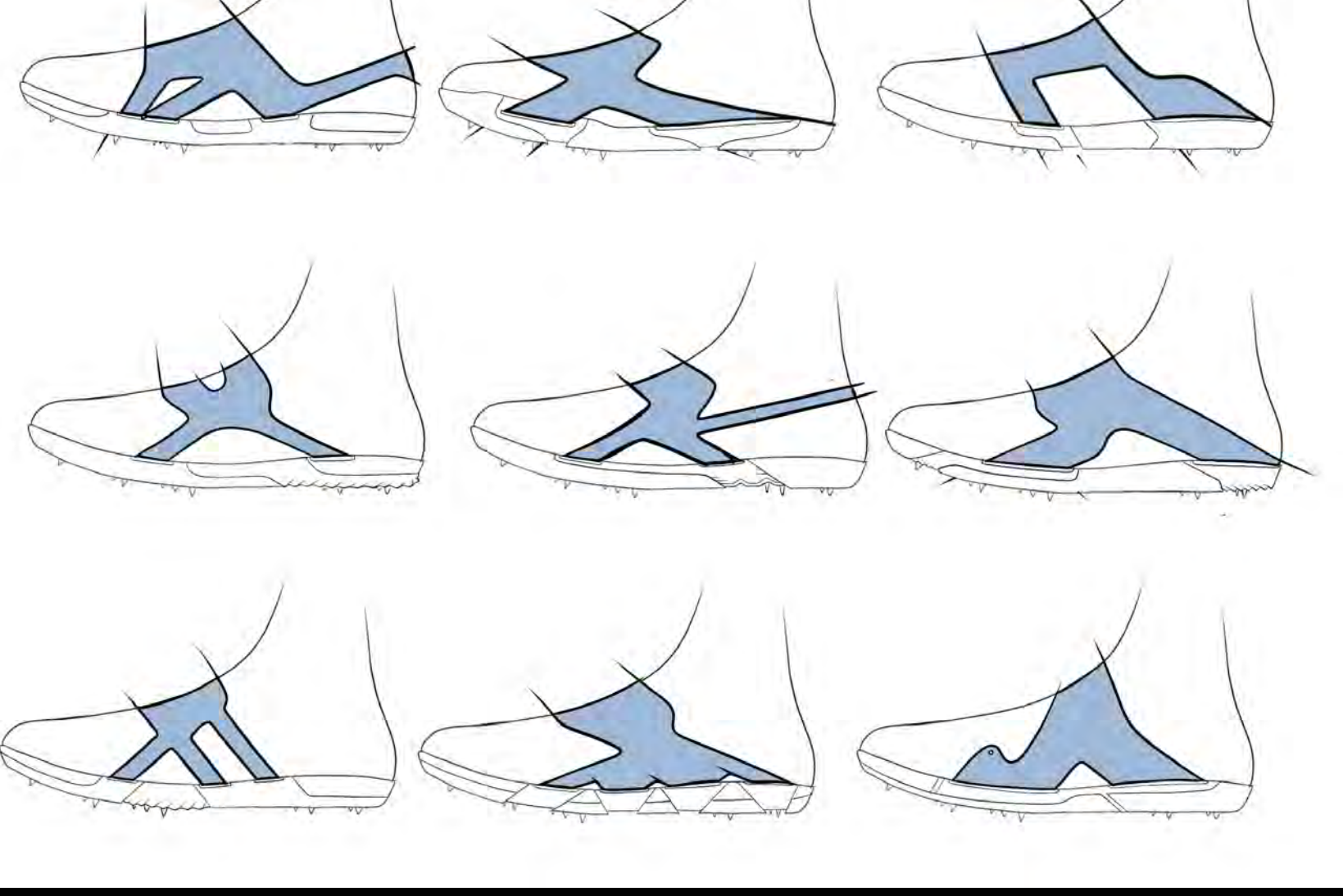
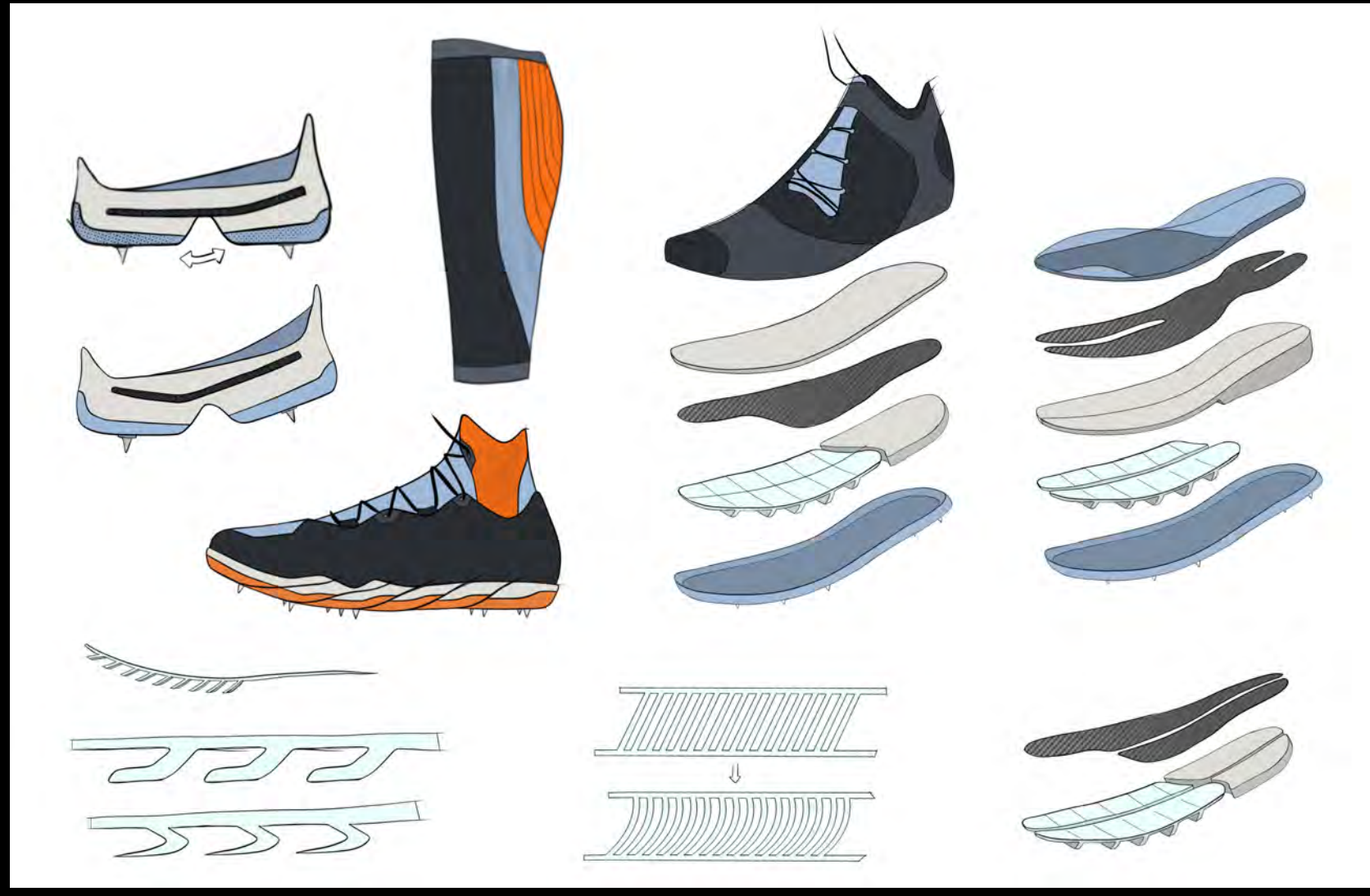
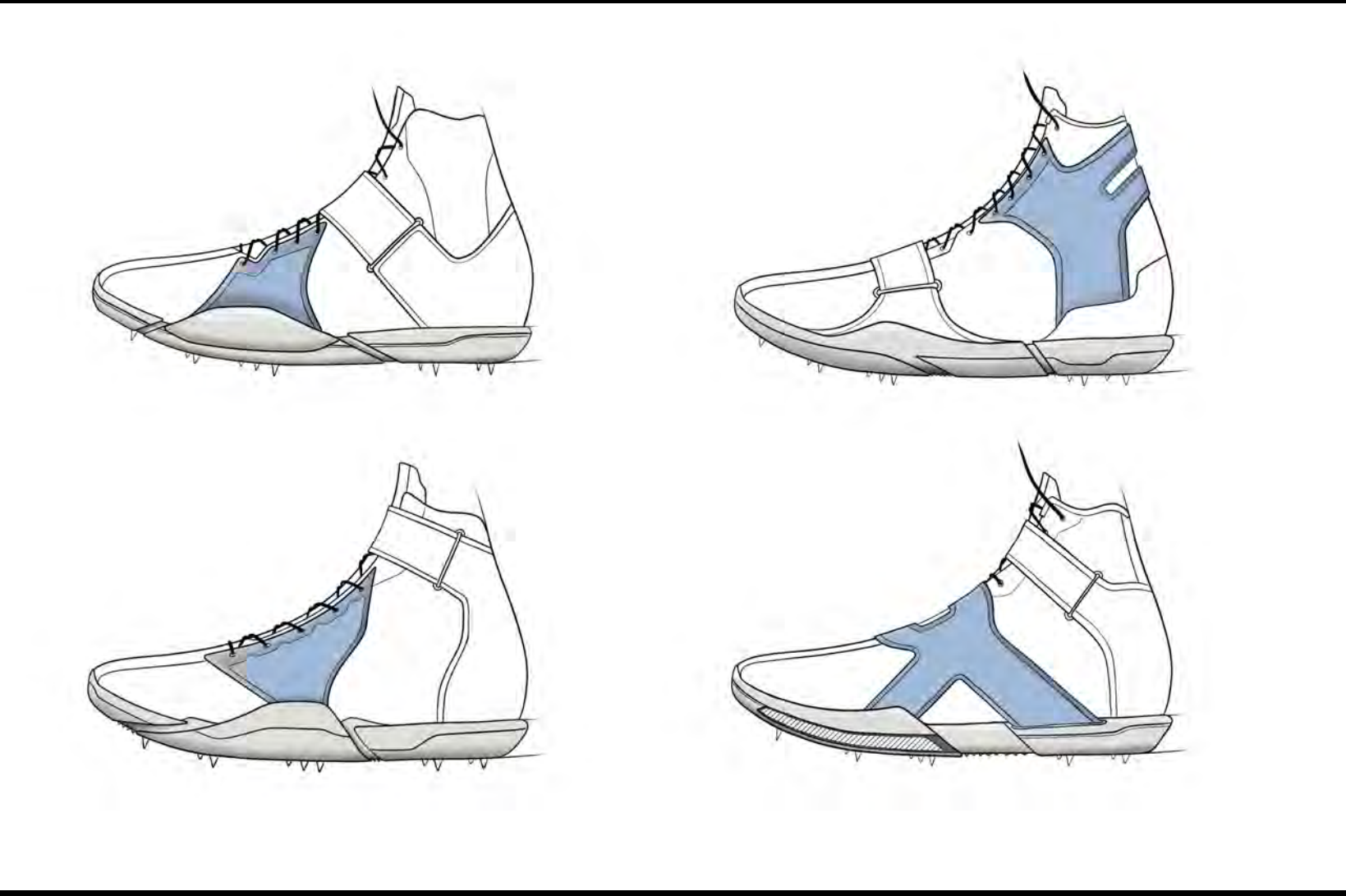
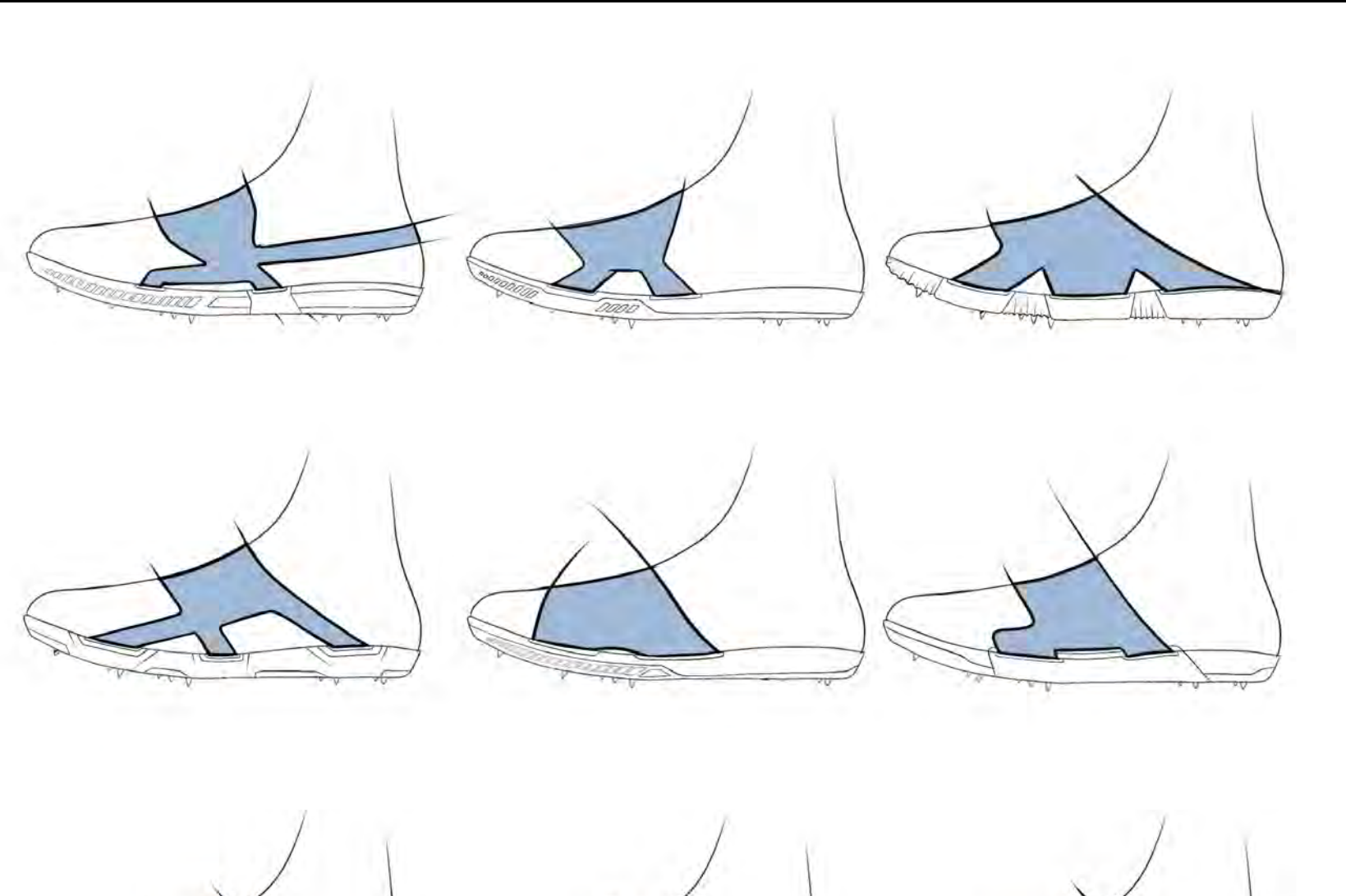
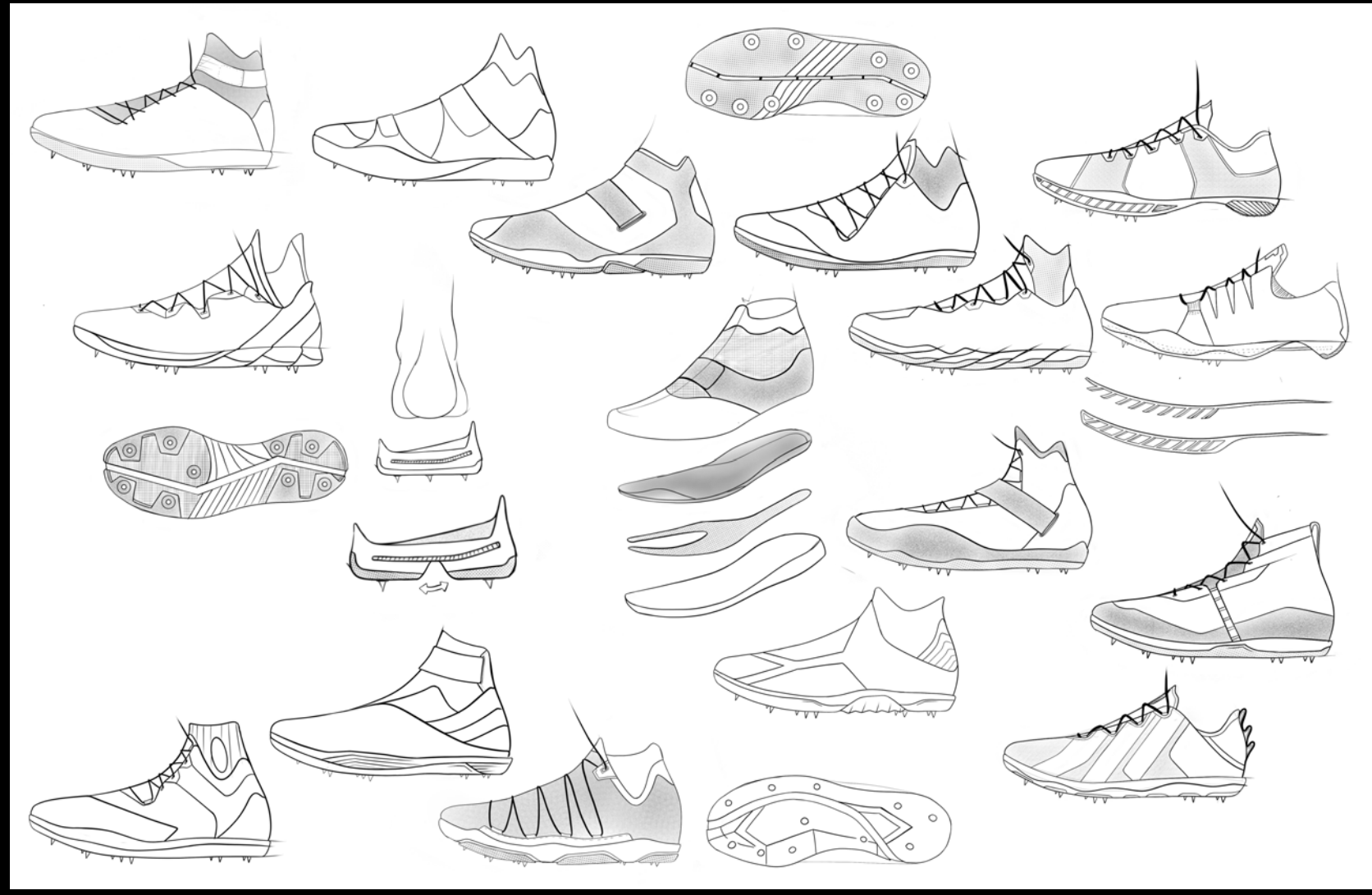
Compression Upper

Insole Support

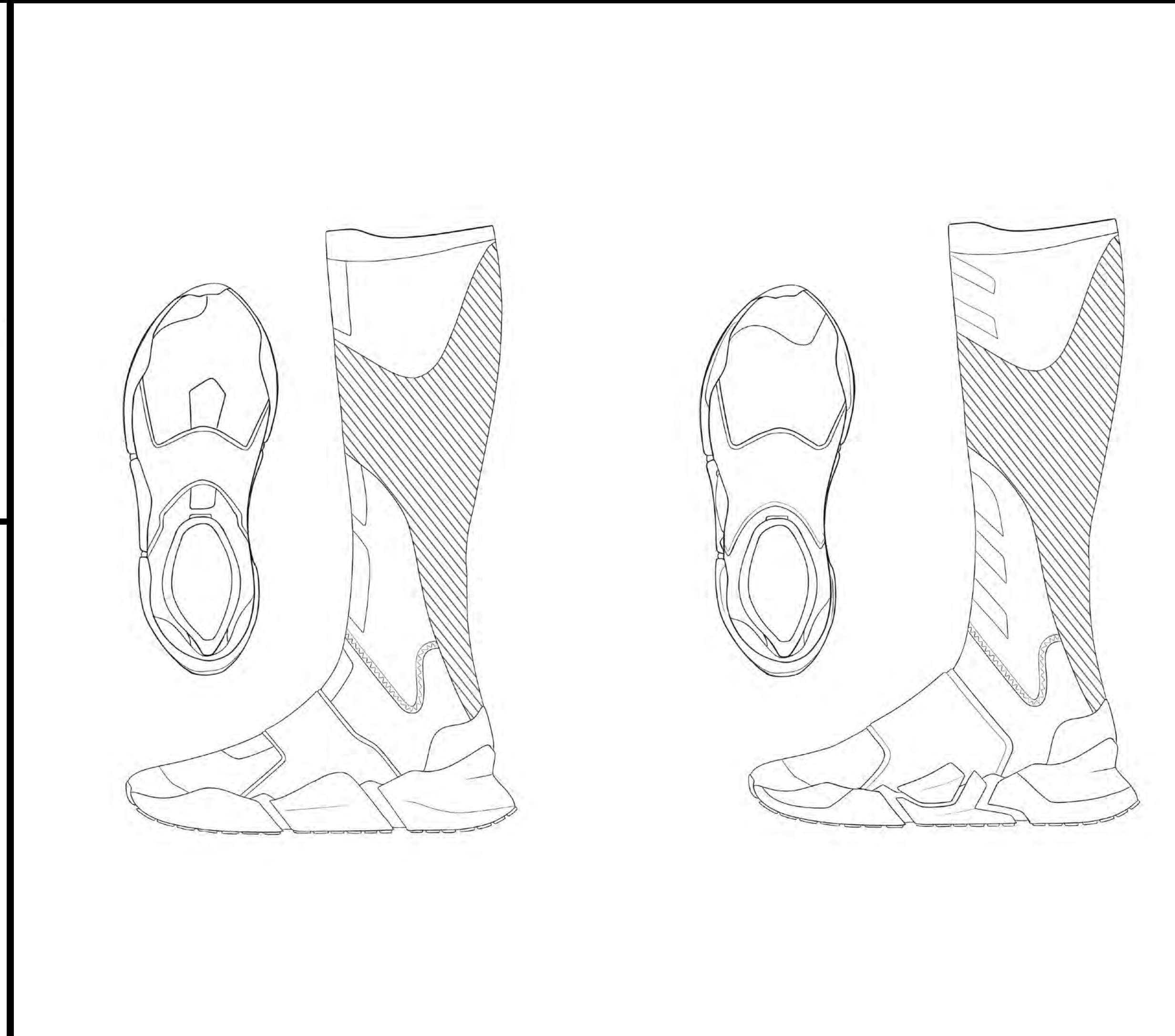
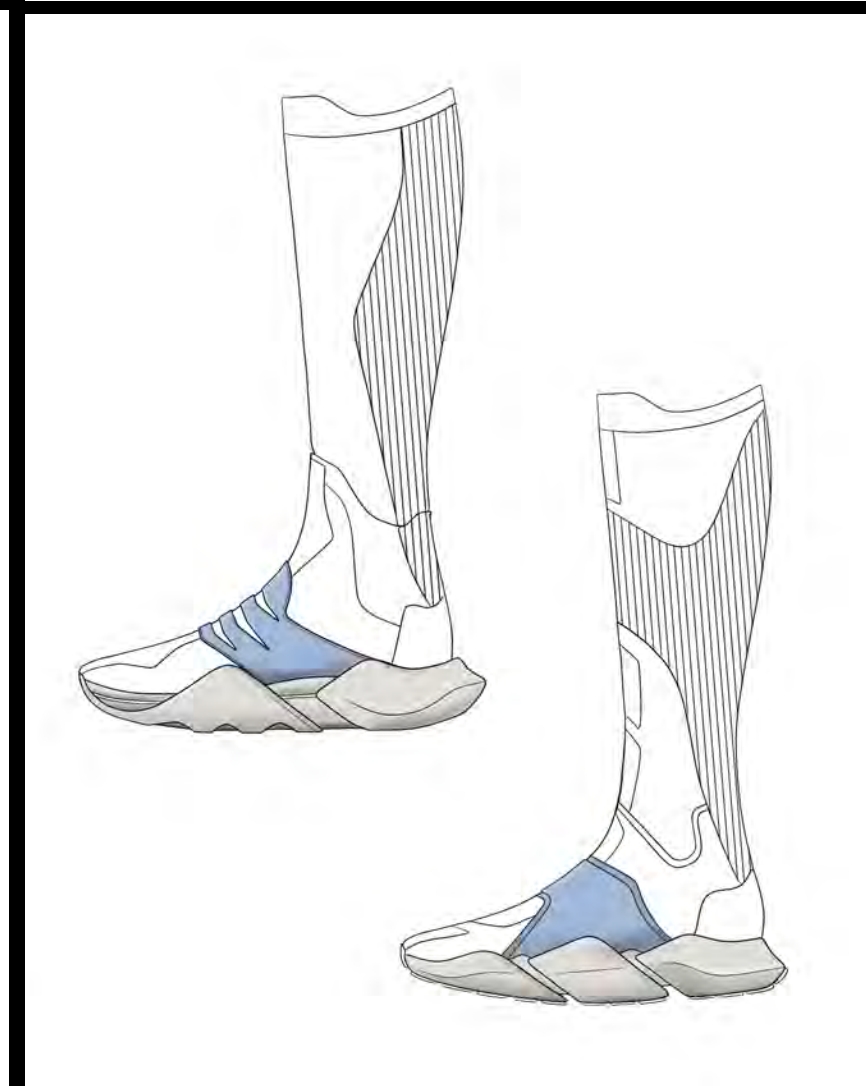
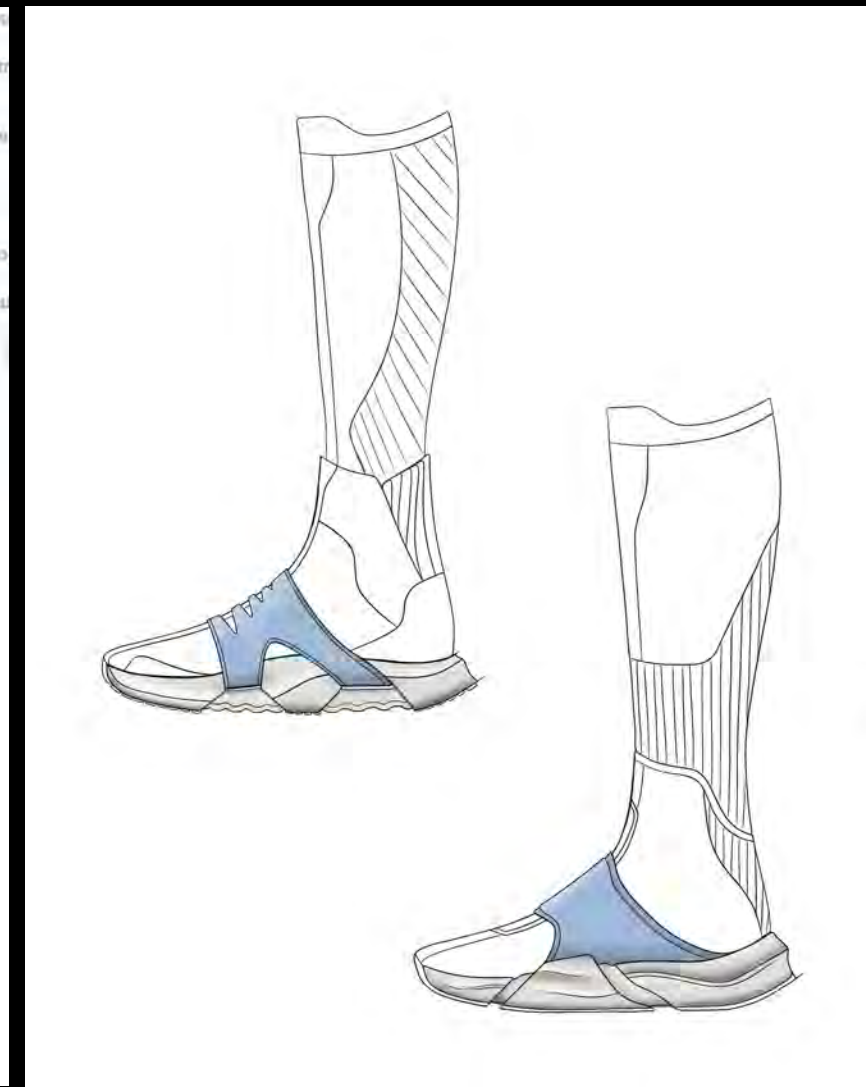
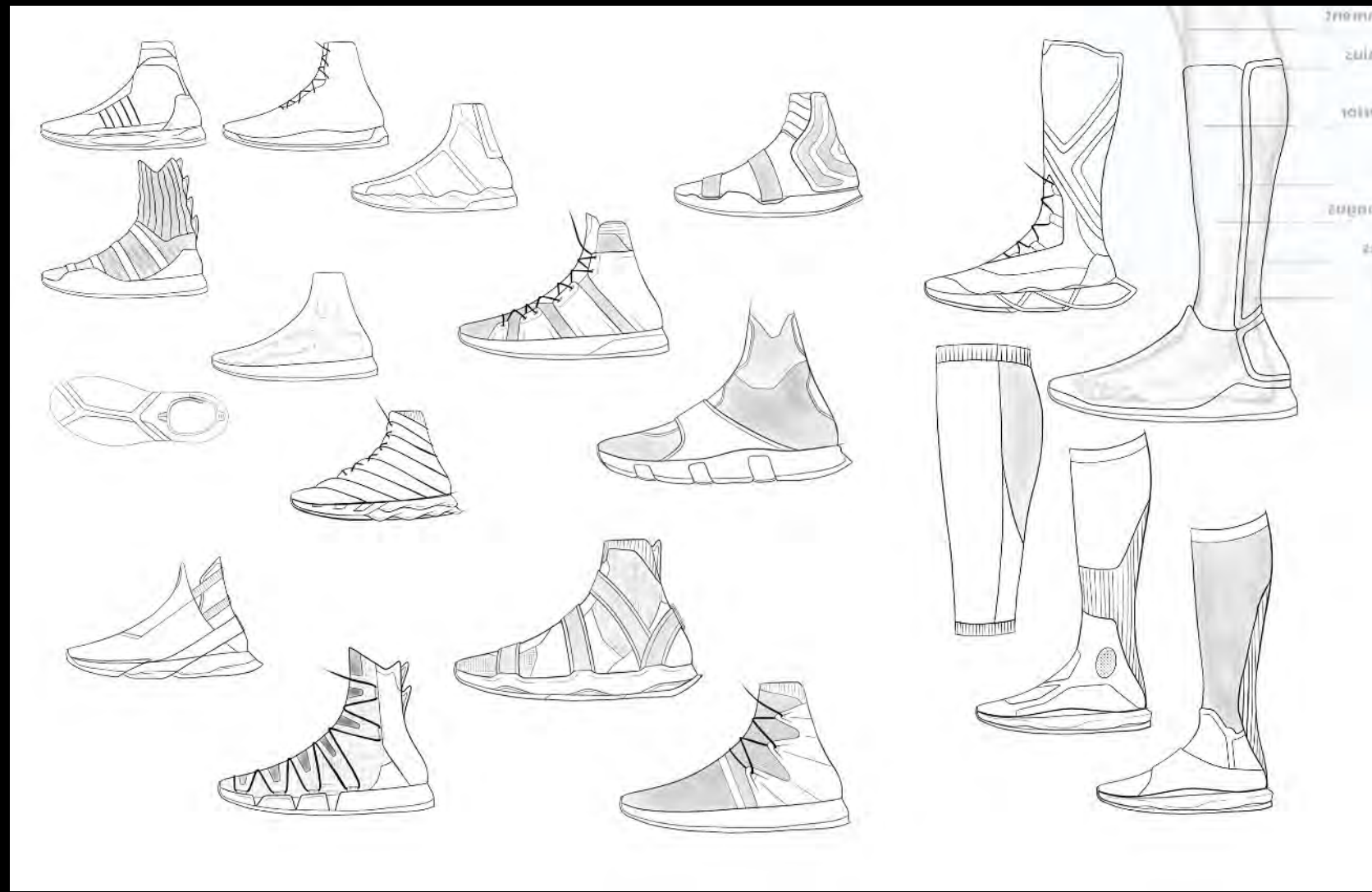
TRAINER IDEATION

