Throwing Sports—Shot put, Discus, Javelin & Hammer Throw Footwear Innovation Design

Capstone Proposal

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Part 1

Throwing sports historical research.

Shot Put

Shot put was originated from the ancient Celtic tradition of "putting the stone" was used by local people to identify their strongest men for battle purposes (Olson, 2000). The first evidence shows the modern shot put occurred in the Middle Ages when soldiers held competitions for throwing cannonballs (Colin, 2010). Morden Shot put competitions were first recorded in early 19th century Scotland. The men's shot put has been part of every modern Olympics since 1896. The first women's shot put is in 1948 Olympic (Leonard, 2000).

Figure 1. The athlete warms up during the 1908 Olympics (Leonard, 2000).

Discus

Discus was an event in the original Olympic Games of Ancient Greece and poet Homer was also mentioned that the discus was a part of the Greeks' pentathlon event in the 8th century B.C. (Mandell, 1999). The discus back then were made of unwrought bronze and iron and were apparently heavier than today's (Leonard, 2000).

Since the first modern competition, the 1896 Summer Olympics, the first organized Men's competition was resumed in the late 19th century and has been a part of the modern Summer Olympic Games. (Leonard, 2000).

Figure 2. American discus athlete Alfred Adolf Oerter Jr (Leonard, 2000).

Javelin

The javelin throw has many connections to warfare of all the Olympic events (Globuk 1984). During the era between the Mycenaean times and the Roman Empire, the javelin was actually considered as a widely used offensive weapon because it was lighter than the spear with longer distance attacks allowed (Olsaon 2000).

The first known competitive use of javelin was as one of the five-event pentathlons in the ancient Greek Olympics. (Globuk 1984).

Hammer Throw

Figure 3. Eric Lemming works out during the first Olympic javelin throw competition, in 1908 (Globuk 1984).

The legend hammer throwing can be traced back in various forms to the Tailteann games held in Tara, Ireland, around 1829 B.C. Centuries after until 1866, it was developed into a regular part of track and field competitions and England, Scotland, and Ireland (Jun, 2000). These hammers were made of forged iron of no prescribed weight and had handles varying in length from 3 to 3 1/2 feet. The athlete swung the hammer around his head and threw from a standing position (White, 2010).

Figure 4, John Flanagan—Olympic hammer throw champion (St. Louis, 1904)

Throwing sport playing field/arena/environment

According to the International Association of Athletics Federations' (IAAF), the following are the Track and Field requirements for the facilities specifications.

Shot put/Hammer/Discus throwing area materials

The circles in throwing events shall be made of a band of metal 6 millimeters in thickness of suitable rigid material firmly secured flush with the throwing surface, the top of which shall be flush with the surface outside the circle. The interior surface should be of concrete or material providing a similar surface and shall be 19 (±6) millimeters lower than the surface outside the circle (IAAF, 2010).

Shot Put Area

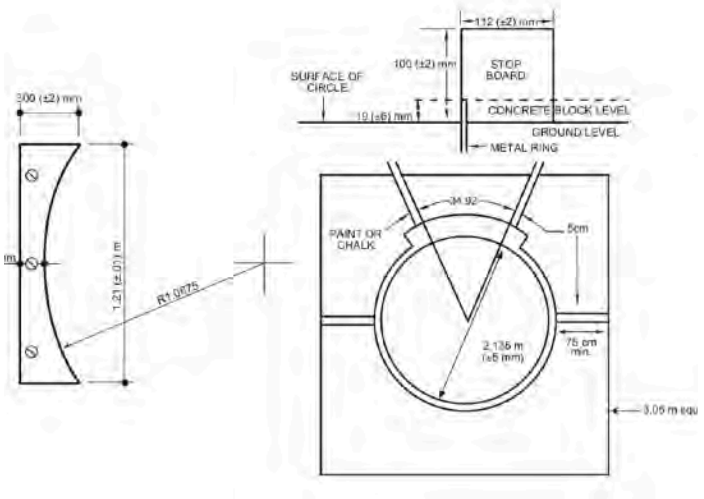


Figure 5. Shot put circle (IAAF, 2010).

The shot put circle stopboard should be an arc of wood, or other suitable materials, painted white and firmly fixed so that its inner edge coincides with the inner edge of the shot-put circle. It shall measure 1.21 (±0.01) meters in length along the chord between its endpoints, 112 millimeters and increasing to 300 millimeters in width, and 100 (±2) millimeters in height (IAAF, 2010).

Discus/Hammer Area

Hammer and discus have the same throwing circle. The only difference is the diameter of the hammer circle is 2.135 meter, the diameter of the discus circle is 2.50 meter (IAAF, 2010).

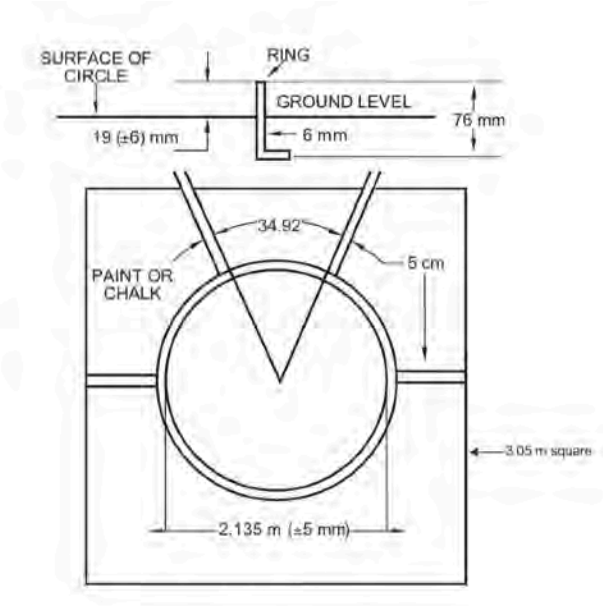


Figure 6. Hammer circle (IAAF, 2010).

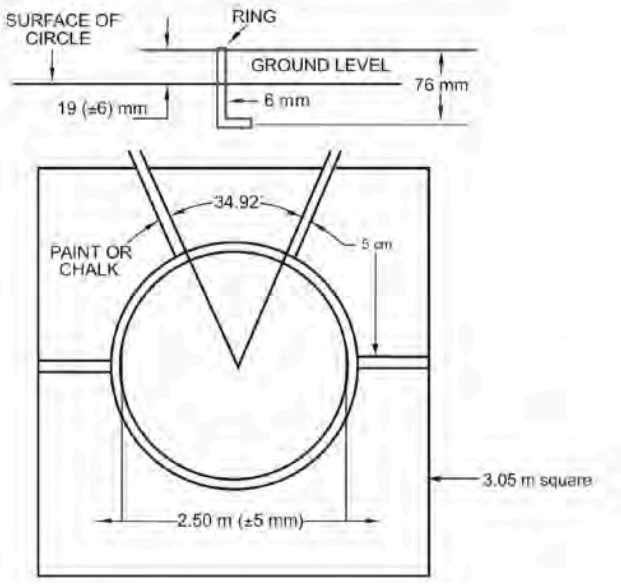


Figure 7. Discus circle (IAAF, 2010).

Base on the requirements of the IAAF, hammer and discus throws area should be made from an enclosure or cage that should be centered on the circle and with the sector centered on

the nonmovable cage opening, designed in such a way to provide adequate control of the implement landing and a fair venue for the throwers (IAAF, 2010). Cage design is acknowledged to provide limited protection for spectators, officials and competitors. The cage should be made with suitable material, hung from and between rigid posts, sufficient to withstand and absorb an impact from the implement so that the implement will not escape over or through, and to reduce the possibility of the implement ricocheting or rebounding back toward the competitor. The purpose of the cage is to contain, but not interfere with, the flight path of the implement (IAAF, 2010).

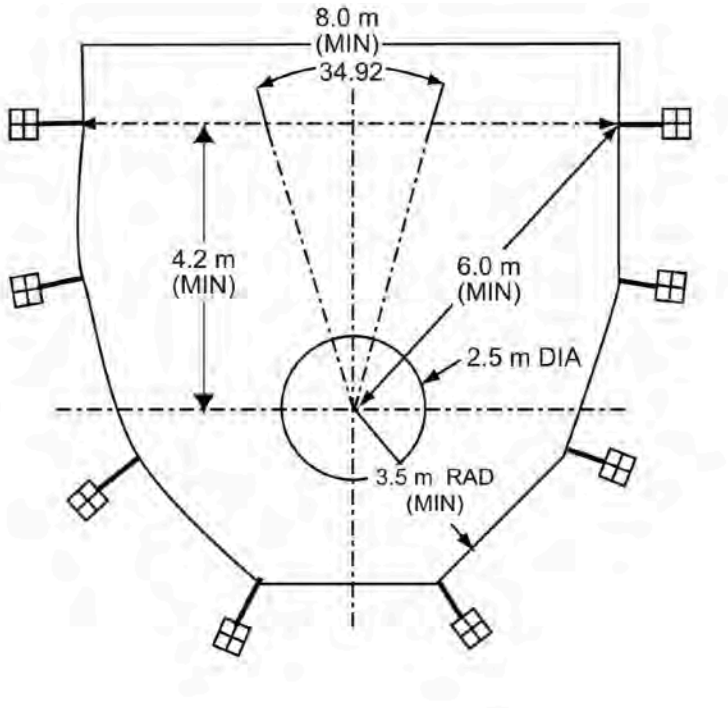


Figure 8. Hammer/Discus throwing cage (IAAF, 2010).

Javelin Area

The runway javelin should be marked by two parallel lines 5 centimeters in width. The minimum length should be 33.5 meters and the width shall be 4 meters between the inside edges

of the marked parallel lines. It is recommended that the runway be constructed of an artificial surface for its entire length. If an artificial surface is used, it is recommended that the runway be extended 1 meter beyond the foul line for safety reasons (IAAF, 2010).

The foul line should be 7 centimeters wide, painted white, and should be made in the shape of an arc with a radius of 8 meters. The distance between its extremities shall be 4 meters, measured straight across from end to end. Lines shall be drawn from the extremities of the arc at

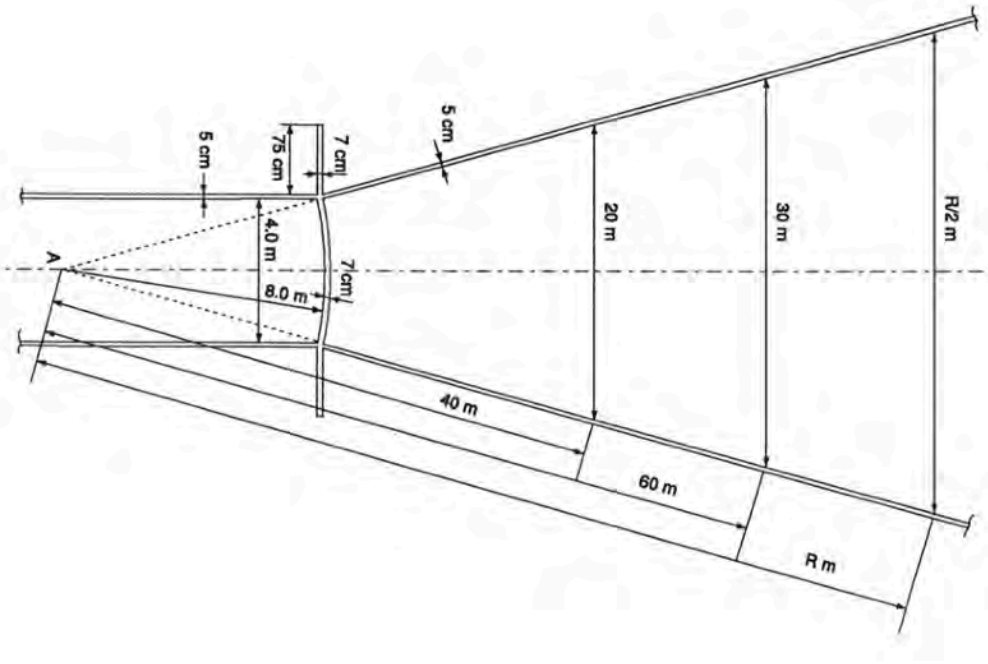


Figure 9. Javelin throwing area (IAAF, 2010).

right angles to the parallel lines marking the runway. These lines should be 75 centimeters in length and 7 centimeters wide (IAAF, 2010).

Throwing sport rules and success to winning/achieving.

Shot Put

The shot, a metal ball which is 7.26kg/16lb for men, 4kg/8.8lb for women, the athlete needs to put the shot with one hand (Leonard 2000). The ultimate goal is to throw it as far as possible from the seven-foot diameter (2.135m) circle (Leonard 2000).

In order to make the put successful, the shot must not drop lower than the line of the athlete's shoulders and must land inside a designated 35-degree sector. At the same time, the athlete must not touch the top of the toe-board during the put or leave the circle before the ball has landed, and then only from the rear half of the circle (Stuhec, 2005).

Discus

Athletes throw a metal disc weighing 2kg and diametering 22cm for men, and weighing 1kg and diametering 18cm for women. The athletes are required to throw as far as possible while remaining inside a 2.5-meter diameter circle (Leonard 2000).

In order to make the throwing successful, the discus must land inside a marked sector and the athlete must not leave the circle before it has landed, and then only from the rear half of the circle. The thrower specifically makes one-and-a-half spins before releasing the discus (Leonard 2000).

Hammer Throw

Athletes throw a metal ball which is 16lb/7.26kg for men, 4kg/8.8lb for women. The hammer is attached to a grip by a steel wire no longer than 1.22m. In order for the throw to be measured, the ball must land inside a marked 35-degree sector and the athlete must not leave the circle before it has landed, and then only from the rear half of the circle (Olson, 2000).

The thrower usually makes three or four spins before releasing the ball. Athletes will commonly throw four or six times per competition.

Javelin

Javelin is thrown by one arm. The athlete must hold the javelin by its corded grip little finger closest to the tip of the implement. The men's javelin must weigh at least 800g and be 2.6m-2.7m long while the women's javelin must weigh 600g and be 2.2m-2.3m long (Olson, 2000).

In order to make the throw successful for measuring, the athletes must not turn their backs to the landing area at any stage during their approach and throw; they must throw the javelin over the upper part of their throwing arm while not exceeding the foul line at any time. The tip of the javelin must land first and within the marked 29-degree sector (Olson, 2000).

The measure starts from the tip and tip only. Athletes will be allowed to throw four or six times for each competition.

Throwing sport positions and athlete experience needed to accomplish the sport.

Shot Put

Glide Technique

The core of the glide technique is to make linear movements. The athlete starts from facing backward of the circle, then hopping or gliding forward until the leading foot is approaching or touching the toe board. Rotating 180 degrees across the circle, and then tossing

the shot (Leonard 2000). Most of the force to get across the circle is generated by unseating and driving the leading leg toward the toe board. The standing leg is picked up and placed near the center of the ring. Once the athlete starts the glide across the ring, the thrower must keep the ball and body moving toward the throw (Leonard 2000). Shot-putters need to increase the speed of the throw during this movement and set up a proper throwing position (Stuhec, 2005).

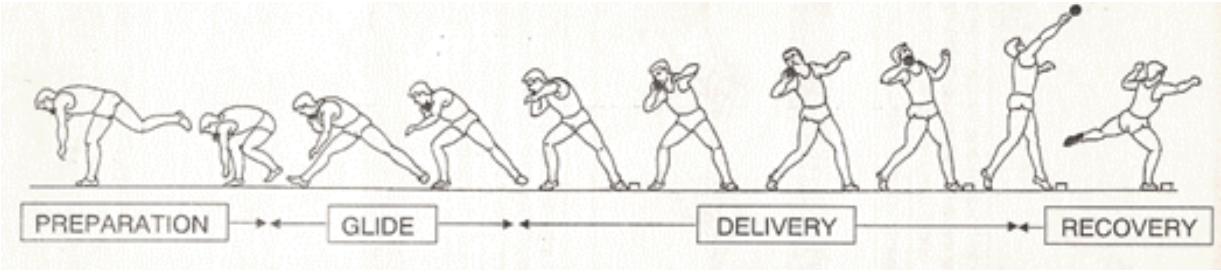


Figure 10. The picture shows the different phases of glide techniques

Rotation Technique

Differentiating from the glide technique, the thrower starts with facing the rear. At the back of the circle the thrower's weight is switched from left leg to the right leg. As the right leg is picked, the thrower shifts onto the left leg. The thrower comes around and faces the front of the circle and drives the right foot into the center of the circle. When the left foot reaches to the front of the circle eventually, the thrower then puts the shot (Stuhec, 2005).

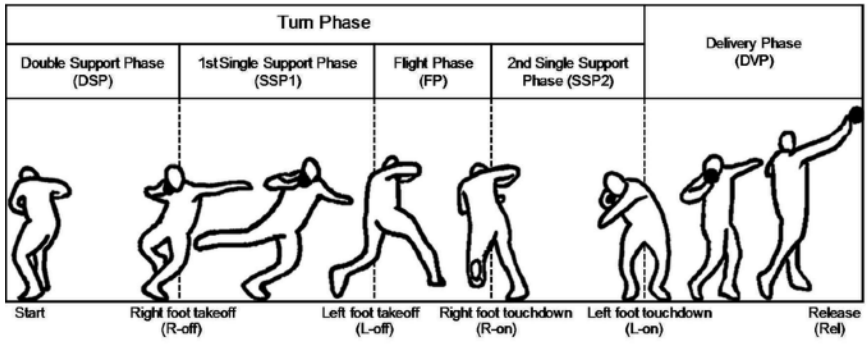


Figure 11. The picture shows the different phases of shot put rotation techniques (Stuhec, 2005).

Discus

There are mainly three stages for discus throwing: preparation, momentum building and delivery.

Preparation: stand with left shoulder pointing at the target and the body facing the direction perpendicular to the shoulder (for right-handers). Keep feet shoulder-width apart. Bend knees slightly. Hold the discus to the front of body, palm down. (Han and Yu, 1995).

Momentum building: swing the arm with holding the discus far back, palm still facing down (Han and Yu, 1995). Once the arm is pulled back to research the limit, swing the discus to the front. Then, twist the hips, and snap the left arm across the chest to the left (James, 1995).

Delivery: The throwing hand should follow through at an angle where the discus should be landed. To eject the discus, the discus spins off the index finger (James, 1995).

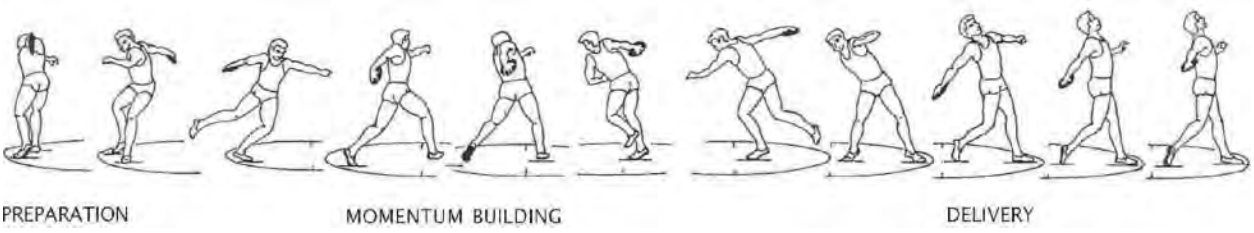


Figure 12. The picture shows the different phases of discus throwing techniques (James, 1995).

Javelin

The javelin is associated with factors like head height, arm bent, and elbow pointing forward. The athlete begins with run-up with the relaxed grip, wrist, elbow and shoulder (Stander, 2006, p.2).

Then move the javelin to the rear, over the right shoulder until the arm is straight and at shoulder height with the palm facing upwards. Rotate the shoulders to line up with the direction of the throw with hips remaining forward to maintain approach speed (Stander, 2006, p.2).

Weight is transferred and accelerated through the hips. The free arm remains relaxed ahead of the body and throwing arm remains extended (Stander, 2006, p.4).

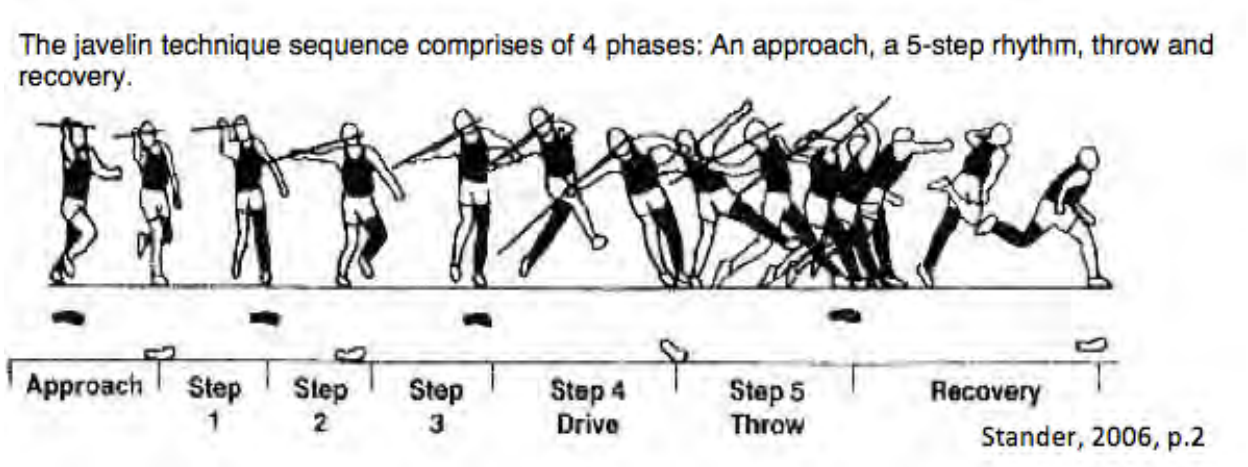


Figure 13. The picture shows the different phases of javelin throwing techniques (Stander, 2006, p.2)

Hammer Throw

The preliminary swings must be done with a relaxed rhythm just as employed in all the turns of the throw (Gutierrez, 2002). The essential aspect of the technique is pushing the hammer in the double support phase of the thrower's rotation and letting the hammer run freely in the single support phase of the rotation (Gutierrez, 2002).