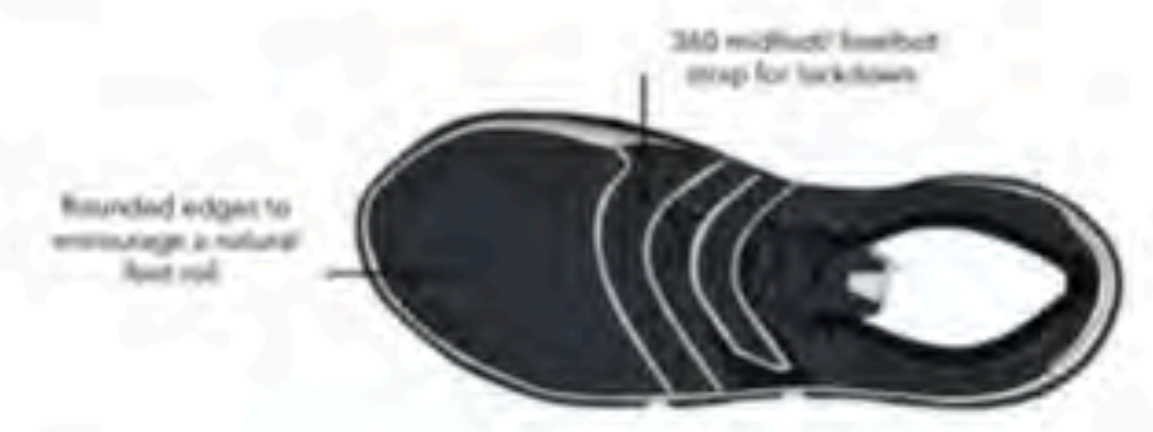


SPIKE IDEATION



RECOVERY IDEATION





STRESS TEST



UPPER PROTOTYPES







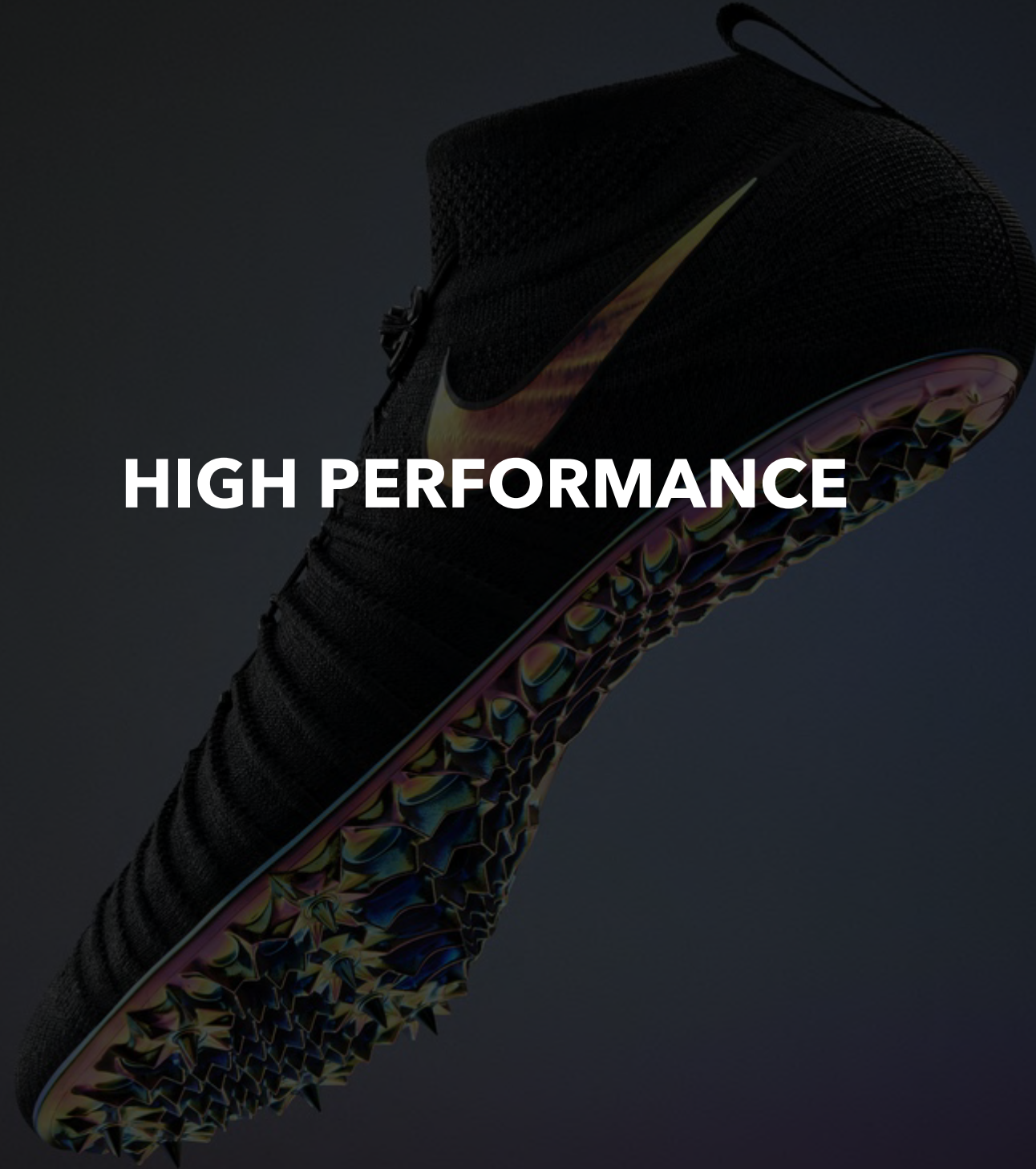


MY ASPIRATIONS

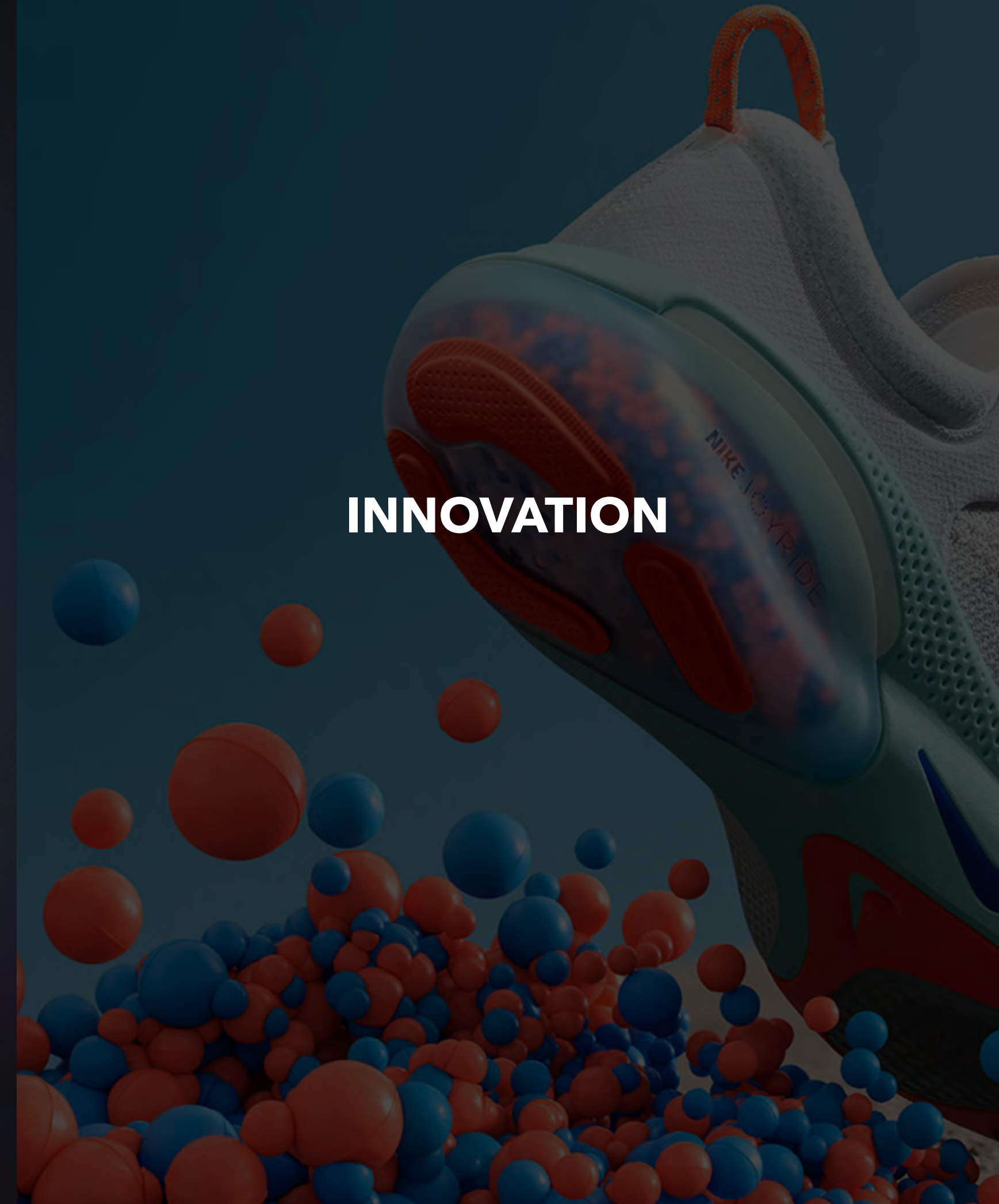
TRACK & FIELD / RUNNING



HIGH PERFORMANCE



INNOVATION



MENTORSHIP



SARA NOVAK

Footwear Designer - Running
adidas

OTHER INSIGHTS:

DANIEL SCHUSTER

Footwear Product Tester
adidas

ERIC HOLMES

Product Testing Manager
adidas

MIKE FRITON

Footwear Design Innovator
Ex Nike/ MF Design Studio

A high jumper is captured in mid-air, performing a Fosbury Flop over a bar. The athlete is wearing a black singlet and shorts, with white athletic shoes. The background is a blurred stadium with spectators. The text is overlaid on the image.

T.C.R. JUMP COLLECTION

TRAINING, COMPETITION AND RECOVERY SHOES FOR ELITE MALE HIGH JUMPERS

NATE ROESE

DIMAS PUTRA

RD DIMAS DIM

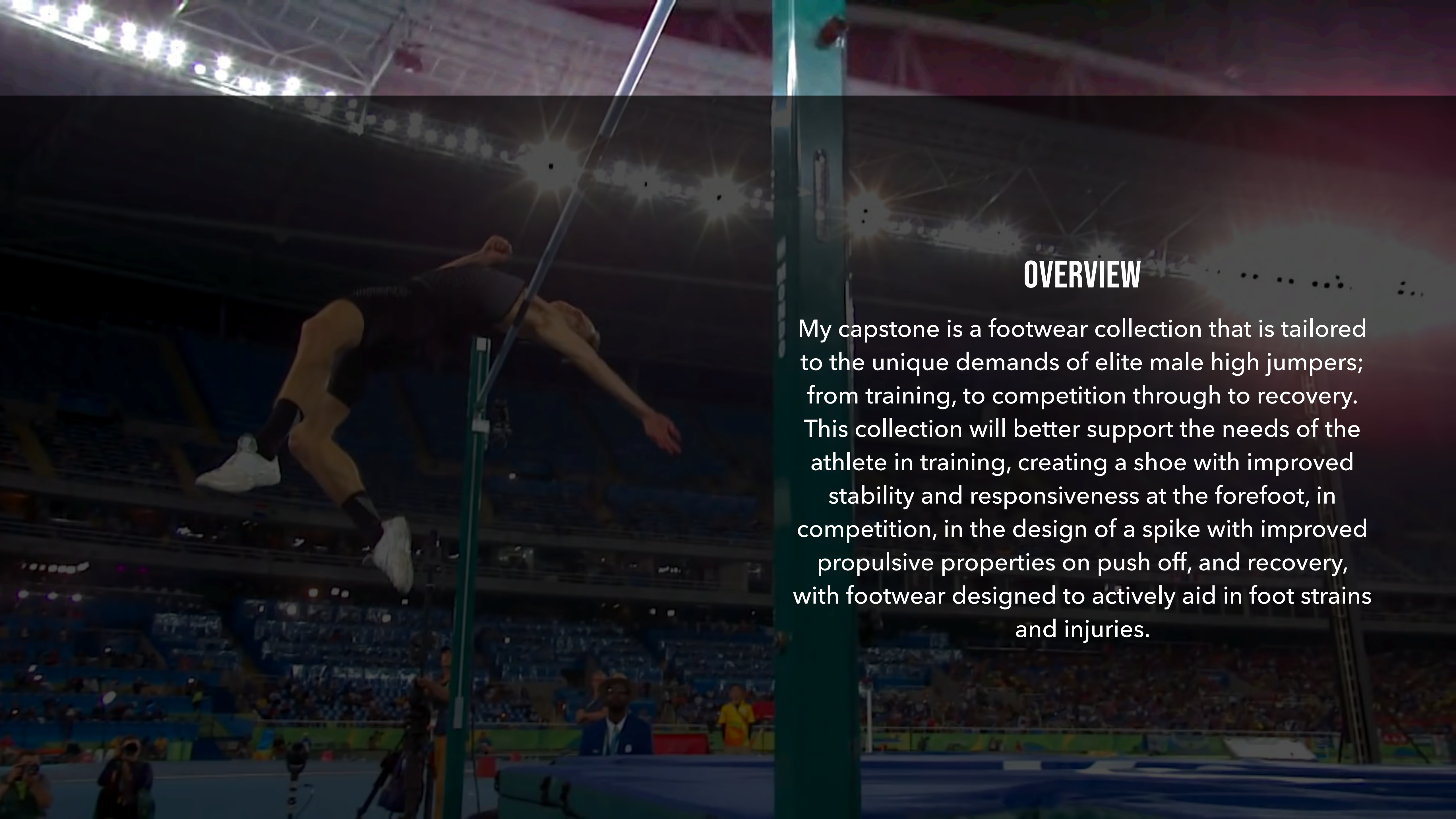




RECOVERY

TRAINING

COMPETITION



OVERVIEW

My capstone is a footwear collection that is tailored to the unique demands of elite male high jumpers; from training, to competition through to recovery. This collection will better support the needs of the athlete in training, creating a shoe with improved stability and responsiveness at the forefoot, in competition, in the design of a spike with improved propulsive properties on push off, and recovery, with footwear designed to actively aid in foot strains and injuries.



TRAINING

Plyometrics

Forefoot // Landing Mechanics
Responsive // Cushioning

Sprint Intervals

Forefoot // Form Mechanics
Lightweight // Responsive



COMPETITION

The Approach

Speed // Tight Curve
Lightweight // Supportive

Take Off

High Force // Injuries
Durable // Supportive



RECOVERY

Injuries

Foot Pains // Ankle Sprains
Shin Splints // Knee Pains

Methods

Icing // Compression
Performance Fabrics

RESEARCH

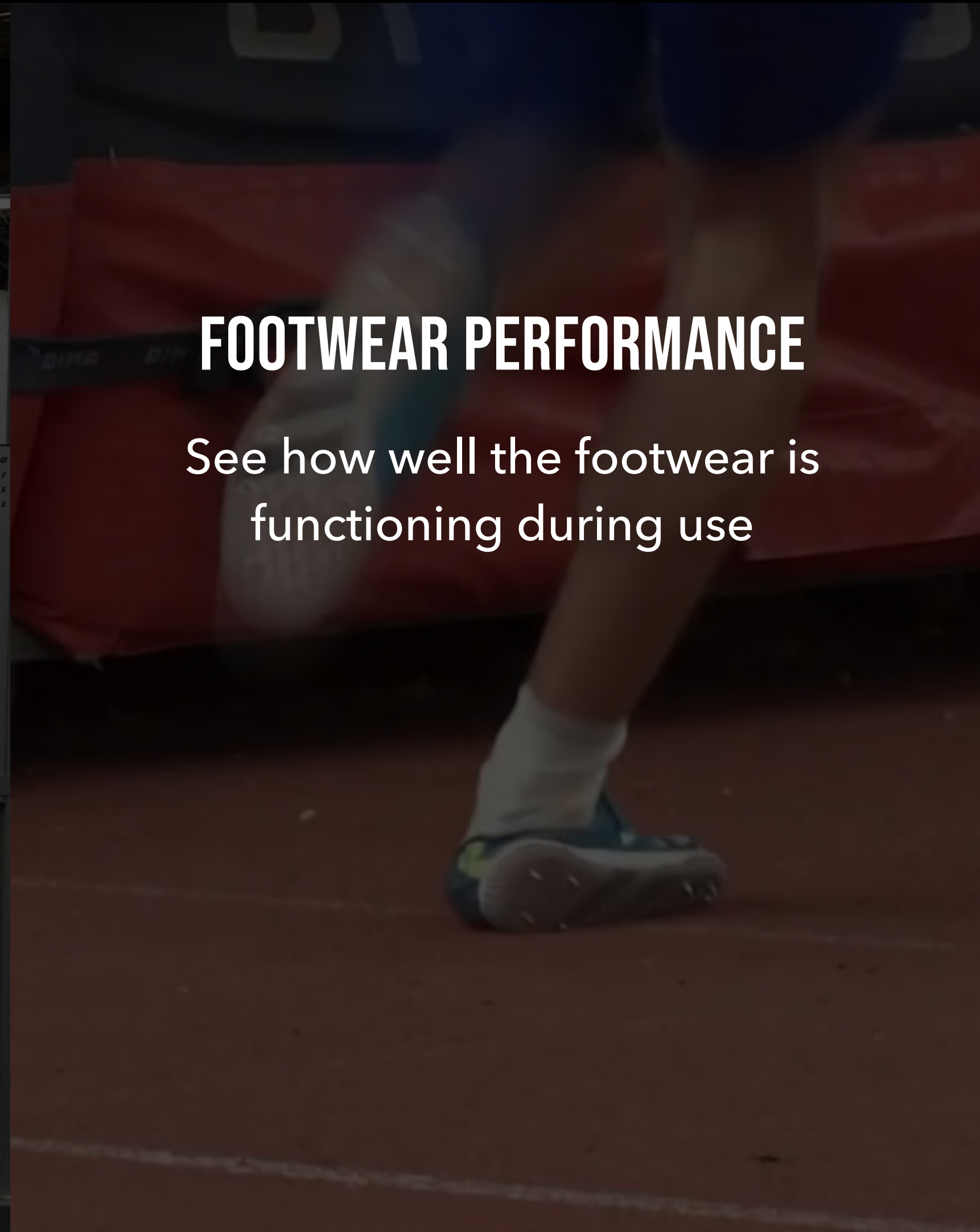
ATHLETE RESEARCH

Insights from coaches, trainers
and athletes



FOOTWEAR PERFORMANCE

See how well the footwear is
functioning during use



FOOT DATA RESEARCH

Specific footwear needs and
different foot pressures



INSIGHT

COLLEGIATE



BEN MILLIGAN // 7' 2.5"



RYAN LOCKARD // 7' 3"



NICK BACHINSKI // 7' 0.50"

PROFESSIONAL



LUCA WIELAND // 7' 2.5"



ADRI GLEBAUSKAS // 7' 5"

STAFF



ZACH SEIGMEIER // HJ COACH



BEN GUCINSKI // 7' 1"



MICHAEL BURKE // 7' 3"



DANNY SCHILLER // 7' 0.25"



SHELBY MCEWEN // 7' 7"



KEVIN SCHULTZ // 7' 2.5"



KATIE MADDEN // TRAINER

ATHLETE FEEDBACK

INJURIES

Shin splints
Achilles soreness
Ankle sprains
Heel bruising
Soleus soreness
Knee pain
Hamstring soreness

Reasons are from running tight turns, incorrect planting technique and competition in general

TRAINERS

Like:
Lightweight
Breathable
Durability
Comfortable

Dislike:
Forefoot cushioning
Upper stability
Fit
Bulky
Outsole durability

SPIKES

Like:
Lightweight
Heel support
Flat sole

Dislike:
Durability
Ankle Support
Cushioning
Outsole material
Dorsal/ Mid-foot Fit

RECOVERY

Flight Soreness:
Muscles in feet & ankle
Calf muscles
Knee & Hips

Ideal Shoe:
Cushioning
Lightweight
Comfortable
Breathable
Easy to get on

6-12 hour flight // whole day traveling wearing the same shoes

COACH FEEDBACK



ZACH SEIGMEIER

Minnesota High Jump Coach

IMPORTANT PART OF APPROACH

Gaining speed from the start and maintaining it around curve as well as maintaining posture

COMMON INJURIES

Ankle injuries from an unstable take off and lower back injuries. And of course shin splints

EFFECTS OF TRAVEL

Not exactly sure but I assume they feel sore, probably in their calves, feet and maybe knees

MUSCLES USED THE MOST

Our jumpers are speed based which means more force is applied on tendons and fasciae than muscles

AVERAGE WEEK OF TRAINING

A lot of speed work (10-20-30m sprints), technical and mechanical work, box jumps, hurdle hops, bonding, etc.

FOOTWEAR REVIEW

Not a lot of problems with the training shoe. Jumpers will blow through the toe in the spikes during take off

TRAINER FEEDBACK



KATIE MADDEN

Minnesota Athletic Trainer

COMMON INJURIES

Achilles and lower back are big. Men are more predisposed to ankle injuries. A lot depends on body mechanics

CURRENT TRAINING SHOES

Training shoes seem to be okay. A big offset could cause more stress fractures but a small offset is fine.

BLOOD CIRCULATION

Usually we will use compression to increase blood flow. Heat also helps to dilate blood vessels.

TREATMENTS FOR INJURIES

Effleurage massage, mobility exercises, standard taping, sometimes will reinforce with thicker tape for competitions

EFFECTS OF TRAVEL

Dehydration, and muscles definitely get tighter. Elevation change causes more swelling for injuries.

RECOMMENDATIONS

Trainer-reduce impact but still supportive
Spike-more support & stability for ankle
Recovery-compression, light, & moves well

FOOTWEAR PERFORMANCE

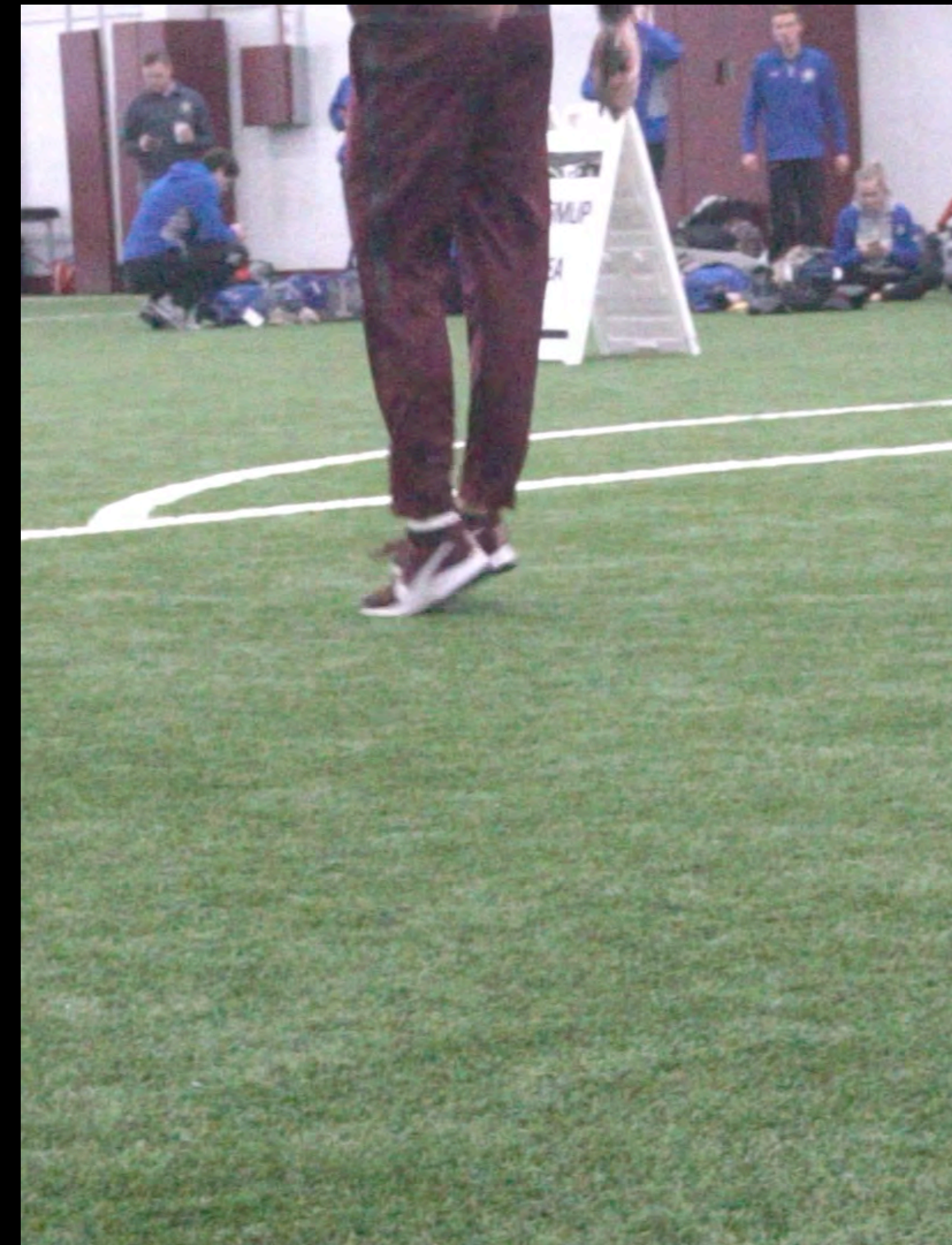
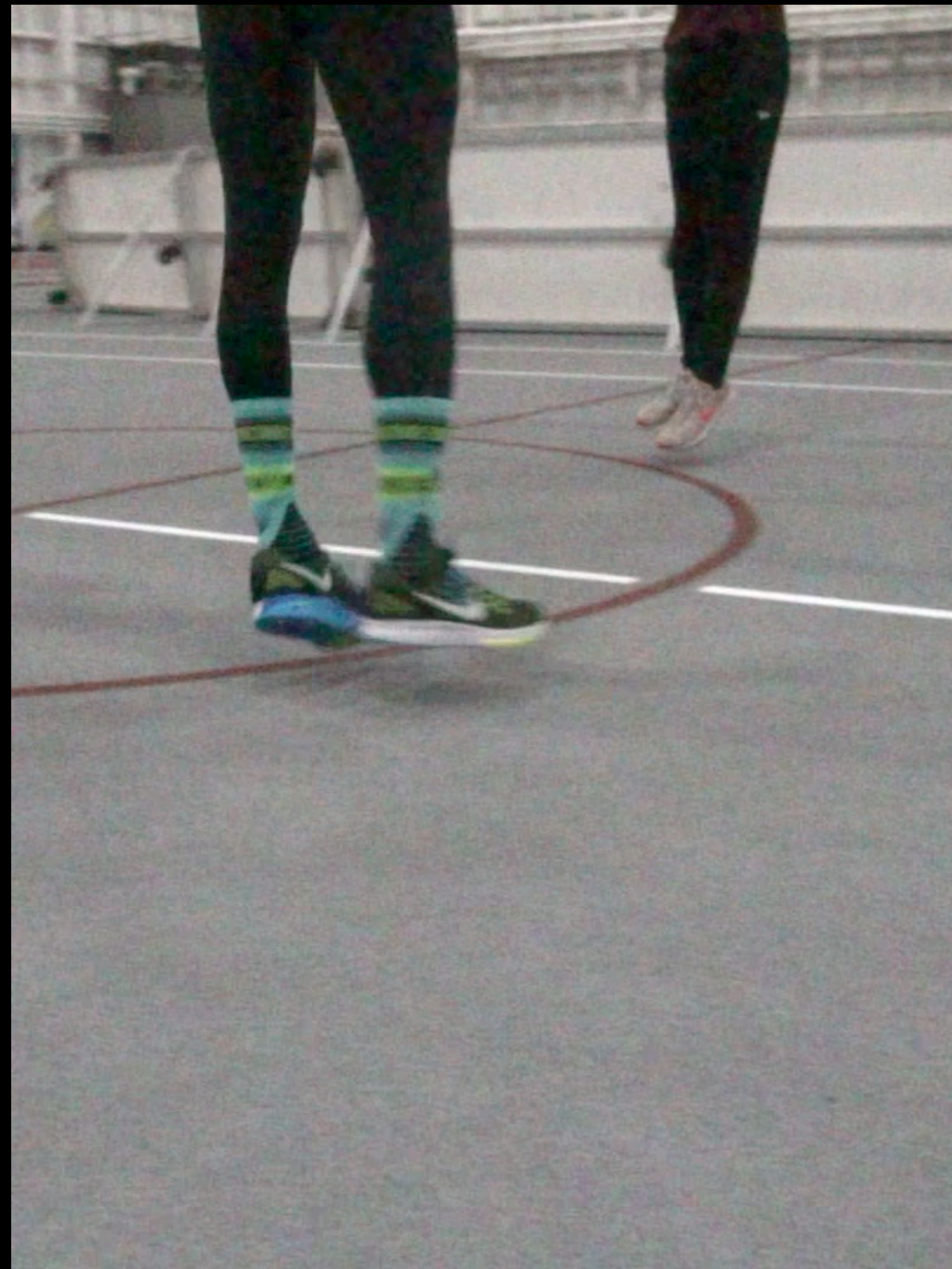
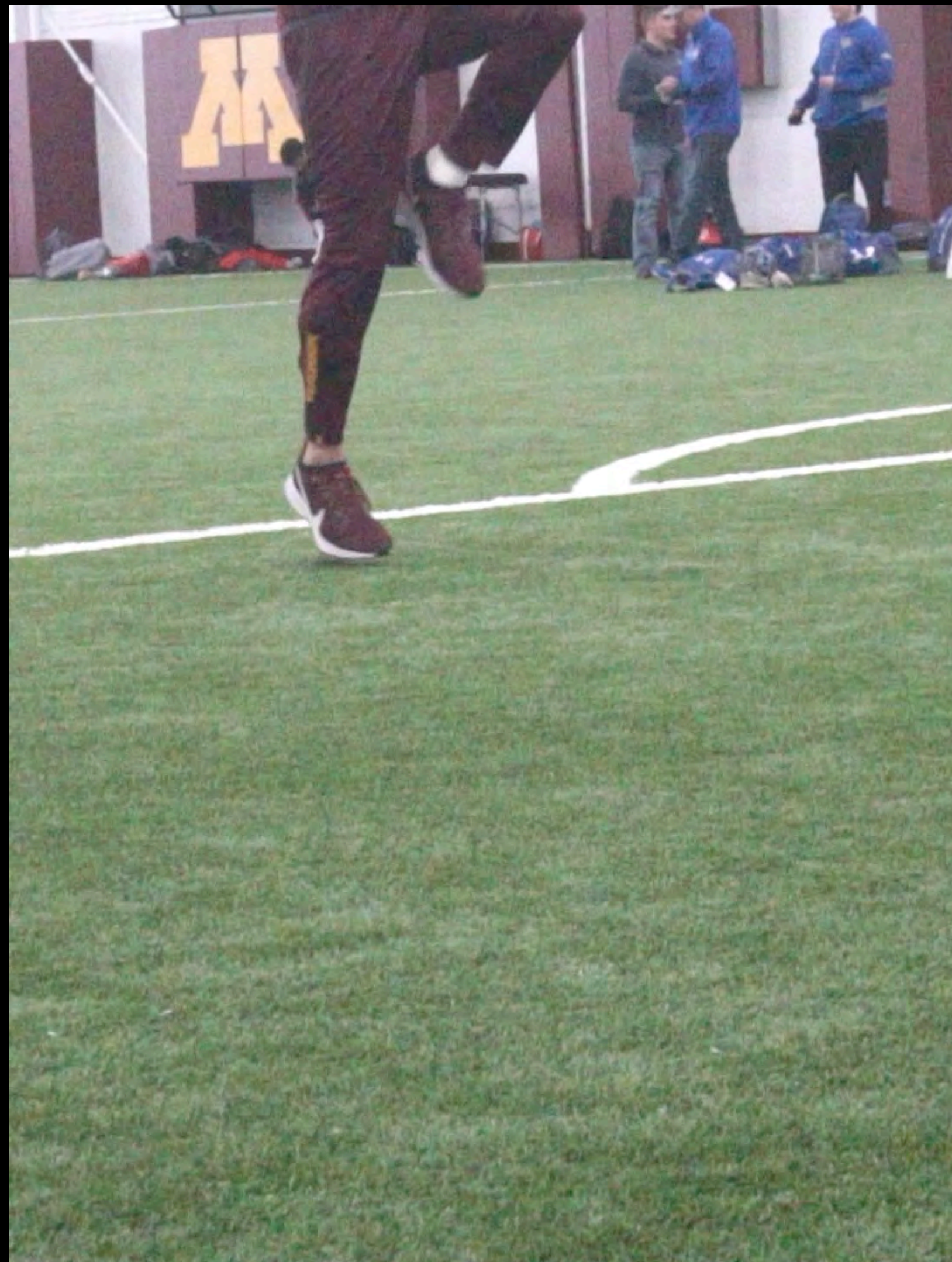


UNIV. OF WASHINGTON

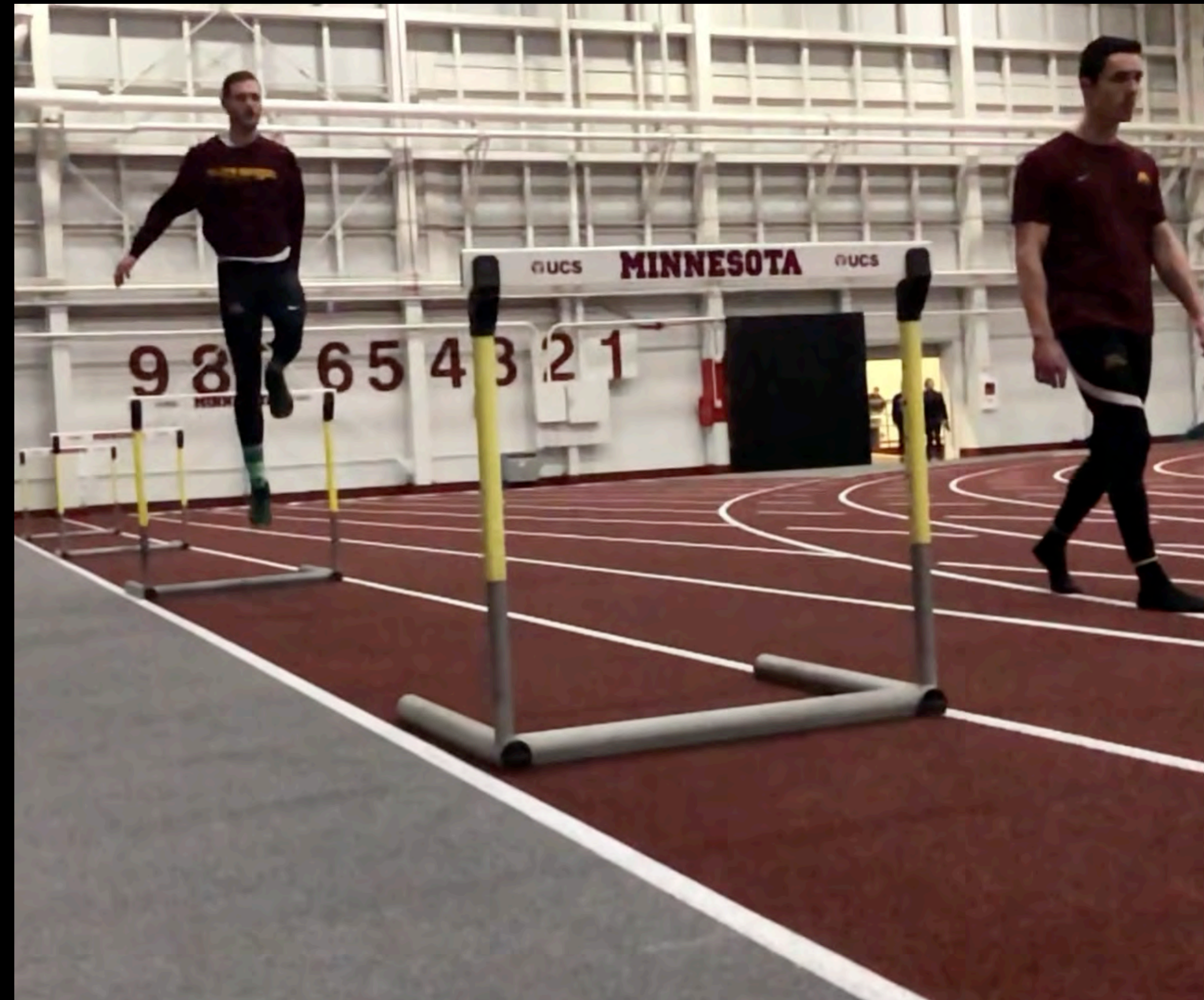


UNIV. OF MINNESOTA

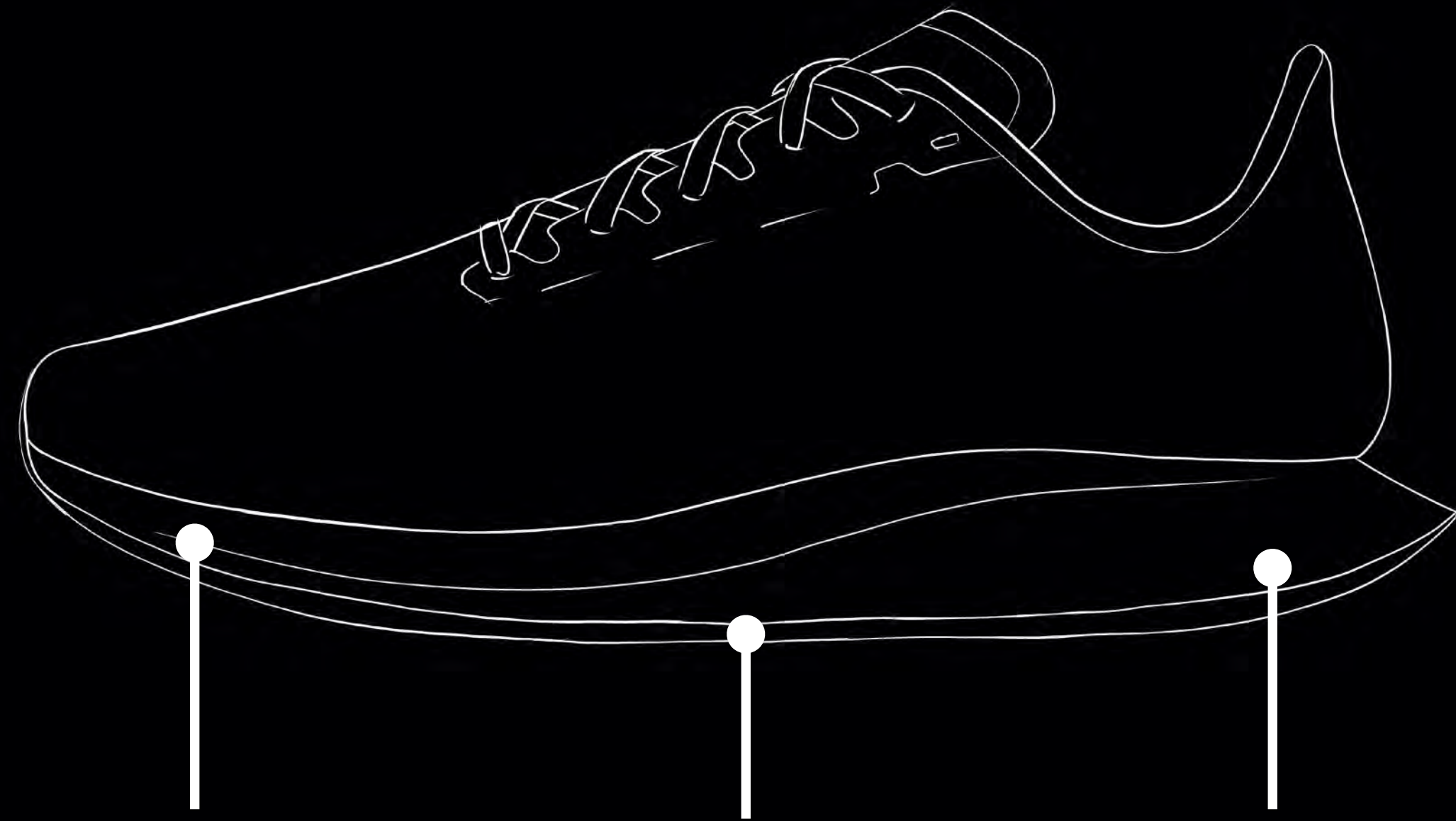
SLOW MOTION - WARM UPS



SLOW MOTION - TRAINING



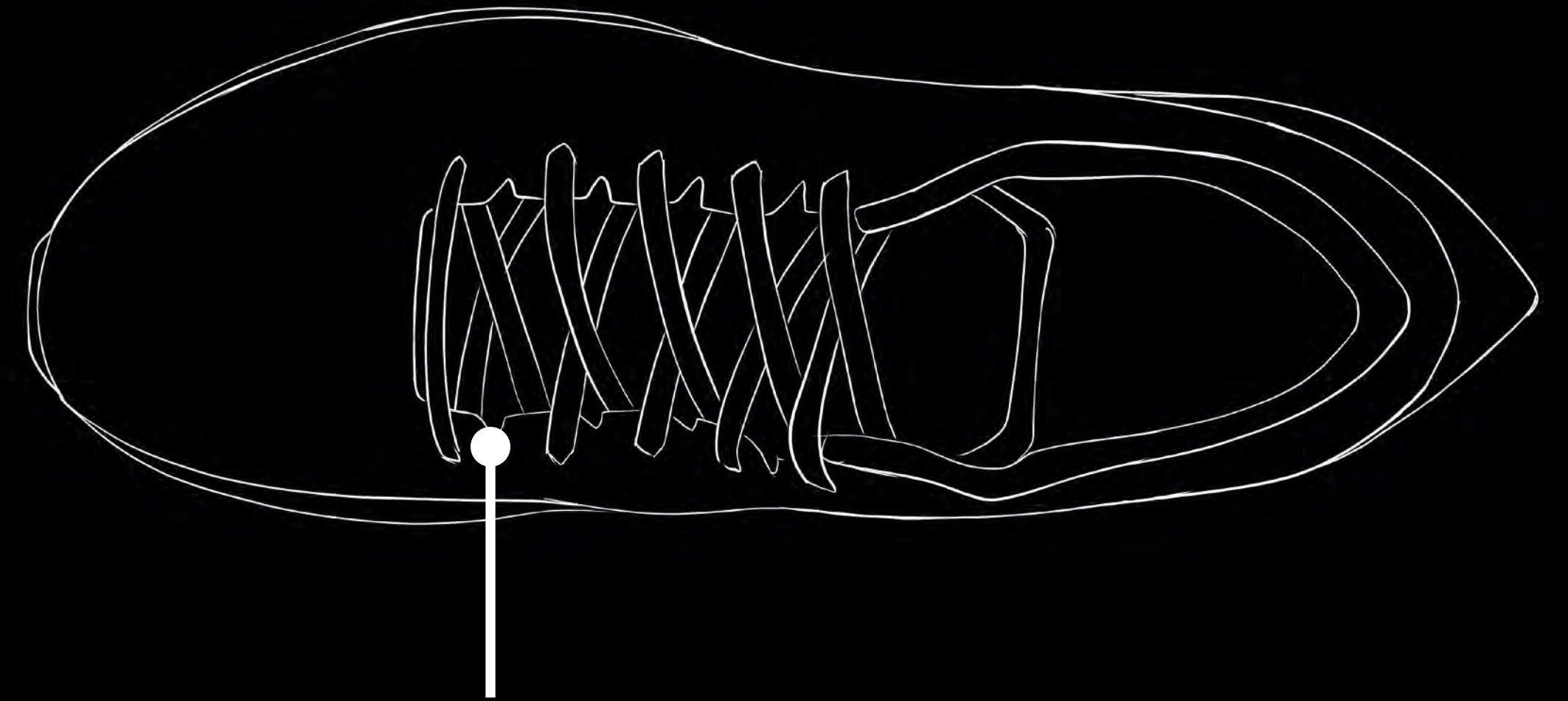
AREAS FOR IMPROVEMENT



Forefoot Cushioning

Durable Outsole

Lower Offset



Forefoot Upper Stability

SLOW MOTION - SPIKES



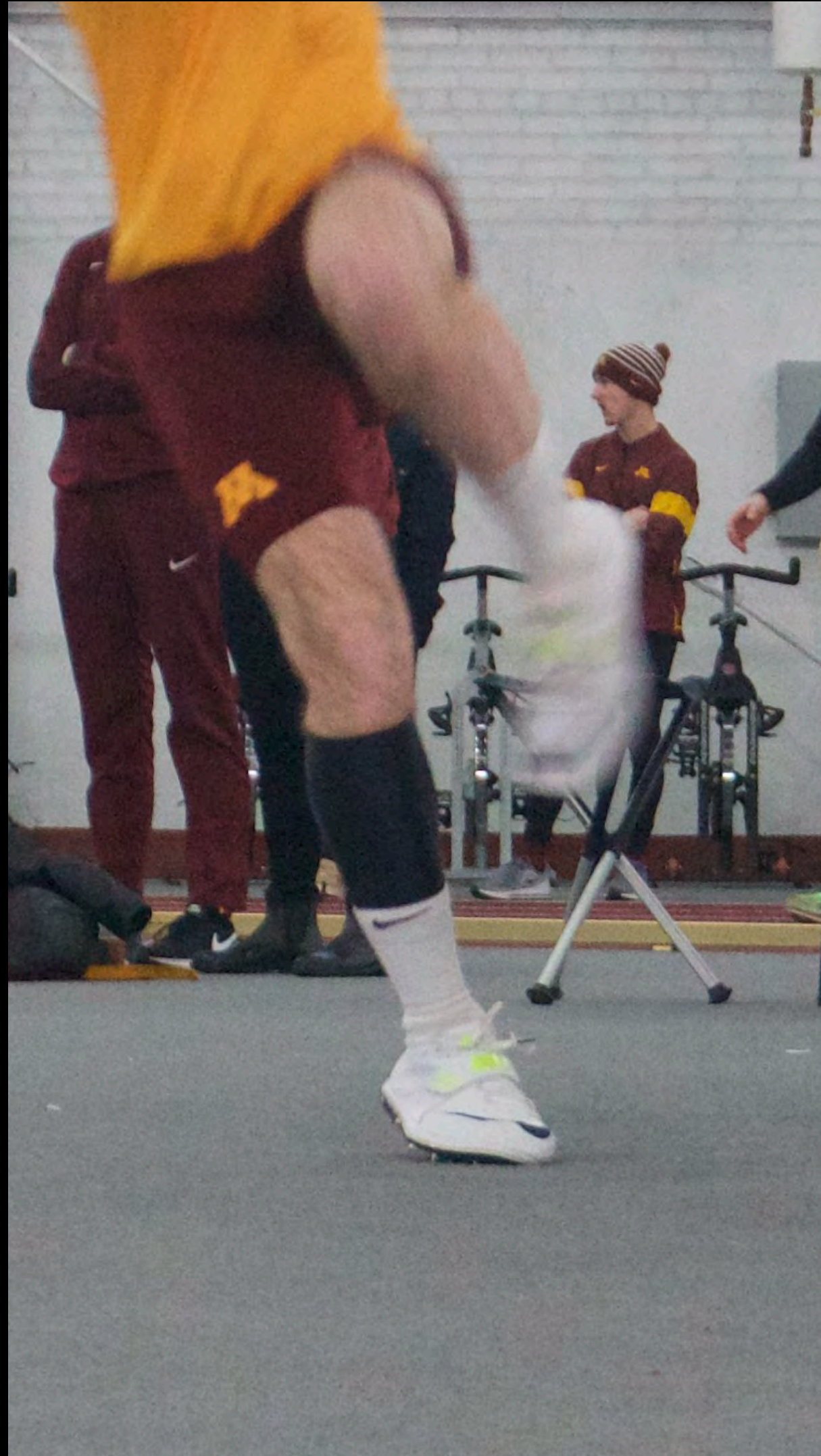
TAKE OFF FOOT



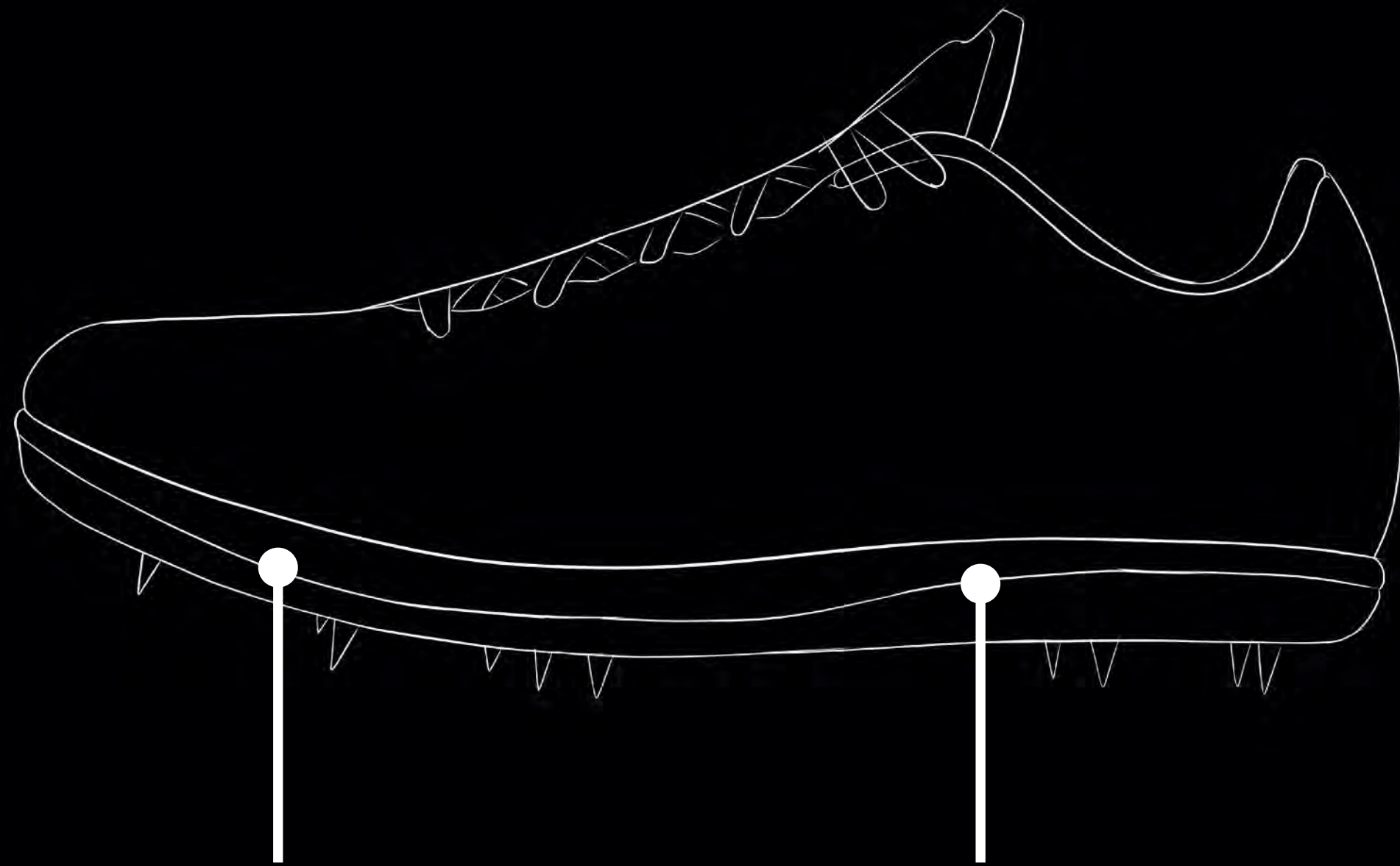
SLOW MOTION - SPIKES



TAKE OFF FOOT

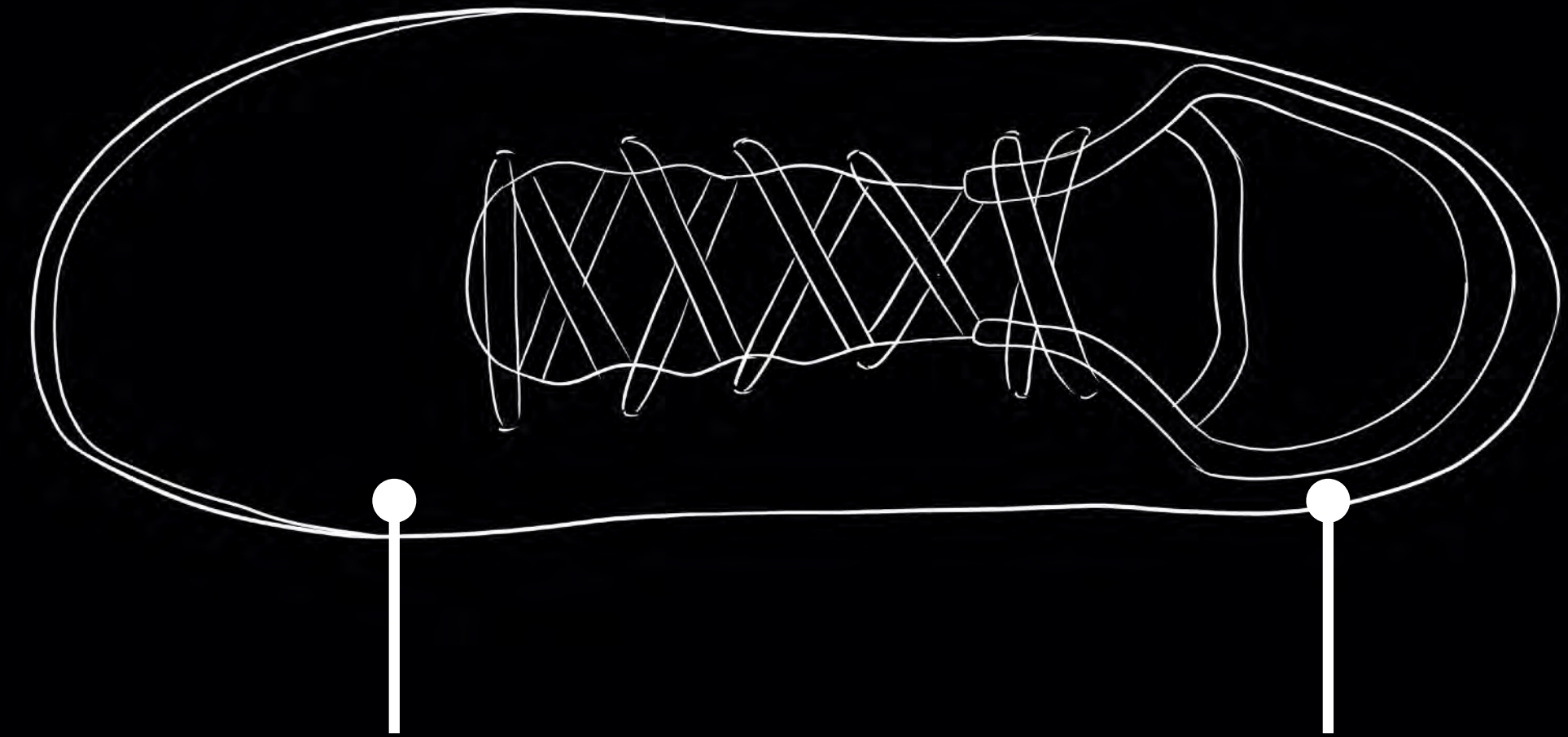


AREAS FOR IMPROVEMENT



Firmer Medial Foam

Plate Torsion



Stronger Medial Upper

Better Ankle Support

FOOT PRESSURE

THE APPROACH

TAKE OFF

Straight

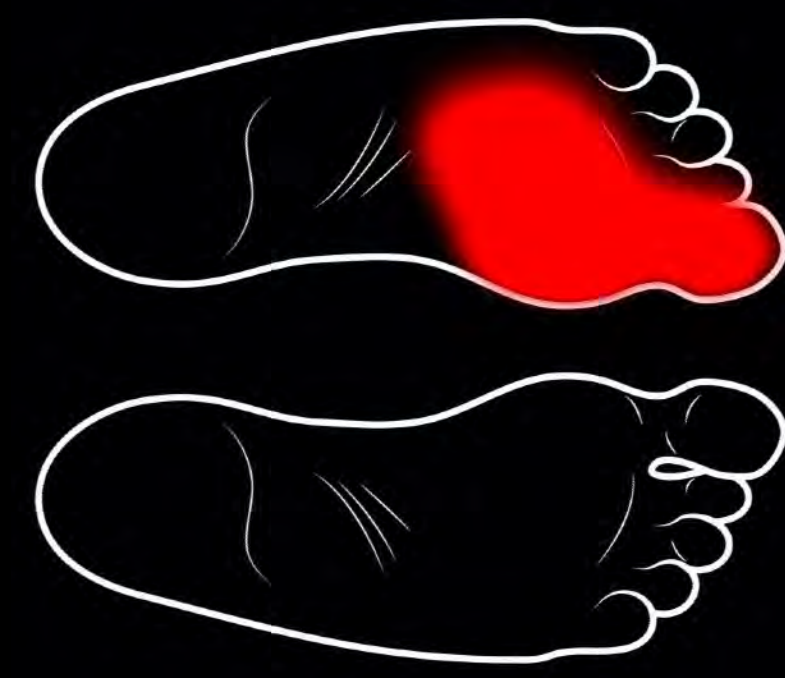
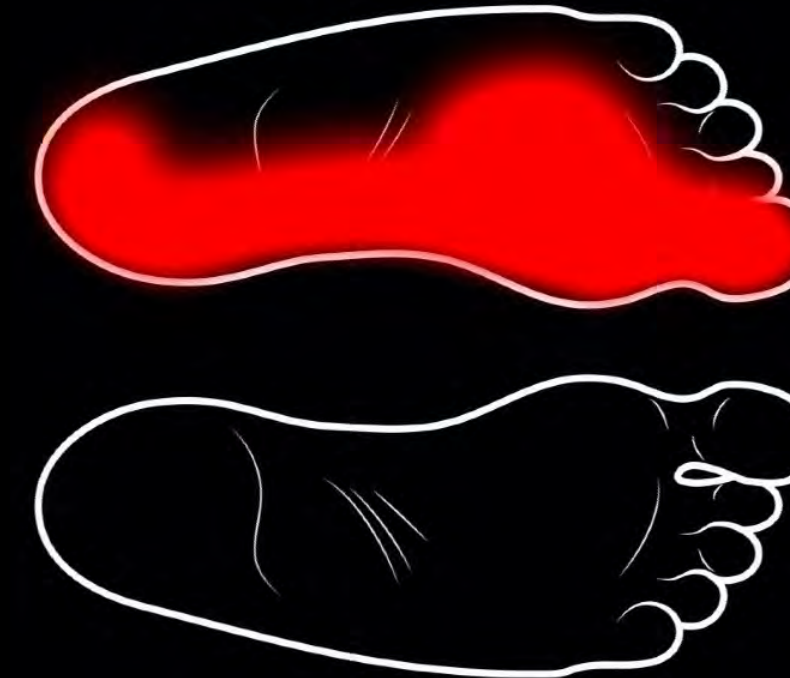
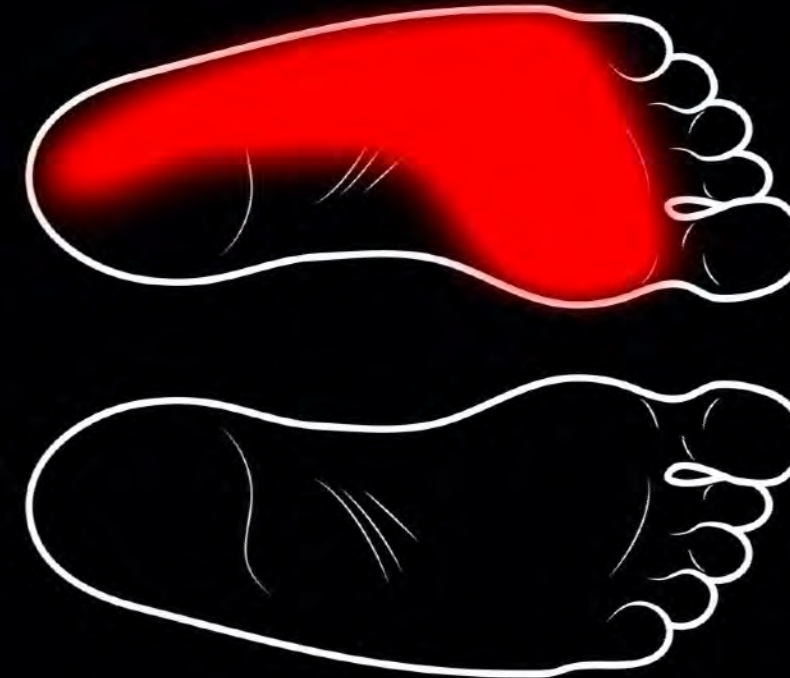
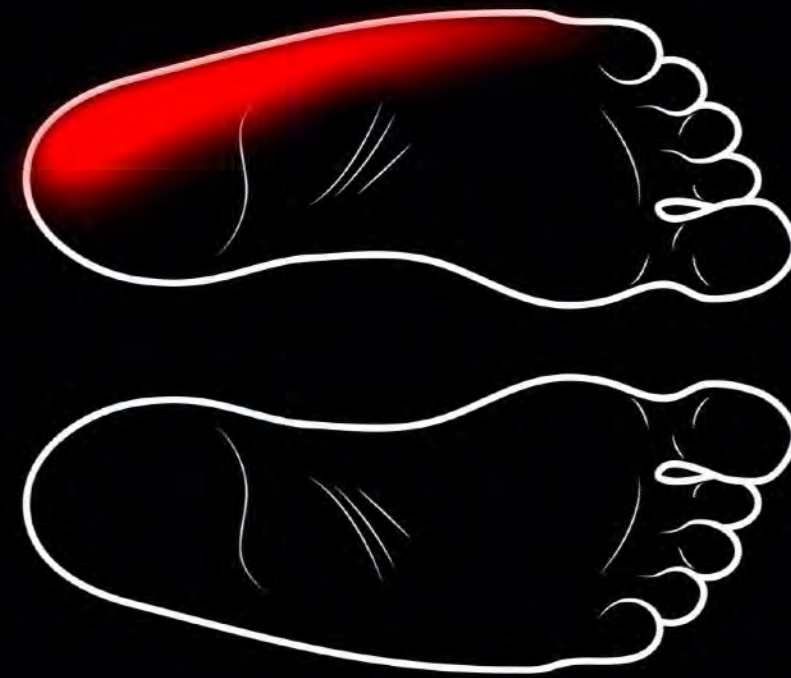
Curve