The throwing motion involves about two swings from stationary position, then three, four or very rarely five rotations of the body in circular motion using a complicated heel-toe movement of the foot (Brice, Ness, and Davis 2008). The ball moves in a circular path, gradually increasing in velocity with each turn with the high point of the hammer ball toward the target

sector and the low point at the back of the circle (Gutierrez, 2002). The thrower releases the ball

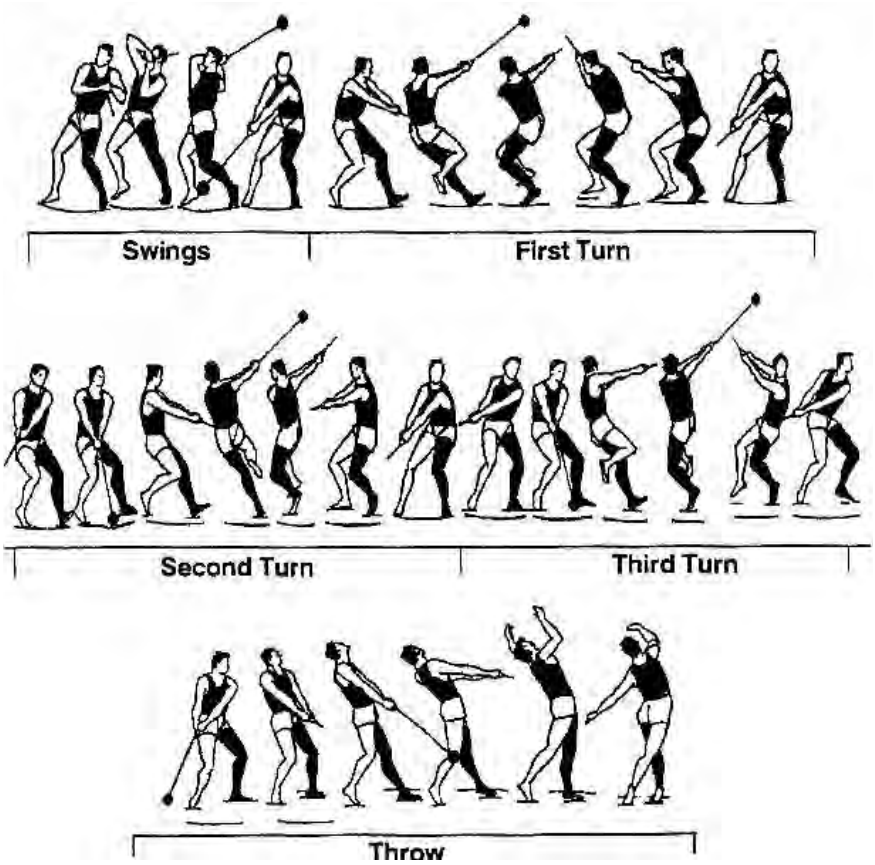


Figure 14. The picture shows the different phases of hammer throwing techniques (Gutierrez, 2002)

at the side of the circle as the hammer's velocity tends upward and toward the target.

Relevant physiological and biomechanics needs of athletes for throwing sport.

Shot Put & Discus

Three important factors will affect the performance of the shot put: height, the angle of release, and the velocity of the shot at the point of release (Stuhec, 2005).

Angle of release is important in the shot event as the release speed of the shot decreases when thrown with a higher release angle. The decrease in projection velocity with increasing projection angle is a result of two factors:

- When throwing with a high projection angle, the athlete must expend a greater effort during the delivery phase to overcome the weight of the shot, and so less effort is available to accelerate the shot (Stuhec, 2005).
- The structure of the human body favor the production of putting force in the horizontal direction more than in the vertical direction (Stuhec, 2005).

Release velocity is undoubtedly the most important factor in determining the distance of a throw. Release velocities in excess of 13 m/s are necessary for elite level throws. As such, all attempts should be made to maximize release velocity (Kavouras, & Georgiadis, 2010).

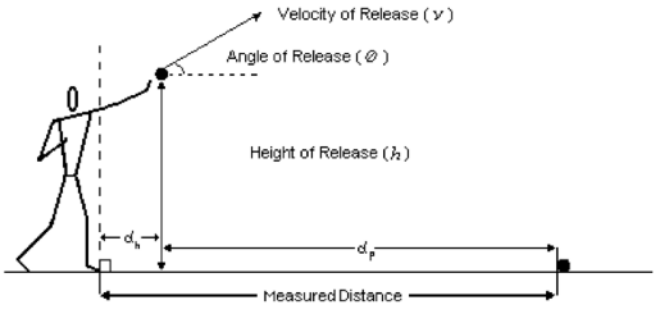


Figure 15. Height, the angle of release, and the velocity of the shot are the three important factors. (Kavouras, & Georgiadis, 2010).

Similar to shot put, discus-throwing performance is influenced by three factors, the velocity of release, the release angle and the relative height of release of the projection. The ultimate goal of the technique in each throwing event is to obtain the maximum speed and

optimum height and angle of release, which are key factors influencing the throwing distance. (Yu, Broker, & Silvester, 2002).

The release speed is critical within the discus through in order to reach peak performance. The previous research defined the release speed as being ‘equal to the speed of the discus immediately before release’ which is created by the speed of the performer spinning on their vertical axis with the arm in an outstretched position (Yu, Broker, & Silvester, 2002).

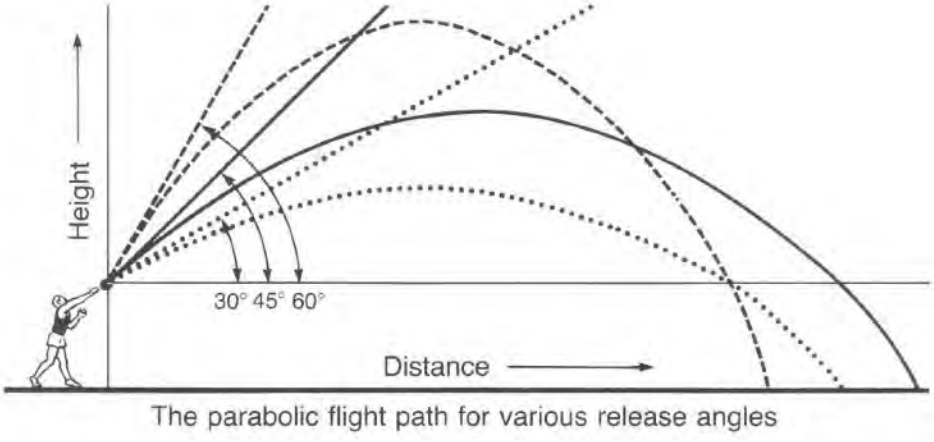


Figure 16. The picture shows that the release angle is the key factors for discus flight distance (Dai, et al., 2013).

In order to get the maximum release velocity, the discus and shot put rotational throwers need to reach a high rotational foot speed and to transfer the energy to the shot/discus (Linthorne, 2001). The glide/rotation shot putter and discus throwers force on the shot/discus with an explosive movement of the foot, coupled with a raising and rotation of the legs and trunk, followed by a rapid extension of the arm in the direction of the throw (Sugumar, 2014).

It has been shown that the activity of the right foot (right hand throwers) is the decisive element in the acceleration for both glide and rotational thrower (Umberge et al., 2013). During the delivery an effective acceleration of the center of gravity can come from the right foot only in an indispensable interaction with the work of the left (Bartonietz, 1999). The function of the feet during the delivery is to manage the straightening the body with a heave-up push to give the base for the powerful trunk turn. These actions create the push to give the base for the powerful trunk turn and better the release of velocity (Bartonietz, 1999).

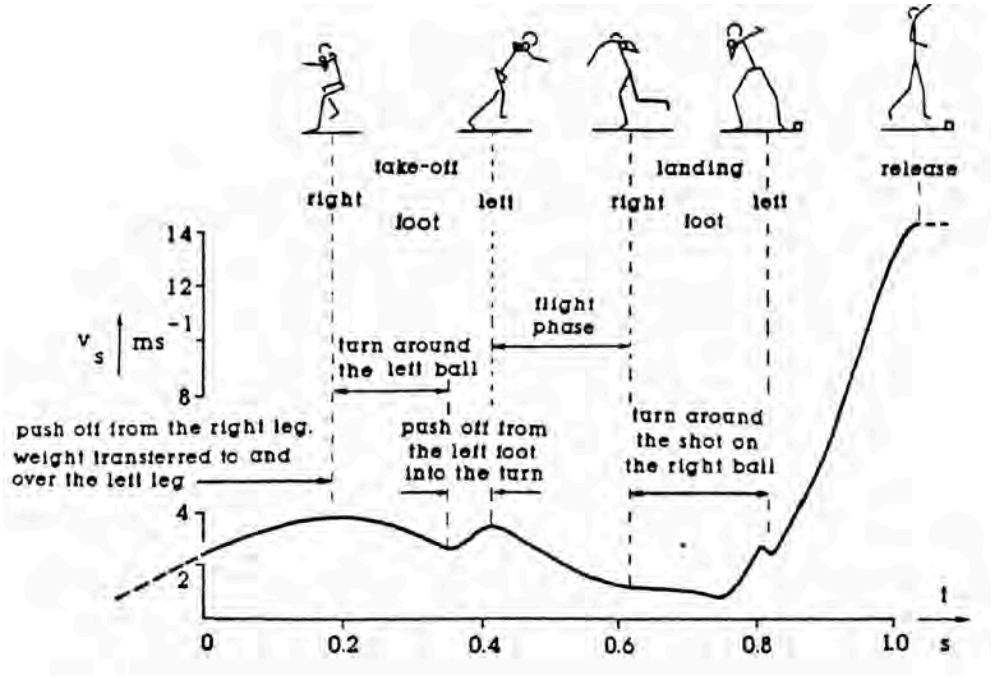


Figure 17 Shows the different phase of the rotational footwork related changes of the shot velocity (Bartonietz, 1999).

For the rotational throwers, the previous researches showed that the stable foot landing and high velocity rotation can effectively improve throwing performance (Bartonietz, 1999). This requires that the throwing shoes are very fit and the outsole needs to be made for reducing the friction between the outsole and the ground.

For the glide shot putter, the goal will be for the athlete to be able to rotate upper body easier and faster, can lead to a greater shoulder-hip separation and greater knee flexion at the moment the right foot (back foot) lands on the ground for the final release phase (Oesterreich, 1997). So the throwing shoes for the glide shot putter need to be more stable and rigid than rotational shoes so that there is an efficient and most direct application of force to be transmitted on the shot itself.

Javelin

Javelin throwing is a highly technical event and requires perfect coordination of multiple joints in different planes of motion. The distance a javelin is thrown is affected by factors such as wind speed and direction and the aerodynamics of the javelin. But the two most important and controllable factors are javelin release speed and release angle (Barber, 2014).

A javelin throw involves a run-up of six to 10 steps, followed by two or three crossover steps before the thrower releases the javelin. Once the front foot is down, the motion of the upper body begins. As one joint such as the hip which reaches the end of its range of motion and decelerates, the next is the shoulder, then elbow and finally the javelin – is rapidly accelerated (Barber, 2014).

Figure 18. Angle definitions of javelin throwing (Barber, 2014).

The second important parameter is the angle at which the javelin is thrown. The best angle of release for a javelin is between 32º and 36º, but this is tough to achieve consistently (Bartlett, 1996).

The flight path and distance of the javelin depends on the angle of attack, which is the difference between the:

- Angle of attitude: the orientation of the javelin to the ground.
- Angle of velocity vector: the flight path of the javelin's centre of mass (Bartlett, 1996).

The ideal angle of attack is zero degrees (Barber, 2014). If the angle of attitude is larger than the angle of velocity vector, the javelin won't travel in the most aerodynamic way. Its increased surface area will slow it down and decrease the throw length.

For a right-hand thrower, javelin throwing starts with an approach run followed by a delivery strike. At the initial stage(Figure 19), acceleration begins smoothly, with the objective to reach 6 to 10 running strides before release, with the first few running steps used to gain speed and rhythm (Torim, 2012). Sprinting is performed on the balls of the feet, with toes pointing forward not downwards in a dorsiflexed position which ensures that there is not a breaking motion (BBC Sport, 2013).

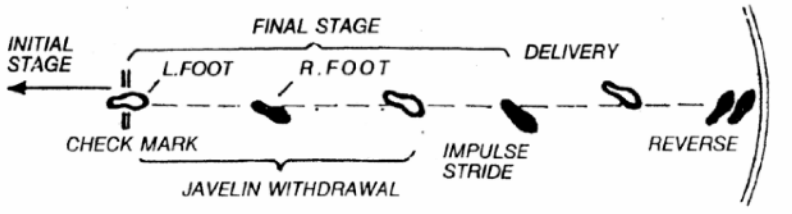
The contact between the foot and the running surface should be feel light, to ensure that minimum force is shot back, placing unnecessary stress on the athletes legs. Ensuring that the feet (forefoot) grip the surface will improve the friction and gain the ground reaction force

throughout the running strides (Torim, 2012). This is the reason why the javelin shoes usually have spike on the forefoot of the shoes.

Throughout the initial phase of the run up, the knees are slightly bent on contact with the surface and that each foot lands just below the hips, which is below the centre of gravity (BBC Sport, 2013). This will make sure that the leg works in a circular motion from the hip joint, which brings the heel of the foot behind the body.

Figure 19 shows the initial phase of run up (Willams, 2015).

The final stage can be divided to a withdrawal phase, impulse stride phase and delivery. The javelin withdrawal phase starts with the left foot landing and ends with the left foot landing (Willams 2015). The next two phase starts with the the right foot landing and ends with the release of the javelin.



THE MAIN PHASES OF THE JAVELIN RUN-UP

Figure 20. Different footworks phases of javelin throwing (Bartonietz, 2000).

So, the increased speed developed in the approach of the javelin throw places a considerably greater load on the athletes' feet and ankles, thus creating an even greater need for leg and ankle strength this event (Zatsiorsky, 1995). Additionally, it is very important for javelin throwers to have extreme eccentric strength in the non-throwing side foot to be able to apply the braking forces necessary to rapidly decelerate the body during the final release (Bartonietz, 2000).

Hammer throw

The biomechanics of the hammer throw are complex as the movement involves rotations of the hammer in varying planes, coupled with the translation and rotation of the thrower across the throwing circle (Brice et al. 2008). Within each turn, the thrower should ensure they utilize a technique that results in a good increase in hammer speed whilst also allowing them to end the turn in such a position that they can further increase the speed in the subsequent turn (Dapena, 1986; Dapena & Feltner, 1989).

The three main parameters that determine thrown distance are the velocity of release, the angle between the velocity vector and the horizontal plane and the height of the hammer at the instant of the release. The release velocity should be maximum. The optimal angle ranges from 43° to 44°, depending on the athlete's height (Dapena, 1984).

The motions of the thrower's centre of mass are influenced by three forces; gravity, a reaction force exerted by the ground on the thrower's feet which is ground reaction force

(Dapena, 1986; Dapena & Feltner, 1989). In order to get a good throw, the thrower must achieve an appropriate combination of hammer and ground forces that will produce a good increase in hammer speed (Dapena & Feltner, 1989).

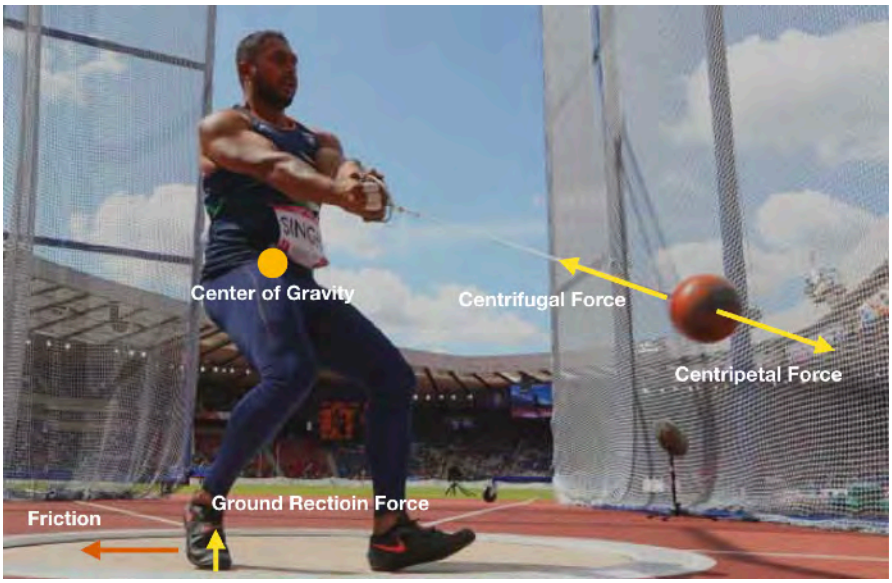


Figure 21. Hammer throw free body diagram (Li, 2019).

In order to generate as much release velocity with the implement as possible, while maintaining balance and coordination through the sequence of turns. Although the trunk and upper-body musculature are used in a throw, the feet and legs provide the larger muscle groups that initiate movement of the hammer (Dapena & McDonald, 1989). The fast spin of the feet and the initiation of the large muscles of the legs helps create momentum. This action is followed by isometric actions of the trunk and upper-body musculature to allow for a larger turn radius (Dapena & McDonald, 1989).

Therefore, same as the throwing shoes for shot put, reducing the friction between the outsole and the ground is very important for improving spin velocity. Also, the ankle support

and stability of the shoes upper is important for hammer throwers because they need to adjust the posture at the hip and shoulders during the course of the fast turns.

Athlete/consumer/user data (gender, age, location) and pertinent market size.

The pervious research claimed that the participation rates in throwing sports continued to rise during the 2018-19 academic year in the USA, with the number of teams competing in NCAA championship sponsored sports reaching an all-time high of 29,079 (Johnson, 2019)

The following statistic (Figure 22) shows the number of participants (male/female) in high school track and field in the United States from 2009/10 to 2018/19. In the 2018/19 season, over 488.2 thousand girls and over 605.3 thousand boys participated in a high school track and field program (Gough, 2019).

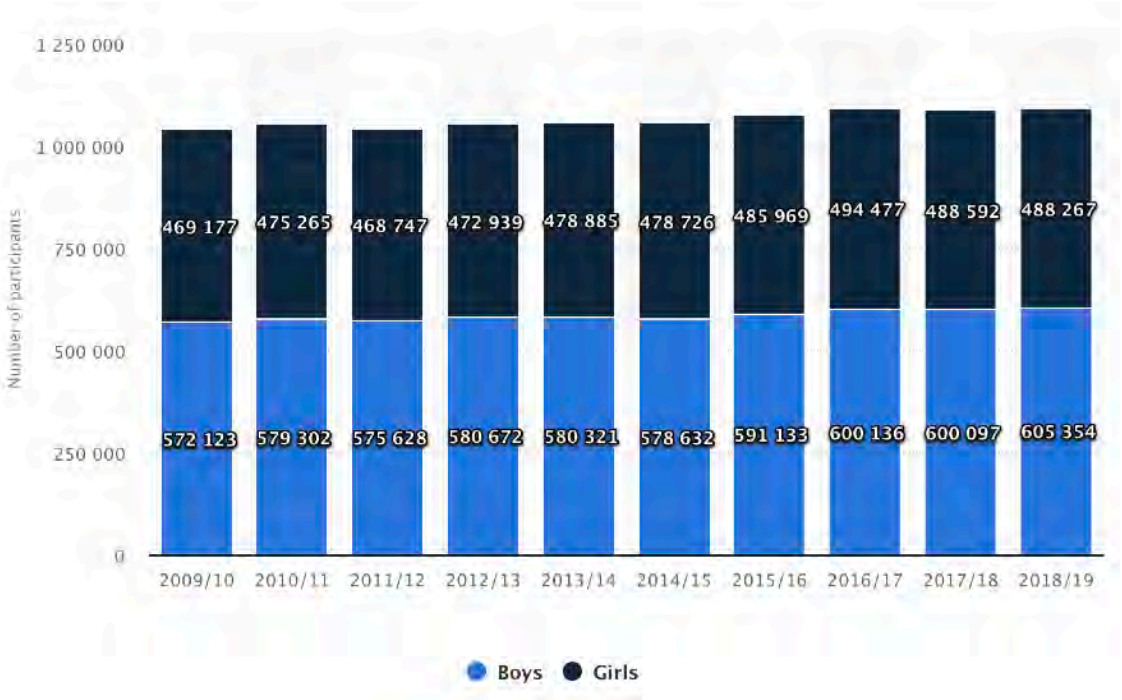


Figure 22. Retrieved from https://www.statista.com/statistics/268002/participation-in-us-high-school-track-and-field/

Another research showed that the global track and field shoes market exhibits a consolidated structure, finds a report by Transparency Market Research (TMR, 2017). The top five players in this market, namely Nike Inc., Adidas AG, PUMA, Asics Corp., and New Balance, together held more than 60% in this market in 2016. Rising at a healthy CAGR of 2.90% from 2016 to 2025, the opportunity in this market is to touch US$16.88 bn by the end of 2025. In terms of volume, the researcher claimed the market is anticipated to cross 262.8 million units mark by 2025（Transparency Market Research, 2017).

In this research, the researcher will focus on the elite male throwing athletes. However, female throwing athletes share a similar explosive movement and techniques with male athletes, so the design of throwing shoes from this capstone research also apply to female throwing athletes.

Current/competitor product research (products, price points, features and benefits).

Figure 23 is Nike Zoom Rotational 6
Hammer, Discus, Rotational Shot Put
$100
Durable mesh with a seamless vamp.
Mid foot strap and an external heel counter for lockdown.
Full-length, thin EVA midsole for lightweight protection.
Full-length BRS 1000 smooth rubber with a full-length Pebax® plate for durability.
Retrieved from https://www.amazon.com/Nike-Zoom-Rotational-Mens-685131-600/dp/B07HYW3LR9

Figure 24 is Nike Zoom SD 4
Discus, Glide Shot Put
$80
Synthetic leather with the strap for increased lockdown.
EVA foam midsole for durable cushioning. Rough BRS 1000TM carbon rubber with a contoured design for traction and durability.
Retrieved from https://www.eastbay.com/product/~/85135002.html?

Figure 25 is Adidas Throwstar
For Throwing Beginners, glide technique
$84
Lightweight with a synthetic upper.
Lace up closure for a locked down fit.
Soft ankle collar for comfort.
Strap band provides great midfoot support. Carbon rubber crepe outsole for durability and traction.
Retrieved from https://runrepeat.com/adidas-throwstar

Figure 26 is Adidas AdiZero
Discus, Shot put, and hammer Rotational
$110
Synthetic cage upper construction is internally reinforced with a hook-and-loop strap for lockdown during rotation.
Soft collar for reduced pressure on the ankle and Achilles.
Carbon rubber outsole for durable traction through your. throwing motion.
Retrieved https://www.ebay.com/i/362555552767?chn=ps&var=631829676678&norover=1&mkevt=1&mkri

Figure 27 is Unleash SD 2

Discus and Shot put Rotational

$100

ISOFIT system provides stabilizing support while adapting to the movement of the foot.

FLEX-FILM upper is lightweight and supportive. Midfoot cross strap locks foot to platformInternal EVA midsole for underfoot cushioning.

Retrieved from https://www.eastbay.com/product/saucony-unleash-sd-2-mens/290352.html

Figure 28 is Asics Unisex Throw Pro

Discus and Shot put Rotational

$120

Synthetic leather upper, easy to clean.

An abrasion and tear resistant synthetic leather for increased upper durability.

Improves bounce back characteristics and decreases. midsole breakdown.

Retrieved from https://www.amazon.com/ASICS-Throw-PRO-M-Black-Flash/dp/B00XXF97XU/ref=asc_df_B00XXF97XU/?

Figure 29 is Nike Zoom Javelin Elite 2

$90

Flywire technology, fused materials, and a midstrap wrap over the foot for a lock-down fit.

Full-length Phylon™ midsole offers responsive cushioning and the anatomical heel allows natural foot movement.

Midfoot shank provides stability and propulsion to ignite your step and power your throw.

Full-length Pebax® plate with 11 spikes ensures powerful traction.

Retrieved from https://www.eastbay.com/product/model/nike-zoom-javelin-elite-2-mens/207248.html

Figure 30 is Lanzar JAV 2

$100

SOFIT upper adapts to the shape of your foot for a snug fit that moves with you.

Cross strap across the midfoot for secure lockdown.

EVA midsole cushions and returns energy with every step.

Full-length, 11-spike plate for aggressive traction on the track and grass.

Includes 3/8" removable pyramid spikes and a wrench.

Retrieved from https://www.saucony.com/en/lanzar-jav-2/886129897963.html?utm_source=google&utm_medium=cpc&adpos=1o1&scid=scplp27271U-886129897963&sc_intid=27271U-8861298

State of the art materials & manufacturing of current throwing shoes.

Synthetic Leather

Due *to* the heavy weight of the throwers, the durability of the shoes upper is very important. Also they need their shoes provide very stable support while adapting to the foot movement.

Synthetic leather are used a lot on the throwing shoes upper to retain the shoes form and are usually very durable. Synthetic leather is also designed to hold up against weather conditions and the wear and tear of spining and gliding over an extended period of time.

Synthetic leather is a layered composite made by coating a polyurethane paste onto a fabric substrate (Ritter, 2014). Most synthetic leather manufacturers use cotton or polyester as the base material for their fabrics (Hodakel 2019). Then, bind PU or PVC to the underlying base textiles, a variety of processes may be used, but they generally involve melting the plastic and overlaying it on the base textile. Once the plastic has been bound to the underlying fabric, it is cut into the desired shape and size (Hodakel 2019).

S*ynthetic mesh*

The mesh may be mixed with suede or nylon. Although mesh is not as durable as canvas or leather, this material allows the throwing shoes to breathe, which helps keep throwers feet cool and comfortable during training or competition wear (Staikos, Heath, Haworth and Rahimifard, 2006).

Mesh' itself refers to a knitted structure of fibers, and is technically a barrier created from connected strands. The yarns are knitted or woven together, resulting in a fabric with open spaces in between the strands of yarn. When it comes to mesh fabric, the material is typically made from

polyester or nylon. The synthetic fibres are woven to create a flexible, net-like fabric which has a huge range of uses. Contrasting to this, mesh can also be created from metals for a sturdier and more structured material, often for industrial use (Carbonell, 2013).

TPU Toe Cap

A lot of throwing shoes use TPU (thermoplastic polyurethane) to make toe cup for better protection (Yan & Xu, 2009). The most of throwing techniques require a lot of rotating which will wear the fo toe cup very quickly and hurt the toe. So TPU provides an easy way to protect thrower's toe from wear and damage in the spin movement. Also TPU offers the better abrasion resistant for the forefoot of the shoes (Ziegler and Marquez, 2018).

Like all thermoplastic elastomers, TPU is elastic and melt-processable. It can be processed on extrusion as well as injection, blow and compression molding equipment. It can be vacuum-formed or solution-coated and is suited for a wide variety of fabrication methodologies. Also , TPU can even be colored through a number of processes (Patton, Chen, Hu, Grazulis, Schrand, and Roy, 2017).

EVA Midsole

EVA (Ethylene-vinyl acetate) also known as PEVA (poly-ethylene-vinyl acetate), is the copolymer of ethylene and vinyl acetate. When two plastic types join in the same polymer chain, the polymer is called a copolymer (Yan & Xu, 2009) .

EVA midsoles are the most popular cushioning in sports footwear. You can find a lot of throwing shoes made by EVA midsole, which makes the throwing shoes became lightweight,

resists compression set, provide cushioning and shock absorption for throwers. The classic way to foam EVA is to use an expansion press, the more modern way to expand EVA is by using an injection machine (Yan & Xu, 2009).

Carbon Rubber Outsole

The outsole uses the textured carbon rubber to increase grip and durability. Carbon rubber also offers high wearing traction for fast throwing rotational or glide and wet conditions. For the manufacturing, injection molding is the method for making outsole. Raw rubber is placed into the mold, where it will soon flow in to form the outsole. Put the rubber into the full mold and heat for a short time to create the outsole. Once out of the heat press, the excess rubber is cut away to leave a perfectly formed outsole (Hussain, 2001).

Throwing shoe manufacturing process

Currently, most of sports manufacturers make shoes with the following method： First, the upper part. The upper pattern parts for the shoe are made into steel cutting dies. Each upper part is cut from rolls of fabric or from leather hides (Motawi, 2017). Today more and more sports footwear companies use 4D knitting construction to make upper which is produced by a CNC knitting machine then assembled with the tongue, lining materials, and reinforcements (Schmelzeisen, Koch, Pastore, & Gries, 2018).

Next, stitch the parts of the upper and sewing them together. The shoes upper is prepared with the strobel bottom. The shoe upper is steamed to soften the materials and the last is inserted and pulled tight. While the upper is being lasted, the sole is being prepared. In the throwing shoe

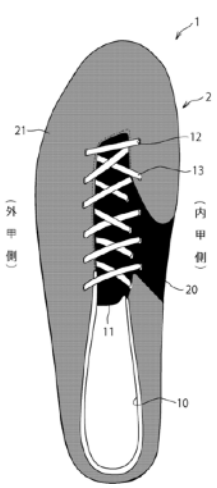
area, rubber sole is commonly used and it usually combines with the foam cushioning component cemented inside (Motawi, 2017).

When the upper has lasted tightly and the outside unit is competing, the two pieces come together. Then, the rubber sole unit will receive coatings of primer and cement. The outsole will get its own special primer. The shoe upper is also prepared with its own special primer and cement (Motawi, 2017).

After the contact cement and primer have been completely dried in the heating tunnels, the two pieces are joined together by hand. A skilled shoe maker aligns the upper and outsole together then places the shoe in a hydraulic press. Once the shoe is pressed together it's often put in the cooling tunnel to set the glue. After the cooling tunnel, a shoe de-lasting machine is used to push the last out of the shoe without wrinkling the shoe upper (Motawi, 2017).

Utility patent landscape

Upper Structure for shot put shoes



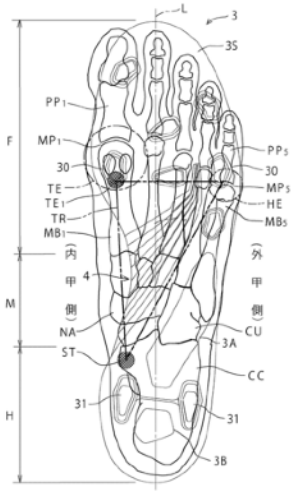


Figure 31. *Upper structure for shot put shoes from Yangping, J and Zhongcun, J. (2015). WO2016152490A1. Retrieved from https://patents.google.com/patent/WO2016152490A1/en?oq=shot+put+shoes*

Two Japanese inventors Yangping Jitian and Zhongcun Jin invented an upper structure of the shoes in 2015 to reinforce the performance and stability of rotational shot put especially when the foot needs to turn. According to the inventors' description, the sustainability of the shoe on the current market is not good enough when the rotation foot tends to move to the upper side of the upper during the turning movement. In this invention, the inventors integrate an elastic part of the inner side region of the upper and non-elastic part of the outer side region of the upper as one piece of the upper structure for the shoes to improve the stability during turning. The contraction part will follow the twist of the foot and the non-stretchable part will hold the foot well when the foot is moving to the upper outer side during rotation (Jitian and Jin, 2015).

Javelin shoes having metatarsal cushion on spike plate

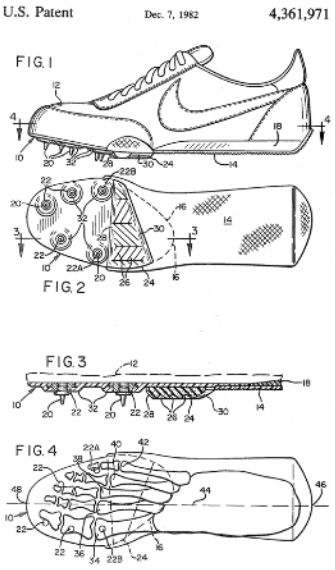


Figure 32. *Javelin shoes having metatarsal cushion on spike plate from Bowerman, J. (1980). US4361971A. Retrieved from https://patents.google.com/patent/US4361971?oq=discus+throwing+shoes*

In 1980, William J. Bowerman invented a track shoe with metatarsal cushion in spike plate for sprinters and hurdlers. And this invention may also apply to the javelin because the run-up before the final throwing. The cushion is designed to absorb shock, provide extra traction and foot stability for the running and landing. This inventive cushion may help javelin throwers a better performance during the run-up and land steadily for the final throw (Bowerman, 1980).

Gripper elements for sports shoes

Figure 33. *Gripper elements for sports shoes from Dassler, A. (1972). US3859739A. Retrieved from https:// patents.google.com/patent/US3859739?oq=javelin+shoes.*

The inventor Adolf Dassler invented few new constructions of gripper elements for sports shoes to make the spikes are less deep into the plastic track comparing to the previous gripper elements. The inventor mentioned that this new spikes may also apply to javelin. The new type of gripper elements allow a certain turning of the shoe about an axis approximately at right angles to the track. Furthermore, they can produce more support against the surface to generate a catapult effect so that those sharp edges could penetrate into the track (Dassler, 1972).

Graphic, and color application on current product space.

Figure 34. Adidas Throwstar color and graphic (Li, 2019)

Figure 35. Adidas Adizero color and graphic (Li, 2019)

Figure 36. Saucony Unleash SD 2 color and graphic (Li, 2019)

Figure 37. Asics Throw Pro color and graphic (Li, 2019)

Figure 38. Nike Zoom SD 4 color and graphic (Li, 2019)

Figure 39. Saucony Lanzar Jav 2 color and graphic (Li, 2019)

SWOT analysis of current product (strengths, weaknesses, opportunities and threats).

Extremely Fast, Forces you onto ball of foot, Grips well. It developed specifically for Discus and Shot Put rotation.

STRENGTHS

This shoe specifically forces you to be on your toes throughout the rotational movement and this takes some getting used to. Due to this unusual design of the sole these shoes are not suited to hammer throwing.

WEAKNESSES

THREATS

Outsole wear out too fast than other product on the market.

OPPORTUNITIES

More comfortable upper and breathable features could be helpful.

A reinforced synthetic cage upper with supportive straps helps securely hold feet in place. Carbon rubber toe caps provide added protection. Tools to remove the spikes are included. A soft ankle collar and microsuede lining offer comfort and durability in high-tension areas.

STRENGTHS

They may take a little time to break-in. Athletes have to spend more time to get used to it.

WEAKNESSES

THREATS

Spikes not really specific locate at demand area, need more traction.

OPPORTUNITIES

More flexibility design for the upper and straps.

The Adidas Throwstar is a very nice shoes for throwing beginners. provide a starting point for throwing shoes that doesn't cost you a lot of money. These shoes are extremely grippy and flexible.

STRENGTHS

Because of the extremely grippy and slow nature of the shoes they are not recommended for hammer throwers. Only for beginners or glide shot putter.

WEAKNESSES

THREATS

Competitor have more beautiful graphics design than this one. Lack of innovation & technology

OPPORTUNITIES

More rounded edge of outsole could be helpful for rotational technique throwers.

The sole of these shoes are much faster than the other throwing shoes available for purchase and as a result are more suited to rotational movements (Hammer, Discus, Rotational Shot Put.)

STRENGTHS

The shoes have a fairly rigid sole with not much give. A downside to these shoes is that the sole wears through fairly quickly.

WEAKNESSES

THREATS

Competitor's products have begun to be updated, but the technology on this pair of shoes have not been updated many years.

OPPORTUNITIES

Improve outsole quality make it more durable, midsole cushioning, more flexible upper.

Part 2

Project Alignment

First of all, the researcher was a professional athlete who concentrated on shot put and discus. The experience came from professional training and competition fields became an irreplaceable core strength and support for this research. With the thoroughly acknowledge of the competition and training progresses, regulations and environment, the researcher masters at athletes' demands and this will become valuable base and inspiration for this project.

As stated previously, these four different types of sports share resembling techniques. However, no matter which type of technique it may apply, the movements from athletes' feet and body are the keys to the high quality of performance. As a result, a good pair of shoes is vital for those four throwing sports. The researcher once had experienced how tremendously a pair of non-fitted shoes could affect the performance. For example, the glide throwers require more liner movements instead of rotational throwers, as a result, the outsole of the shoes should be designed more flat and smooth for a steadier landing.

Second of all, strong sketching skills would advance the process of the research. It will deliver the researcher's ideation accurately. Furthermore, the precise and creative sketching skills will help with the following design directions.

Thirdly, the internship at Nike Shanghai in Global Football Department provides more practical techniques to translate the stories behind products in graphic designs. The researcher designed a pair of player edition soccer cleats for a famous soccer athlete through athlete research, sketching, storytelling. Conducted soccer products landscape and product line research. Worked with team members in design, development and merchandising to ensure project

feasibility, meeting price point, merchandising needs and product creation timelines. The research gained a lot of very useful skills and knowledge through this intern experience which will become the strengths for the capstone research.

Furthermore, good appearance and strong interpersonal communication skills will help gather valuable feedbacks and needs from more professional athletes.

Finally, all the skills and the acknowledgment from the beginning research to ideation and designing, and all the way to manufacturing the product， the researcher obtains will smoothly advance the progress of the project. This project will fully demonstrate the researcher's abilities of innovative ideations and the best skills he has.

Field Work

Shot Put Athlete Research/Interview Questions:

1.Which techniques are you using for shot put? Glide or Rotational?

2. What are the important factors that affect your performance? (spin velocity? body posture? why?)

3. Could you tell me about how are you using your body/strength to control your footwork technique?

4. What kind of shoes do you usually wear for training?

5. What kind of throwing shoes do you wear for competition ?

6. Is there anything that frustrates you about your current throwing shoe design?

7. Do you buy throwing shoes for your specific throwing technique?

8. What other considerations do you make when buying your shoes?

9. What is the most important performance feature that you look for?

Hammer Throw Athlete Research/Interview Questions:

1. Could you tell me about how are you using your body/strength to control your footwork technique?

2. When you spinning your feet, do you think the maximum friction area between shoes and ground is the ball of the foot? Or the edge of the shoes?

3. In terms of hammer throw technique/footwork, what are the important factors that affect your performance? (spin velocity? body posture? why?)

4. What kind of throwing shoes (brand/Size) do you wear for competition? Do you like it? Why?

5. Is there anything that frustrates you about your current throwing shoe design?

6. What is the most important performance feature that you want for your hammer throw shoes?

7. What other considerations do you make when buying your hammer throw shoes?

8. Do you think ankle protection is necessary fo hammer throw shoes?

Javelin Throw AthletwResearch/Interview Questions:

1. When you sprinting(run up stage), what part of the footwork helps you to generate your speed?

2. In terms of javelin throw technique/footwork, what are the important factors that affect your performance? (speed? body posture? why?)

3. What is the frustration parts for your current javelin shoes?

4. Do you think ankle protection is necessary for your javelin shoes?

5. When you do the “crossover” steps, could you tell me how do you control this technique ?

6. What kind of shoes do you wear for training?

7. What is the most important performance feature that you think is necessary for javelin shoes?

8. Do you think the asymmetrical shoes works better for javelin footwork?

2020 Indoor Track Preview

In order to collect research data and athlete insight, the researcher went to 2020 Indoor Track Preview at the university of Washington in Seattle. To observe their footwork on site and interview athletes.

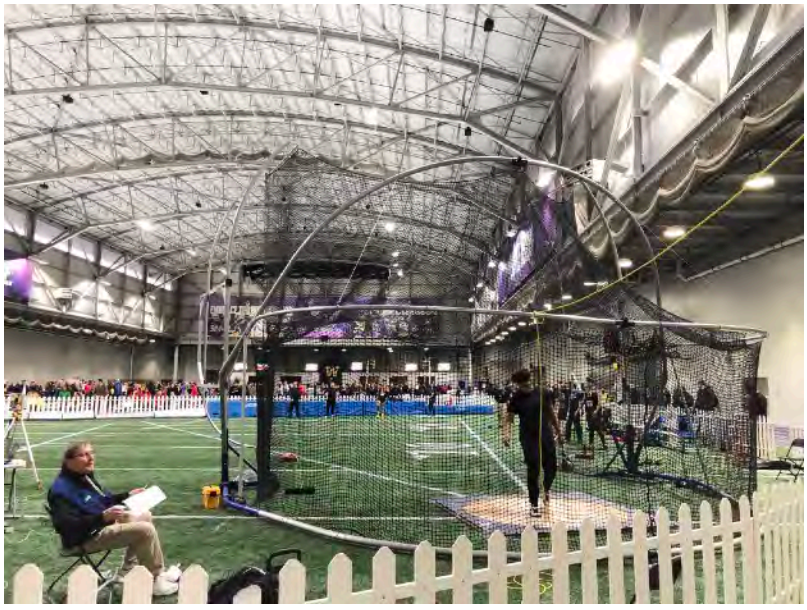


Figure 40. 2020 Indoor Preview,Dempsey Stadium at the University of Washington in Seattle. (Li, 2020)

Data Collecting Method:

The researcher used a slow-motion camera to record the athlete's footwork, then analyzed and compared different videos and thorough evaluation to assess footwork techniques, foot activation, and specific movements in order to better identify problems, physical limitations, and athlete's needs. This method allows researcher to get to the root of the footwork performance in order to get more clearly identified for design direction.

The Key Findings of Shot Put/Discus

From the slow-motion video analysis, the researcher found that the spin velocity and release velocity will affect the athlete's performance(Figure 41). The faster athlete spins the faster release velocity they get. The function of the right foot (landing foot) during the delivery is to manage the body with a heave-up push to give the base for the powerful trunk turn. And the forefoot on the landing foot is the area that absorbs body weight and delivers the power of the final push.

Figure 41. Three different athletes slow-motion video analysis and performances comparison. (Li, 2020)

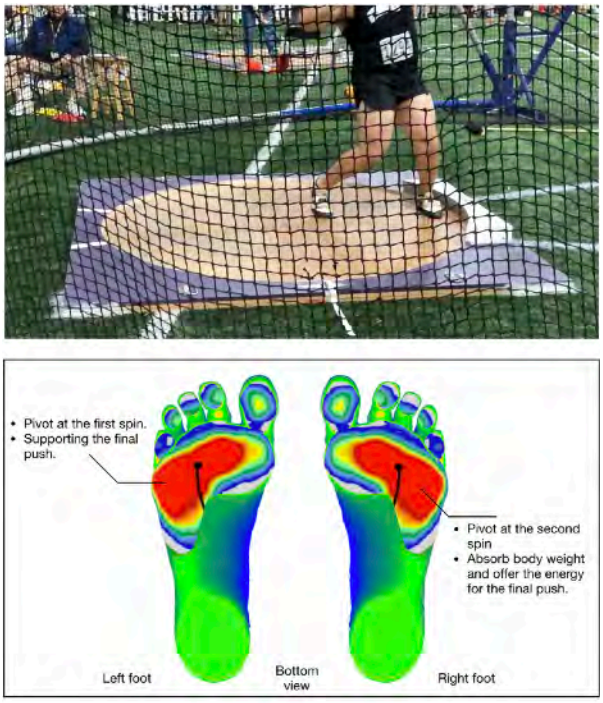


Figure 42. The contact area analysis of the foot for the shot put/discus footwork. (Li, 2020)

The Key Findings of Hammer Throw

From the hammer thrower slow-motion video analysis, the researcher found that some athletes have 4 turns before releasing the ball, some of them have 5 turns. The spinning takes the left foot as the central pivot point, another foot is balancing the body and creating the momentum, forefoot and heel both absorb the force from body weight. When spinning, the elite athlete will use the edge of the left foot to spin instead of the forefoot or the heel (Figure 42). In order to get fast spin velocity, athletes need to reduce the ground friction area.

Figure 43. Three different hammer throw athletes slow-motion video analysis and performances comparison. (Li, 2020)

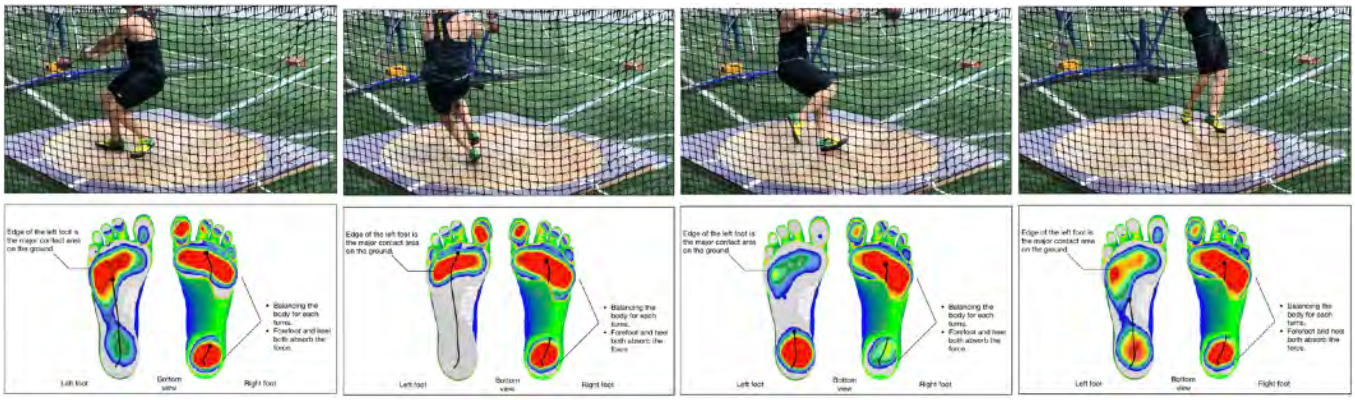


Figure 44. The screenshots of the hammer throw athletes foot contact area analysis and performances comparison. (Li, 2020)

The Key Findings of Javelin Throw

A javelin throw involves a run-up of 6 to 10 steps, followed by two or three crossover steps before the thrower releases the javelin. Sprinting is performed on the balls of the feet, with toes pointing forward. Ensuring that the feet (forefoot) grip the surface will improve the friction and gain the ground reaction force throughout the running strides.