Initial Contact

Full Contact

Medial Transfer

Toe Off



FOOT SORENESS DATA

Left

Right

MTP & General
Forefoot Pain

Arch Pains



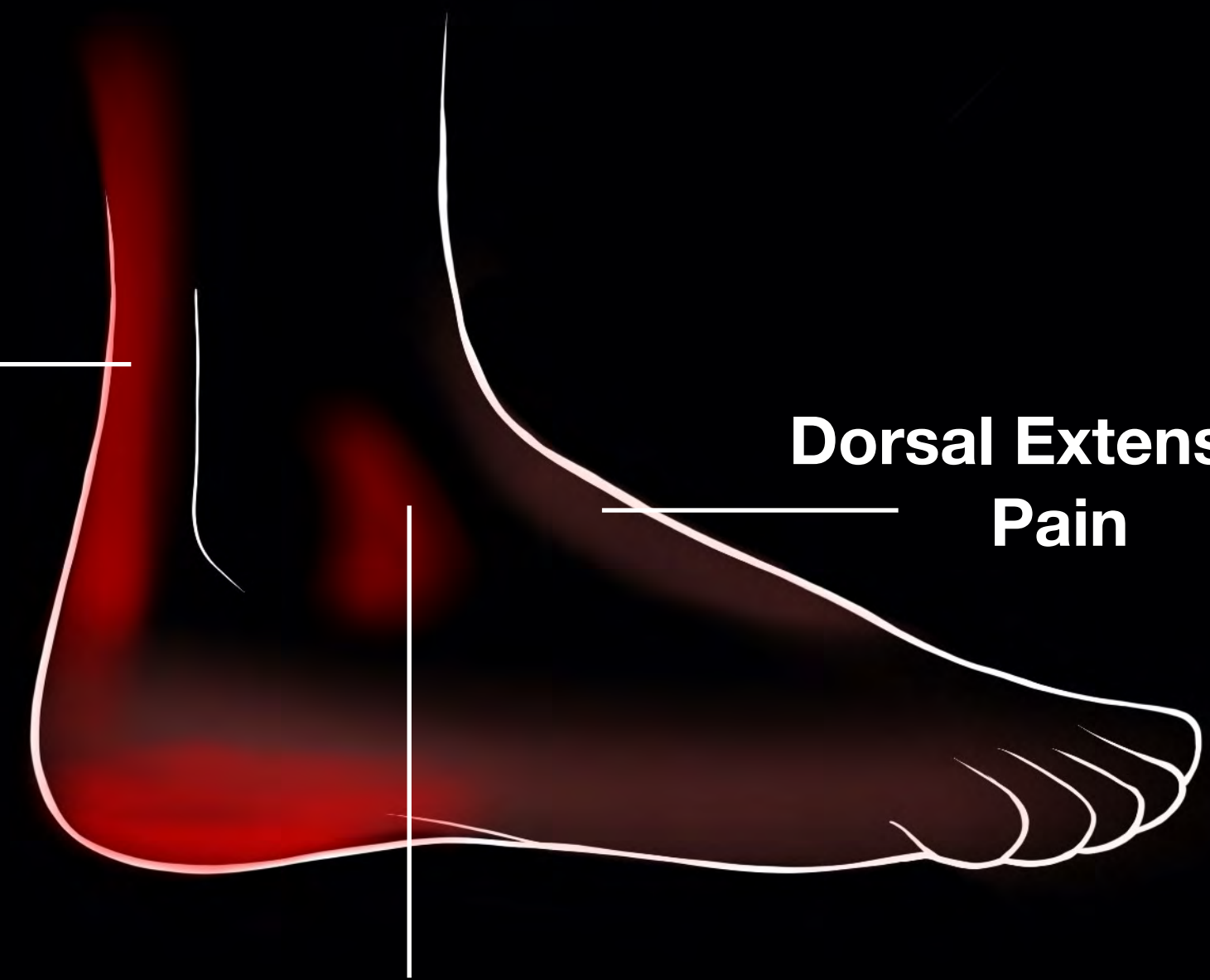
Calcaneus
Bruising

Jump Foot

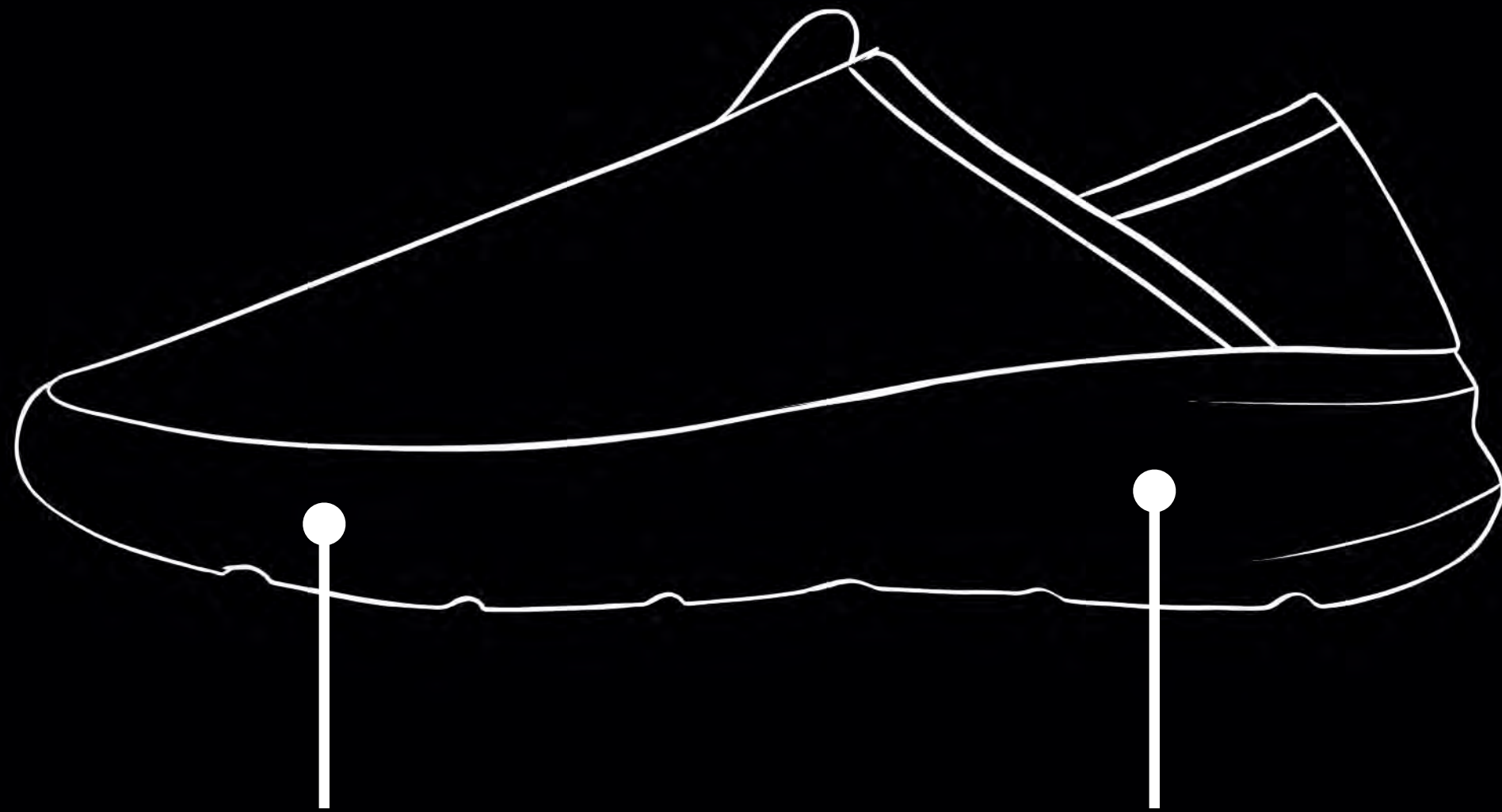
Achilles
Tendon

Dorsal Extensors
Pain

Anterior Talofibular
Ligament Strain

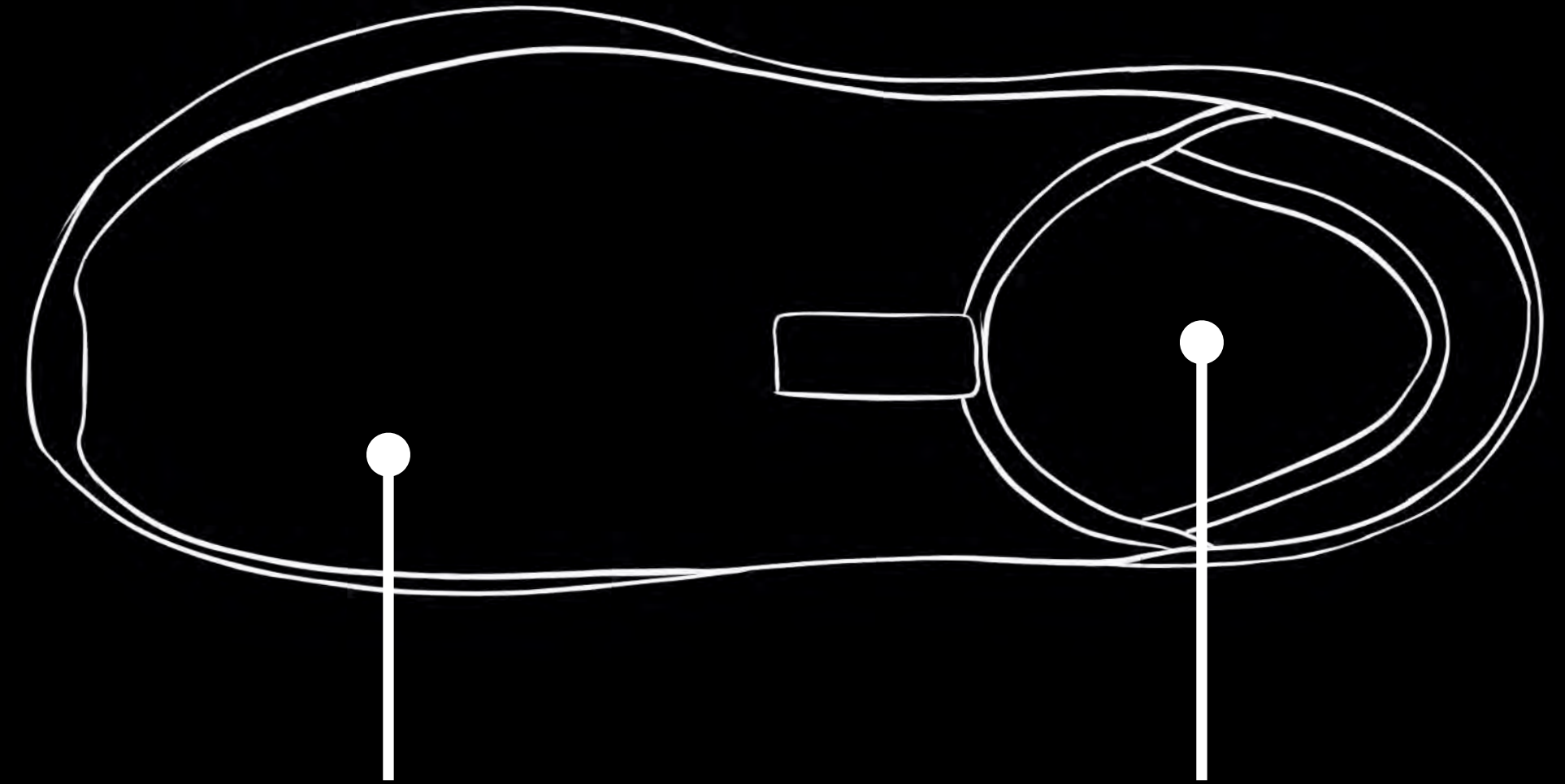


AREAS FOR IMPROVEMENT



Sole Formation


Adequate Heel Cushioning



Compression Upper

Insole Support

DESIGN BRIEF // TRAINING

A high jumper is captured in mid-air, clearing a bar on a track. The background shows a grassy field and trees. The image is overlaid with white text.

Design training shoes for elite male high jumpers that focuses on forefoot cushioning and responsiveness while keeping the shoe comfortable and lightweight

FOB \$35 // Retail \$140

Spring 2024 for Paris Olympics

Cushioning / Lockdown / Durability

FEATURES & BENEFITS

Upper reinforcements for increase foot stability

Propulsive properties for a more responsive feel

Midsole plate for optimal energy return

Low foot drop for an optimal foot position



**Polyester // Dyneema // TPU overlay
37.5 technology // Pebax foam
Graphene rubber // Carbon fiber plate**

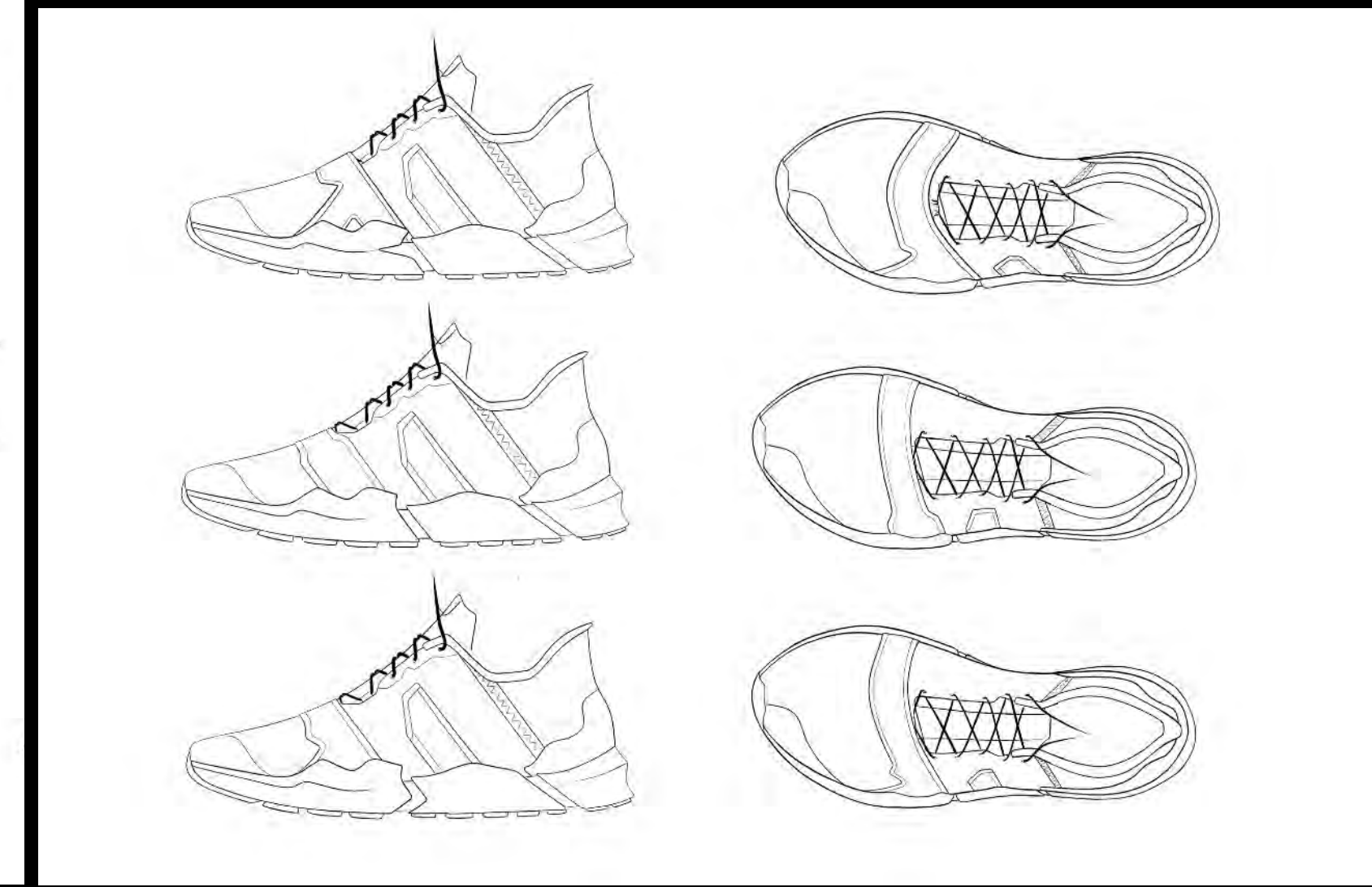
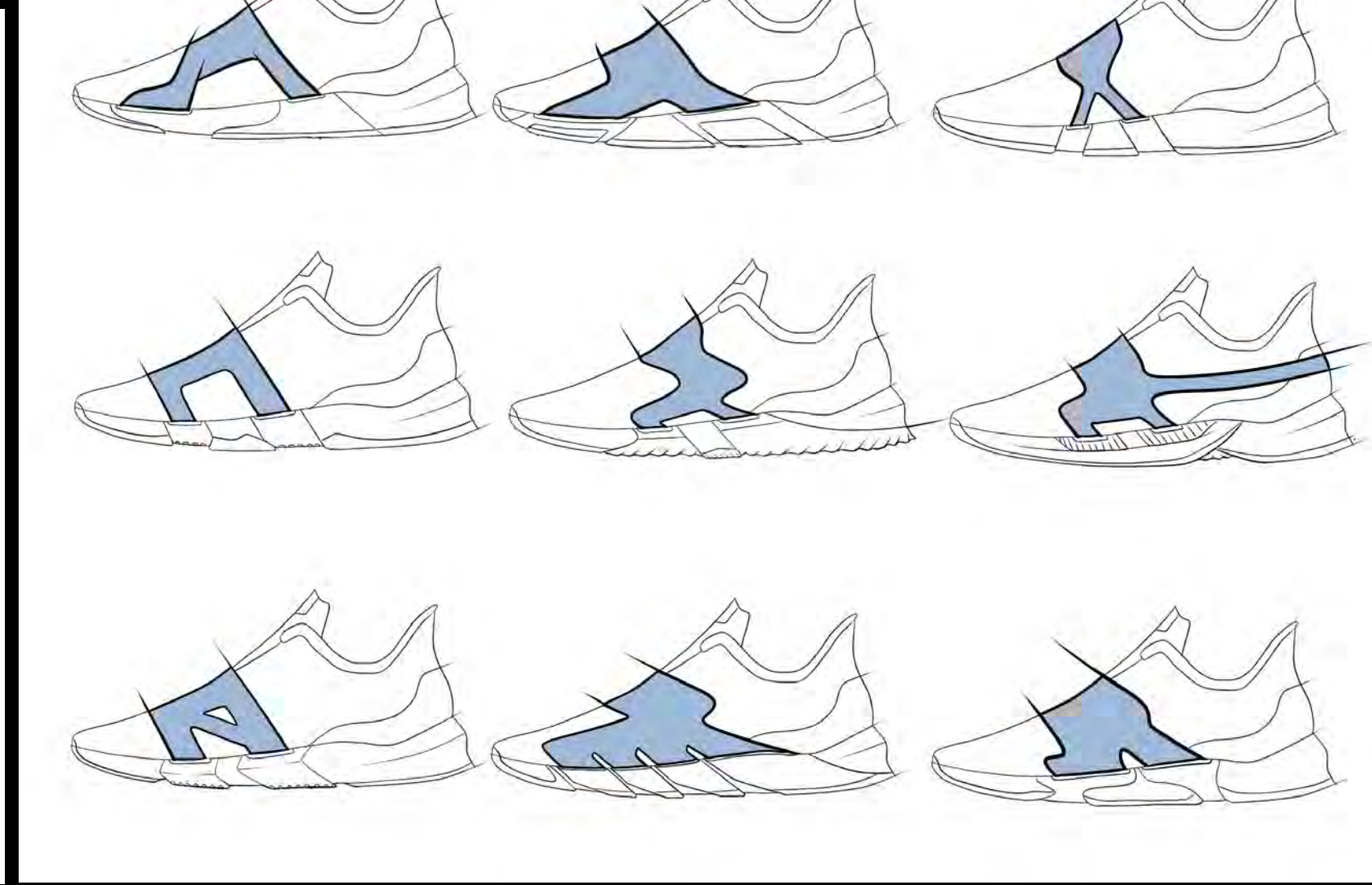
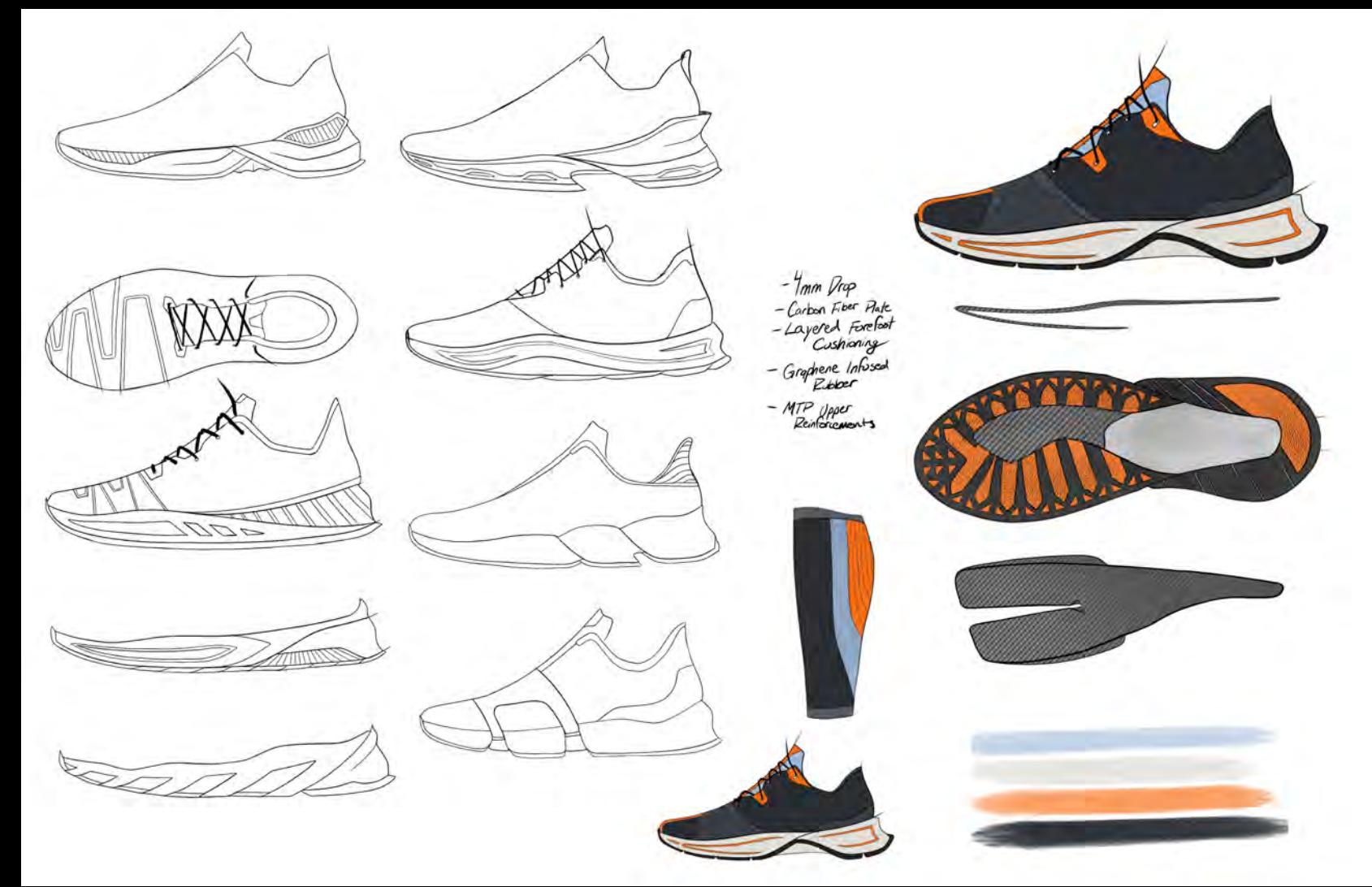
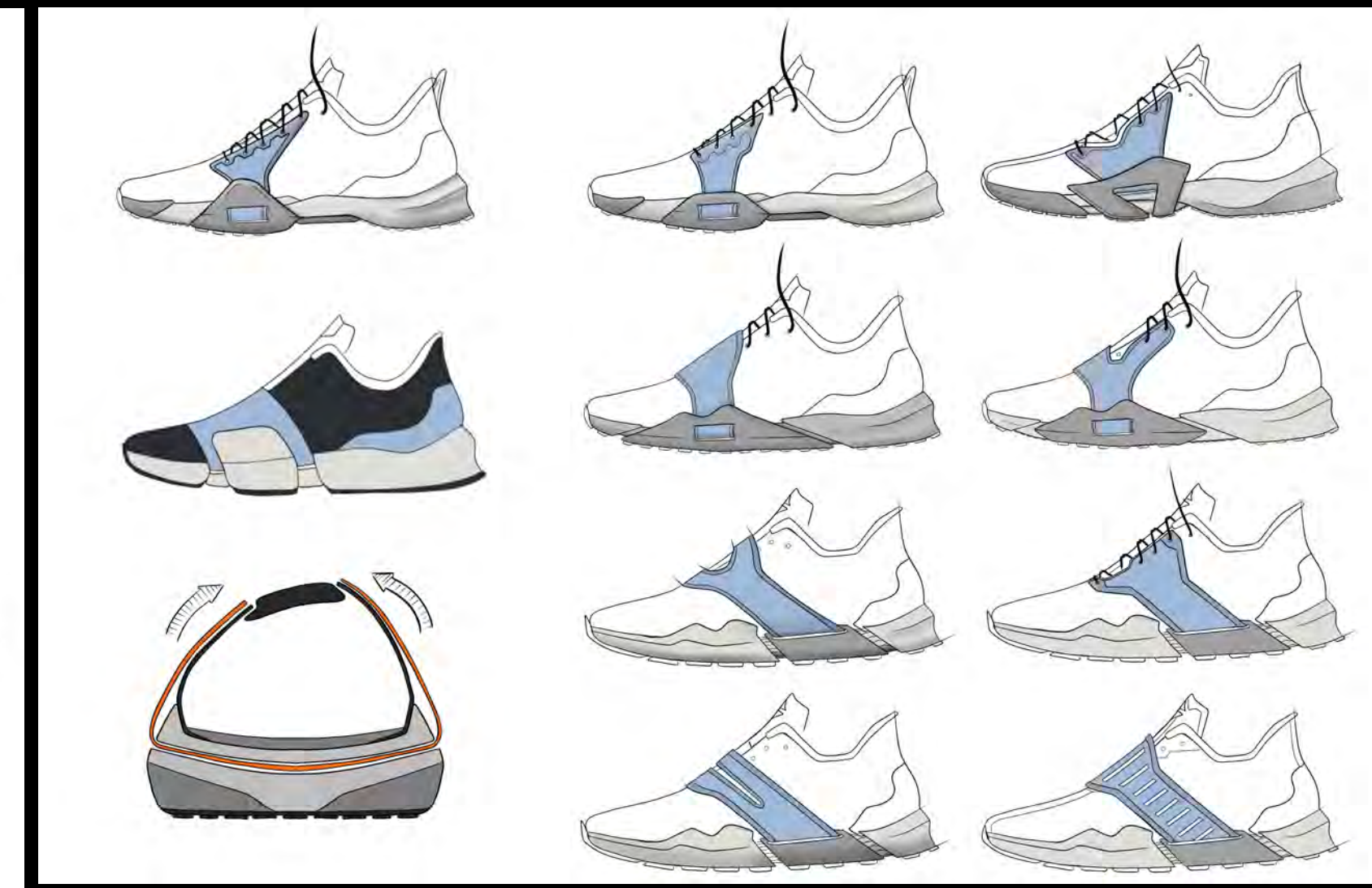
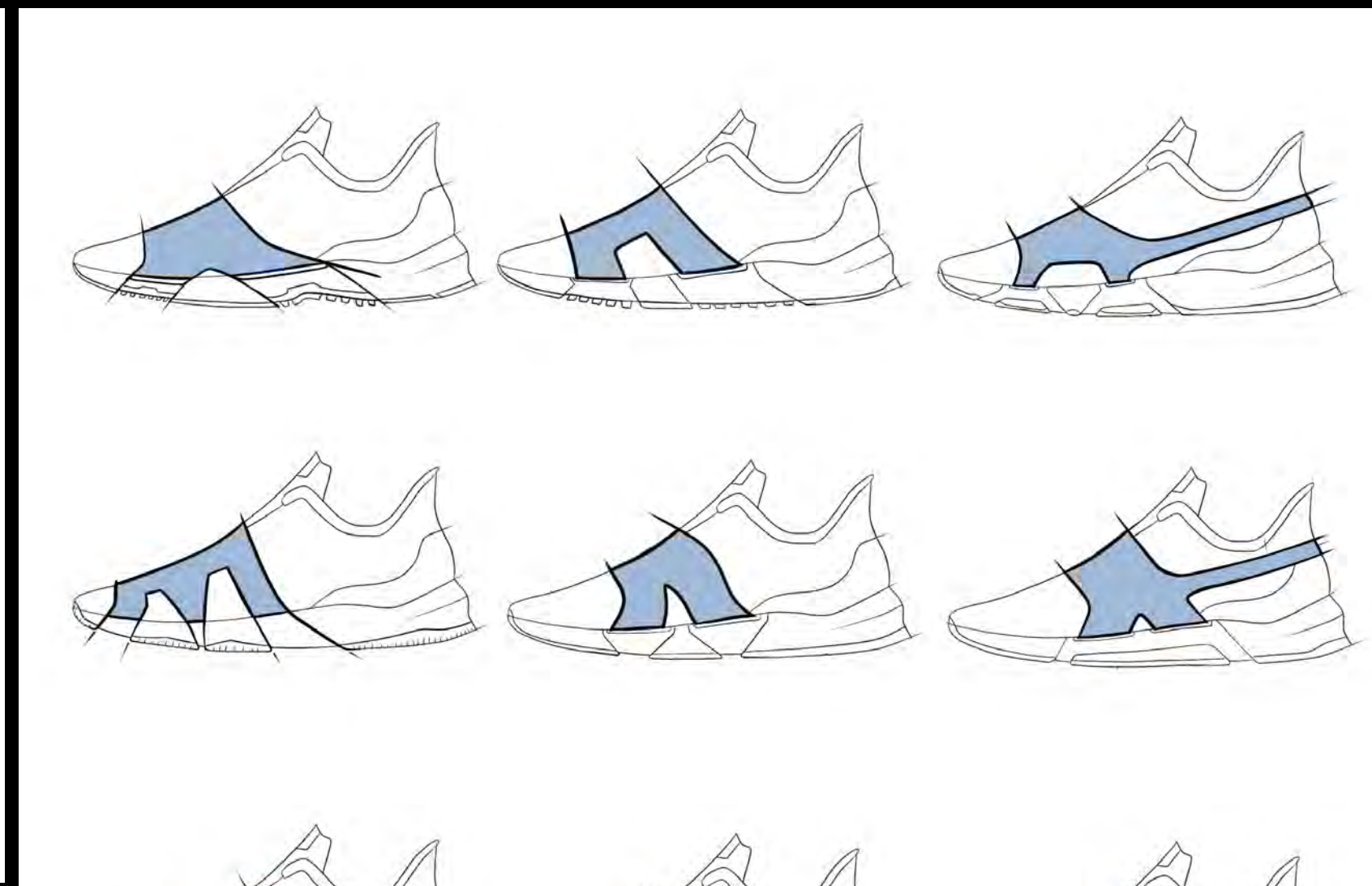
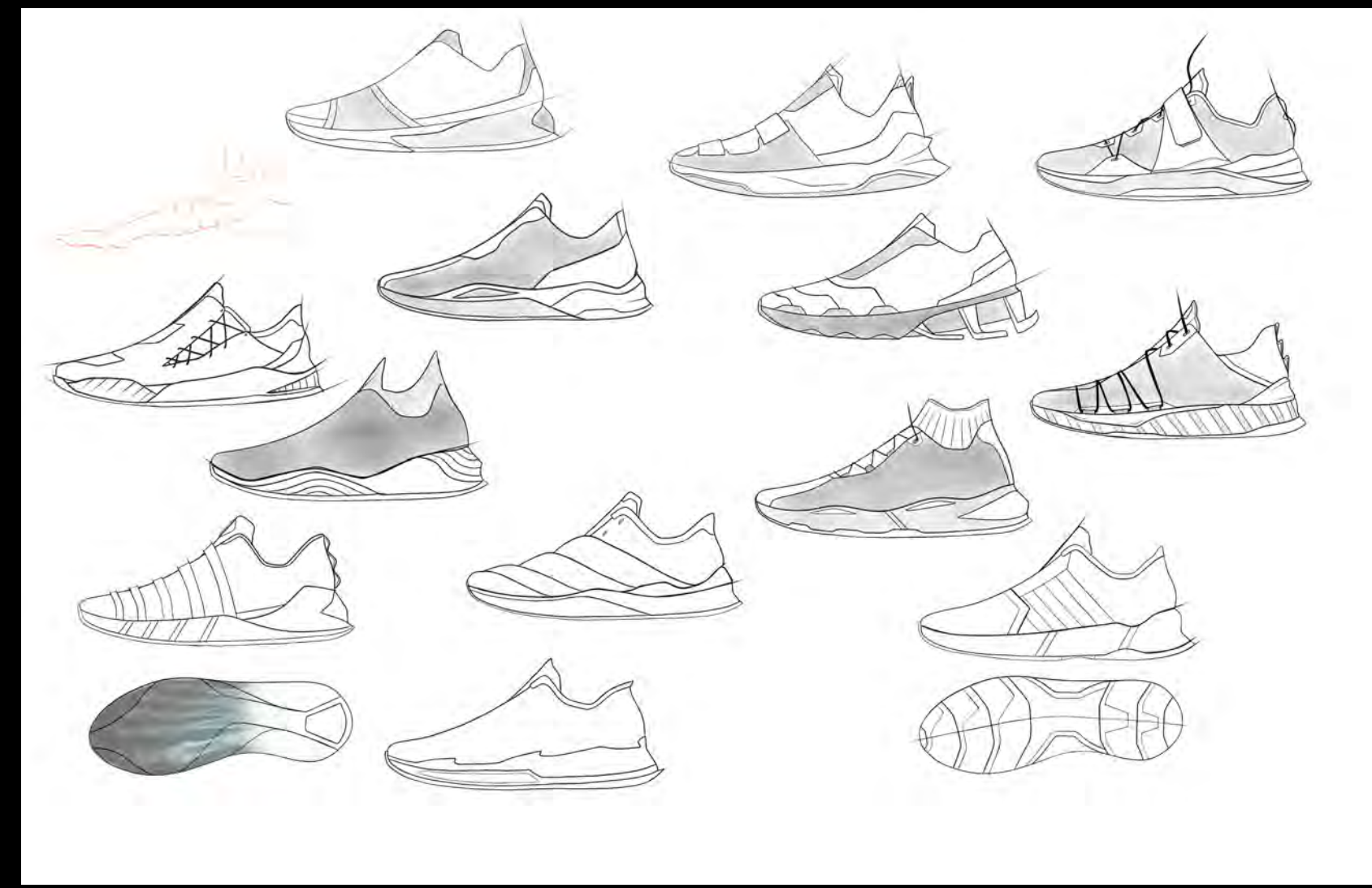


**Engineered mesh upper
Injection molding for midsole
Vacuum form carbon fiber plate**



**Cooling Energy Palette
Sunrise Orange // Midnight Blue
Charcoal Black**

TRAINER IDEATION



DESIGN BRIEF // COMPETITION

Design competition spikes for elite male high jumpers who jump off the left foot that increases propulsion on take off while locking down the foot and supporting the ankle