At the run-up stage, the forefoot is the main contact area for both feet and the forefoot absorbs the body weight. At the crossover stage, the ball of the foot is the main contact area on both feet. At the final release stage, the left whole foot is contacting the ground, stopping the body. The right foot is balancing the body for the final release.

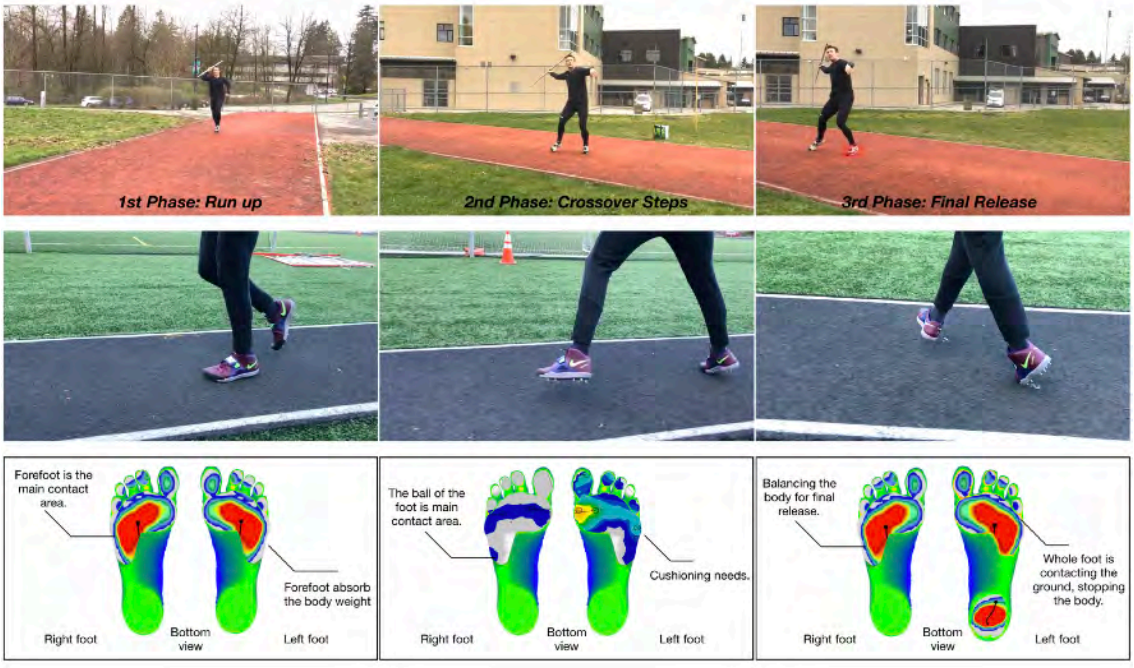


Figure 45. The screenshots of the javelin throw athletes foot contact area analysis and performances comparison. (Li, 2020)

Athletes Interview/Insights

When the researcher at the 2020 Indoor Track meet, the research had the opportunity to interview two athletes face to face at the scene:

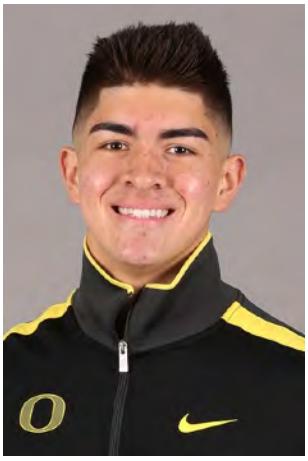


Figure 46. DEREK AKEY, University of Oregon, Shot Put/Discus
Personal-best throw of 55.36m/181-7.5 to win FHSAA 4A regional title
Retrieved from https://goducks.com/sports/track-and-field/roster

Derek mentioned he wants to have stiff shoes upper, he doesn't want the upper too flexible. He claimed that a good pair of shot put/discus throwing shoes usually don't very flexible which is good for throwers. He also mentioned there is very little arch support in the Nike SD's, and his ankles pronate a lot in them. That wasn't as much of a case with the Nike Rotational. Furthermore, he likes the strap on the zoom rotational 6, really helpful for lockdown (Derek, 2020).

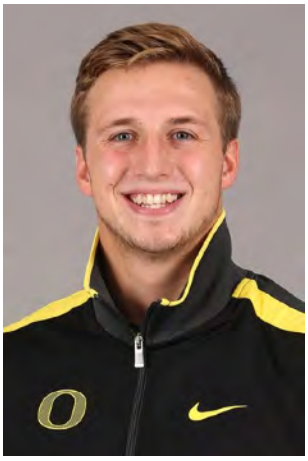


Figure 47. AUSTIN THARP, University of Oregon, Hammer Thrower
Competed in the hammer throw (173-11/53.00m) at the PAC-12 Championships.
Retrieved from https://goducks.com/sports/track-and-field/roster

Austin stated that the three most important areas of strength for a hammer thrower are the legs, the core, and the posterior chain. Controlling the placement of the athlete's feet and legs is essential to a good throw. He claimed that for shot put/discus athletes, they are only turning on the toe, a lot more spin at the beginning of the throw. Hammer throw has some spins on the heel. He also mentioned that he wanted to have tighter and breathable upper material for the shoes (Tharp, 2020).

Beside interviewed Austin and Derek on site, the researcher also reached out three more thrower through email questionnaires:

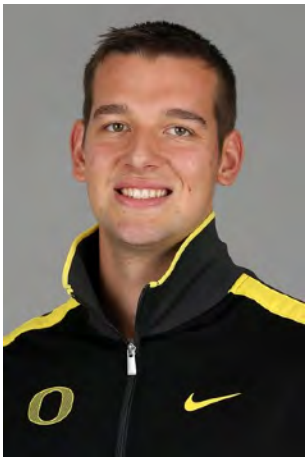


Figure 48. TY HAMPTON, University of Oregon Field & Track Team, Javelin Throw
Won the PIAA District XI 3A Championships title as a junior with a season-best throw of 179-11
Retrieved from https://goducks.com/sports/track-and-field/roster

In the questionnaire, TY stated that spikes do not necessarily have to be super comfortable, they should serve a purpose. He mentioned he often took off his spikes in competition. Because spikes are very tight and stiff. This is good for relaxing his feet and energy recovery. He also talked about his current shoes is high top Nike Javelin Elite II which overall works ok for him. But the foam midsole is too soft for him. He explains the soft midsole is not good for blocking. The javelin throwers want it to be rigid so they can instantly stop themselves with the block. The other point is the single strap on the shoe. It's simply not enough to support when blocking for him. And he also talked about ankle support in javelin is a critical component. The goal for ankle protection is to have strong support to hold the ankle in place for the block. TY said Nike's high top doesn't even cover the ankles with the elites (Hampton, 2020).

Figure 49. CONNOR ROUSEMILLER, University of Minnesota, Hammer Thrower
Recorded a season-best mark of 19.63 meters (64-05.00 ft.) to finish third at the Snowshoe Open in 2019 season.
Retrieved fromhttps://gophersports.com/sports/mens-track-and-field/roster/connor-rousemiller/18214

Based on the feedbacks from Connor, he claimed that the throwers even throw with two different types of shoes on because they like the feel of one of the shoes doing the left foot's

work and the other shoe doing the right foot's work. He mentioned that having outsole individualized to the function of the foot would be an interesting concept since each foot has different responsibilities in the throw (Rousemiller, 2020).

Figure 50. Yang Liu, Chinese National Field & Track Team, Shot Put/Discus
Recorded a personal bests in the event are 19.77 meters outdoors (Shenyang 2013).
Retrieved https://www.gettyimages.co.uk/photos/yang-liu?family=editorial&page=14&phrase=yang%20liu&sort=mostpopular

This interviewee is Yang Liu who is a shot putter from the Chinese National Field & Track team. He used size 13.5 Nike Rotational 6 for the majority of my career. However, he recently switched to size 13.5 Nike SD's. He made the switch because SD's have a different texture/material on the bottom that is better for slippery throwing circles. He thought would be awesome to find a material that performed similarly on different types/finishes of concrete/wood/ linoleum, because the materials and finishes of circles around the world vary significantly (Liu, 2020).

He also claimed that durability is important, as he usually went through one pair of shoes every six months. That is roughly 4000 throws in his experience (Liu, 2020).

Design priorities and design briefs

Shot Put/Discus

The shot put/discus shoes are designed specifically for the rotational technique shot put/ Discus. Based on the previous research findings, the innovative shot put/discus shoes combine the specific needs of the spinning technique to provide the best lockdown performance and support.

Features & Benefits:

- Specific traction design provides the balance of spinning and stability.
- Crossover straps and an external heel counter for best lockdown.
- The comfortable midsole for durable cushioning at the specific areas.
- Lightweight breathable mesh material upper with synthetic polyester overlay reinforcement.

Hammer Throw

According to the field research and athlete's insight/feedback, the hammer throw shoes provide the best performance for executing rapid pivots for hammer thrower. The design will help the athlete to absorb shock, enhance stability, and localized traction provides the specific traction support.

Features & Benefits:

- Upper construction is internally reinforced with a strap for lockdown during fast rotational.
- Asymmetrically designed outsole for hammer throw specific movements and provide individualized traction support.
- Built-in cushioning collar for reduced pressure on the ankle.

Javelin Throw

Based on the javelin footwork analysis and research findings, this shoes is asymmetrically designed for javelin specific movements and delivers great lockdown and flexibility exactly where athletes need it.

Features & Benefits:

- Lockdown system stabilize dorsal foot and wrap over heel at the same time, offers better foot lock-down fit.
- Removable spikes are conveniently for athletes to install and take out during the competition.
- Midsole cushions and returns energy with every step and power the final release.
- Spikes and traction will ensure the feet grip the ground improve the friction.

Ideation process and methods used

Destructive Analysis

In order to get a better understanding of the shoe materials and structure. The researcher destructed thees three most popular throwing shoes. They all have TPU heel counter support, and mid strap to lock down the foot. Synthetic polyester overlays on the upper to provide support and reinforcement. Nike Rotational 6 has the EVA midsole and rubber outsole. Adidas Adizero also has rubber outsole but the midsole is the PVC material. The Nike Javelin Elite 2 also has EVA midsole and has a small carbon fiber plate at the center of the sole to offer stability for athlete.

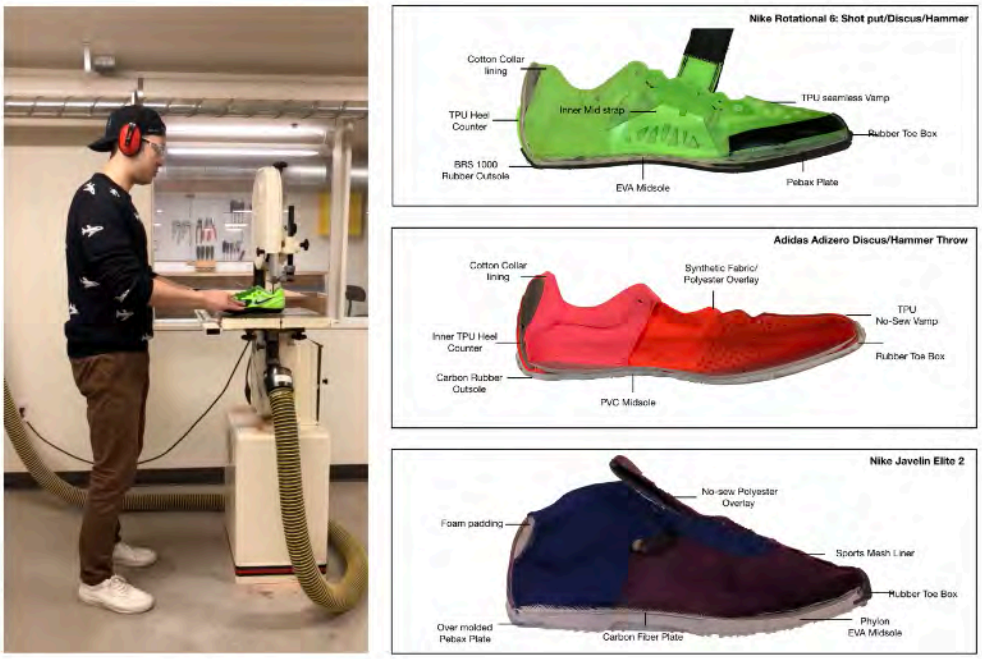


Figure 51. Three different throwing shoes materials call-out. And the photo of researcher was cutting the shoes in order to get the section view of the shoes (Li, 2020).

Color Ideation

Usually throwers are very huge and powerful, It reminded the researcher of some very powerful beasts or monsters. The researcher was looking at some characters such as: Godzilla, Fire Dragon, Hulk. These characters have amazing strength and huge bodies. In this project, the researcher got color inspiration form this three characters. Their unique color properties represent each of the throwing sport. Shot put/discus shoes will be volt green color and inspired by Hulk. Hammer throw shoes will be navy blue which is inspired by Godzilla. And javelin throw shoes will be scarlet red which is inspired by Fire Dragon.

Figure 52. Color ideation final direction (Li, 2020).

After the color direction is confirmed, the researcher also uses the monster as the inspiration for graphics, texture, lines, and shapes for the design of visual aesthetics.

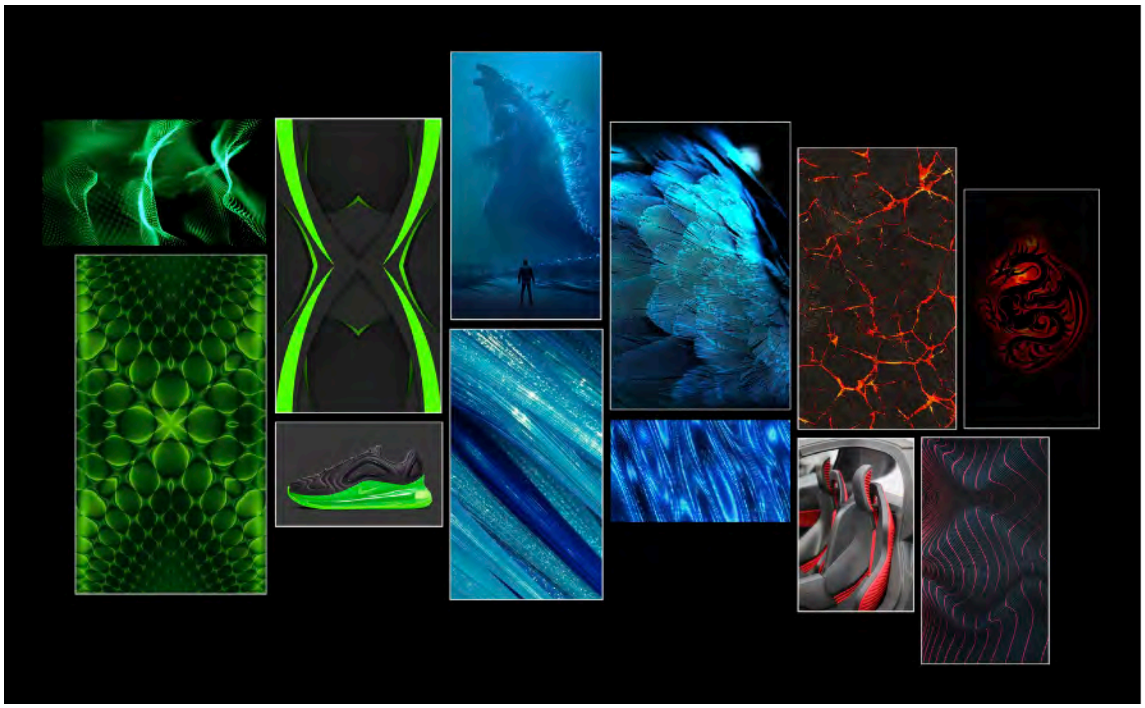


Figure 53. Graphics ideation final direction (Li, 2020).

Sketch ideation

For the Shot put/Discus, the researcher decided to use cross structure for straps which can offer the better lockdown for the foot. Specific outsole friction areas on are also considered.

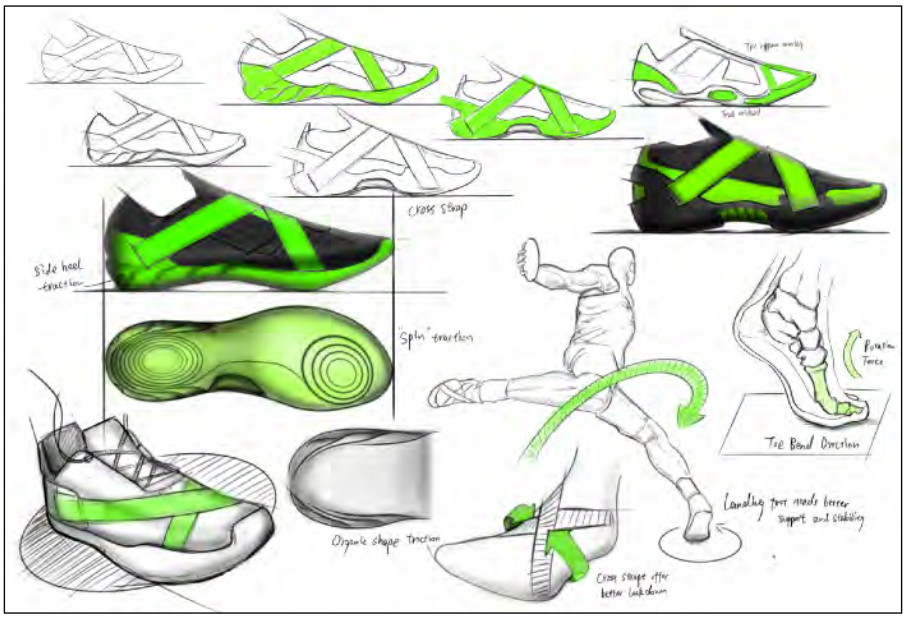


Figure 54. Shot put/Discus ideation sketching (Li, 2020).

Based on the research, hammer throw footwork have different needs for foot, Asymmetrically outsole traction designed will help athletes to get support. Cross straps are also working for the hammer throw shoes upper.

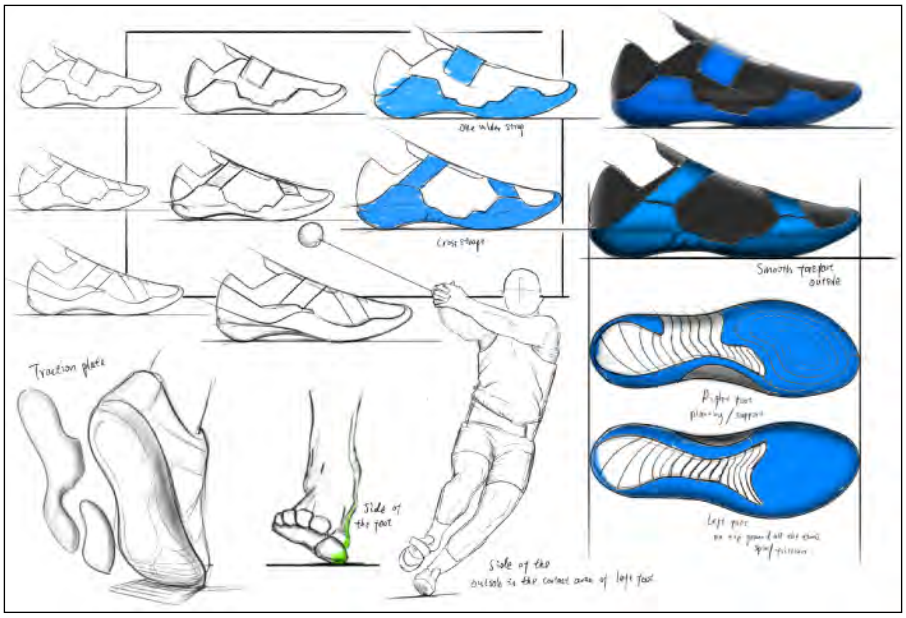


Figure 55. Hammer throw ideation sketching (Li, 2020).

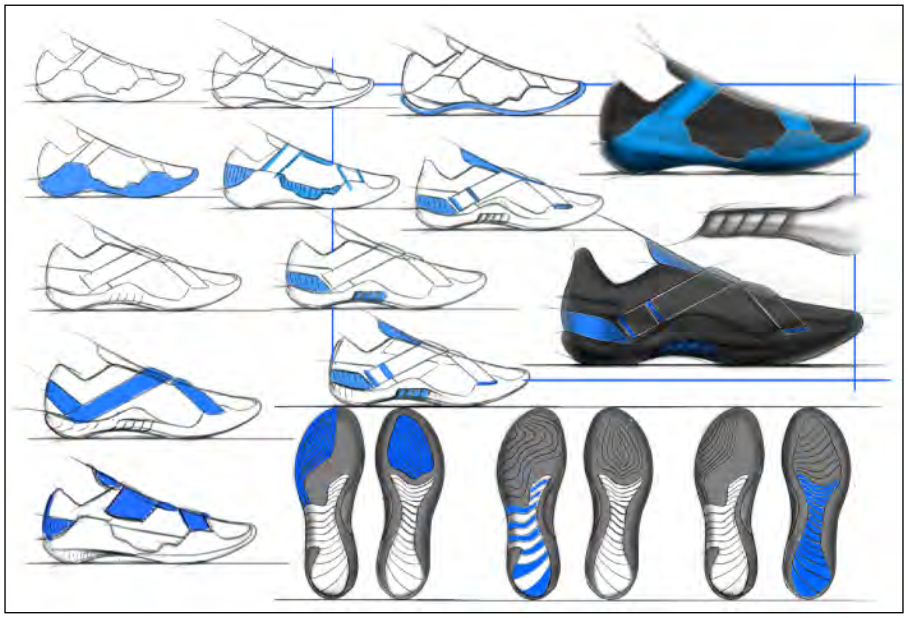


Figure 56. More hammer throw ideation sketches (Li, 2020).