FOB \$30 // Retail \$120

Spring 2024 for Paris Olympics

Support / Propulsion / Lockdown

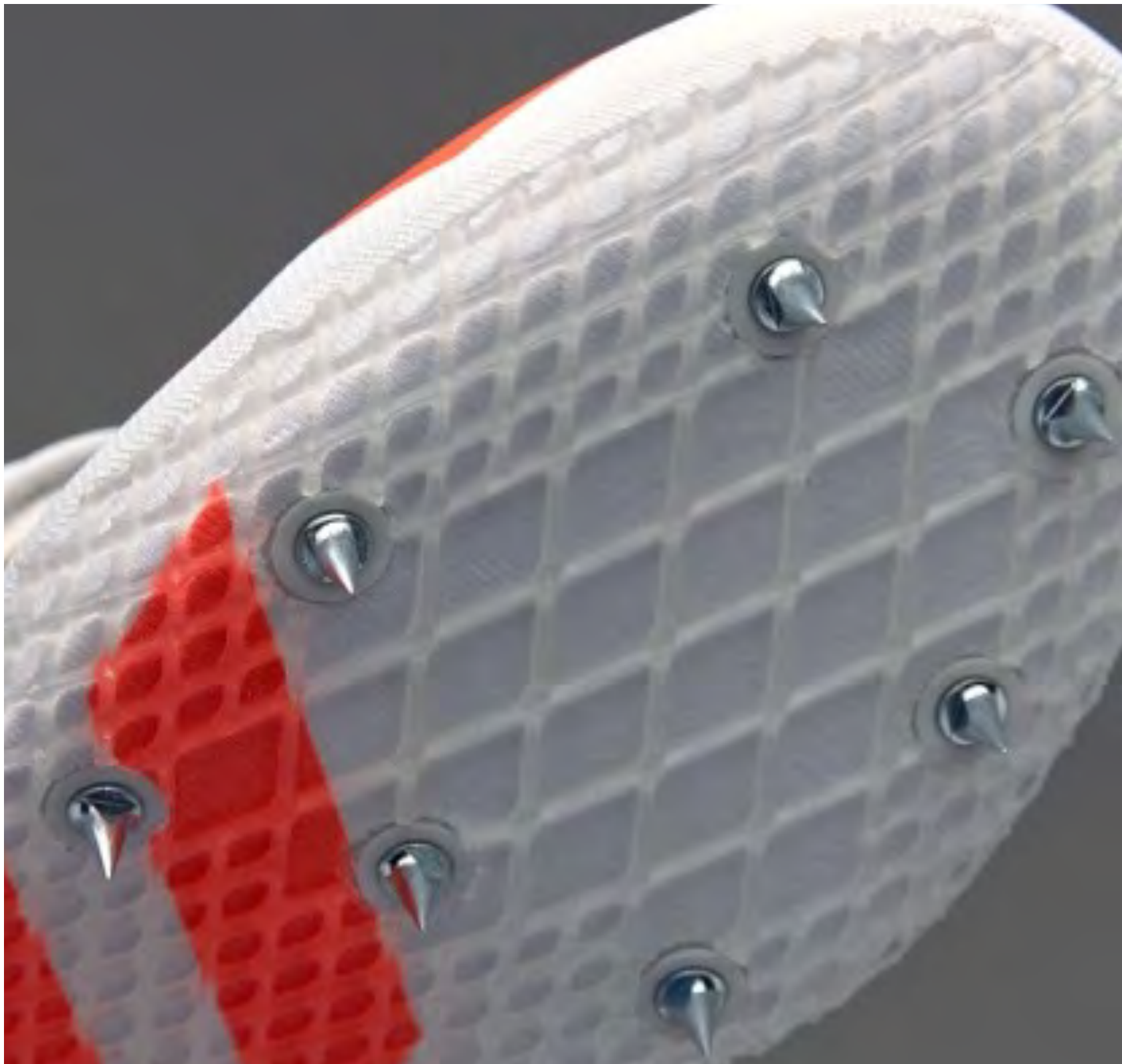
FEATURES & BENEFITS

Insole configuration for increasing COM during take off

Midsole plate for optimal propulsive properties

Upper reinforcements on jump foot for foot lockdown

High top silhouette for ankle and foot stability



**Polyester // Non woven // TPU overlay
Pebax foam and spike plate
37.5 Technology**

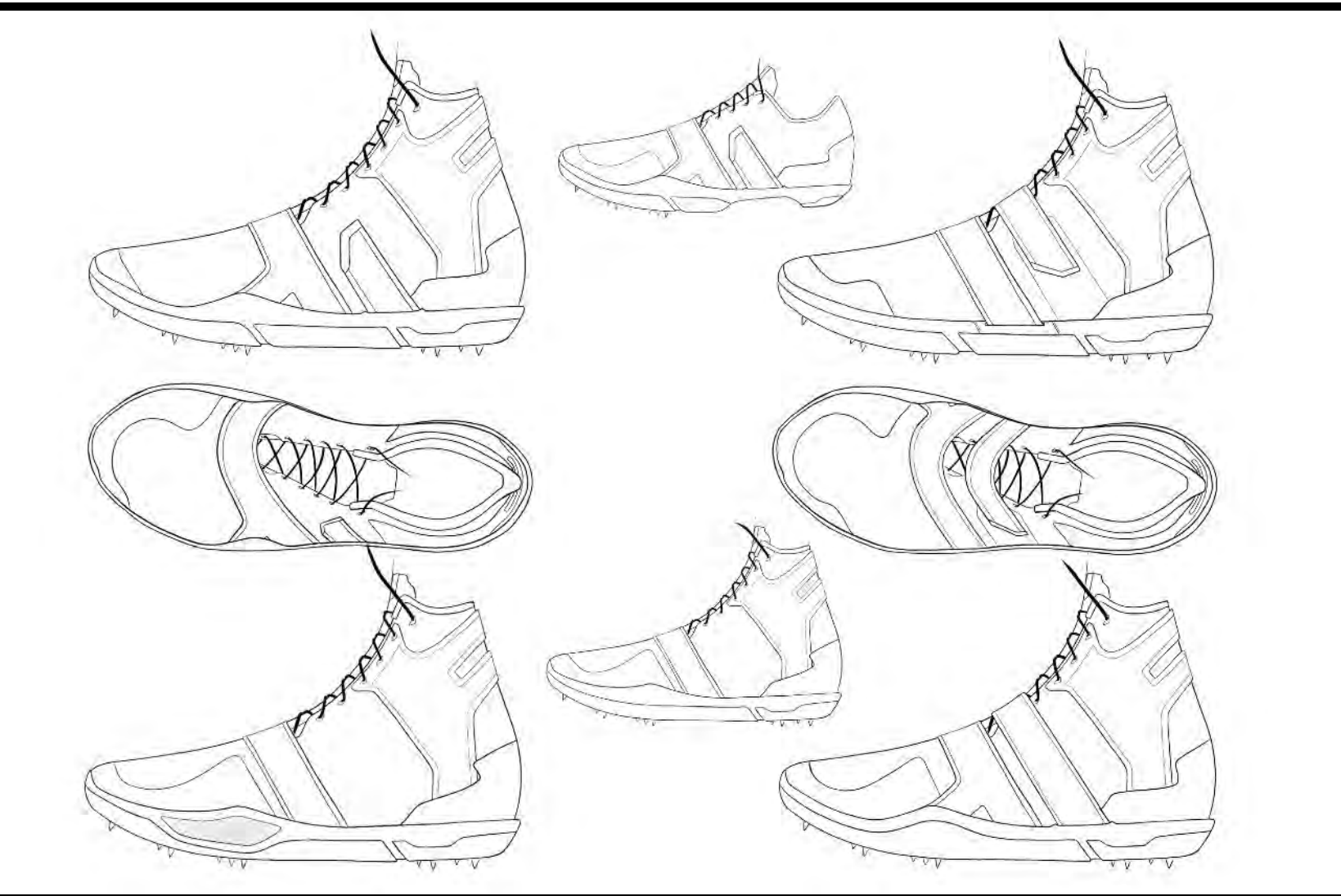
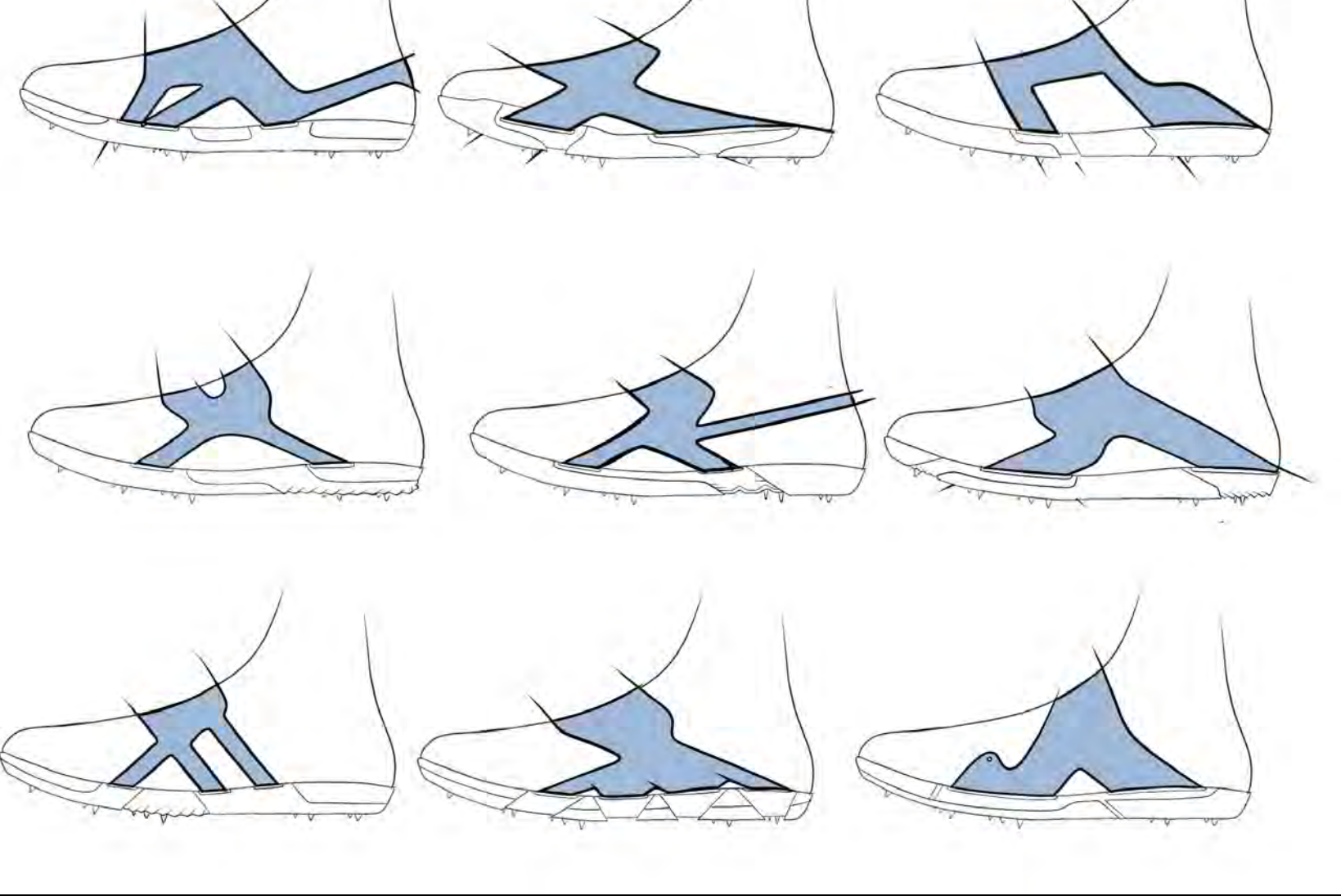
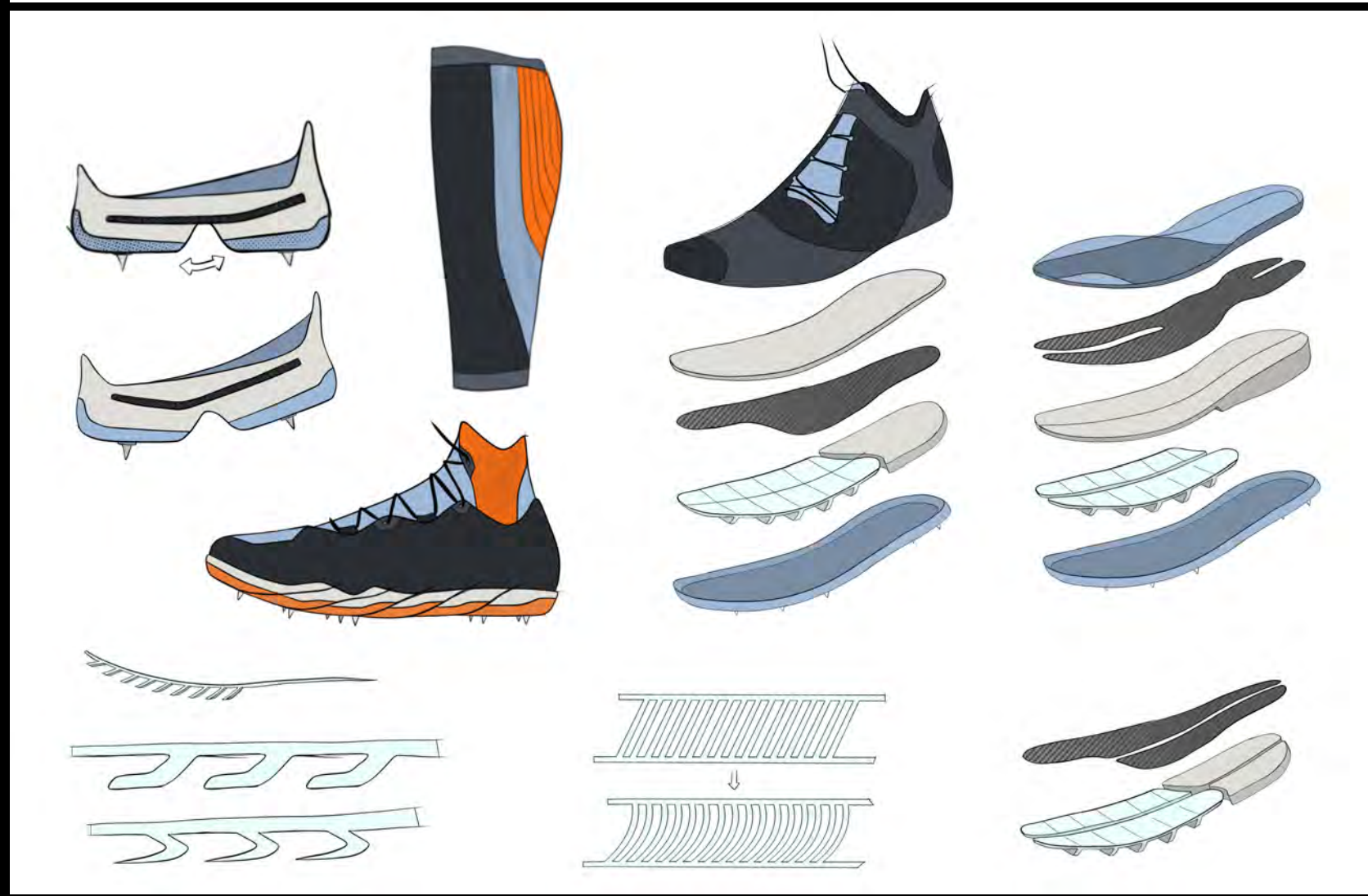
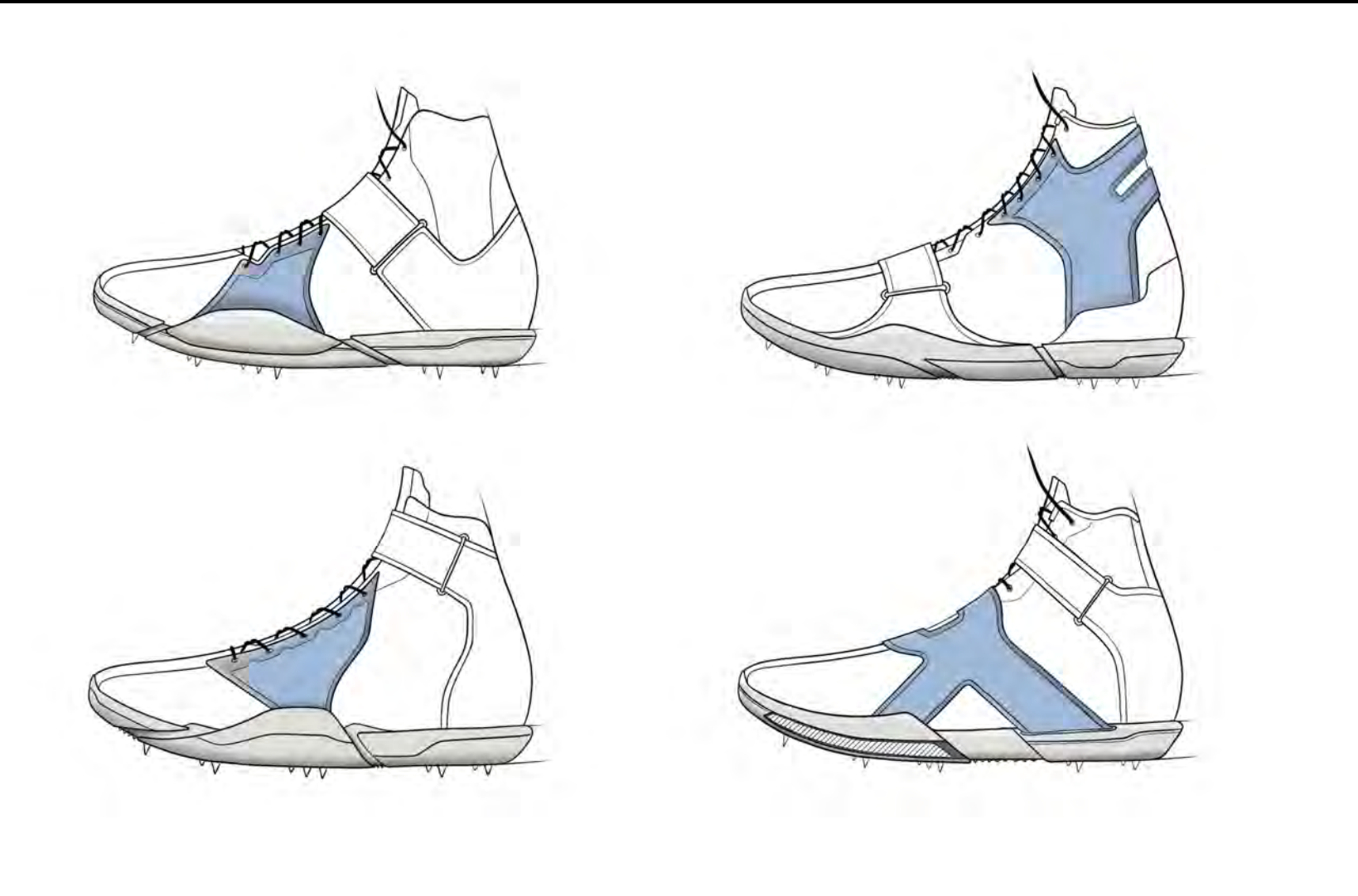
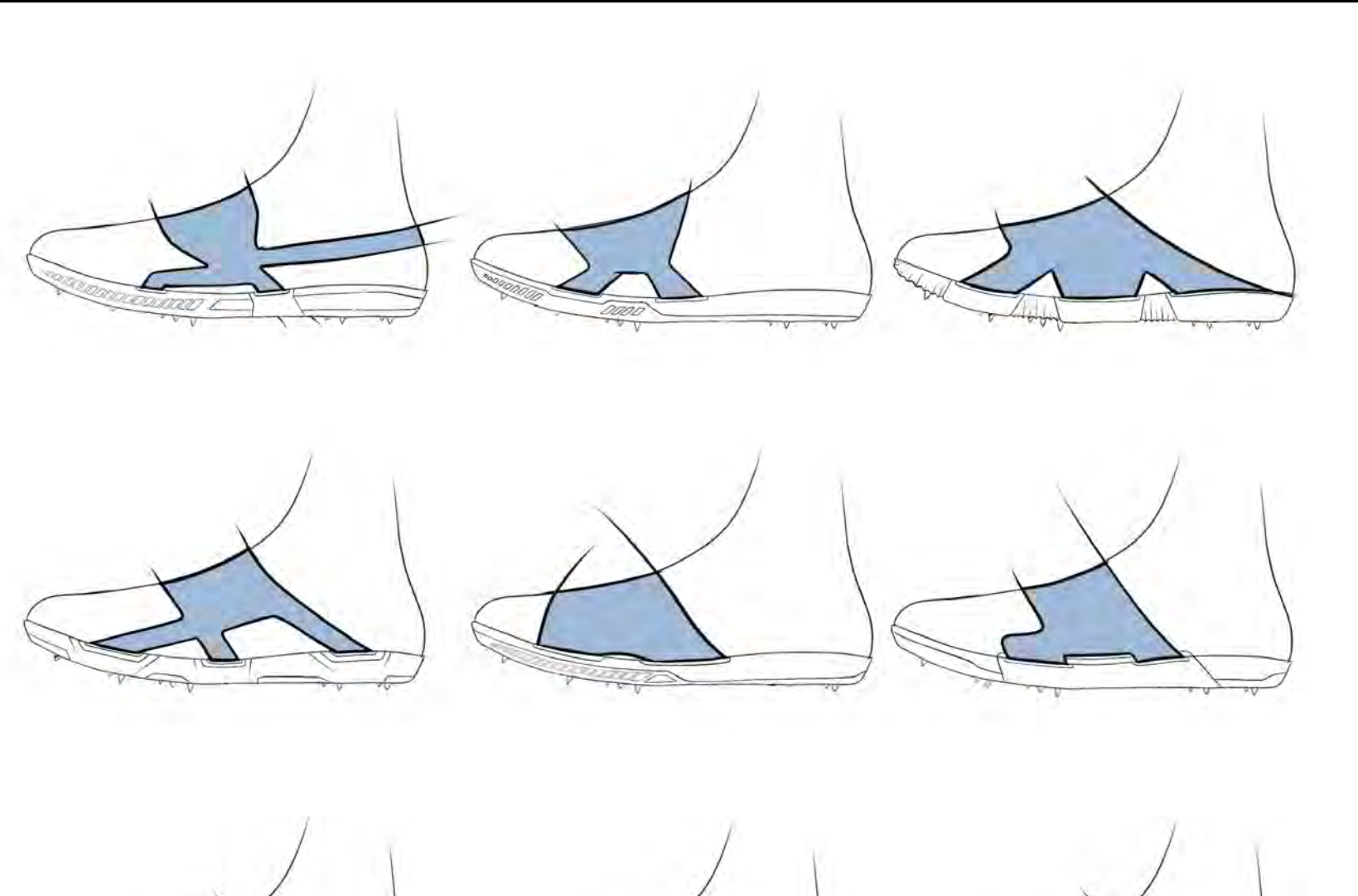
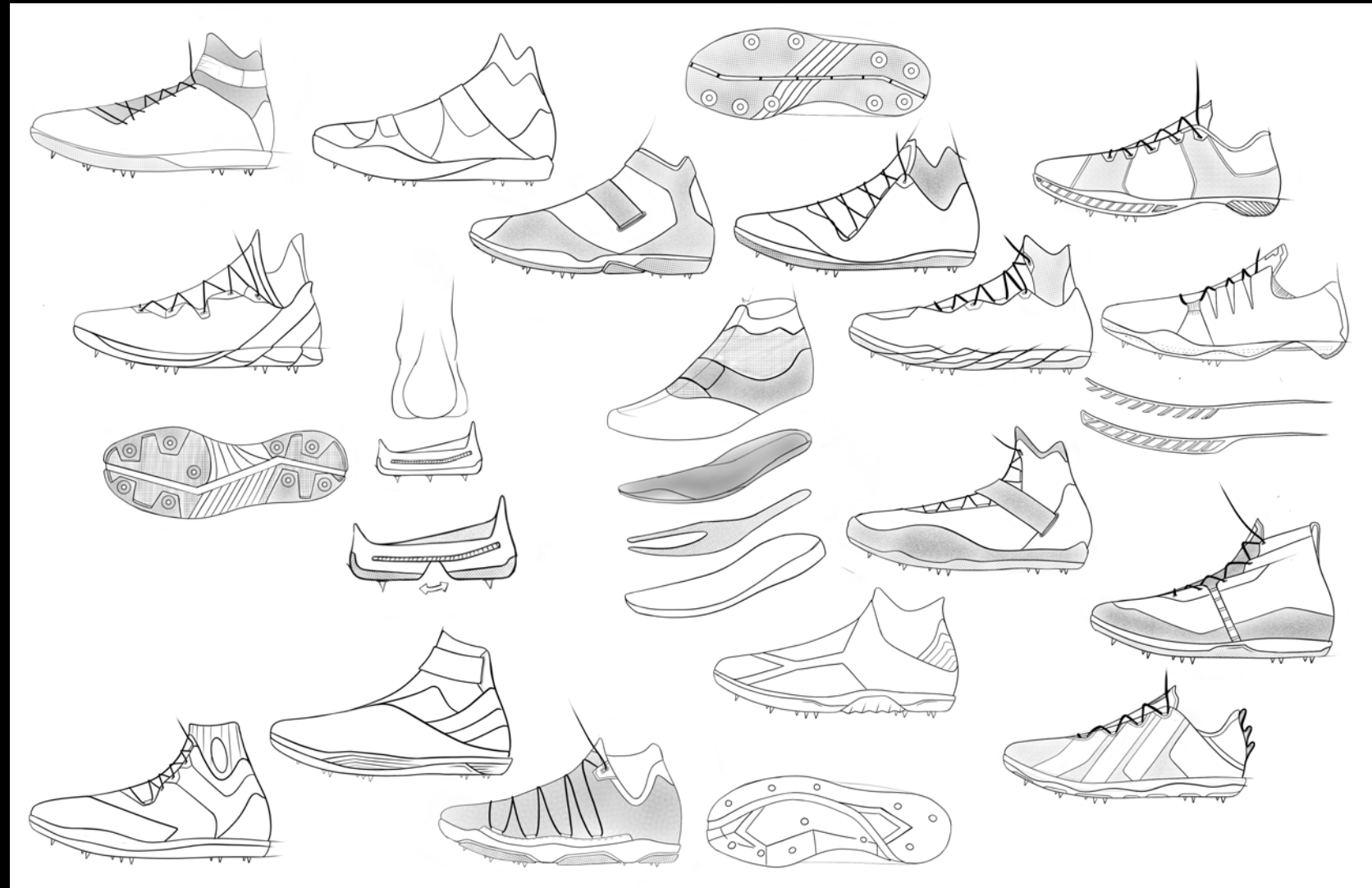


**Laser cut upper, heat press TPU
Injection molding for midsole
3D printed spike plate**



**Cooling Energy Palette
Sunrise Orange // Midnight Blue
Charcoal Black**

SPIKE IDEATION



DESIGN BRIEF // RECOVERY

Design a recovery shoe for elite male high jumpers that aids in foot pains and injuries while being extremely comfortable, breathable and supportive

FOB \$25 // Retail \$100

Spring 2024 for Paris Olympics

Circulation / Cushioning / Support

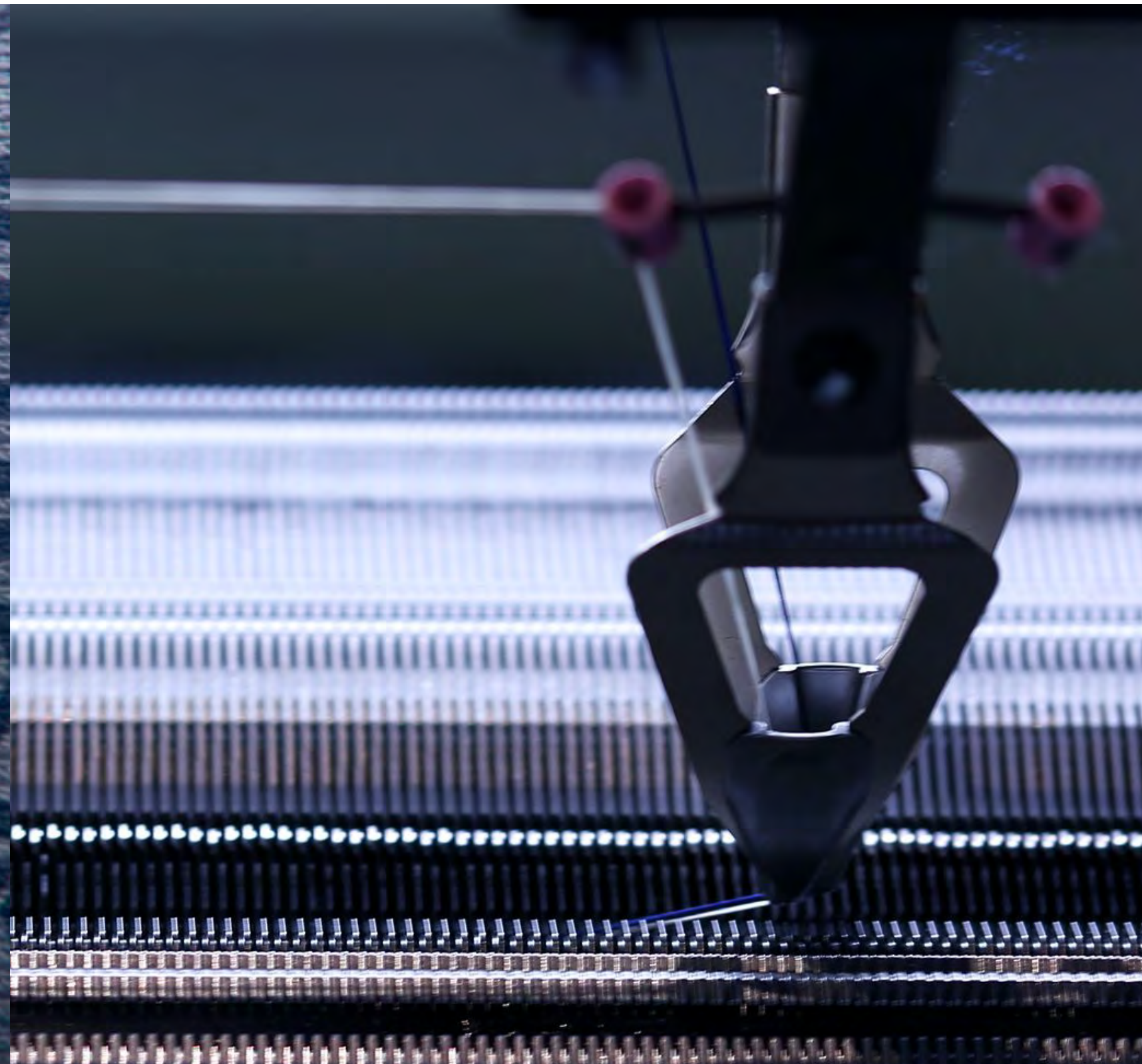
FEATURES & BENEFITS

Upper technology to increase blood circulation to the feet

Sole incline to actively stretch calf muscles

Stimulating and cushioning sole to rejuvenate muscles and joints in the feet

Interchangeable sole for customizable fit and feel

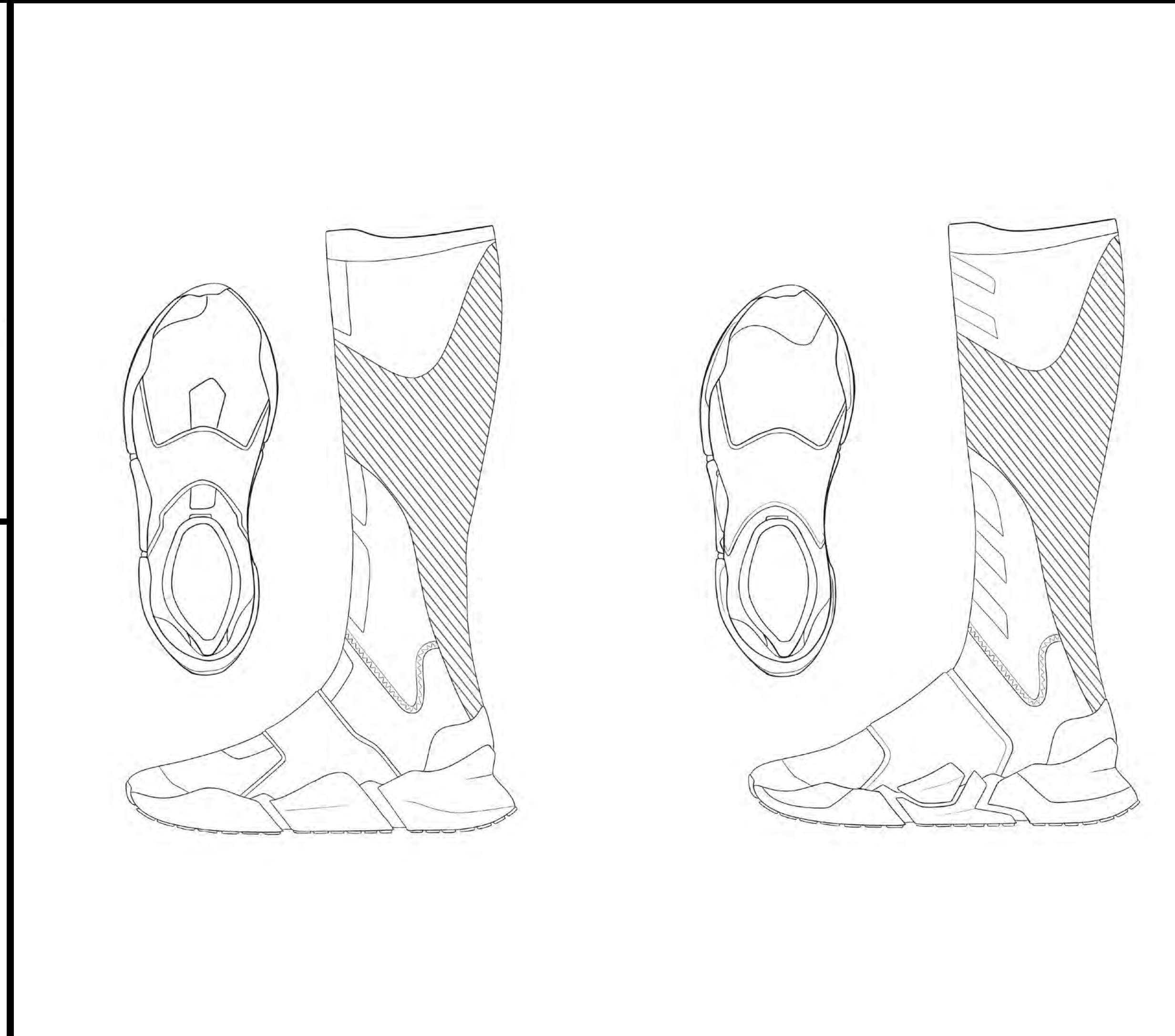
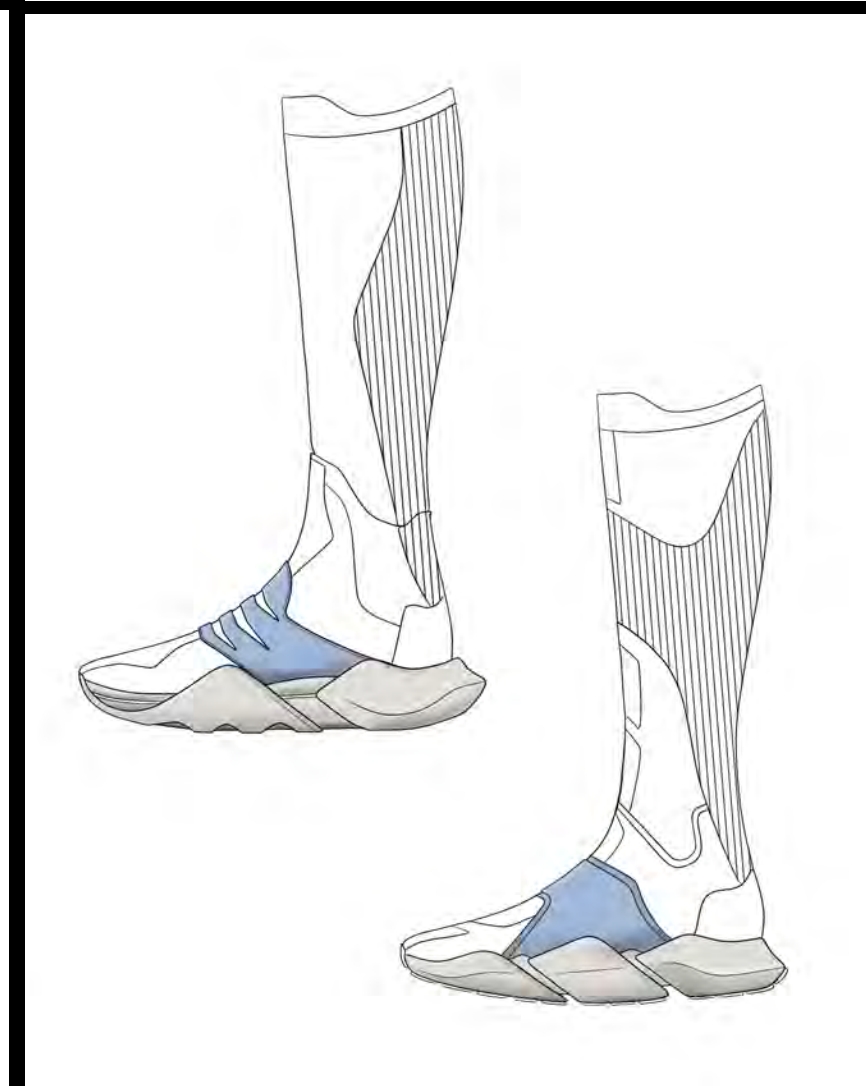
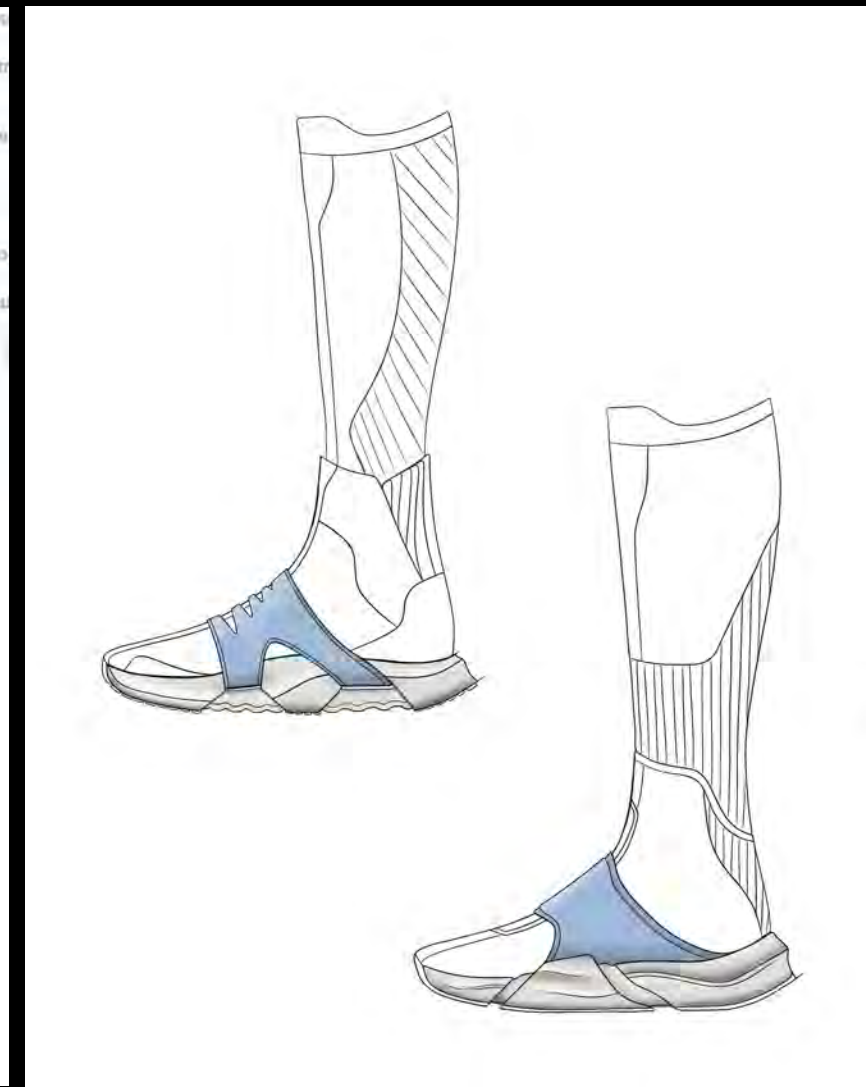
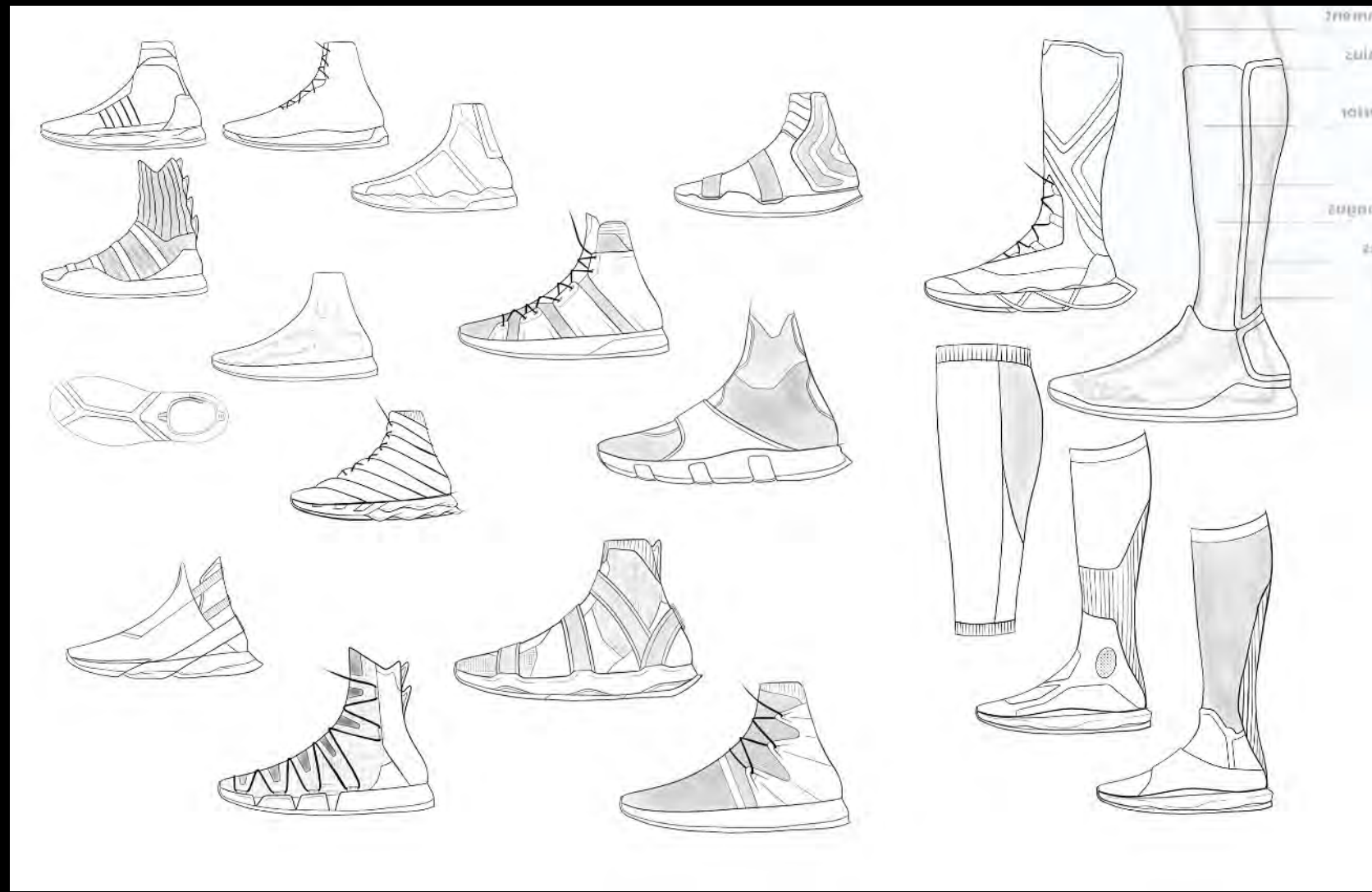


**Polyester knit upper // Elastane
Oofos Foam // Recycled rubber
37.5 Technology // Celliant**

**Industrial knitting machine
Injection molding for midsole
Heat press**

**Cooling Energy Palette
Sunrise Orange // Midnight Blue
Charcoal Black**

RECOVERY IDEATION



FINAL DIRECTION



Jobs To Be Done - Presentation

Week 1-2

Prototypes

Week 3-4

Validation - Order presentations materials

Week 5-6

Validation/ Final Prototype - Start laying out packaging and prints for display, prep parts for exploded view

Week 7-8

Work fully on completing packaging, pamphlets and the exploded view. Have big prints for boards ready to print

Week 9-10

Finish up any loose ends and practice presentation.

Jobs To Be Done - Validation

Week 1-2

Prototypes prepped for validation

Week 3-4

Validate shoes with 3 athletes. Depending on virus, I would have to stay here and use athletes in the area or go back to Minnesota

Week 5-6

Validation/ Final Prototype - Start laying out packaging and prints for display, prep parts for exploded view

Week 7-8

Work fully on completing packaging, pamphlets and the exploded view. Have big prints for boards ready to print

Week 9-10

Finish up any loose ends and practice presentation.

TRAINING

UPPER

COLLAR

INSOLE

MIDSOLE

PLATE

OUTSOLE

CUSHIONING

Heel counter & achilles cushioning and foam

Textured collar for a little extra padding

More dense foam in forefoot

Thin gel layer in forefoot
Ergonomic design

Waved plate to allow cushioning but also return energy

Durable outsole to protect midsole cushioning

RESPONSIVE

Lightweight material
Non intrusive design

Snug fit to keep heel in place

Energy returning foam

Energy return foam
Firmer layer of foam

Optimized design and shape for forefoot push off

Graphene infused rubber for traction

DURABILITY

Forefoot reinforcements on both lateral and medial

Fabric with high strength

More dense foam in forefoot

High quality foam with a wall that covers the upper to protect upper from ripping

Carbon fiber plate

Graphene infused rubber for traction

COMPETITION

UPPER

COLLAR

INSOLE

MIDSOLE

PLATE

SPIKES

SUPPORT

High top ankle support
with thicker / rigid materials

TPU support
structure in lining
to resist ankle
eversion

Left foot medial wall
cushioning

Slanted midsole
to support foot on
curve and take off

Slanted plate to
encourage vertical
force

Spike placement
to allow better support

PROPULSION

Denser foam with
energy return

Snug foam lining
to keep foot in place

Denser foam with
energy return

Energy return foam
Firmer layer of foam

Optimized design and
shape inspired by take
off foot pressures

Graphene or nanotube
spikes - really lightweight

LOCKDOWN

Left foot medial reinforcement
Right foot lateral reinforcement
Lightweight & non stretch
around forefoot

Snug foam lining
to keep foot in place

Curved insole to
keep foot centered

Slanted midsole to
keep foot on top of
sole - better lockdown

Ergonomic shaped
plate to help foot
lay naturally

Spike placement
to encourage foot to
stay in place

RECOVERY

UPPER

COLLAR

INSOLE

MIDSOLE

OUTSOLE

CIRCULATION

Compression upper to increase blood flow

Bioceramic infused lining

PR sole inspired bumps for stimulating the foot - ergonomic and interchangeable

Shaped to allow foot to lay in natural position

High traction to allow other parts of the shoe to work properly

COMFORT

Breathable and form fitting upper
Knit/ Elastane

Soft and stretchy lining

High cushioning insole - interchangeable Ortholite foam

OOFOS cushioning for ultimate

Segmented outsole to allow midsole cushioning

SUPPORT

Midfoot support strap and high cushioning on heel

Foam in lining to have snug fit on heel

Cushioning insole to support foot in the best resting position

Structure midsole to support arches and natural foot position

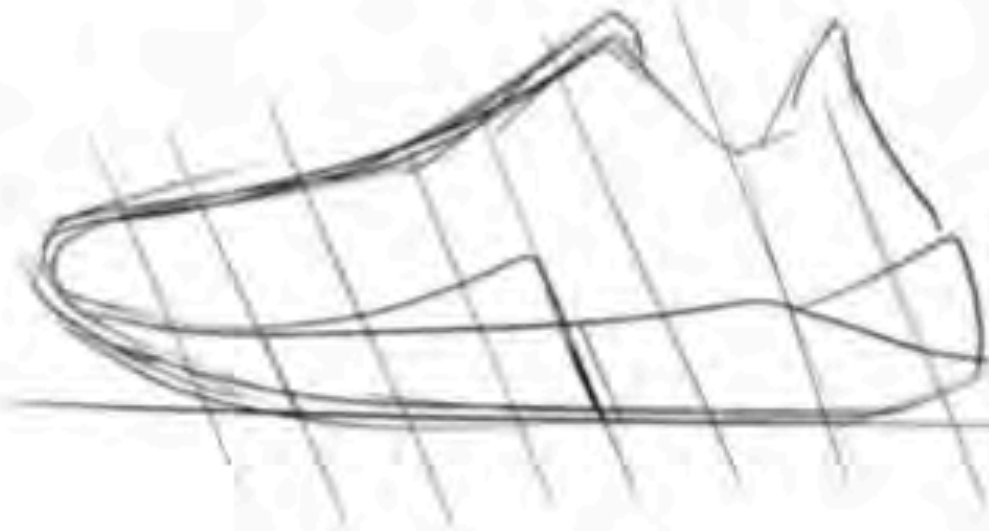
Ultimate traction to keep foot where it's suppose to be

A high jumper is captured in mid-air, performing a Fosbury Flop over a bar. The athlete is wearing a black and white striped singlet with a Canadian flag on the chest, black shorts with white polka dots, and white shoes. The bar is white with the brand name 'MONDO' visible. The background is a blurred stadium setting.

SPRING PROCESS

NATE ROESE

IDEATION



3D MODELING



3D MODELING

Bottom



Perspective



Left



Right



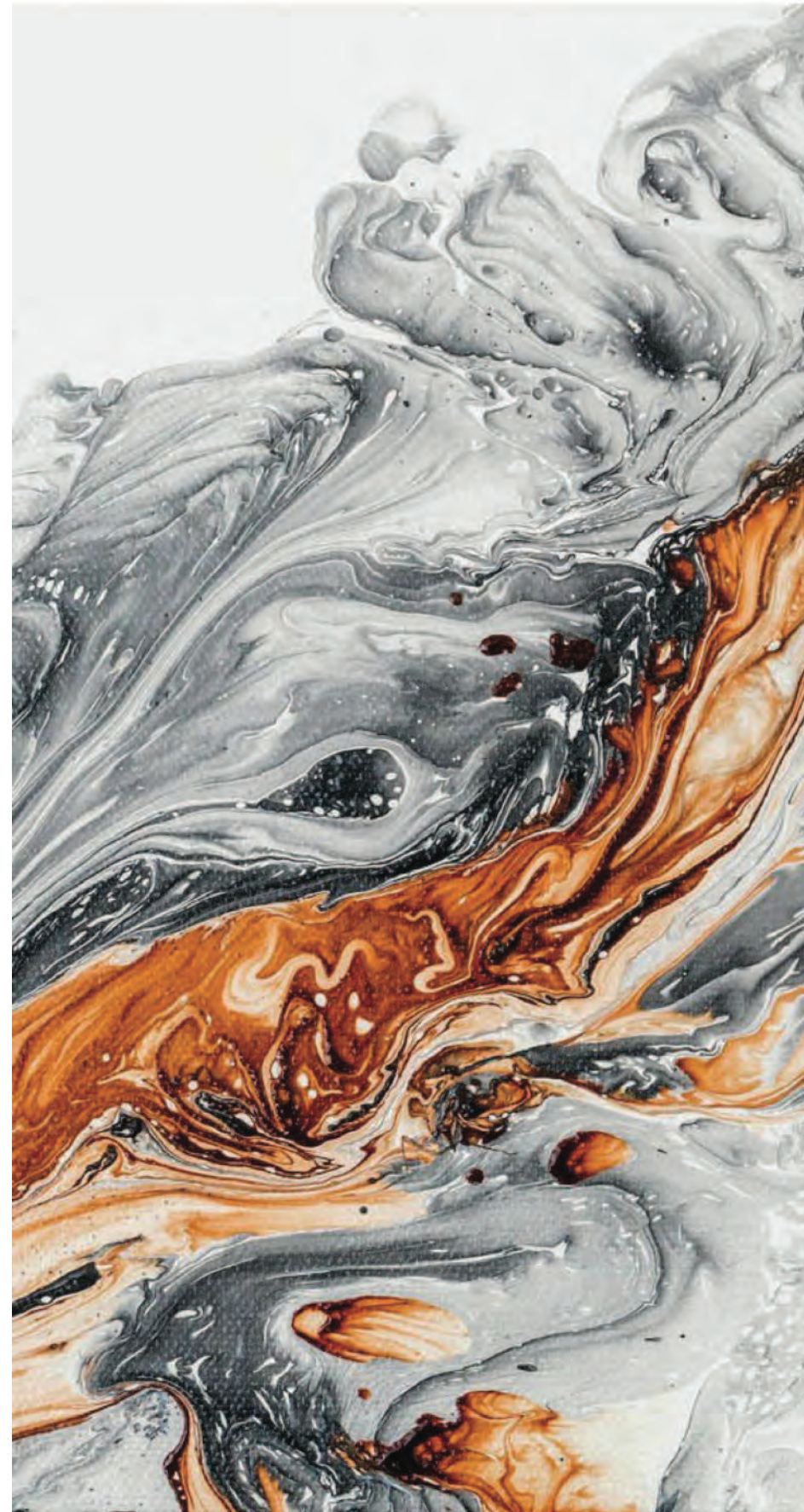
3D MODELING



MOODBOARDS

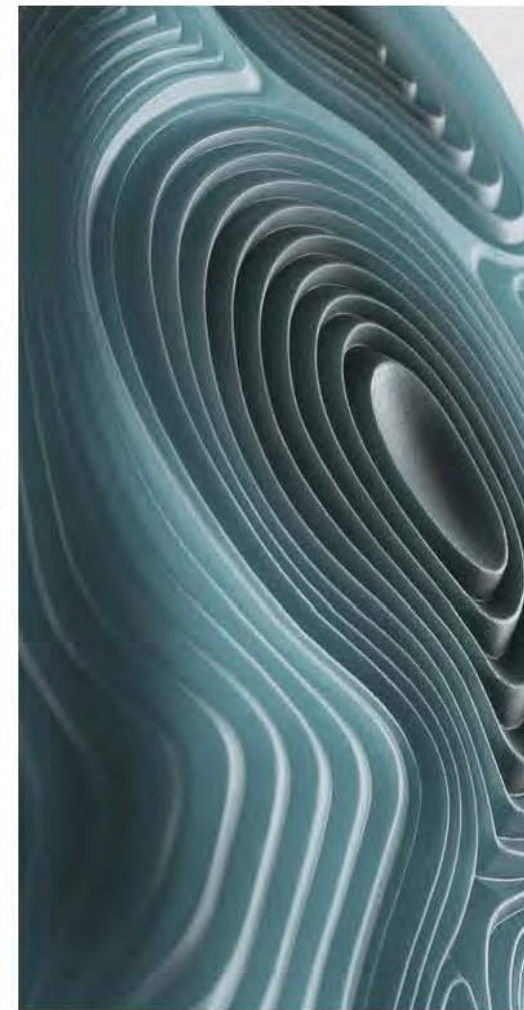
COLOR

ENERGY // CALMNESS // BALANCE



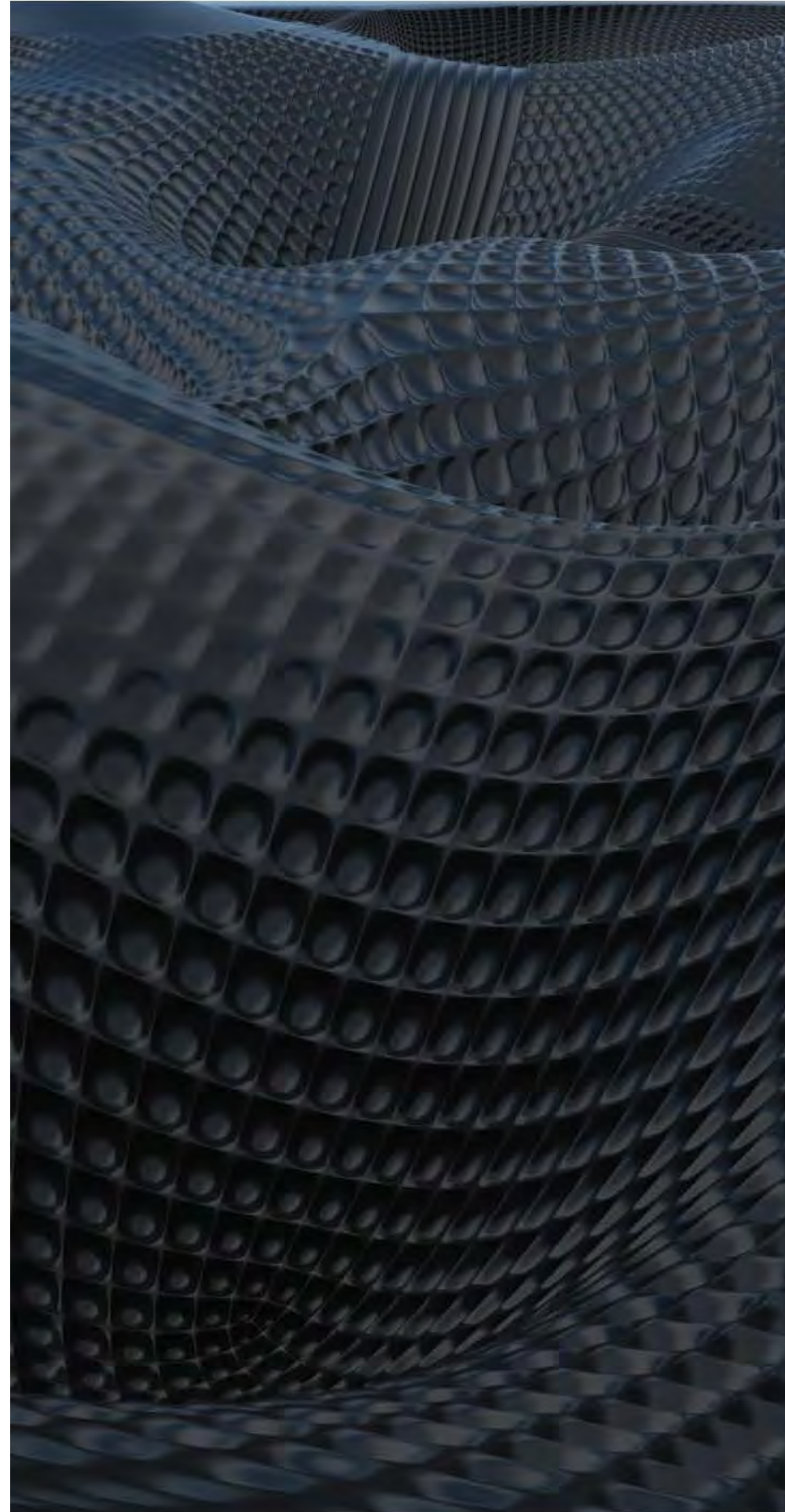
TRAINING

CUSHIONING // LOCKDOWN // DURABILITY



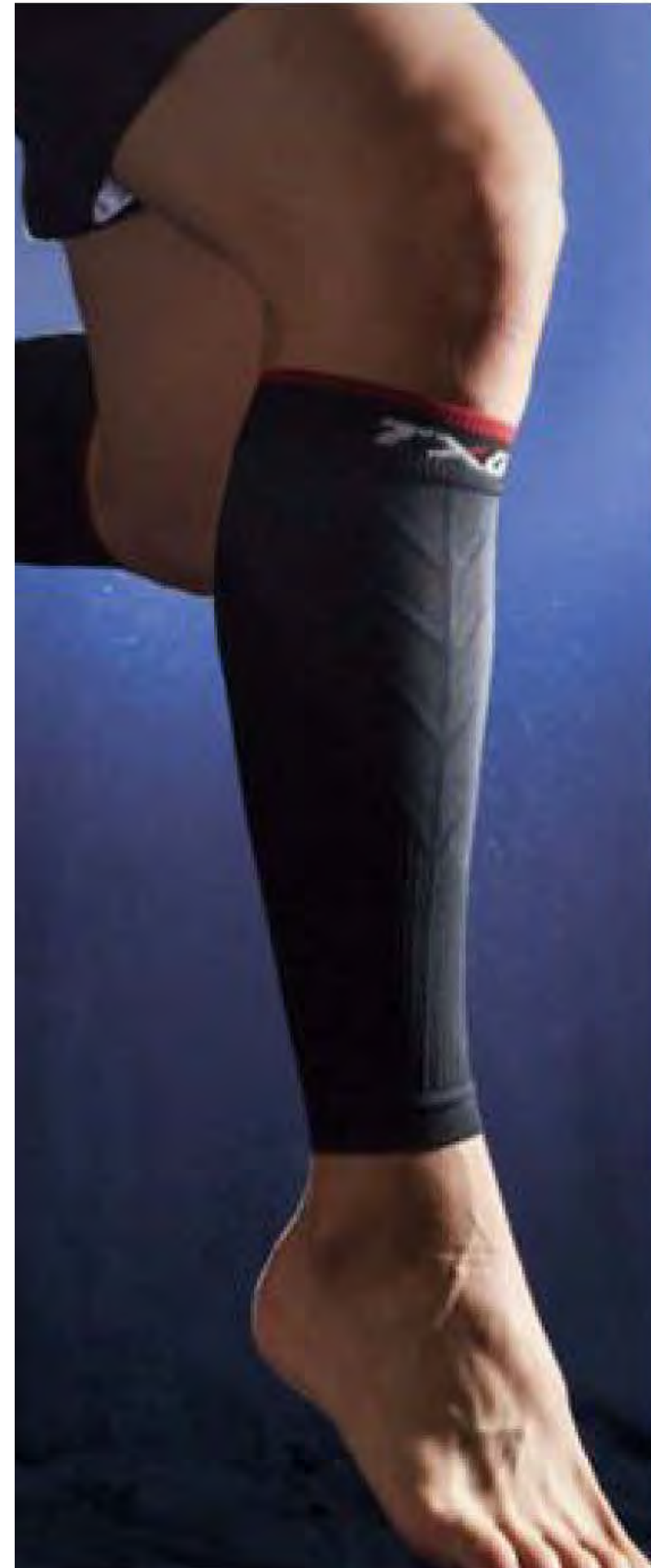
COMPETITION

SUPPORT // PROPULSION // LOCKDOWN



RECOVERY

CIRCULATION // CUSHIONING // SUPPORT

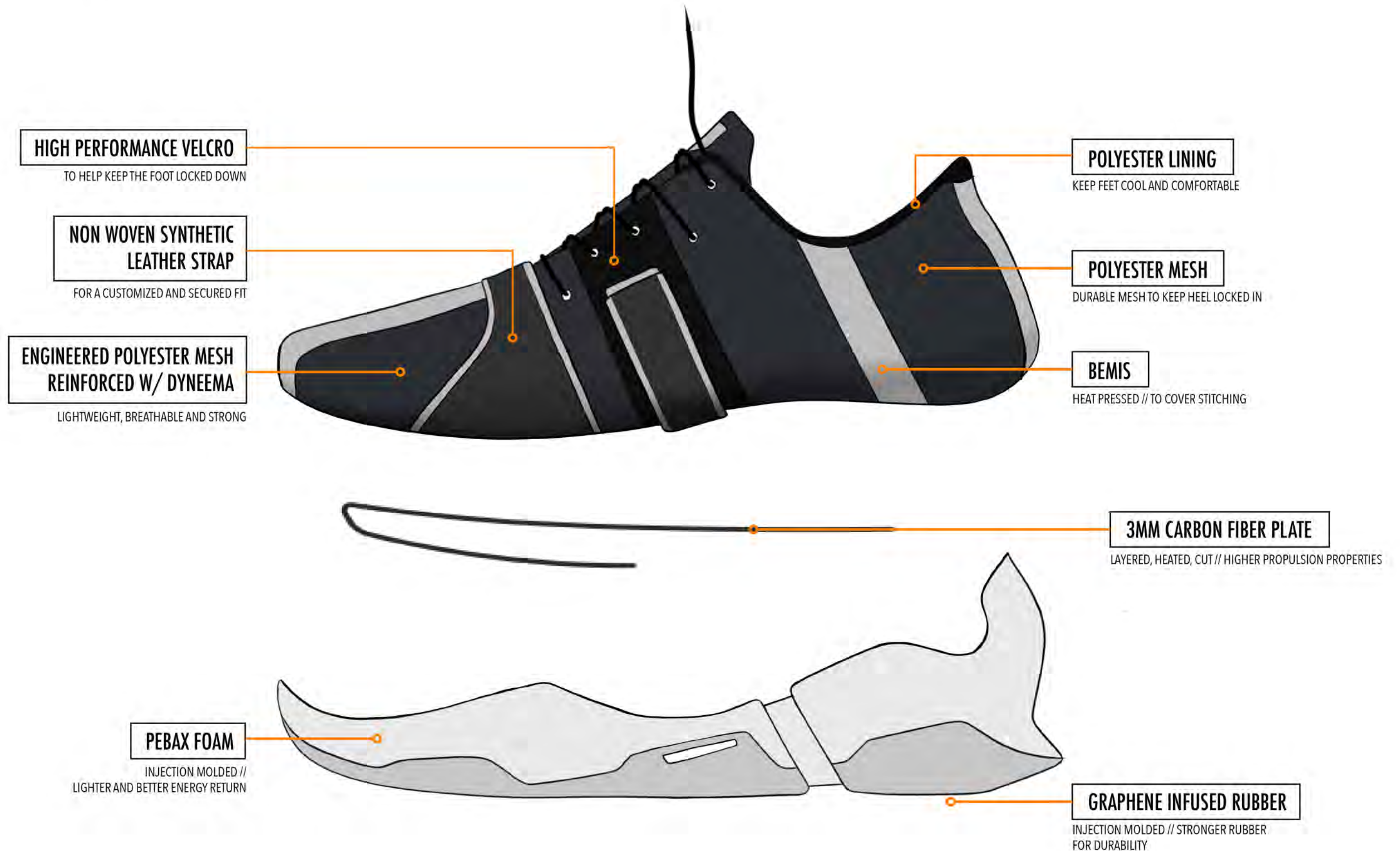


PACKAGING

CONTRAST // LINES // REVEALING



T.C.R. TRAINER



HIGH PERFORMANCE VELCRO

TO HELP KEEP THE FOOT LOCKED DOWN

NON WOVEN SYNTHETIC LEATHER STRAP

FOR A CUSTOMIZED AND SECURED FIT

ENGINEERED POLYESTER MESH REINFORCED W/ DYNEEMA

LIGHTWEIGHT, BREATHABLE AND STRONG

POLYESTER LINING

KEEP FEET COOL AND COMFORTABLE

POLYESTER MESH

DURABLE MESH TO KEEP HEEL LOCKED IN

BEMIS

HEAT PRESSED // TO COVER STITCHING

3MM CARBON FIBER PLATE

LAYERED, HEATED, CUT // HIGHER PROPULSION PROPERTIES

PEBAX FOAM

INJECTION MOLDED // LIGHTER AND BETTER ENERGY RETURN

GRAPHENE INFUSED RUBBER

INJECTION MOLDED // STRONGER RUBBER FOR DURABILITY

T.C.R. SPIKE



NON WOVEN SYNTHETIC LEATHER STRAPS
FOR A CUSTOMIZED AND SECURE FIT

LIGHTWEIGHT SPACER OVERLAYED W/ TPU FILM
EXTREME STRENGTH, LIGHTWEIGHT & BREATHABILITY

POLYESTER LINING
KEEP FEET COOL AND COMFORTABLE

LIGHTWEIGHT SPACER OVERLAYED W/ DYNEEMA
EXTREME STRENGTH, LIGHTWEIGHT & BREATHABILITY

TPU FILM
HEAT PRESSED // LOCKDOWN HEEL

HIGH PERFORMANCE VELCRO
TO HELP KEEP THE FOOT LOCKED DOWN

PEBAX FOAM
INJECTION MOLDED // LIGHTER AND BETTER ENERGY RETURN

PEBAX PLATE
INJECTION MOLDED // LIGHTER, STRONGER AND BETTER ENERGY RETURN

PEBAX FOAM
INJECTION MOLDED // LIGHTER AND BETTER ENERGY RETURN

T.C.R. RECOVERY



COLORWAYS













BRANDING ELEMENTS

Diagonal Line

Unifying angled lines throughout the upper and midsole

Medial Lateral Split

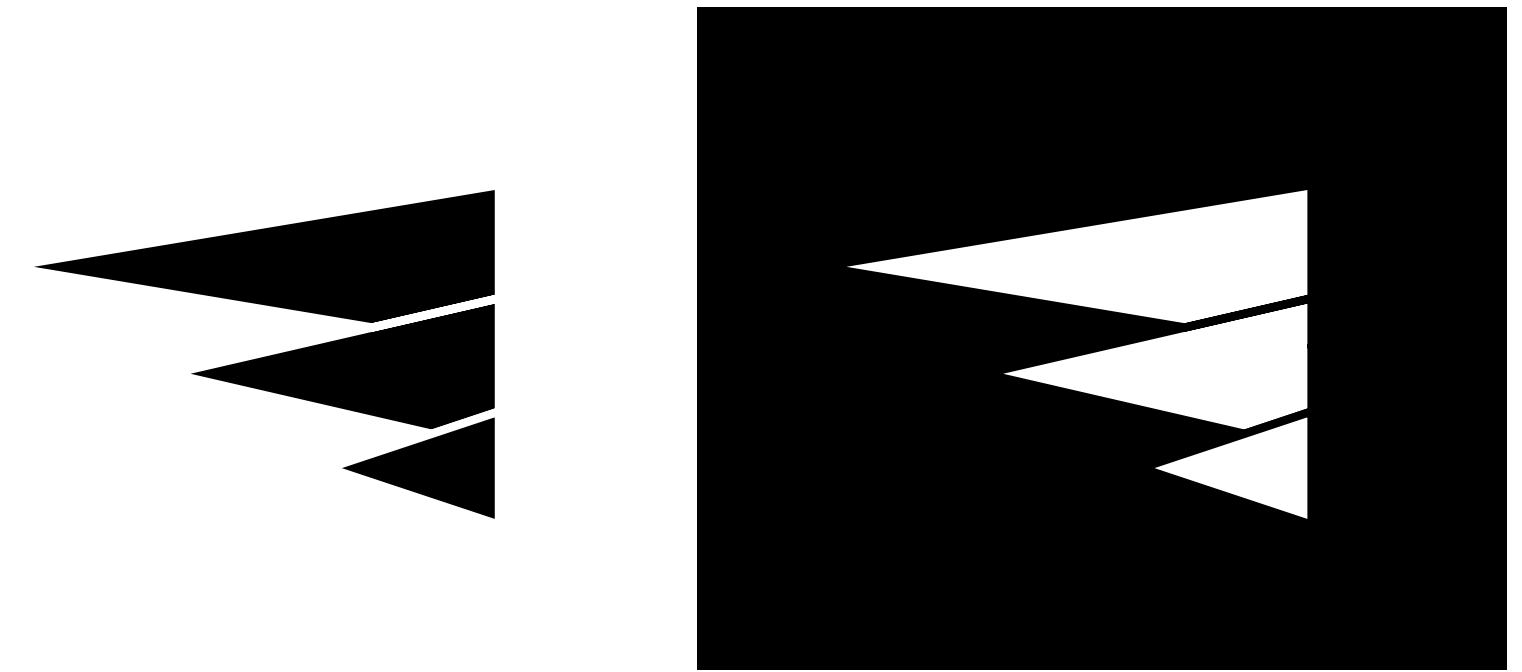
Functional split down the middle of the collection

Color Palette

Same color palette throughout the collection

Logo

Small icon to identify the brand



Simple triads represent the 3 shoes in the collection.
Symbolizes an abstract wing for flight and speed.