In order to get maximum support from shoes and protection, javelin throw shoes are usually high top. The researcher tried to figure out how the straps go around the high top upper and make sure the designs are appropriate for the athlete aesthetically and functionally.

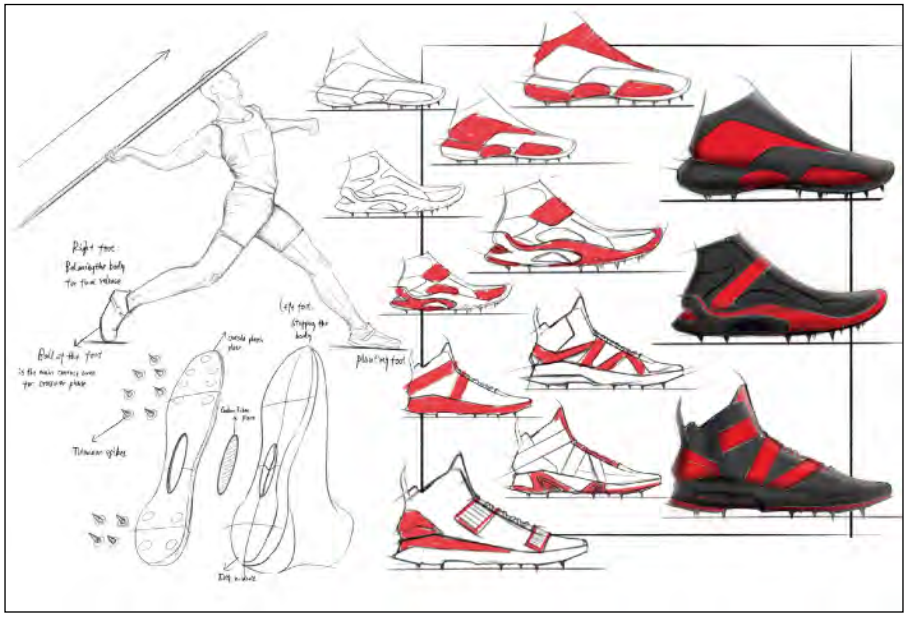


Figure 57. Javelin throw ideation sketching (Li, 2020).

The spikes are also key elements for the javelin shoes. The researcher remapped the spikes on different outsole areas and ensure the feet grip the ground to improve the friction effectively. The shape of the spike positions also inspired by the javelin and trident, make it looks aggressive just like a javelin thrower.

Figure 58. More javelin throw ideation sketches (Li, 2020).

Ideation Prototyping

The researcher made prototypes in order to better understand the dynamics of the design by physically engaging with them and picking apart what makes them work or fail. The researcher started with material selection. Based on the athlete's insight, the upper materials of the throwing shoes need to be very stiff but breathable.

For the shot put/discus and hammer throw prototype, the upper's materials are non-woven polyester fibers sports mesh and synthetic fabric. The sports mesh can make sure the breathability. The synthetic material which is polyurethane plastic film to be used on the upper as the overlay, it helps to give better support reinforcement for the upper.

Figure 59. Upper materials and making process (Li, 2020).

When thrower rotates their foot, the ankle support and stability are very important. The TPU heel counter usually is a solution. Besides this, the researcher came up with another idea that used heat press to sandwiches a foam between the mesh and the synthetic film. By applying this method, the upper will have this "built-in" foam that offers better protection for the ankle and also a beautiful clean shape on the upper.

Figure 60. Ankle protection foam at the specific area of the upper (Li, 2020).

Based on the feedback from the athlete, the single strap on the javelin shoe's upper is simply not enough to support when blocking for javelin thrower. And ankle support in javelin is a critical component. The goal for ankle protection is to have strong support to hold the ankle in place for the block.

So, the researcher wants to find a way that the strap can warp around the feet, lock down the drosal, heel, and ankle at the same time. The researcher started with testing on his own feet with a strap. Tried to use the different directions of the straps to warp around the feet, to figure out which way is the best solution to lock down the feet.

Figure 61. The straps lock down performance experiment (Li, 2020).

The researchers finally find the best solution. One strap goes cross twice at the drosal, heel, and the ankle. In this way, this lockdown system can secure the drosal, the heel, and ankle at the same time. The strap can be adjusted and the strap will become a triangle shape on the side of the shoe, it is working for the athlete aesthetically and functionally.

Figure 62. The prototype shows the solution for javelin lockdown system (Li, 2020).

The researcher used EVA foam to illustrate the hard parts. The EVA foam can be heat pressed then make the shape as needed. In order to get a better result on the prototype, the researcher also dremel the edges of the foam and sprayed paint the color.

Figure 63. Dremel the edges of the foam and sprayed paint (Li, 2020).

Results and findings of ideation process

First Round Prototyping

The materials and the overall strap structure concept are works well for the shot put/ discus upper. But the researcher found that the EVA foam is not a good selection for demonstrating the concept of the strap/lockdown system on the shot put/discus upper.

The researcher found another issue is that he still needs to figure out how to fix the strap on the front side of the shoes, It has to be very solid and durable.

Figure 64. First round final prototype of shot put/discus shoes upper (Li, 2020).

Figure 65. The "Foam" strap holder is not solid enough for the upper (Li, 2020).

The same problem with the upper of the hammer throw shoes, the EVA foam strap holder is not very solid enough on the upper. Another foam strap holder on the mid-foot is not working very well on the upper. The researcher realized that if the strap holder eventually makes by hard plastic pieces, it will chaffing the athlete's foot.

Figure 66. First round final prototype of the hammer throw shoes upper (Li, 2020).

Figure 67. Rear strap holder is not solid enough.(Li, 2020).

The results of the javelin throw upper prototype is pretty good. The concept of the triangle strap lockdown system is working on the upper. The strap holders is located on the appropriate position of the upper which fully demonstrates the concept of the design.

Figure 68. First round final prototype of the javelin throw shoes upper.(Li, 2020).

Second Round Prototyping

Based on the experience and feedbacks from first round prototype, the researcher decided to re-make shot put/discus, hammer throw upper in order to demonstrate the full concept of design.

This time, the researcher used very durable material to make toe cap. The toe cap also is the reinforced piece for fixing straps.

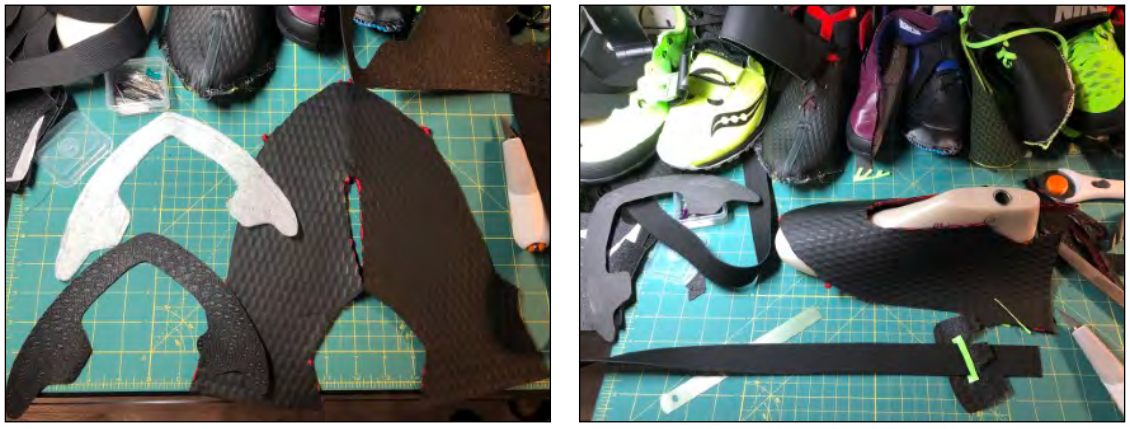


Figure 69. Re-making shot put/discus upper (Li, 2020).

Also, re-made eyelet, the eyelet holes are vertical which can tighten the upper easily for the athletes. Then, used zigzag stitches to reinforce the eyelet part make sure it is solid and durable. “Square ring” strap holders are located at the side of the heel which is double stitched with durable materials.

Figure 70. Re-making shot put/discus upper (Li, 2020).

The result of the re-made upper is pretty good, the straps are located at the appropriate positions and very solid. The strap holder made by hard aluminum ring and synthetic leather with double stitches to make sure 100% solid. The straps are fixing at the front side of the upper and strobel with the bottom piece together.

Figure 71. Re-made final shot put/discus upper (Li, 2020).

Figure 72. The details of the final shot put/discus upper (Li, 2020).

Same with the shot put upper, the hammer throw shoe's upper also use hard aluminum ring and synthetic leather with double stitches to make the strap holder. Hammer throw upper also has ventilation mesh offer better breathability for athlete. The straps go inside the part of the toe cap and strobel with upper together to make sure solid and durable.

Figure 73. Re-made final Hammer throw upper (Li, 2020).

Figure 74. The details of the final hammer throw shoe's upper (Li, 2020).

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Final Round Prototyping

Based on the feedback from the winter term, the researcher started making the final prototype. For the shot put shoes, another pattern was used for the upper, this structure is able to divide the upper into two sections, which have different materials. For the material of the front section, the researcher used Bemis film bonded with synthetic mesh in order to offer better breathability and durability. For the material of the rear section, the reinforced synthetic mesh was applied.

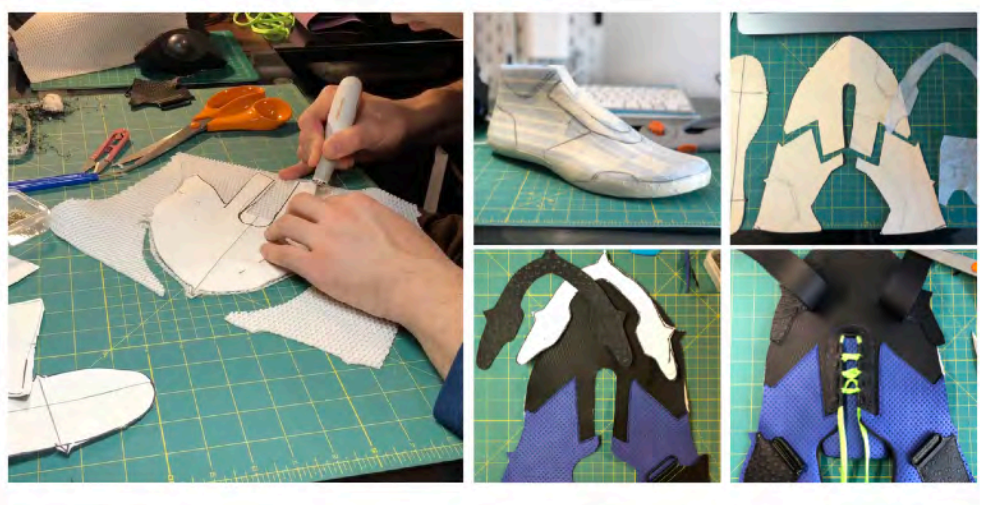

Figure 75. Making process of the final shot put shoe's upper (Li, 2020).

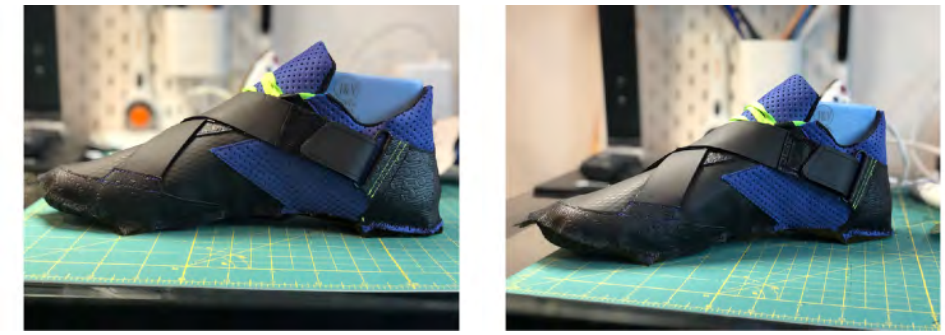

Figure 76. Final shot put shoe's upper (Li, 2020).

For the javelin throw shoes, the researcher spent a lot of time on figuring out the solution to the strap system.The straps system design didn't really solve the problem that how does strap go under the upper.

Figure 77. Previous version of straps for javelin in the winter term, but didn't solve the problem.(Li, 2020).

Figure 78. Close to the final solution of straps system, but still need to figure out how to make the straps attached solidly.(Li, 2020).

In the spring term, the researcher finally figured out the final solution which is the straps go through the midsole then go up to the rear strap holder, the straps cross at the back, helping to stabilize the heel, the straps then wrap towards the dorsal side of the foot where they are

anchored. So this triangle straps system will lockdown the dorsal foot, heel, and ankle at the same time, offers the best lockdown and support performance.

Figure 79. Final solution of straps/lacing system. This system will offer the best lockdown performance and athletes can easily tightening, wear on(Li, 2020).

3D CAD in Rhino

All 3D CAD made in Rhino. The outsole is built on the 3D scan shoe last to make sure the measurement is 100% correct.

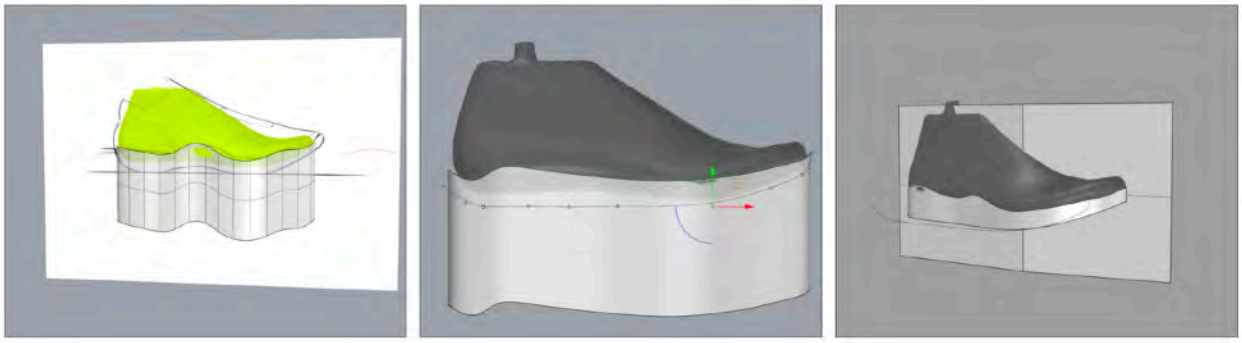

Figure 80. The measurement process of the outsole modeling (Li, 2020).

The Shot put/Discus shoes outsole have rounded edge and smooth forefoot outsole which can enhance spin technique. Medial and lateral traction will effectively reduce the rotation momentum after throwing.

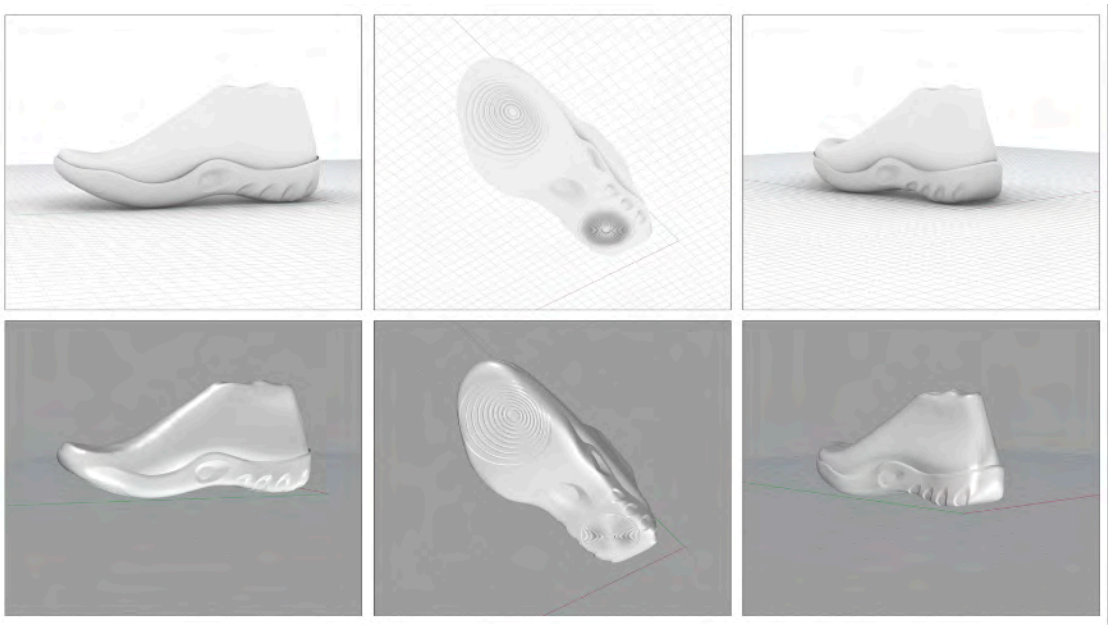

Figure 81. Final 3D direction of the shot put/discus outsole modeling (Li, 2020).

The javelin outsole has removable spikes are conveniently for athletes to customize during competition. Spikes and traction will ensure the feet grip the ground improve the friction.

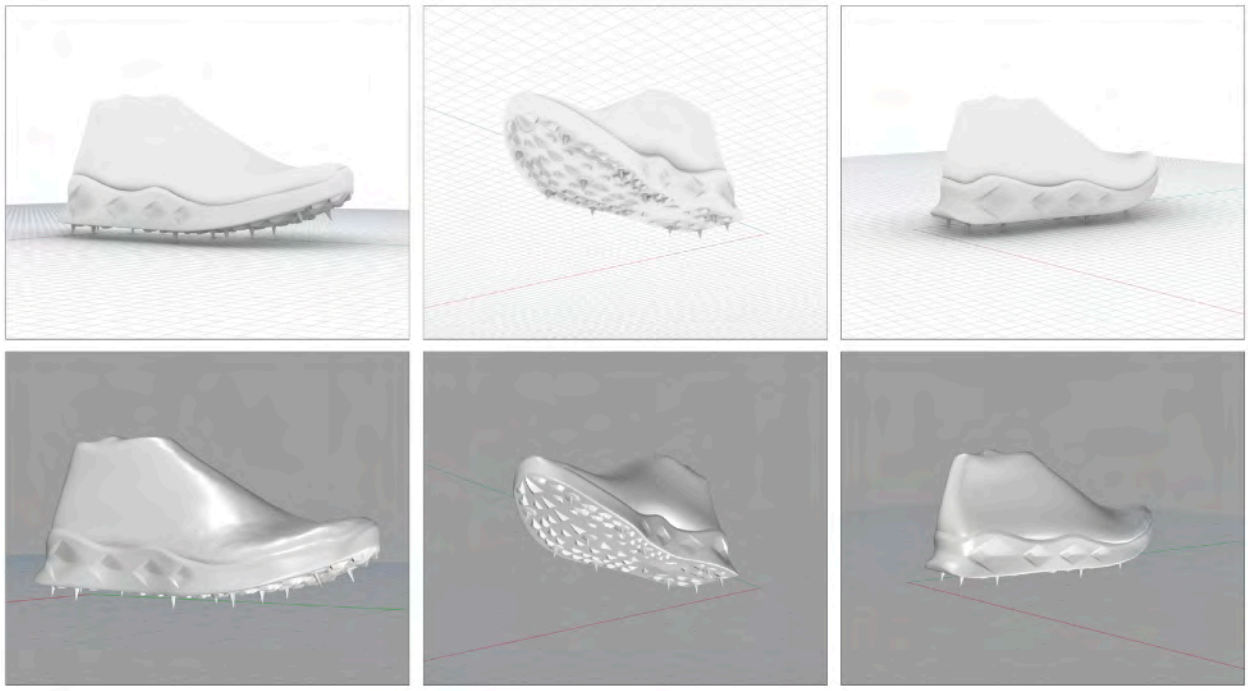

Figure 82. Final 3D direction of the javelin throw outsole modeling (Li, 2020).

2020 Spring Term Updated

Since the straps will go through the midsole of the javelin throw shoes, the researcher remade the CAD of the javelin midsole and outsole. The researcher added more detail on the midsole sidewall, made more traction patterns on the outsole in order to help the athlete to get more grip when athlete sprinting. Making sure the midsole and outsole are separated also 3D printable.

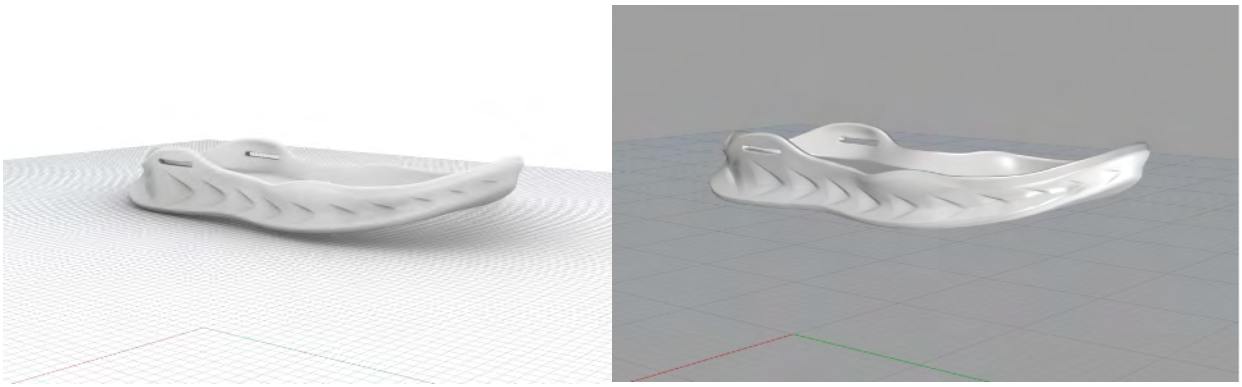

Figure 83. Final javelin throw midsole 3D modeling (Li, 2020).