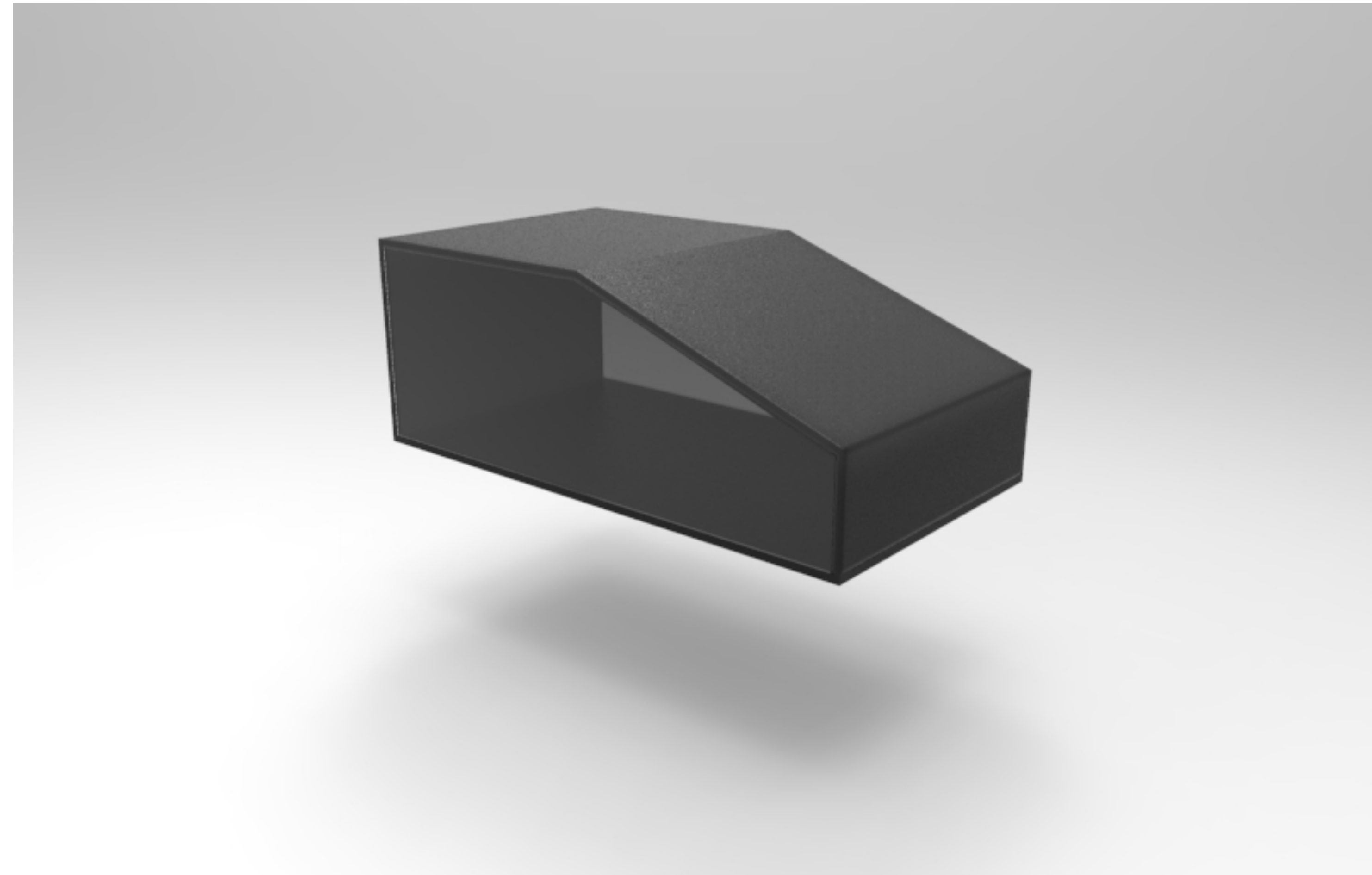


PACKAGING CONCEPT

TCR JUMP COLLECTION

The TCR Trainer is made with the high jumper training routine in mind. The shoe is designed with an innovative strap system that wraps around the upper and through the midsole to lockdown and secure the foot. Integrated into the midsole is a revolutionary carbon fiber plate that increases energy return and allows better propulsion for plyometric training. Lastly the midsole has added forefoot cushioning to reduce stress on the MTP joints so the athlete can focus on training.

- HIGH PERFORMANCE YELLOW
- NON WOVEN SYNTHETIC LEATHER STRAP
- ENGINEERED POLYESTER MESH REINFORCED W/ DYNEEMA
- POLYESTER LINING
- POLYESTER MESH
- BEAMS
- 3MM CARBON FIBER PLATE
- PEBAX FOAM
- GRAPHENE INFUSED RUBBER

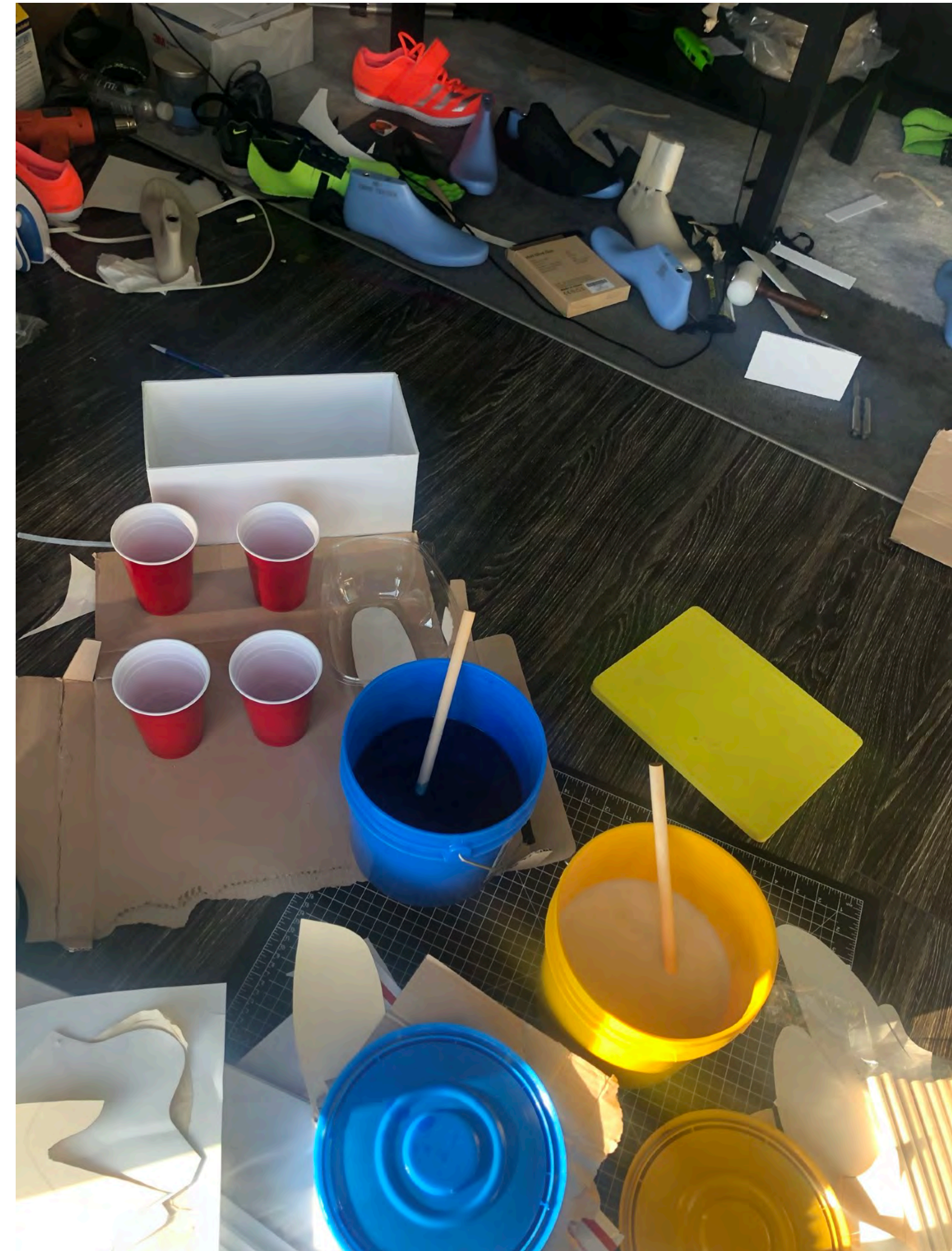


PROTOTYPING



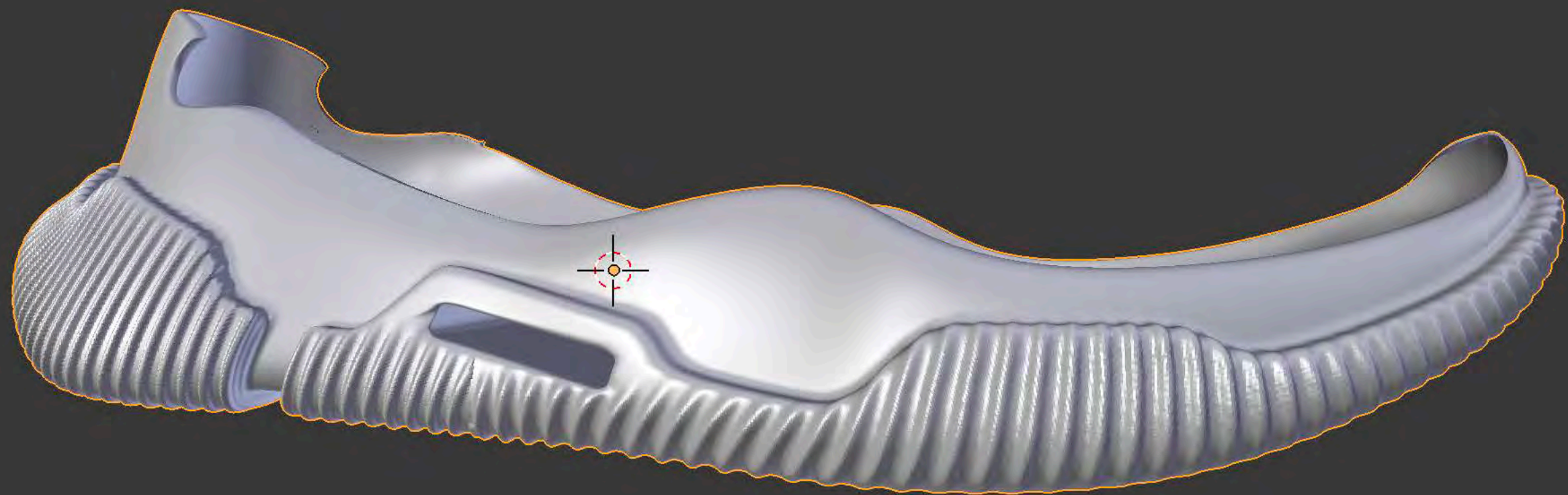


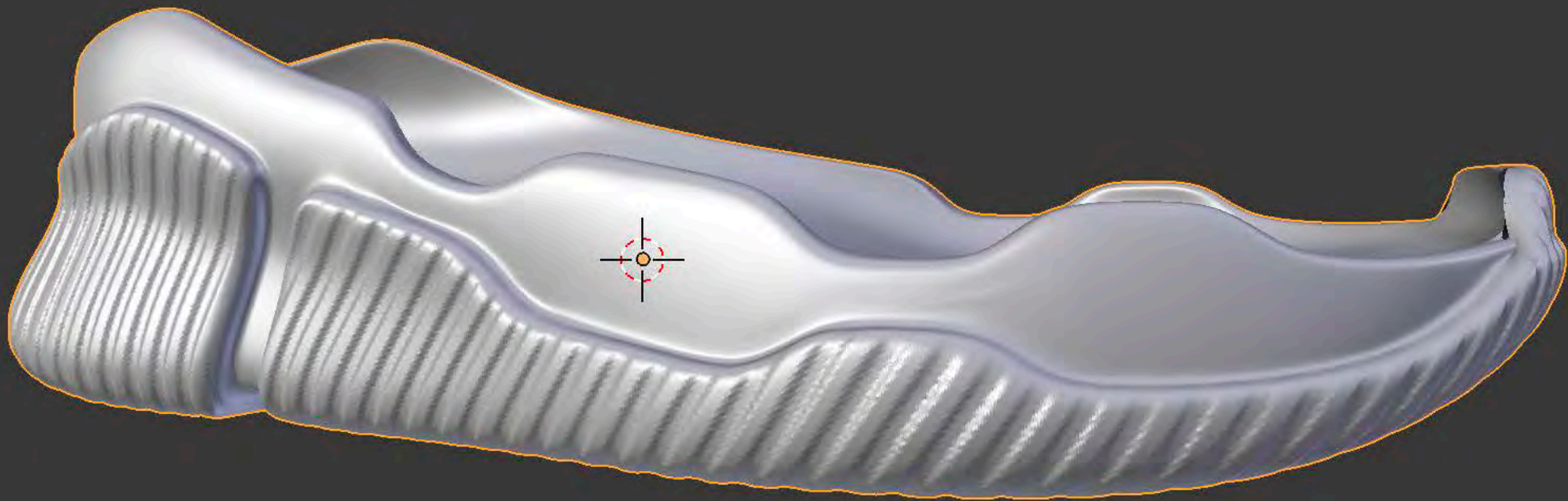


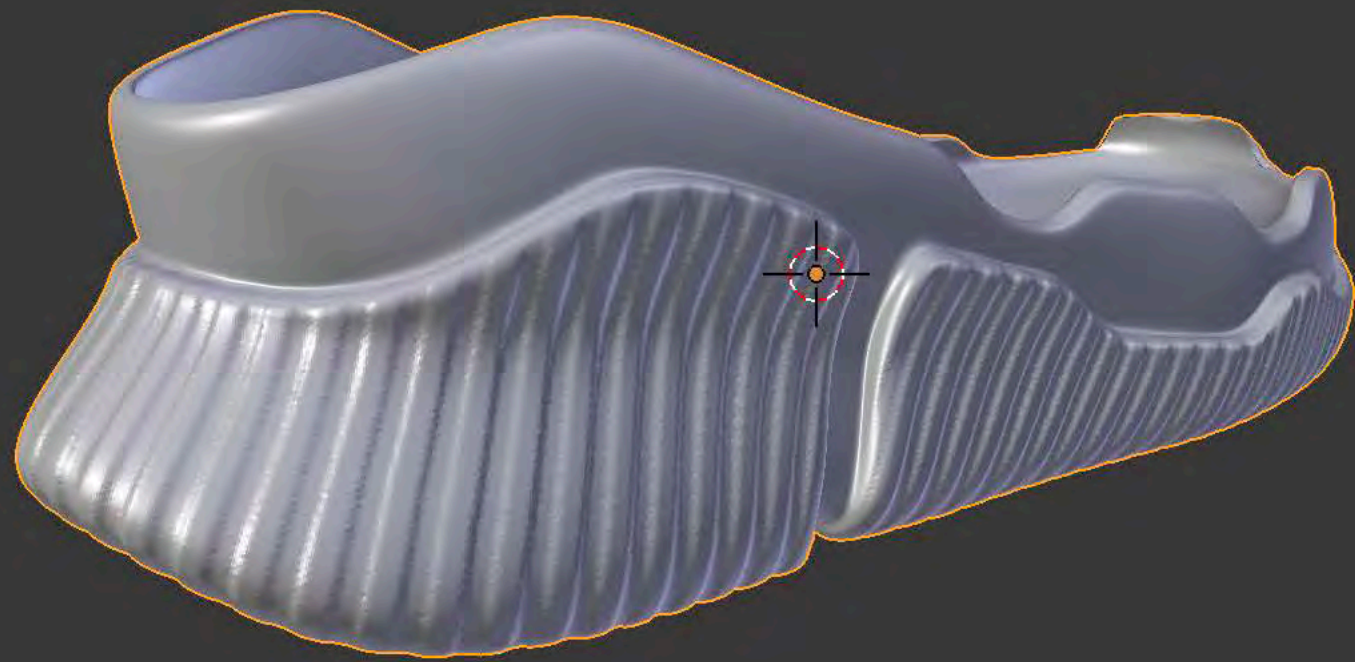


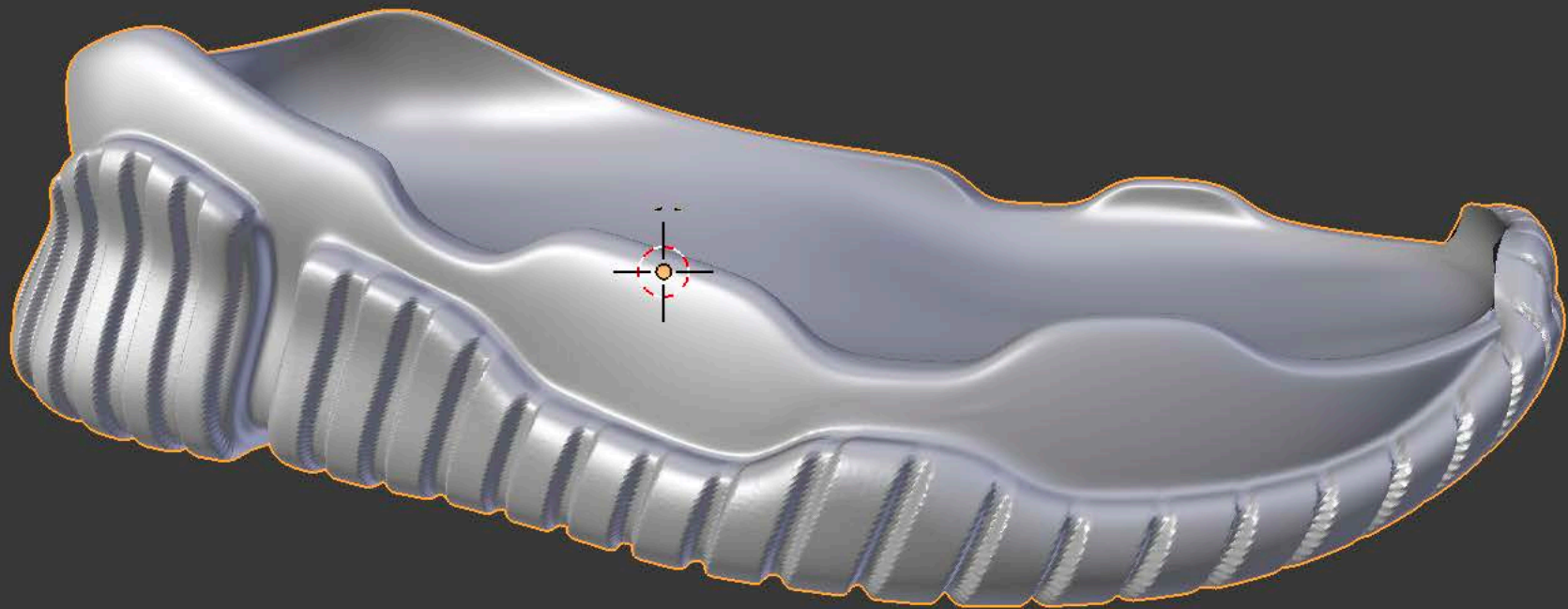


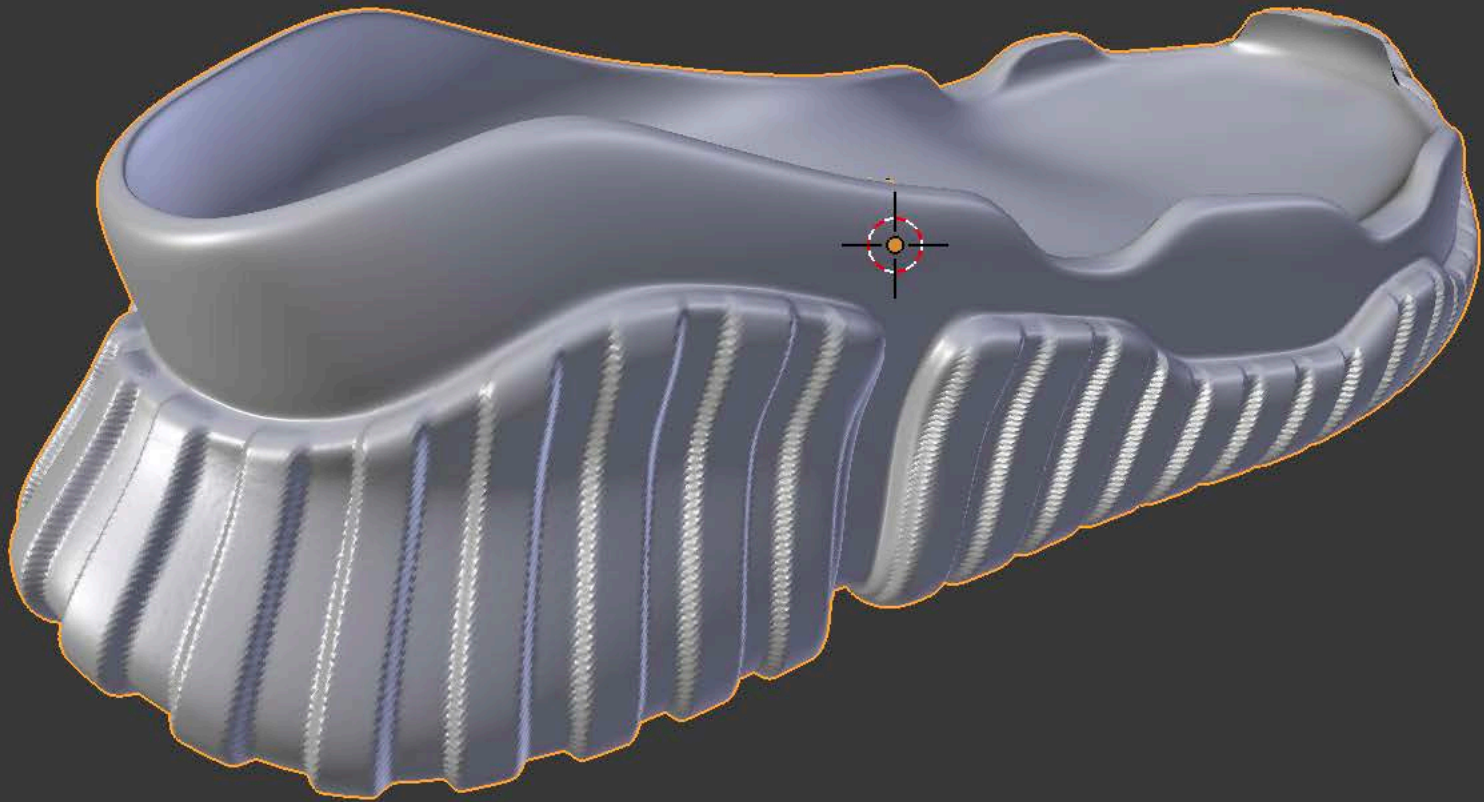














LOOK BOOK















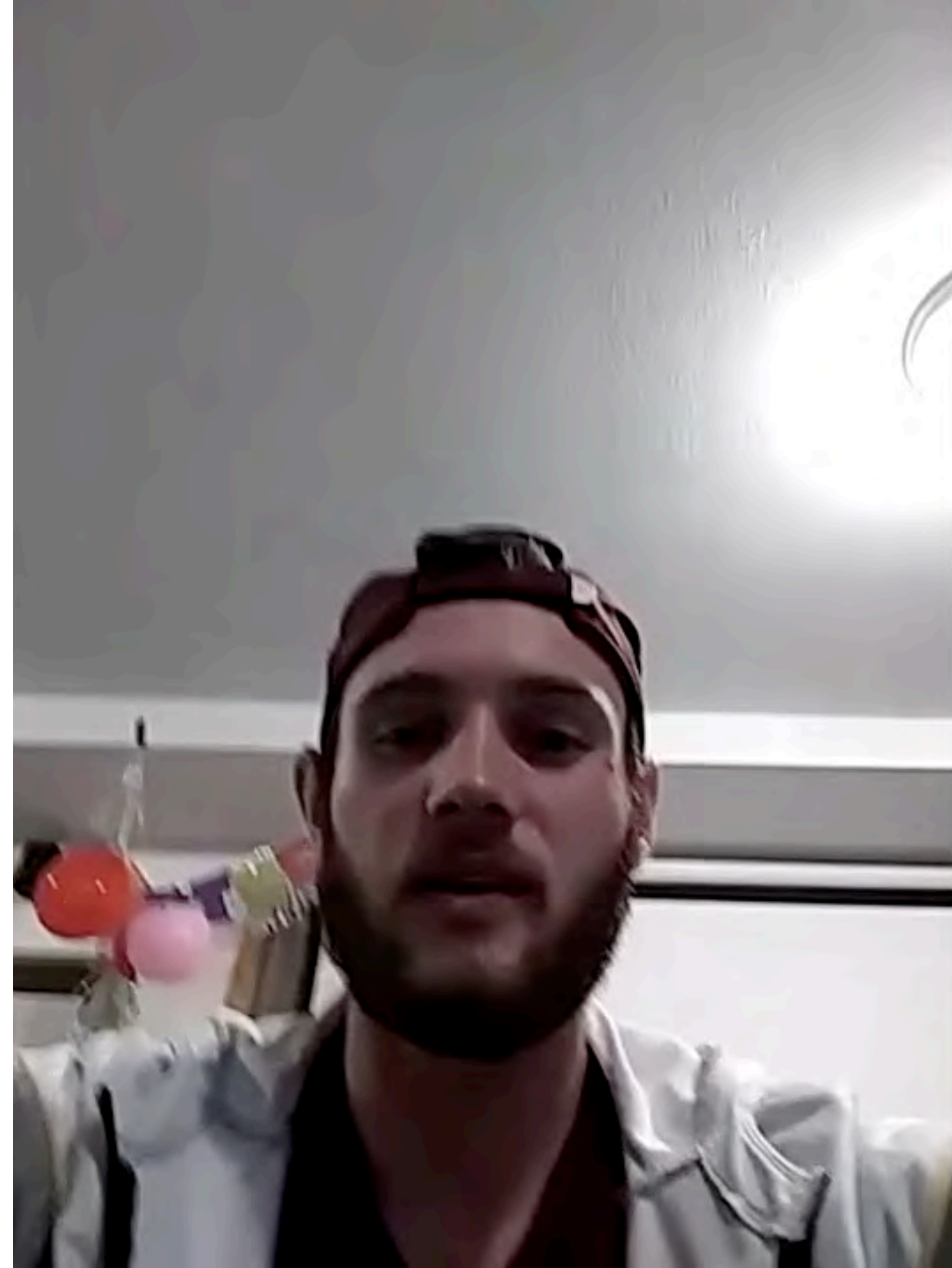
// VALIDATION

"THAT MAKES SENSE IN MY MIND ON HOW IT WOULD RETURN MORE ENERGY TO YOU."

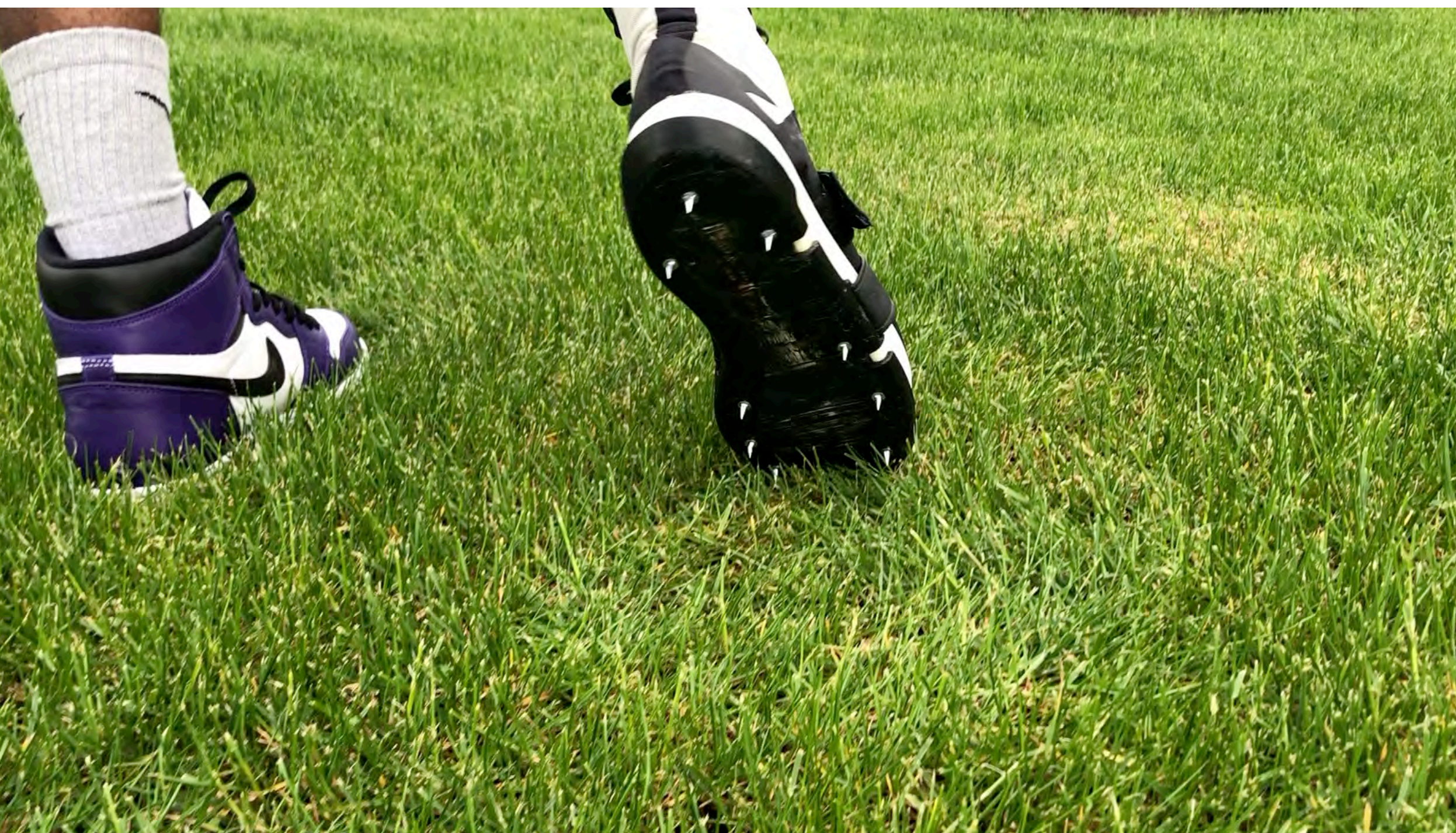
"THE RECOVERY BOOT COVERS ALL OF MY CONCERNS WHEN I NEED RECOVER"

"I LIKE HOW THE TRAINING SHOE IS DESIGNED WITH HOW WE MOVE DURING PLYOMETRICS"

*Nick Bachinski
Post Collegiate High Jumper*



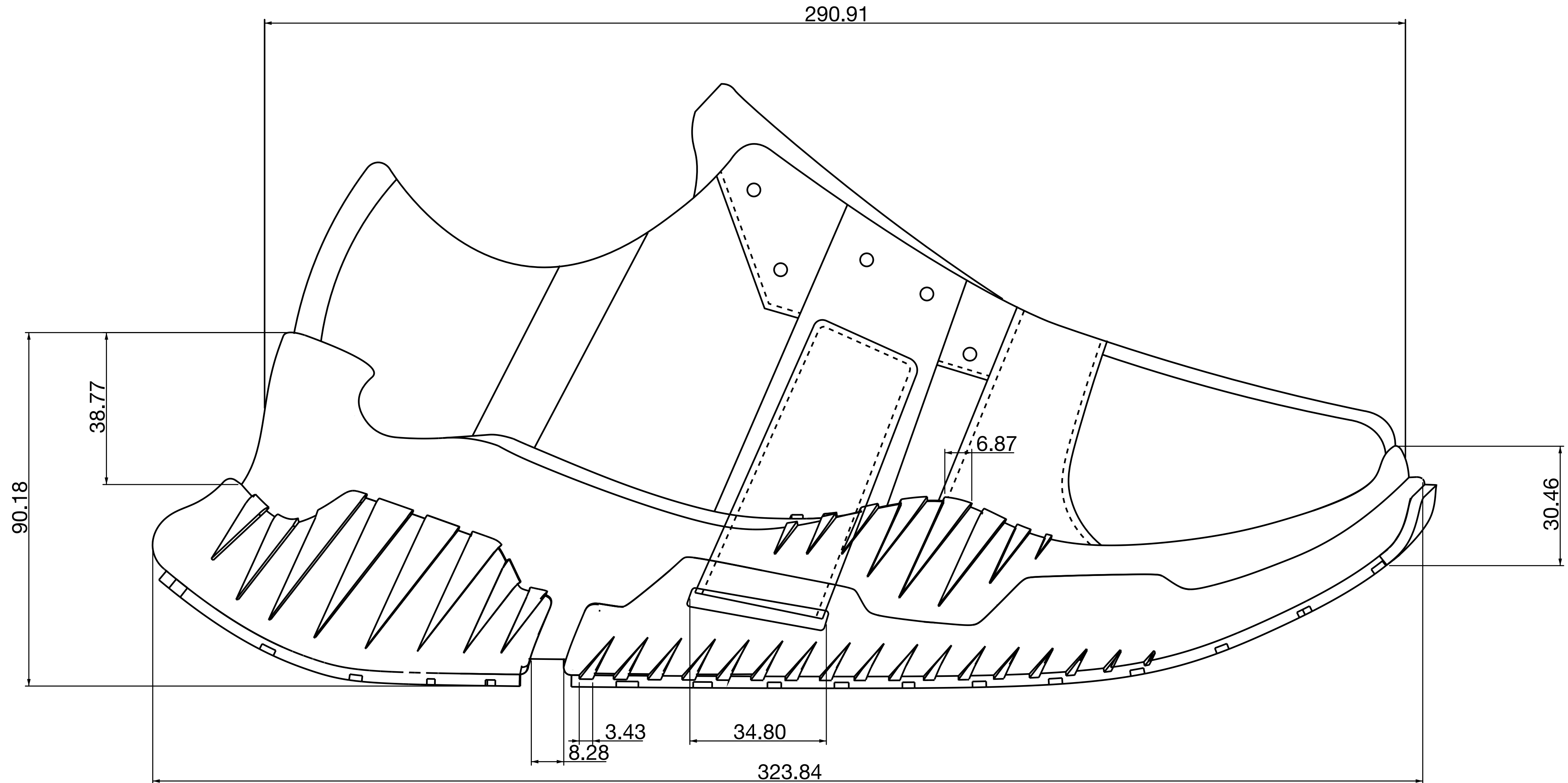




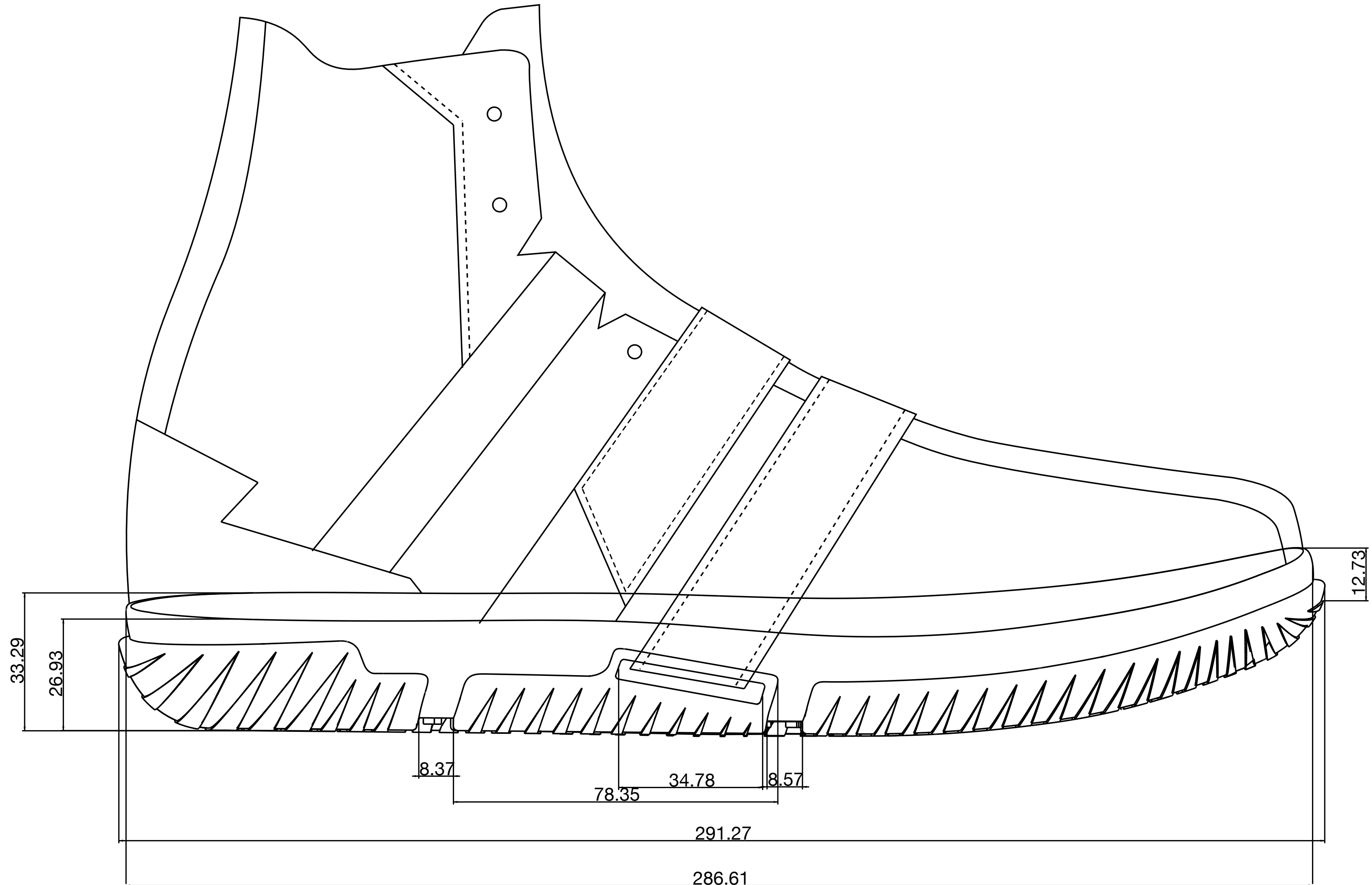




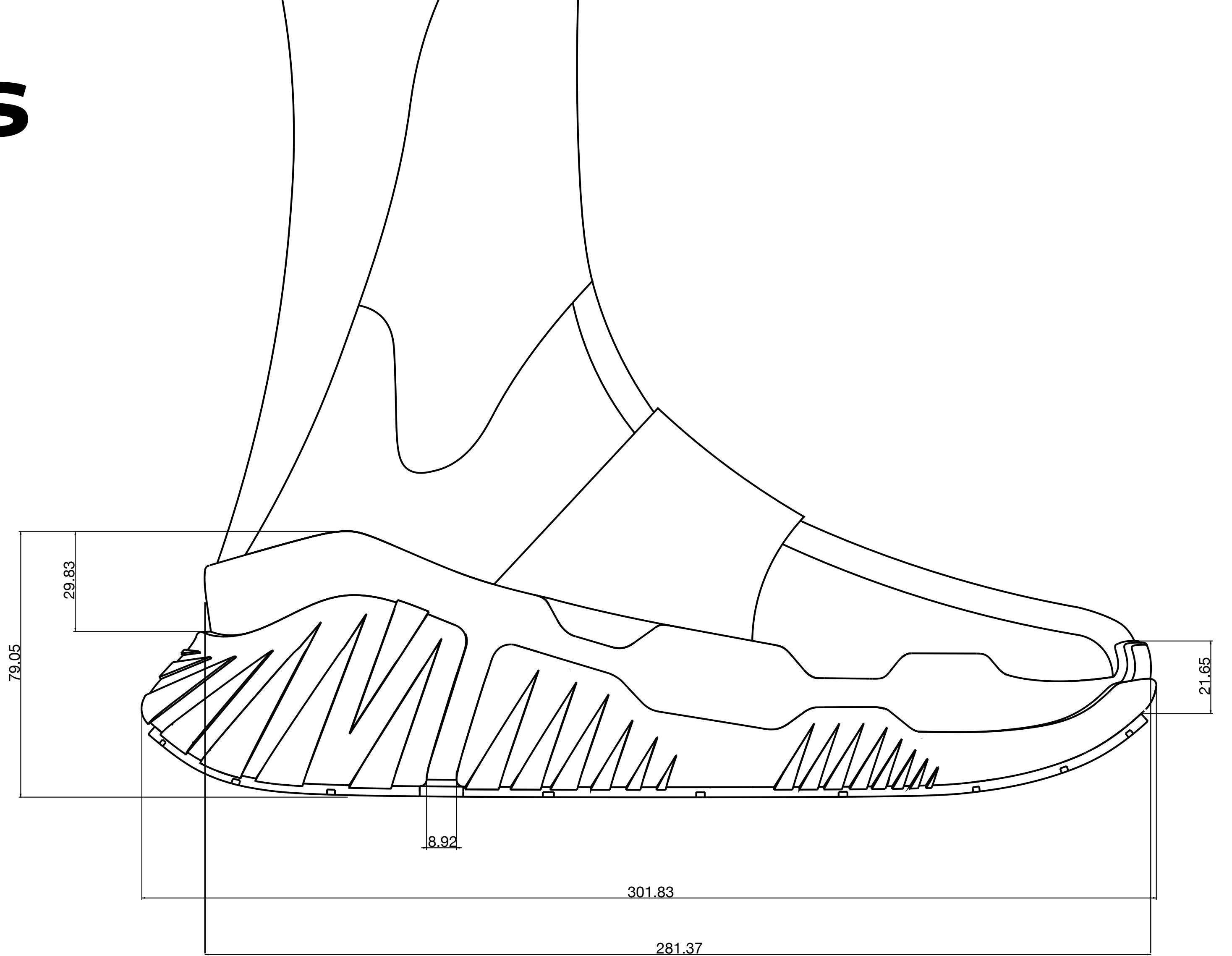
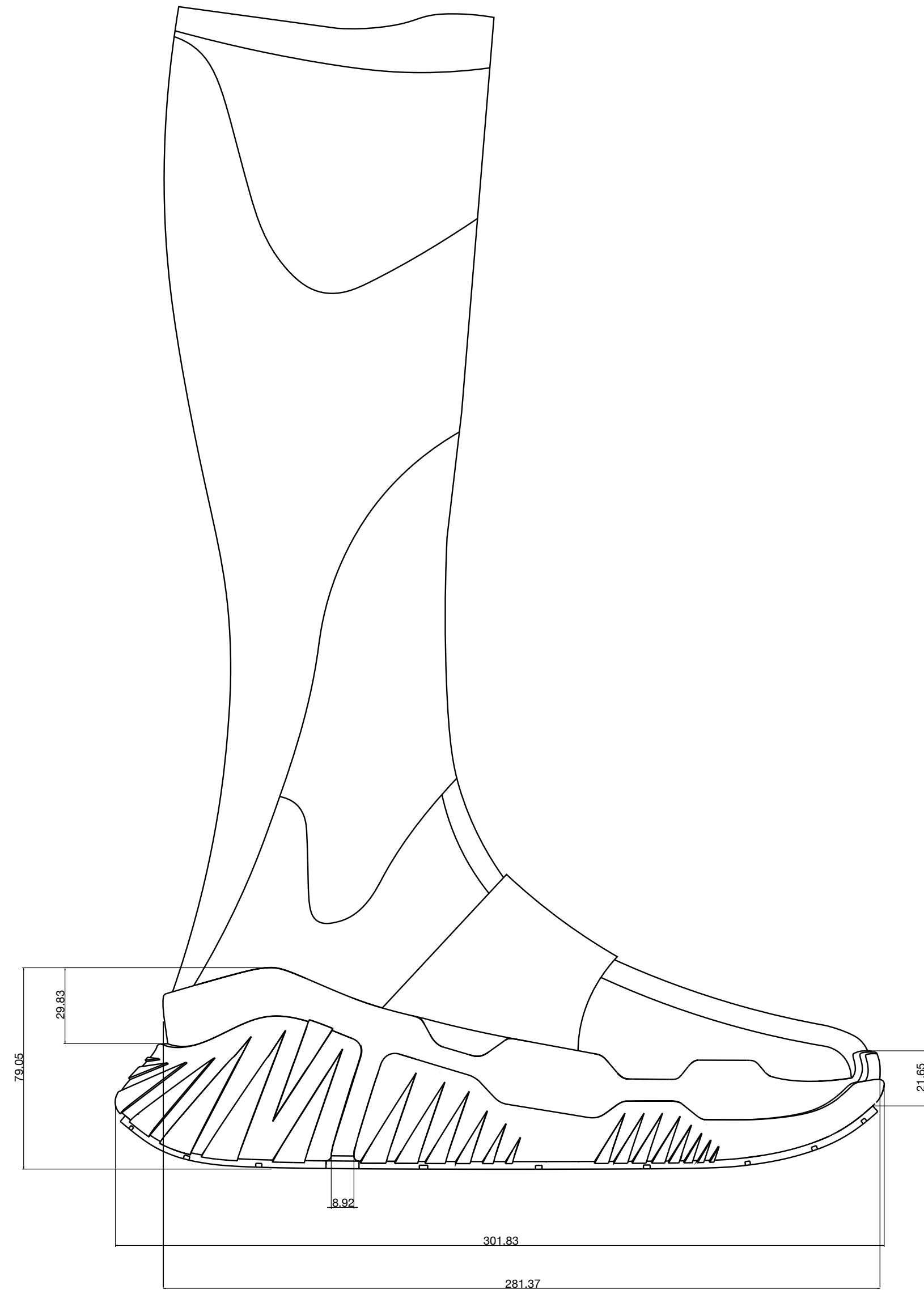
TECH FLATS



TECH FLATS



TECH FLATS



A high jumper is captured in mid-air, performing a Fosbury Flop over a bar. The athlete is wearing a dark singlet and shorts, with white shoes and socks. The bar is green and supported by a tall green post. The background shows a large stadium filled with spectators, illuminated by bright stadium lights that create a starburst effect. The sky is a mix of dark blue and purple, suggesting dusk or dawn.

T.C.R. JUMP COLLECTION

RESPOND // ELEVATE // RESTORE

Nate Roesse
University of Oregon
Capstone Project 2020

DIMAS PUT

SA DIMA DIMA





// VIDEO ANALYSIS

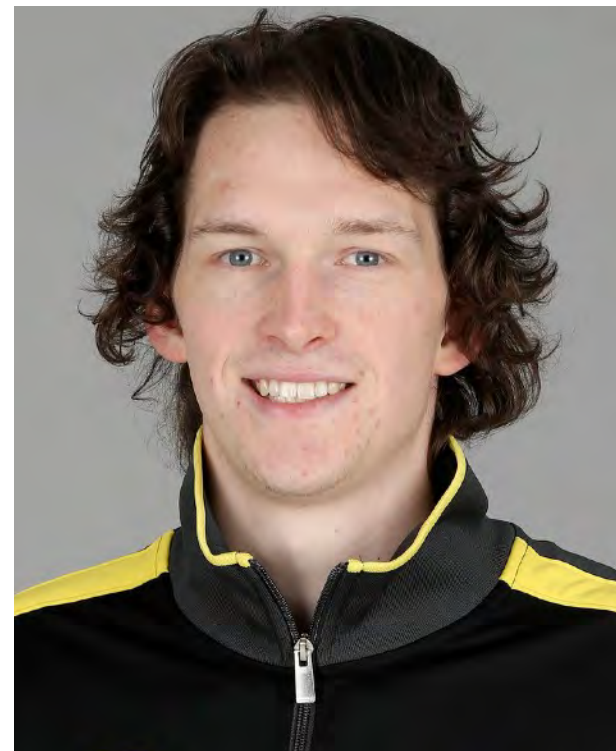


// VIDEO ANALYSIS



// ATHLETES/ STAFF

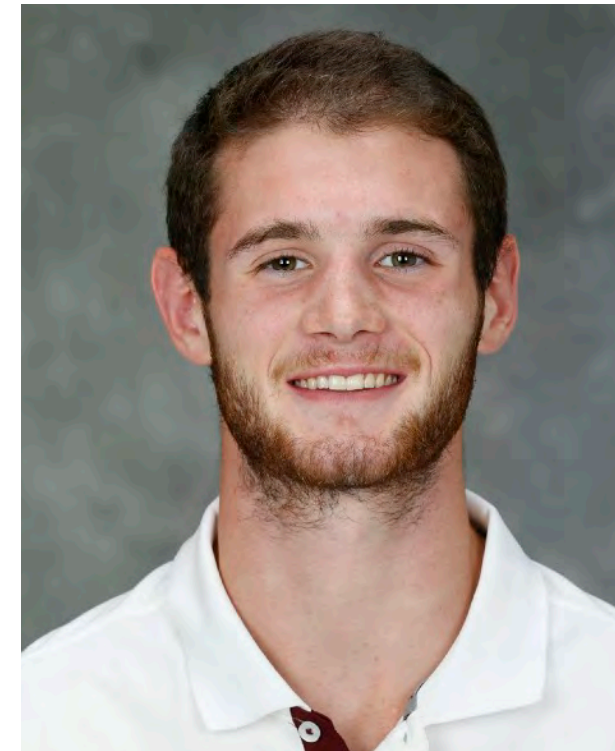
COLLEGIATE



Ben Milligan // 7' 2.5"



Ryan Lockard // 7' 3"



Nick Bachinski // 7' 0.50"



Ben Gucinski // 7' 1"



Michael Burke // 7' 3"



Danny Schiller // 7' 0.25"

PROFESSIONAL



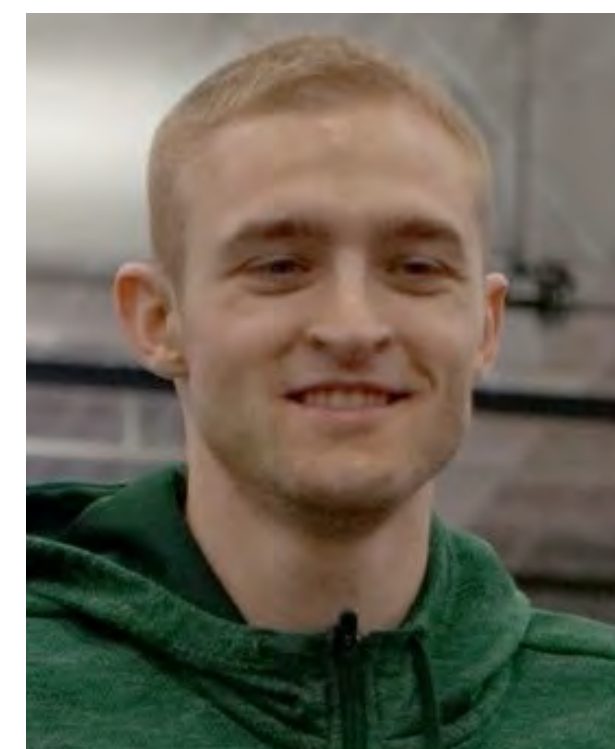
Luca Wieland // 7' 2.5"



Adri Glebauskas // 7' 5"

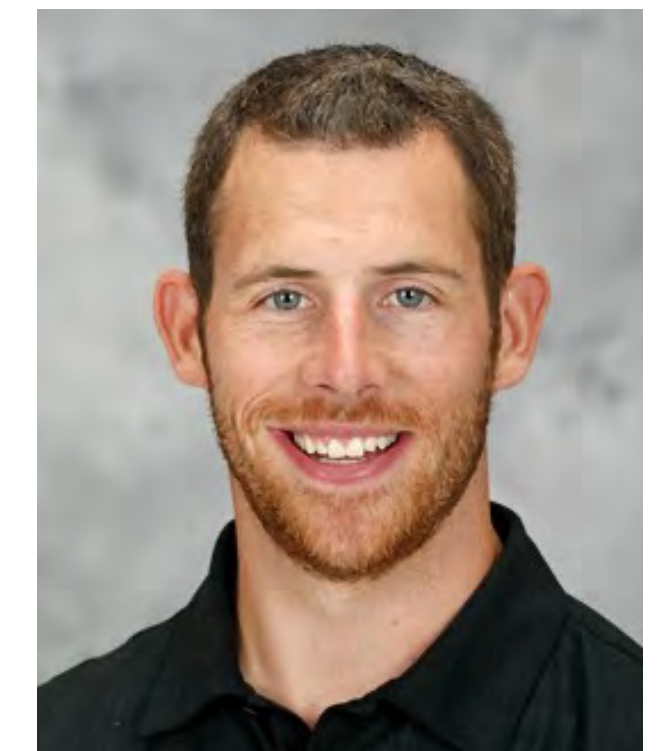


Shelby McEwen // 7' 7"



Kevin Schultz // 7' 2.5"

STAFF



Zach Seigmeier // *HJ Coach*



Katie Madden // *Trainer*

// PROBLEMS

TRAINING

Forefoot cushioning
Foot sliding around
Shoe's felt loose
Durability of outsole

COMPETITION

Ankle support
Spikes felt loose
Material ripping
Lockdown

RECOVERY

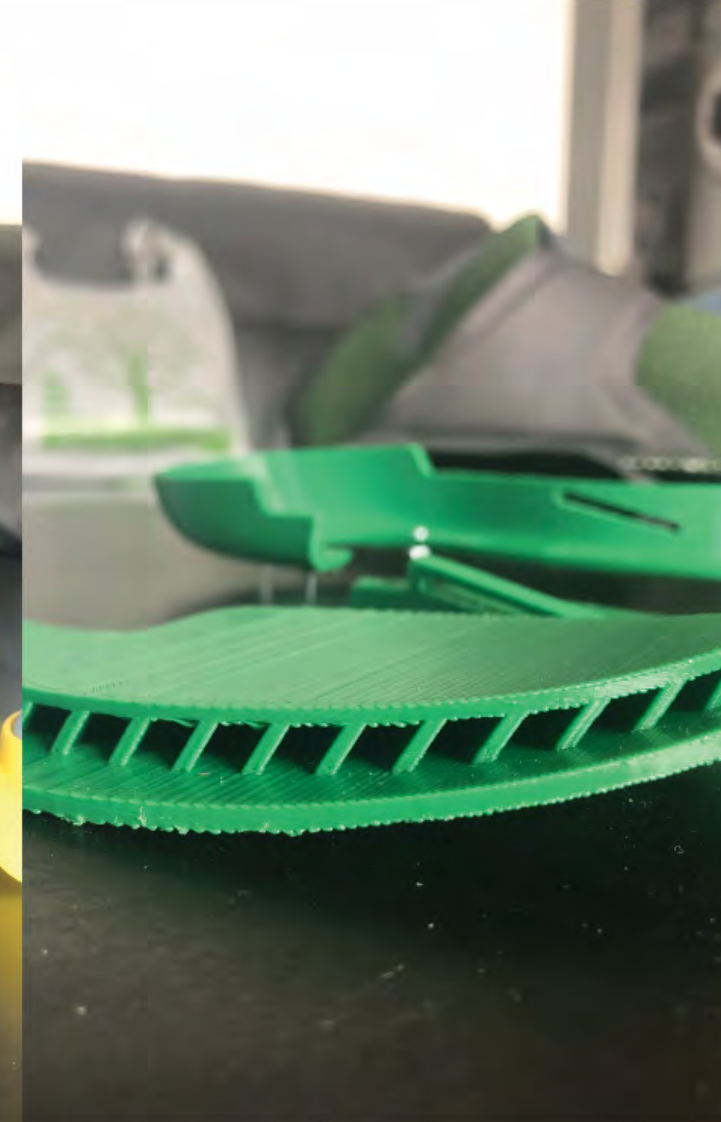
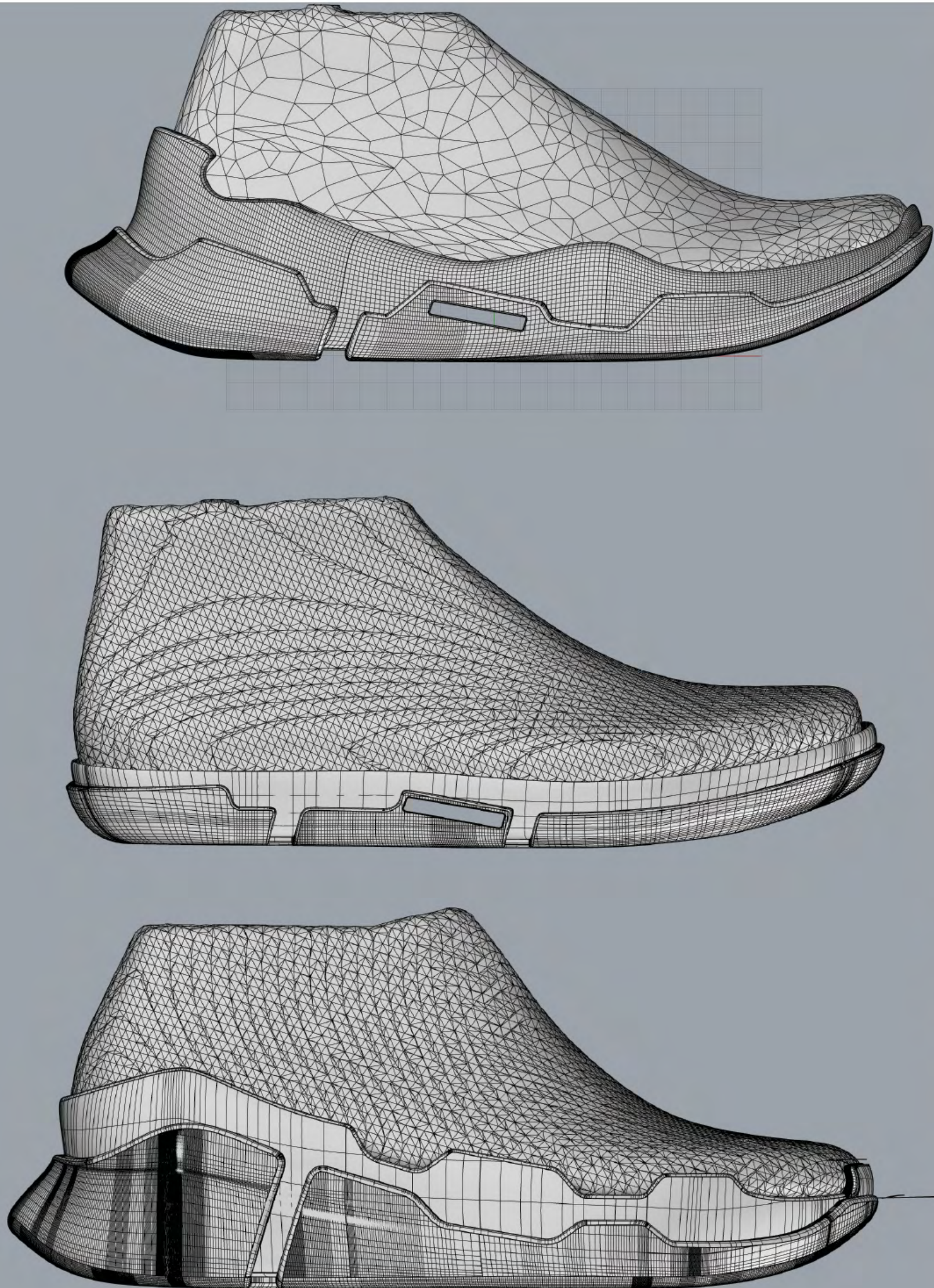
No recovery shoes
Wear lifestyle, sandals
and old trainers

Want something that
will work, comfortable
and lightweight

// DESIGN EXPLORATION



// PROTOTYPING





T.C.R. TRAINING SHOE

LOCKDOWN // CUSHIONING // DURABILITY

// PARTS + PURPOSE

POLYESTER LINING

KEEP FEET COOL AND COMFORTABLE

POLYESTER MESH

DURABLE MESH TO KEEP HEEL LOCKED IN

BEMIS

HEAT PRESSED // TO COVER STITCHING

HIGH PERFORMANCE VELCRO

TO HELP KEEP THE FOOT LOCKED DOWN

ENGINEERED POLYESTER MESH REINFORCED W/ DYNEEMA

LIGHTWEIGHT, BREATHABLE AND STRONG

NON WOVEN SYNTHETIC LEATHER STRAP

FOR A CUSTOMIZED AND SECURED FIT

PEBAX FOAM

INJECTION MOLDED // LIGHTER AND BETTER ENERGY RETURN

3MM CARBON FIBER PLATE

LAYERED, HEATED, CUT // HIGHER PROPULSION PROPERTIES

GRAPHENE INFUSED RUBBER

INJECTION MOLDED // STRONGER RUBBER FOR DURABILITY



// **PEBAX FOAM**

Extremely lightweight foam that maintains a high degree of comfort and energy return. Considered the best performance foam ever.









T.C.R. COMPETITION SPIKE

SUPPORT // PROPULSION // LOCKDOWN

// PARTS + PURPOSE



// PROPULSION PLATE



"IT WOULD BE ADVANTAGEOUS TO TURN THE SPRING BLADES AROUND AND HAVE THEM POINT IN THE FORWARD DIRECTION"

Franz Fuss, 2013









T.C.R. RECOVERY BOOT

CIRCULATION // CUSHIONING // SUPPORT

// PARTS + PURPOSE



// **CELLIANT TECH**

Infused bioceramic fibers that emits FIR when next to the skin. The FIR penetrate deep through the body to help increase blood circulation. Approved by the FDA and has been mostly used in apparel.







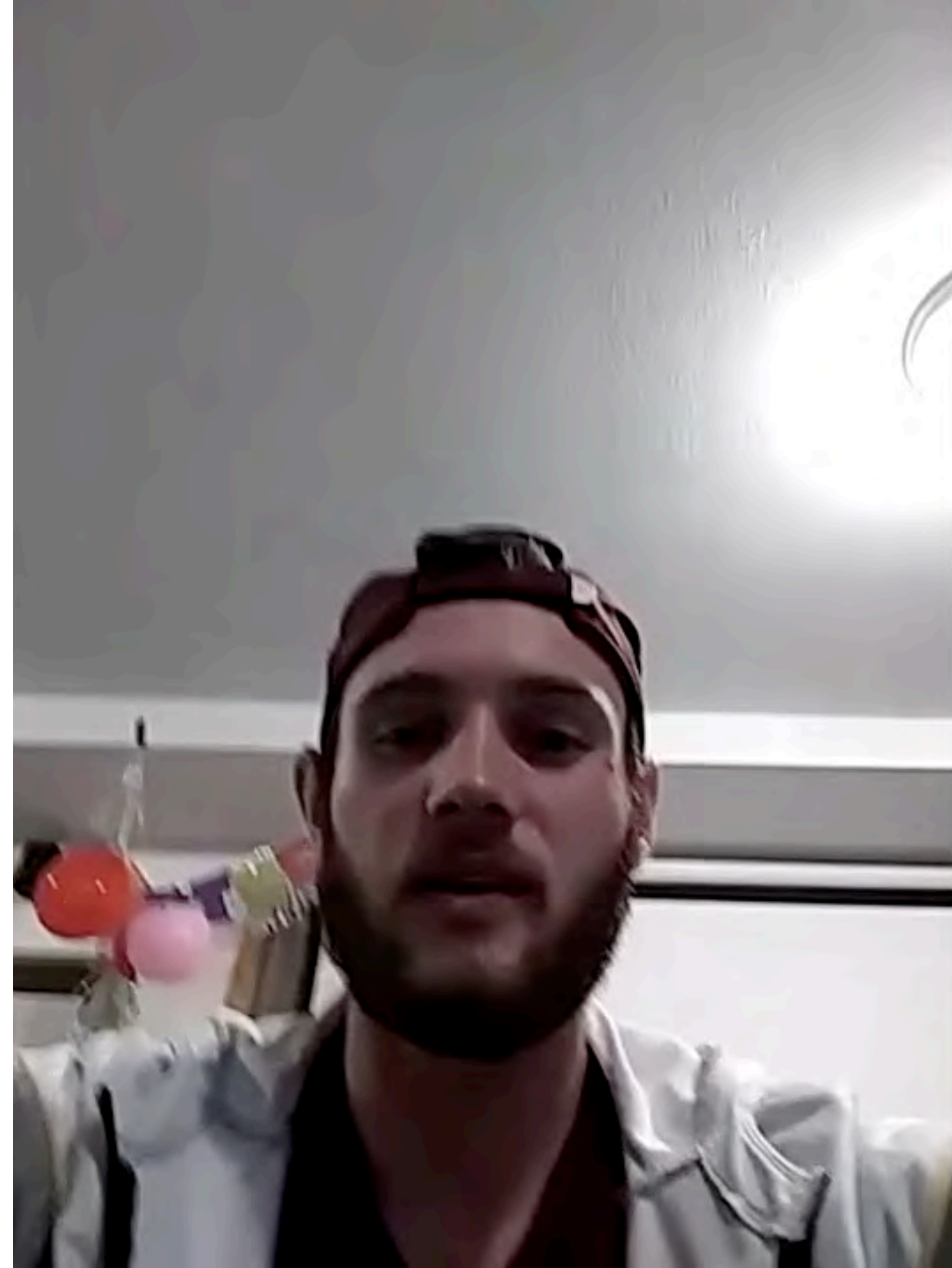
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"THE RECOVERY BOOT COVERS ALL OF MY CONCERNS WHEN I NEED RECOVER"

"I LIKE HOW THE TRAINING SHOE IS DESIGNED WITH HOW WE MOVE DURING PLYOMETRICS"

*Nick Bachinski
Post Collegiate High Jumper*



// IMPACT

This collection will improve all aspects of performance for high jumpers by offering the most tailored footwear to the event. The holistic design approach is what makes the collection so valuable to the athlete.



TCR JUMP COLLECTION



TRAINING SHOE

Train better



COMPETITION SPIKE

Jump higher



RECOVERY BOOT

Recover faster

// SPECIAL THANKS TO...

All the SPD students
and faculty

My mentor, Sara Novak
Footwear Designer
adidas

Brad Wilkins, Ph. D
VP of Science & Innovation
Amp Human

Athletes that gave me
valuable feedback

Daniel Schuster
Footwear Product Tester
adidas

Anita Nagavalli
Materials Innovation
adidas

Celliant for donating
fabric for my collection

Eric Holmes
Product Testing Manager
adidas

Ola Adeniji
Ph. D - Human Physiology
University of Oregon