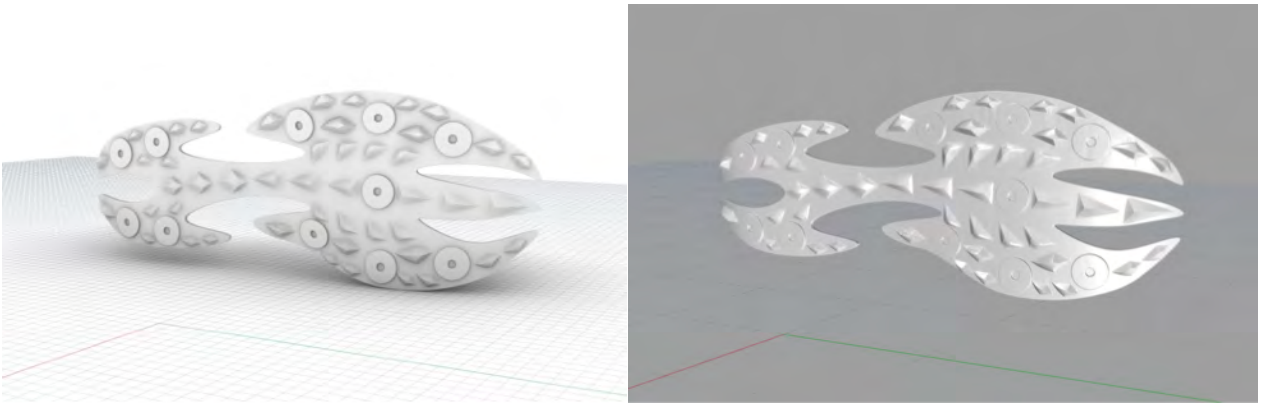

Figure 84. Final javelin throw outsole 3D modeling (Li, 2020).

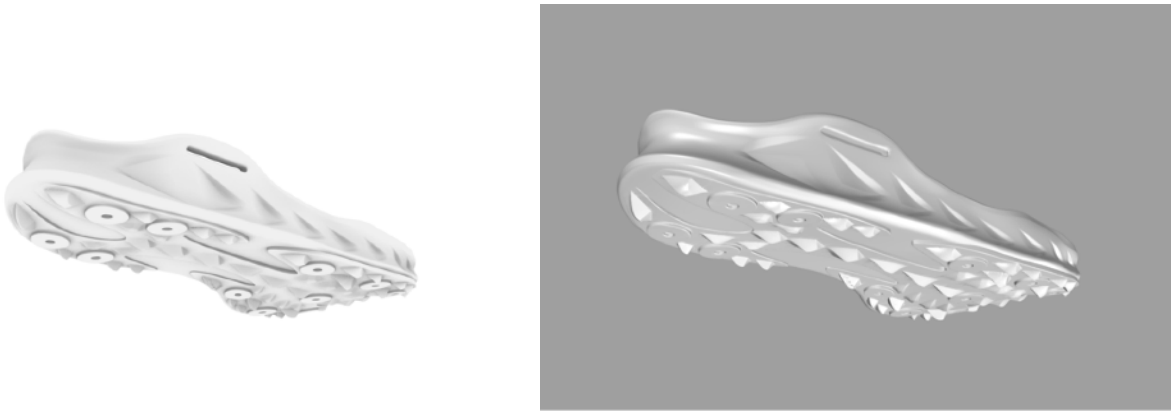

Figure 85. Final javelin throw outsole 3D modeling (Li, 2020).

The hammer throw outsole has asymmetrically designed outsole for hammer throw specific movements. Localized traction provides the specific traction support.

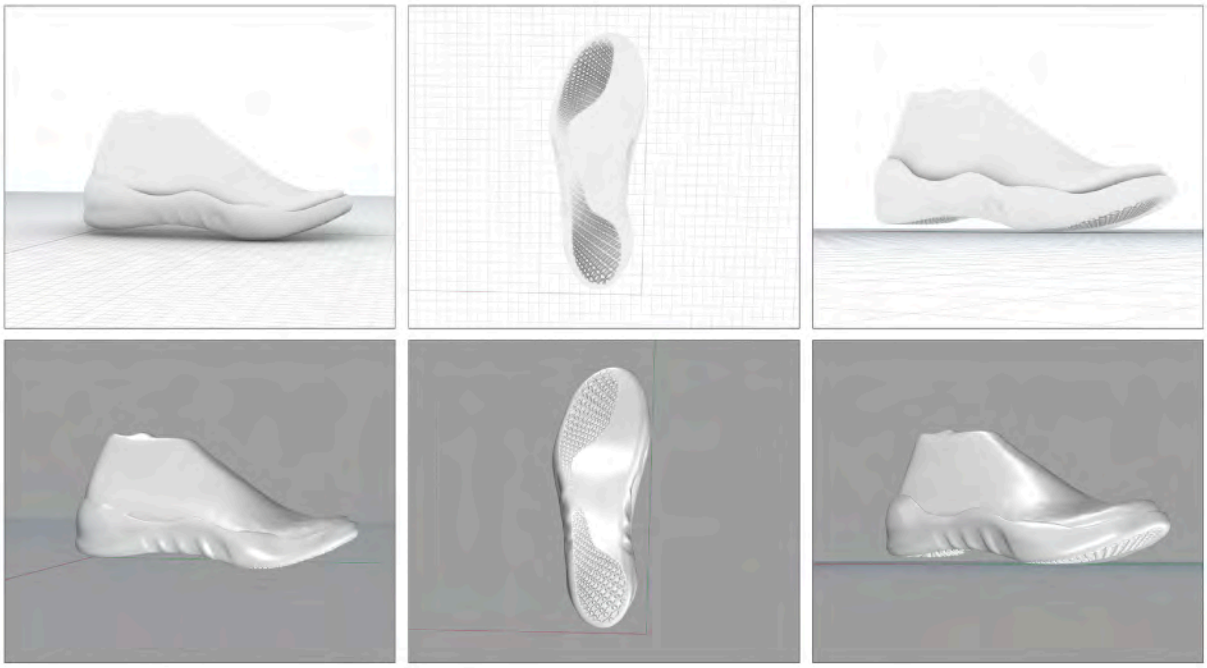

Figure 86. Final 3D direction of the hammer throw outsole modeling (Li, 2020).

2020 Spring Term Updated

Based on the feedback and more iteration, the researcher inspired by parametric graphics, decided to make the hammer throw outsole has more detailed and organic graphic traction. These localized tractions are designed for the specific hammer thrower spin footwork.

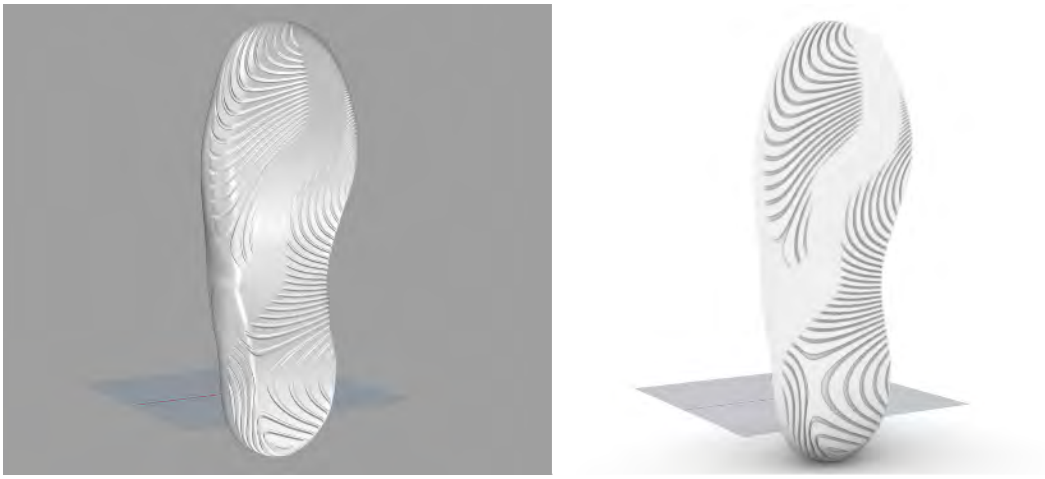

Figure 87. Final hammer throw 3D outsole modeling (Li, 2020).

2020 Spring Term Updated

Midsole & Outsole Prototypes Making

After finishing the 3D CAD in Rhino, the researcher printed 3d shot put outsoles out, then used the silicone to mold the 3D printed outsole. Once the researcher got the silicone mold, the researcher poured flexible polyurethane foam/urethane rubber into the mold (Casting). This method allowed the researcher to get a functional outsole for the prototypes.

Figure 88. Molding process for the final shot put prototype (Li, 2020).

Since the outsole of hammer throw has more detailed traction, in order to get the best results of the casting, researcher made the mold in the rhino and then 3D printed out. So this method allowed the researcher to pour the urethane rubber to the 3D printed mold.

Figure 89. 3D printed mold for hammer throw outsole casting (Li, 2020).

For the javelin throw midsole, the researcher also used silicone to mold the 3D printed midsole. For the outsole, the researcher 3D printed the outsole and the spikes holder separated. This method will make sure the spikes are removable from the outsole. Also, the hard 3D printed plastic will ensure the rubber outsole is rigged and supported.

Figure 89. 3D printed midsole and outsole for hammer throw (Li, 2020)

Figure 90. Final javelin throw midsole made by flexible polyurethane foam (Li, 2020).

Figure 91. Final javelin throw outsole made by flexible urethane rubber (Li, 2020).

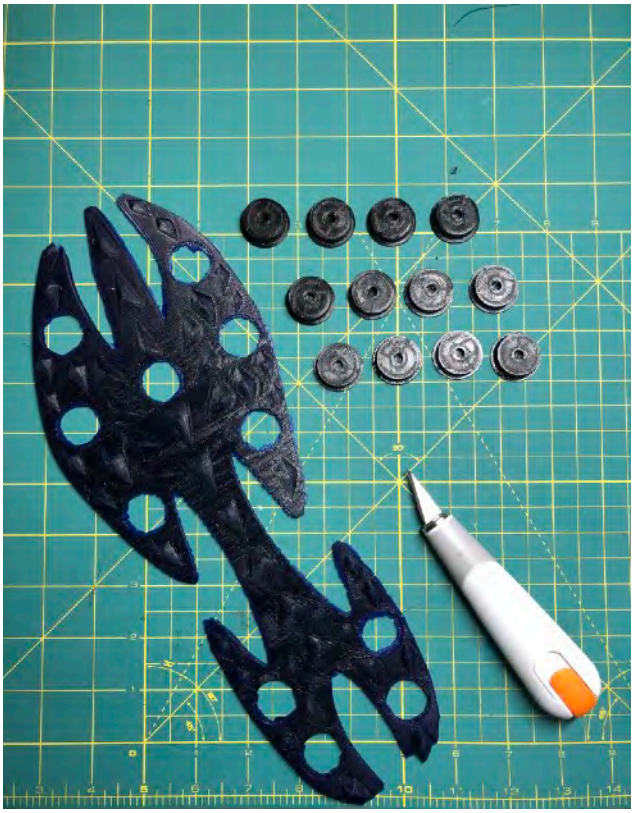

Figure 92. Final rubber javelin throw outsole and 3D printed spikes holder (Li, 2020).

Validation plan

The key innovational component of the design is the straps structure on the upper. The decussating straps structure is for shot put and hammer throw, the straps go all the way down to the heel counter and are fixed by the rings on each side, which can securely lock-down the dorsal and heel. Furthermore, this structure offers quick tightening and wear on. Another similar strap structure is applied to the javelin throw shoes. The triangle lock-down strap structure stabilizes dorsal foot and heel at the same time, offering the superior foot lock-down. The following two test methods are offered to test the validation and feasibility of the product.

2020 Spring Term Updated

Test I Insights from Athletes

Due to the COVID-19, the researcher can't meet the athlete/expert in person, so the researcher decided to get expert feedback and insights through FaceTime. The researcher firstly talked to OLA ADENIJ who is the University of Oregon track team assistant coach also is a human physiology major Phd student.

The researcher showed her the pictures of sketches, photos of prototypes, talked about the features and benefits for each shoes, and also screen-shot of 3D CAD.

Ola talked about she likes the ankle lockdown system, because the ankle support in javelin is a critical component. The goal for ankle protection is to have strong support to hold the ankle in place for the block foot(Ola, 2020). She also mentioned if the shoes is rigid that would be helpful, because the athletes can instantly stop themselves with the block.(Old,2020)

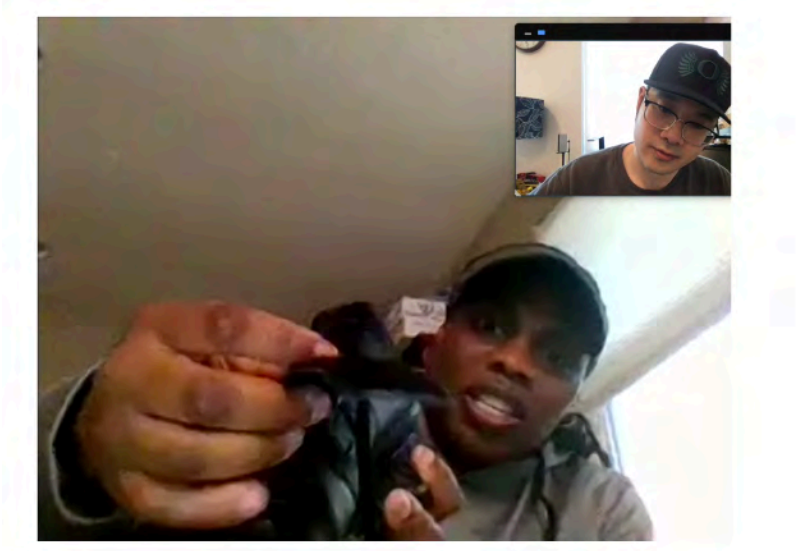

Figure 92. Screenshot of talking to Old Adenij (Li, 2020).

The researcher also talked to DEREK AKEY who is a shot putter and hammer thrower from the University of Oregon. Derek said “I love the way that how the straps wrap around the foot. This is a really cool concept if the straps works well”(Derek,2020)

He also talked to the researcher that if the shoes can help athlete to hold the position before the final release, that would be super helpful.

Figure 93. Screenshot of talking to Derek Akey (Li, 2020).

Test II Area calculation

I. Purpose

No matter which type of strap structure, the key function is to reinforce a secure fit so that the performance will be elevated. The second test method is designed to prove how this structure stabilizes dorsal foot or heel by comparing the area by the straps.

II. Methodology & Research Procedure

Two prototypes (with the strap structure): hammer throw(Since the shot put prototype and hammer throw prototype have the same structure of the straps, so only chose hammer throw upper as the subject), and javelin throw are included in the experimental group. Two shot put shoes -- Asics Throw Pro G605Y.9006, Adidas Adizero Discus/Hammer Throw, two javelin throw -- Saucony Lanzar Jav S29038-2, and Nike Zoom Javelin Elite 2 are in the control group.

Experimental (prototypes)			Control (Bought on the market)			
	Hammer Throw (He)	Javelin Throw (Je)	Asics Throw Pro G605Y. 9006 (Sc)	Adidas Adizero Discus/ Hammer Throw (Hc)	Saucony Lanzar Jav S29038-2 (Jc)	Nike Zoom Elite Javelin 2 (Jc2)

Figure 94. Subjects comparison groups(Li, 2020).

The researcher used the 3d scanner to scan each subjects, than imported the 3d scan files to the Rhino. The researcher extracted the surface of the each shoes straps in Rhino, then calculated the area of the straps area. This method allows the researcher to use the data to compare the area of the straps.

First comparison (He VS Sc, Hc) is between the hammer throw shoes in the experimental group (prototype with strap structure) and the control group (Asics Throw Pro G605Y.9006, Adidas Adizero Discus/Hammer Throw).

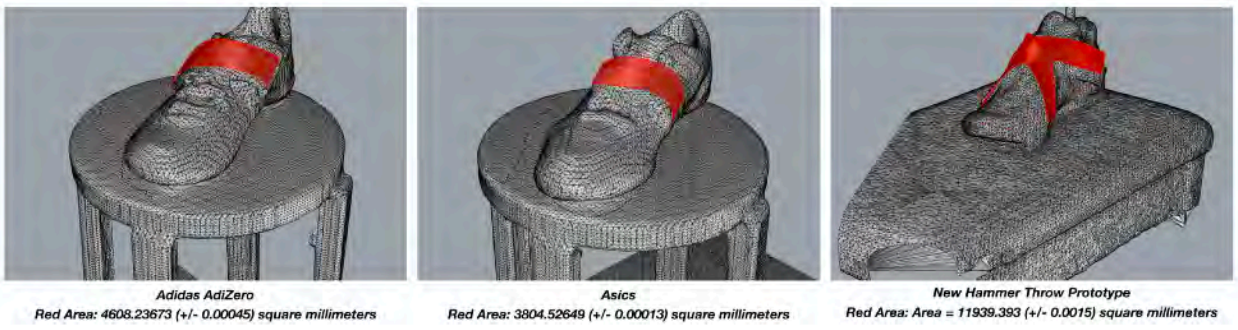

Figure 94. Shot put/Hammer throw shoes data comparison results(Li, 2020).

The second comparison (Je VS Jc,Jc2) is between the javelin prototype shoes in the experimental group (prototype with strap structure) and the control group (Saucony Lanzar Jav and Nike Zoom Javelin Elite 2).

Figure 95. Javelin throw shoes data comparison results(Li, 2020).

Collected the two groups of data from three comparison groups and compare. The result demonstrated that the new design strap structure have larger area on the dorsal foot and feel, this new design straps system can lockdown larger area overall on the dorsal and heel comparing to the shoes that from the current market.

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How will you market and display your work

Logo

The logo inspired by the elements of the three throwing sports. The researcher combined three graphics of the shots, the discus, and the javelin.

Figure 96. Branding logo ideation process(Li, 2020).

Figure 96. Final branding logo & the name for this collection(Li, 2020).

Packaging Box

The research will design his packaging box for the product. The researcher will also review some successful cases of shoebox designs as his inspiration.

Figure 97. Packaging design inspiration (Li, 2020)

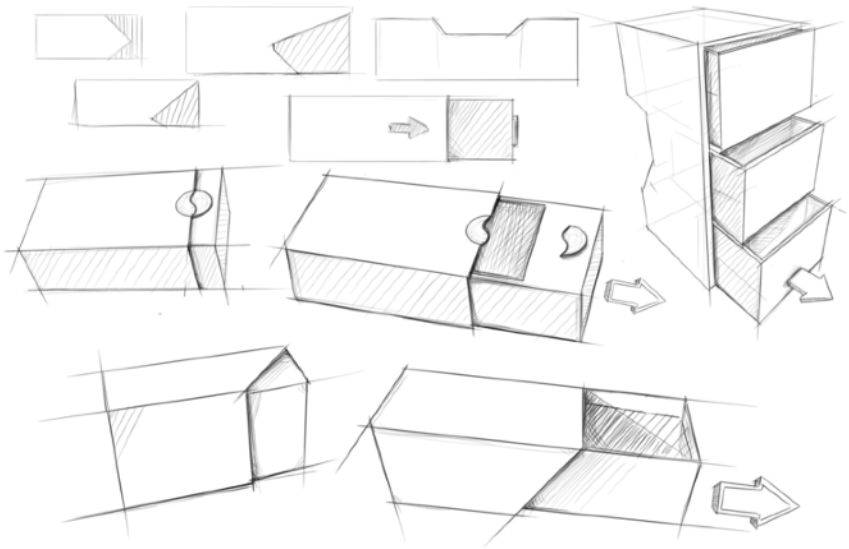

Figure 98. Packaging design sketches and ideation(Li, 2020)

Since the “X” structure straps are applied to this collection of throwing shoes, the researcher decided to use “X” as the symbol of this collection icon. A big “X” structure letter on the front of the shoebox. The customer can open it on both sides.

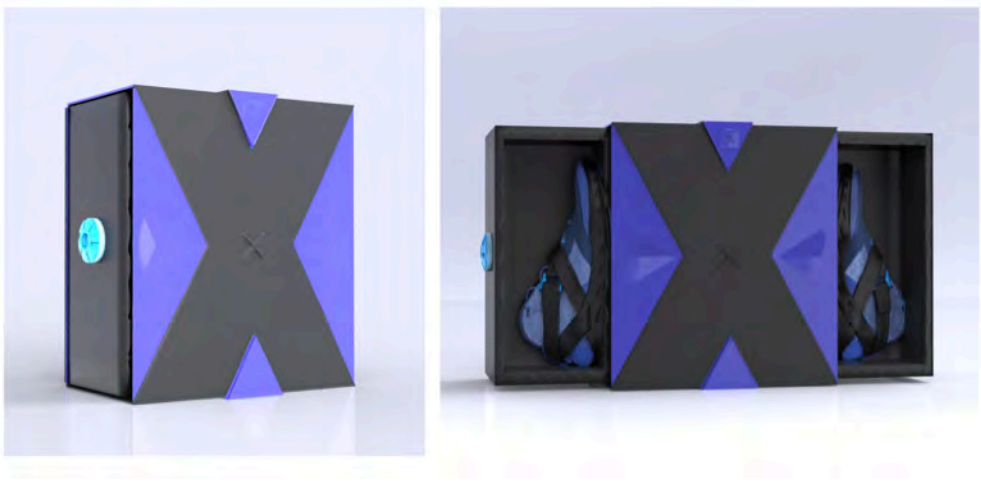

Figure 98. Final packaging rendering (Li, 2020).

Spring term prototyping plan calendar

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Week 1		• Final prototype material order online • Casting material order from Seattle	• Final prototype material order online • Casting material order from Seattle	• If material not available due to virus, the back up plan is using material in studio.	• Collect final material • Shot put shoes final prototype making	• Collect final material • Shot put shoes final prototype making	• Collect final material • Shot put shoes final prototype making
Week 2	• Collect final material • Shot put shoes final prototype making	• Shot put/discus final prototype details polish • Shot put/discus CAD final details	• Shot put/discus final prototype details polish • Shot put/discus CAD final details	• Shot put/discus final prototype details polish • Shot put/discus CAD final details	• Shot put/discus final prototype details polish • Shot put/discus CAD final details	• Shot put/discus final prototype details polish • Shot put/discus CAD final details	• Shot put/discus CAD final rendering • Shot put shoes final prototype
Week 3	• Shot put/discus CAD final rendering • Final sketch rendering	• Shot put/discus CAD final rendering • Final sketch rendering	• Shot put/discus CAD final rendering • Final sketch rendering	• Shot put/discus CAD final rendering • Final sketch rendering	• Shot put/discus CAD final rendering • Final sketch rendering	• Shot put/discus CAD final, ready to print	• Shot put/discus CAD final, ready to print
Week 4	• Hammer throw final prototype making • Hammer throw/Shot put midsole casting	• Hammer throw final prototype making • Hammer throw/Shot put midsole casting	• Hammer throw final prototype making • Hammer throw/Shot put midsole casting	• Hammer throw final prototype making • Hammer throw/Shot put midsole casting	• Hammer throw final prototype making • Hammer throw/Shot put midsole casting	• Hammer throw final prototype making • Hammer throw/Shot put midsole casting	• Hammer throw final prototype making • Hammer throw final CAD
Week 5	• Hammer throw final CAD rendering • Upper CAD details	• Hammer throw final CAD rendering • CAD details	• Hammer throw final CAD rendering • CAD details	• Hammer throw final CAD rendering • Upper CAD	• Hammer throw final CAD rendering • Upper CAD	• Hammer throw final CAD rendering • Upper CAD	• Hammer throw final CAD rendering • Finish Hammer CAD details
Week 6	• Hammer throw final CAD rendering • Upper CAD	• Javelin Throw final upper prototype making	• Javelin Throw final upper prototype making	• Javelin Throw final upper prototype making	• Javelin Throw final upper prototype making • Javelin final CAD	• Javelin Throw final upper prototype making • Javelin final CAD	• Javelin Throw final upper prototype making • Javelin final CAD
Week 7	• Javelin Throw final upper prototype making • Javelin final CAD	• Javelin Throw final upper prototype making • Javelin final CAD	• Javelin final CAD • Javelin final rendering	• Javelin final CAD • Javelin final rendering	• Javelin final CAD • Javelin final rendering	• Javelin final CAD • Javelin final rendering	• Packaging making for three different shoes
Week 8	• Packaging design sketch • Packaging details rendering	• Packaging design sketch • Packaging details rendering	• Packaging design sketch • Packaging details rendering	• Packaging making	• Packaging making	• Packaging making	• Packaging making
Week 9	• Packaging making	• Refine prototypes	• Refine prototypes	• Refine prototypes	• Refine prototypes	• Refine prototypes	• Refine prototypes
Week 10	• Refine prototypes	• Refine prototypes	• Refine prototypes	• Refine prototypes			

Spring term validation plan calendar

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Week 1		• Send the final sketch and prototypes photos to the athletes	• Send the final sketch and prototypes photos to the athletes	• Refine the prototype and design by athletes feedback	• Refine the prototype and design by athletes feedback	• Refine the prototype and design by athletes feedback	• Refine the prototype and design by athletes feedback
Week 2	• Refine the prototype and design by athletes feedback	• Refine the prototype and design by athletes feedback	• Refine the prototype and design by athletes feedback	• Send the update prototypes to the athletes • Collect thier feedback	• Send the update prototypes to the athletes • Collect thier feedback	• Send the update prototypes to the athletes • Collect thier feedback	• Send the update prototypes to the athletes • Collect thier feedback
Week 3	• Send the update prototypes to the athletes • Collect thier feedback	• 3rd round update to prototypes based on the feedbacks	• 3rd round update to prototypes based on the feedbacks	• 3rd round update to prototypes based on the feedbacks	• 3rd round update to prototypes based on the feedbacks	• 3rd round update to prototypes based on the feedbacks	• 3rd round update to prototypes based on the feedbacks
Week 4	• Send the new update prototypes to the athletes • Collect feedbacks	• Send the new update prototypes to the athletes • Collect feedbacks	• Send the new update prototypes to the athletes • Collect feedbacks	• Send the new update prototypes to the athletes • Collect feedbacks	• Send the new update prototypes to the athletes • Collect feedbacks	• Send the new update prototypes to the athletes • Collect feedbacks	• Send the new update prototypes to the athletes • Collect feedbacks
Week 5	• Clay Experiment prepare	• Clay Experiment prepare	• Clay Experiment • Data collection	• Clay Experiment • Data collection	• Clay Experiment • Data collection	• Data analysis	• Data analysis
Week 6	• Data analysis	• Data analysis	• Data analysis	• Data analysis	• Data analysis	• Data analysis	• Data analysis
Week 7	• Use updated final prototype redo the experiment	• Use updated final prototype redo the experiment	• Use updated final prototype redo the experiment	• Set up video to record the experiment	• Set up video to record the experiment	• Data analysis	• Data analysis
Week 8	• 3rd round experiment	• 3rd round experiment	• 3rd round experiment	• 3rd round experiment	• 3rd round experiment	• 3rd round experiment	• 3rd round experiment
Week 9	• 3rd round experiment data collection and analysis .	• 3rd round experiment data collection and analysis	• 3rd round experiment data collection and analysis	• 3rd round experiment data collection and analysis	• 3rd round experiment data collection and analysis	• 3rd round experiment data collection and analysis	• 3rd round experiment data collection and analysis

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Week 10							

Spring term presentation plan calendar

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Week 1		• Video clips and materials collection	• Video clips and materials collection	• Video clips and materials collection	• Video clips and materials collection	• Video clips and materials collection	• Video clips and materials collection
Week 2	• Video clips and materials collection	• Prototype making process shooting/ record	• Prototype making process shooting/ record	• Prototype making process shooting/ record	• Prototype making process shooting/ record	• Prototype making process shooting/ record	• Prototype making process shooting/ record
Week 3	• 1rd round video edit • Keep collecting the footage of make prototypes	• 1rd round video edit • Keep collecting the footage of make prototypes	• 1rd round video edit • Keep collecting the footage of make prototypes	• 1rd round video edit • Keep collecting the footage of make prototypes	• 1rd round video edit • Keep collecting the footage of make prototypes	• 1rd round video edit • Keep collecting the footage of make prototypes	• 1rd round video edit • Keep collecting the footage of make prototypes
Week 4	• 1rd round video edit • Keep collecting the footage of make prototypes	• Final video edit and AE work	• Final video edit and AE work	• Final video edit and AE work	• Final video edit and AE work	• Final video edit and AE work	• Final video edit and AE work
Week 5	• Final video edit and AE work	• Final video edit and AE work	• Final video edit and AE work	• Final video edit and AE work	• Product rendering/ animation work	• Product rendering/ animation work	• Product rendering/ animation work

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Week 6	• Product rendering/ animation work	• Product rendering/ animation work	• Product rendering/ animation work	• 2nd round video edit and AE edit • Rendering edit	• 2nd round video edit and AE edit • Rendering edit	• 2nd round video edit and AE edit • Rendering edit	• 2nd round video edit and AE edit • Rendering edit
Week 7	• 2nd round video edit and AE edit • Rendering edit	• 2nd round video edit and AE edit • Rendering edit	• 2nd round video edit and AE edit • Rendering edit	• 2nd round video edit and AE edit • Rendering edit	• 2nd round video edit and AE edit • Rendering edit	• 2nd round video edit and AE edit • Rendering edit	• 2nd round video edit and AE edit • Rendering edit
Week 8	• Final video edit(animation +AE+product teaser)	• Final video edit(animation +AE+product teaser)	• Final video edit(animation +AE+product teaser)	• Final video edit(animation +AE+product teaser)	• Final video edit(animation +AE+product teaser)	• Final video edit(animation +AE+product teaser)	• Final video edit(animation +AE+product teaser)
Week 9	• Final video edit(animation +AE+product teaser)	• Final video edit(animation +AE+product teaser)	• Final video edit(animation +AE+product teaser)	• Adjust video and final presentation	• Adjust video and final presentation	• Adjust video and final presentation	• Adjust video and final presentation
Week 10	• Adjust video and final presentation	• Adjust video and final presentation	• Adjust video and final presentation	• Adjust video and final presentation			

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Process Book-Winter 2020

Final Capstone Project

Shawn Li

Professional aspirations

I used to train in competitive shot-put and discus when I was a young child. I have carried my passion for sports throughout my entire life.

Since I came to SPD, I have learned so much skills. SPD has offer me the opportunity to combine my experience and my passion for sports.

I interned at Nike Shanghai last summer, I gained valuable experience at Nike. Learned a lot of very useful skills and knowledge.


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Men’s Throwing Sports Footwear Innovation

This capstone project is to innovate new footwear for shot put/discus, javelin and hammer throw. The collection will provide the best footwear performance and support for elite throwing athletes.

The Innovative Nature of Throwing Sports Footwear/Why is important?

- Shot Put, Discus, Hammer Throw & Javelin are all Olympic events.
- All four events have a very long history in track and field.
- The existing throwing shoes have not been updated for many years.

Product Historical Timeline

1930s

Adidas shot put shoe
worn at the olympic
games in Berlin.

1960s

Adidas adistar 2000
Shot and Discus shoes / adidas
Long jump shoes

1980s

Adidas Vintage shot put shoe. Shot
put field shoes made in west
Germany 1980'S

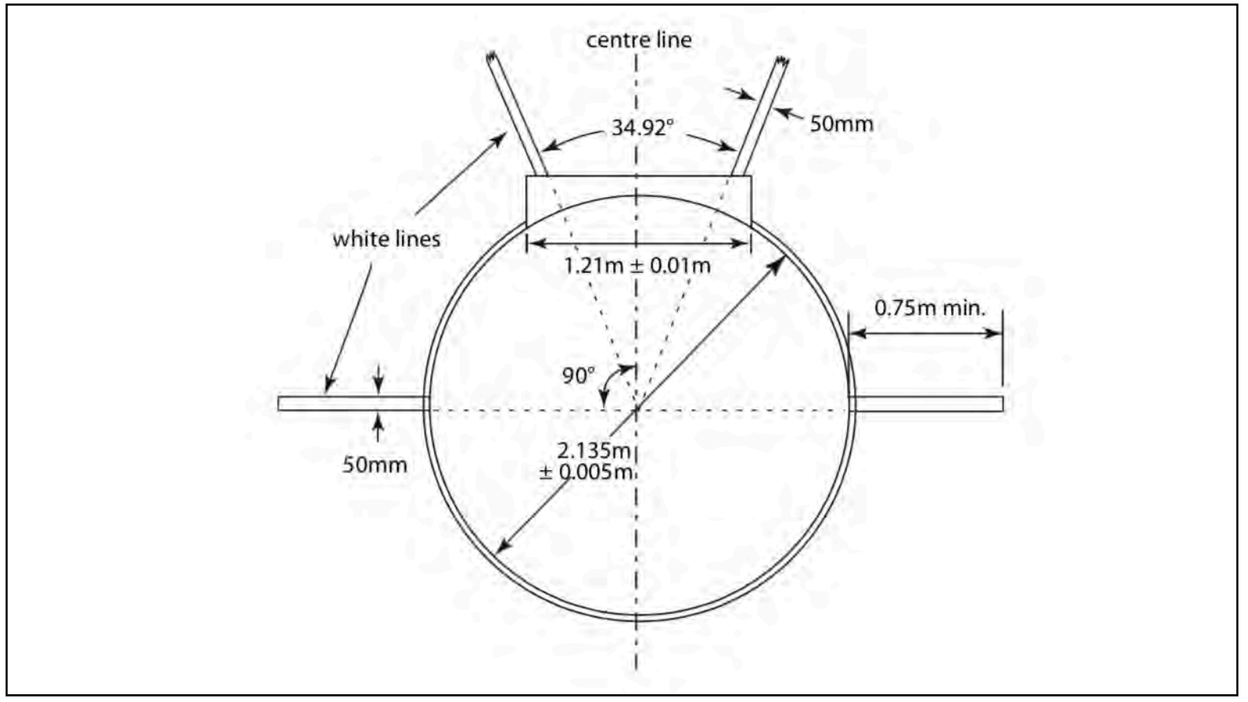
2000s

Nike Zoom Rival SD 2
No-sew synthetic leather upper
Integrated strap wraps the arch.

2015

Nike Zoom Rotational 6
Seamless vamp Full-length, EVA
midsole.

Shot Put/Discus Rules & Competition Field



Shot Put/Discus

The shot, a metal ball which is 7.26kg/16lb for men. The athlete needs to put the shot with one hand. Discus, athletes throw a 2kG and 22cm diameter metal disc.

Shot Put/Discus Throwing Circle

The athletes are required to throw as far as possible while remaining inside a 2.5-meter diameter circle.

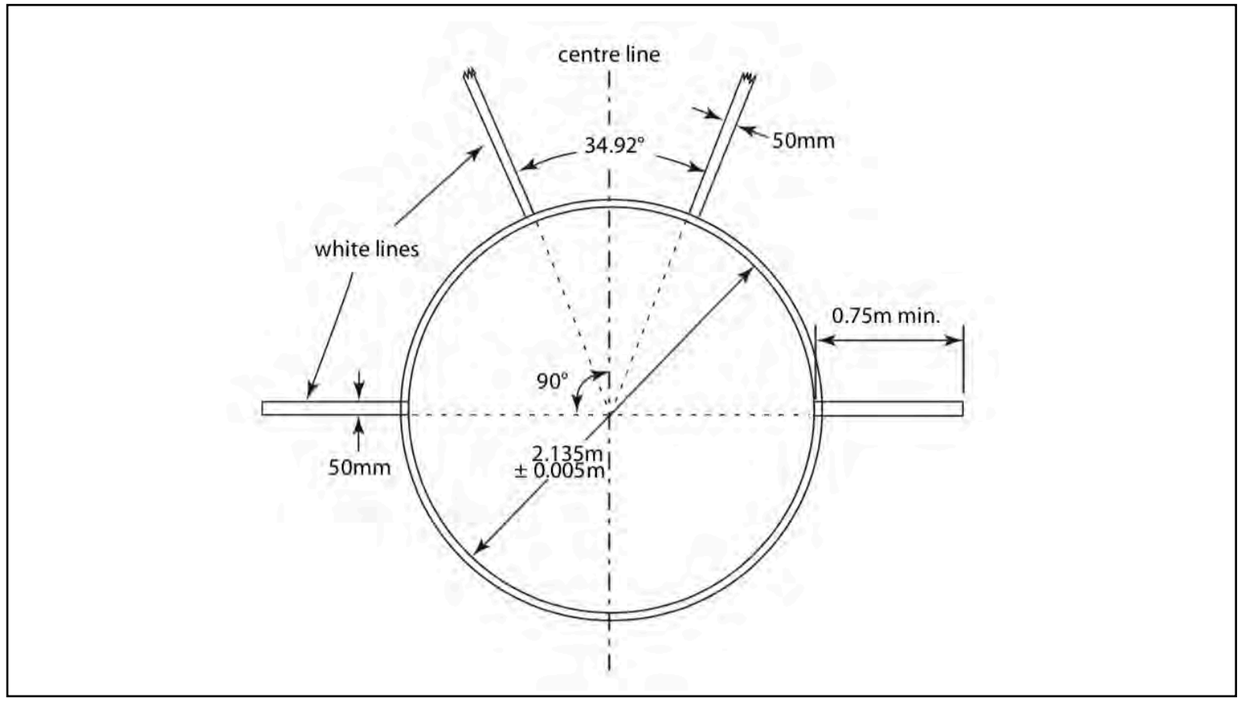
Shot Put/Discus Rotational Technique

In order to get the maximum release velocity, the discus and shot put rotational throwers need to have a stable foot landing and reach a high rotational foot speed to transfer the energy to push the shot/discus. The discus/shot put shoes usually have smooth and rounded edge outsole, with no traction/thread.

Hammer Throw Rules & Competition Field

Hammer Throw

Athletes throw a metal ball which is 7.26kg for men. The hammer is attached to a grip by a steel wire no longer than 1.22m. The thrower usually makes three or four spins before releasing the ball.



Hammer Throw Circle

The diameter of the hammer circle is 2.135 meter. Hammer and discus throws area should be made from an enclosure or cage that should be centered on the circle and with the non-movable cage opening.

Hammer Throw Rotational Technique

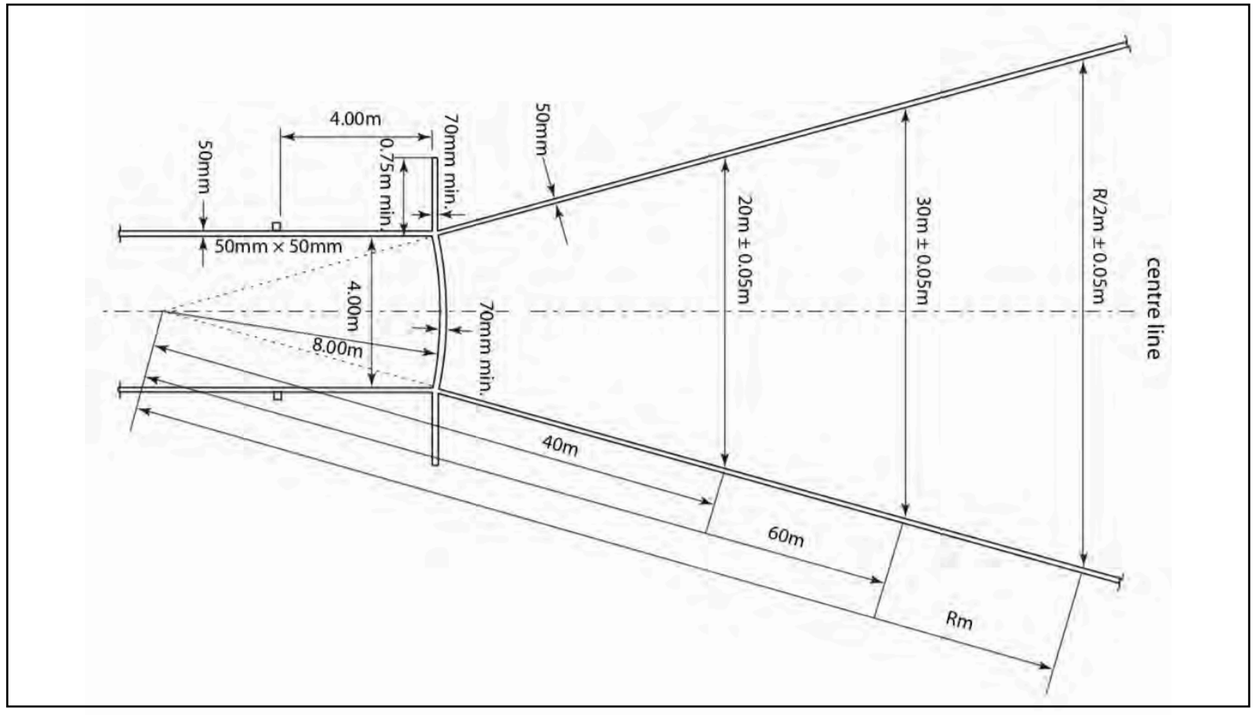
The motions of the hammer thrower's centre of mass are influenced by two forces; gravity, and ground reaction force. So reducing the friction between the outsole and the ground is very important for improving rotational velocity.

BALANCING FOOT

Javelin Throw Rules & Competition Field

Javelin Throw

The men's javelin weigh at least 800gram and be 2.7meter long. The athlete begins with run-up, then throw the javelin over the upper part of their throwing arm. The tip of the javelin must land first.



Javelin Throw Runway

The runway javelin should be marked by two parallel lines 5 centimeters in width. The minimum length should be 33.5 meters and the width shall be 4 meters between the inside edges of the marked parallel lines.

Javelin Throw Footwork Technique

A javelin throw involves a run-up of 6 to 10 steps, followed by two or three crossover steps before the thrower releases the javelin. Sprinting is performed on the balls of the feet, with toes pointing forward. Ensuring that the feet (forefoot) grip the surface will improve the friction and gain the ground reaction force throughout the running strides.

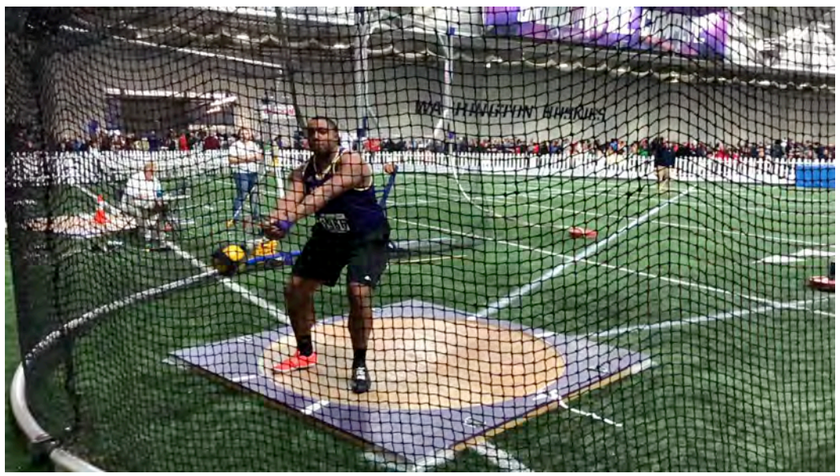
2020 UW Indoor Preview

- Dempsey Stadium at the University of Washington in Seattle.
- The event took place on Saturday, January 18
- Weight/Hammer Throw
- Shot Put

Slow-Motion Video Analysis

Hammer/Weight Throw

1



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3

Hammer/Weight Throw

Some athletes have 4 turns before releasing the ball, some of them have 5 turns. The spinning takes the left foot as the central pivot point, another foot is balancing the body and creating the momentum.

4

5

6

Footwork Analysis

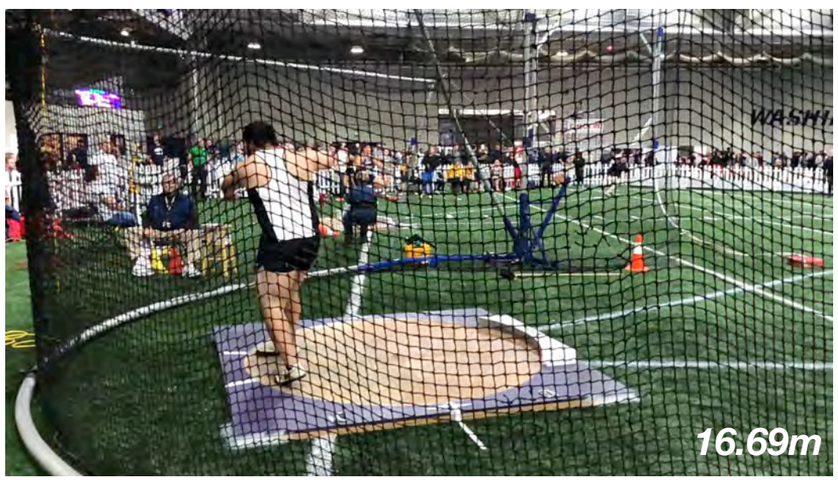
When spinning, the elite athlete will use the edge of the left foot to spin instead of the forefoot or the heel. In order to get fast rotational velocity, athletes need to reduce the contact friction. (Compare video 5 and 6)

Slow-Motion Video Analysis

Shot Put

7

8



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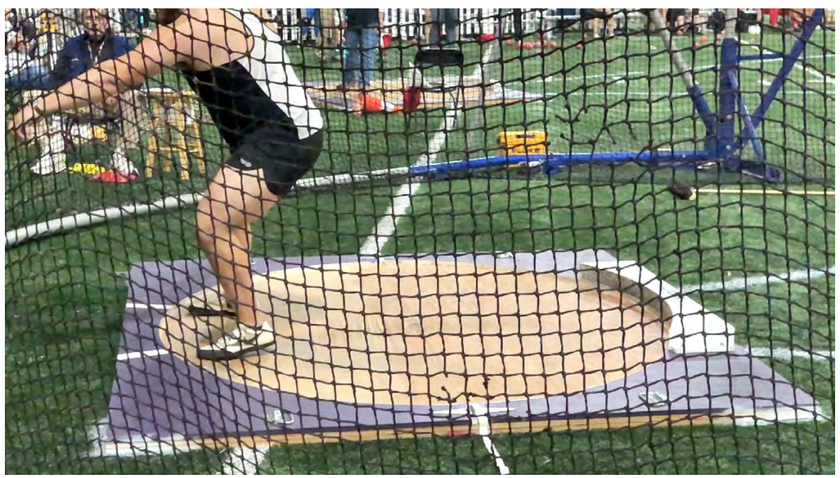
Shot Put Rotational

Left and right feet are alternatively rotate 180 degrees. Spin and release velocity will affect the athlete's performance. (compare video 7, 8 and 9)

10



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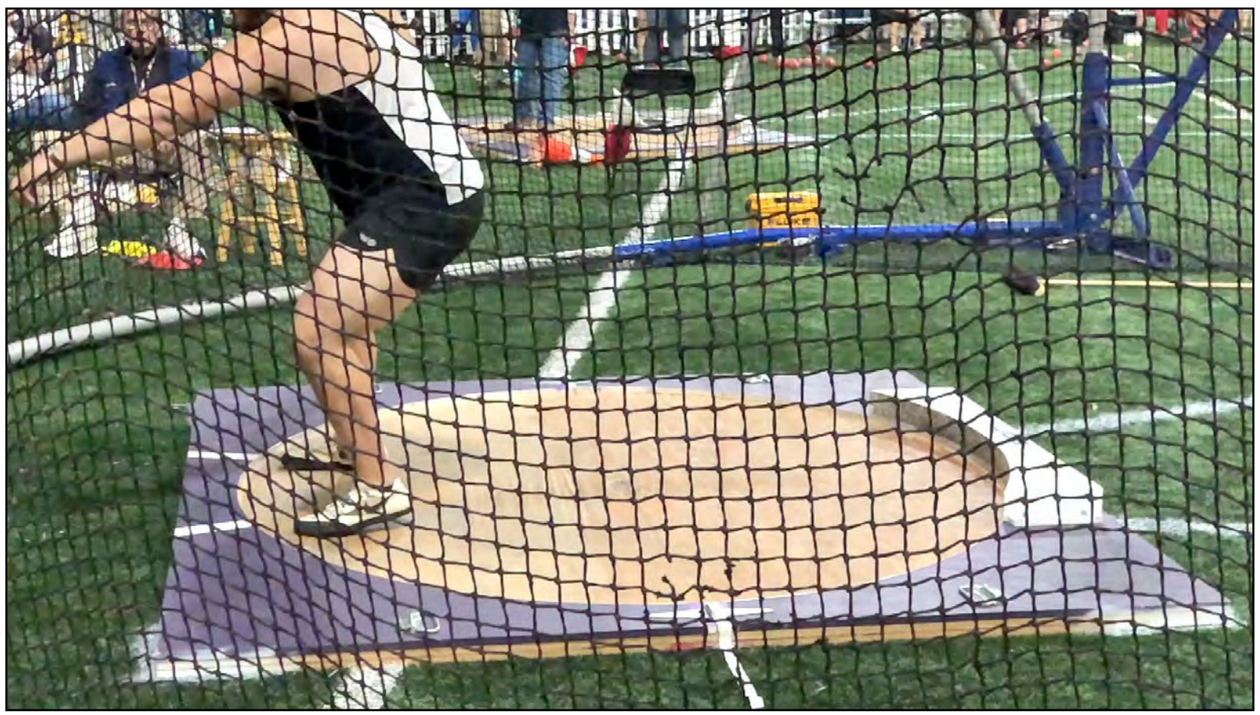
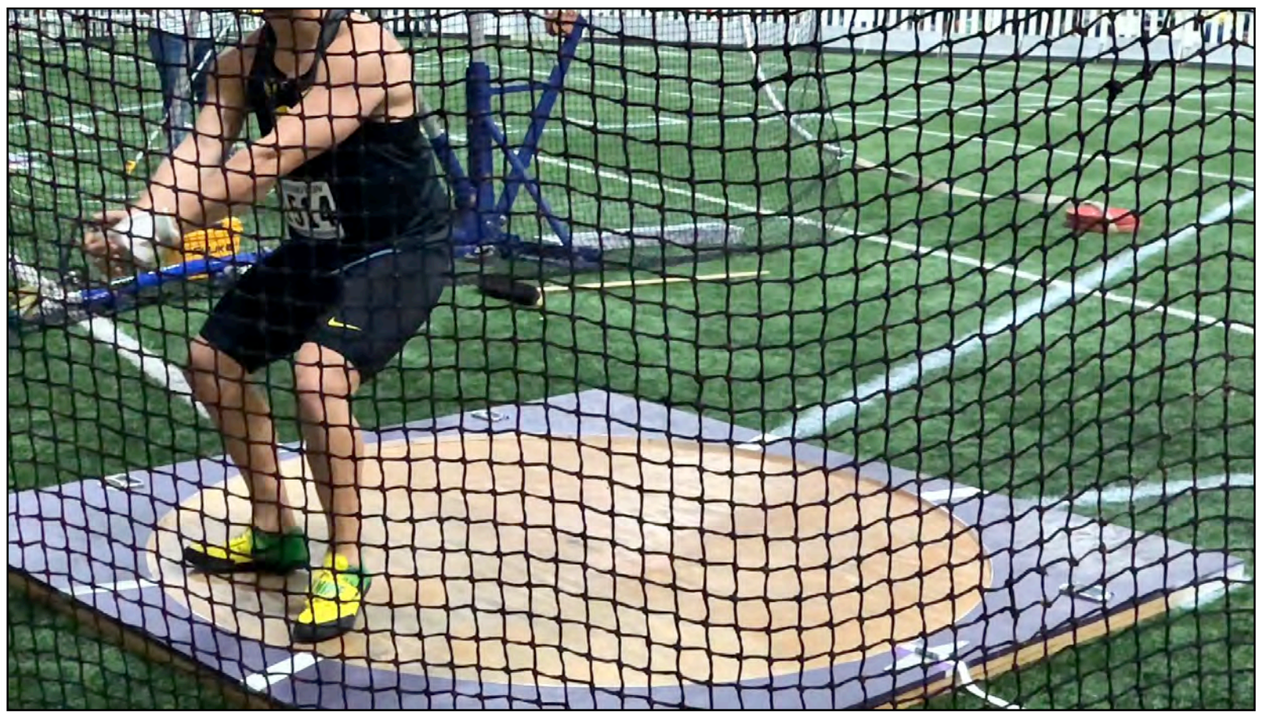
Footwork Analysis

The function of the right foot (landing foot) during the delivery is to manage the body with a heave-up push to give the base for the powerful trunk turn. The forefoot on the landing foot is the area that absorbs body weight and delivers the power of final push.

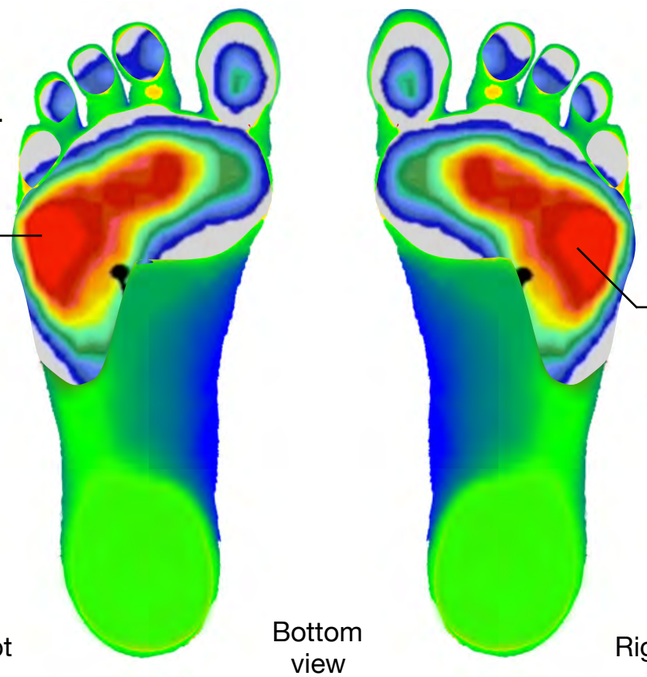
Contact Area/Pressure Point

Shot Put/Discus/Hammer Throw





- Pivot at the first spin.
- Supporting the final push.



- Pivot at the second spin
- Absorb body weight and offer the energy for the final push.

Left foot

Bottom view

Right foot

Edge of the left foot is the major contact area on the ground.

- Balancing the body for each turns.
- Forefoot and heel both absorb the force.

Left foot

Bottom view

Right foot

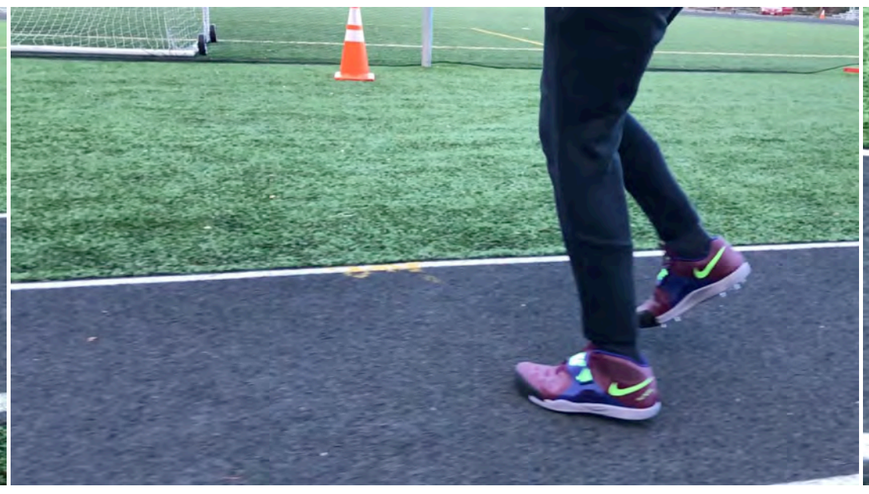
Contact Area

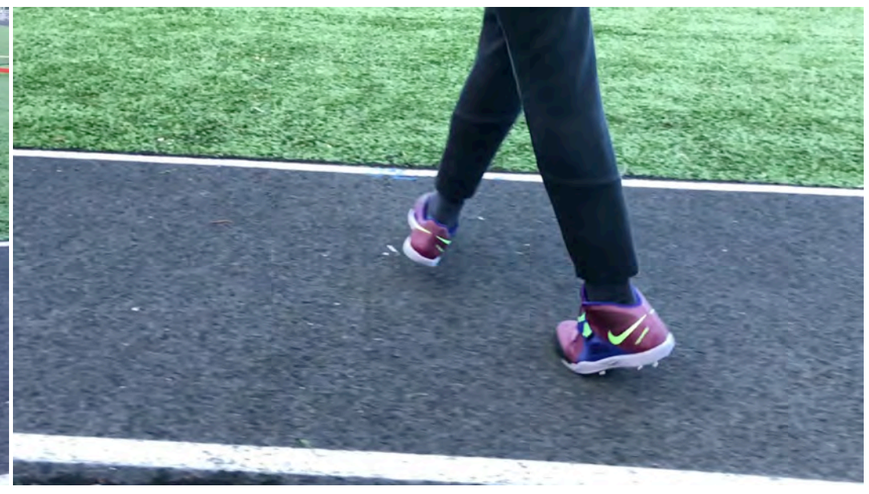
Javelin Throw

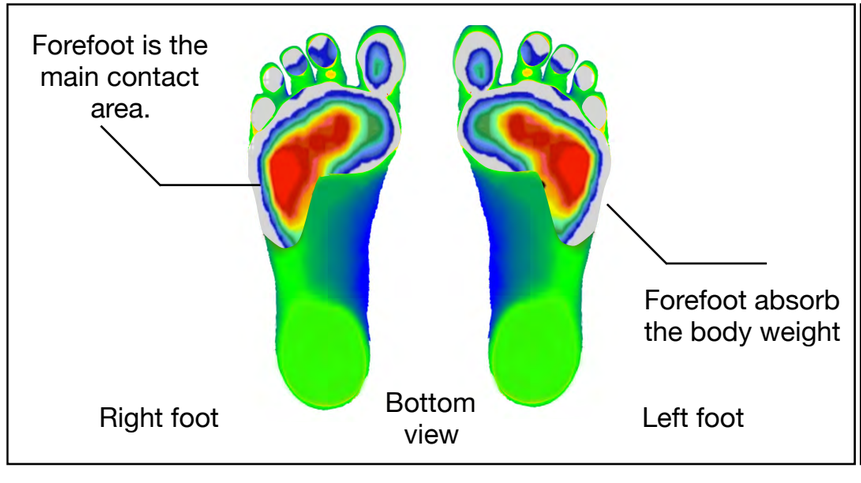
1st Phase: Run up

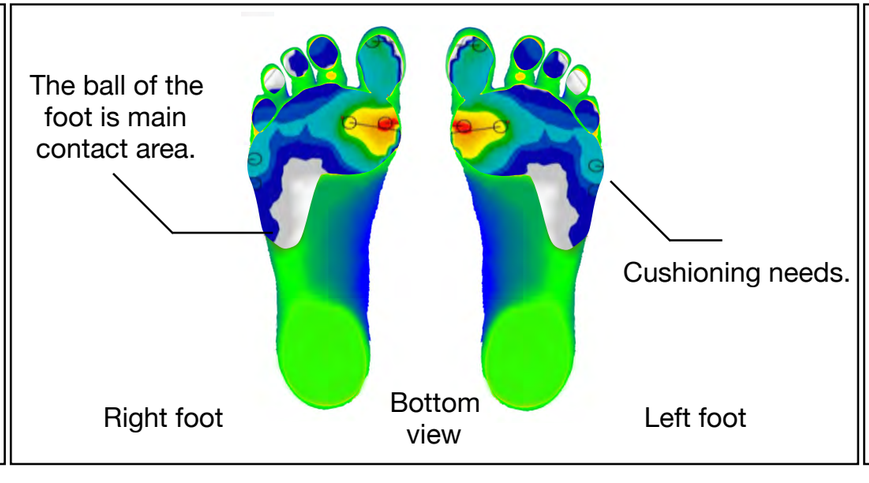
2nd Phase: Crossover Steps

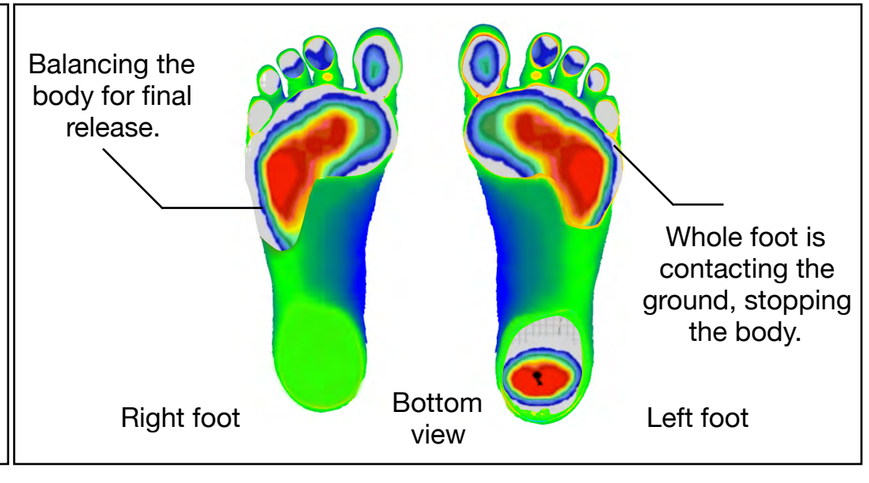
3rd Phase: Final Release



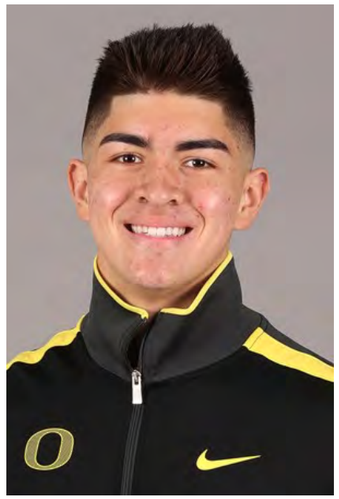








Athlete Insight



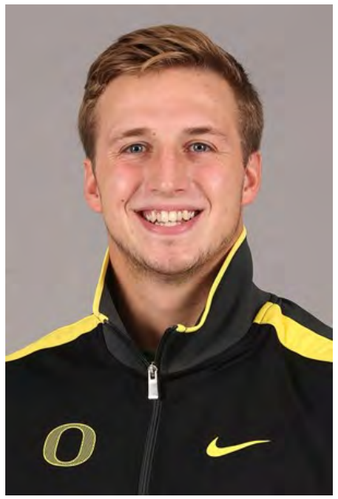
DEREK AKEY
University of Oregon
Shot Put/Discus
Personal-best throw of 55.36m/181-7.5 to win FHSAA 4A regional title

“Throwers are bigger people, we have fat feet, we need bigger toe box, it would be comfortable for us.”

“I want to have stiff shoes upper, don’t make it too flexible, a good pair of shot put/discus throwing shoes usually don’t very flexible which is good for throwers.

“ There is very little arch support in the Nike SD’s, and my ankles pronate a lot in them. That wasn’t as much of a case with the Nike Rotational."

“I like the strap on the zoom rotational 6, really helpful for lockdown.”

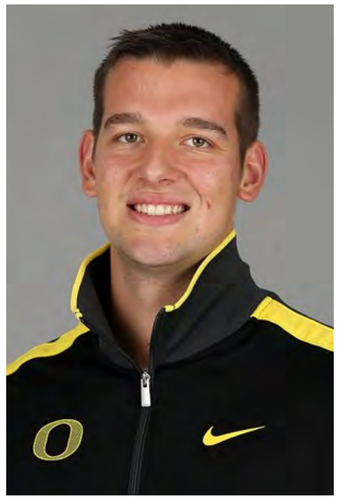


AUSTIN THARP
University of Oregon
Hammer Thrower
-Competed in the hammer throw (173-11/53.00m) at the PAC-12 Championships.

“The three most important areas of strength for a hammer thrower, in my opinion, are the legs, the core, and the posterior chain. Controlling the placement of your feet and legs is essential to a good throw.”

“Shot/discus they are only turning on the toe, a lot more spin at the beginning of the throw. Hammer throw have some spins on the heel.”

“I want to have tighter and breathable upper material for the shoes”



TY HAMPTON
University of Oregon Field & Track Team
Javelin Throw
Won the PIAA District XI 3A Championships title as a junior with a season-best throw of 179-11.

“Spikes do not necessarily have to be super comfortable, they should serve a purpose.”

“ I often take off my spikes in competition. Because they are very tight and stiff. This is good for relaxing my feet and energy recovery.”

“Currently I use a higher top, but not very high left boot, Nike Javelin Elite II.”

“For the durability of the shoes, in normal competition and practice, you can plan with 2 seasons per pair, depending on the technique and practice.”

Athlete Insight

CONNOR ROUSEMILLER
University of Minnesota
Hammer Thrower
Recorded a season-best mark of 19.63 meters (64-05.00 ft.) to finish third at the Snowshoe Open in 2019 season.

“ Some throwers even throw with two different types of shoes on because they like the feel of one of the shoes doing the left foot’s work and the other shoe doing the right foot’s work.”

“ Having shoes individualized to the function of the foot would be an interesting concept, too, since each foot has different responsibilities in the throw. More arch support would be great as well.”

“I don’t think ankle protection is necessary. The only time you would every injure your ankle is from lack of support and rolling it.”

Yang Liu
Chinese National Field & Track Team
Shot Put/Discus
Recorded a personal bests in the event are 19.77 meters outdoors (Shenyang 2013).

“For the majority of my career, I used size 13.5 Nike Rotational 6. However, I recently switched to size 13.5 Nike SD’s. I made the switch because SD’s have a different texture/material on the bottom that is better for slippery throwing circles.”

“It would be awesome to find a material that performed similarly on different types/finishes of concrete/wood/linoleum, because the materials and finishes of circles around the world vary significantly.”

“Durability is important, as I usually go through one pair of shoes every six months. That is roughly 4000 throws in my experience.”

Products Landscape

Adidas AdiZero (2010)
Discus, Shot put, and hammer Rotational
$110

- Synthetic cage upper construction is internally reinforced with a hook-and-loop strap for additional lockdown during rotation.
- Soft collar for reduced pressure on the ankle and Achilles.
- Carbon rubber outsole for durable traction through your throwing motion.

Nike Zoom Rotational 6 (2015)
Hammer, Discus, Rotational Shot Put
$100

- Durable mesh with a seamless vamp.
- Mid foot strap and an external heel counter for lockdown.
- Full-length, thin EVA midsole for lightweight protection.
- Full-length BRS 1000 smooth rubber with a full-length Pebax® plate for durability.

Unleash SD 2 (2015)
Discus and Shot put rotational
$100

- Surface: Concrete, Asphalt or some other Firm.
- ISOFIT system provides stabilizing support while adapting to the movement of the foot.
- FLEXFILM upper is lightweight and supportive.
- Midfoot cross strap locks foot to platformInternal EVA midsole for underfoot cushioning.

Asics Unisex Throw Pro (2014)
Discus and Shot put Rotational
$120

- Synthetic leather upper, easy to clean.
- An abrasion and tear resistant synthetic leather for increased upper durability.
- Spevafoam Midsole Material
- Improves bounce back characteristics and decreases midsole breakdown.

Nike Javelin Elite 2 (2015)
$90

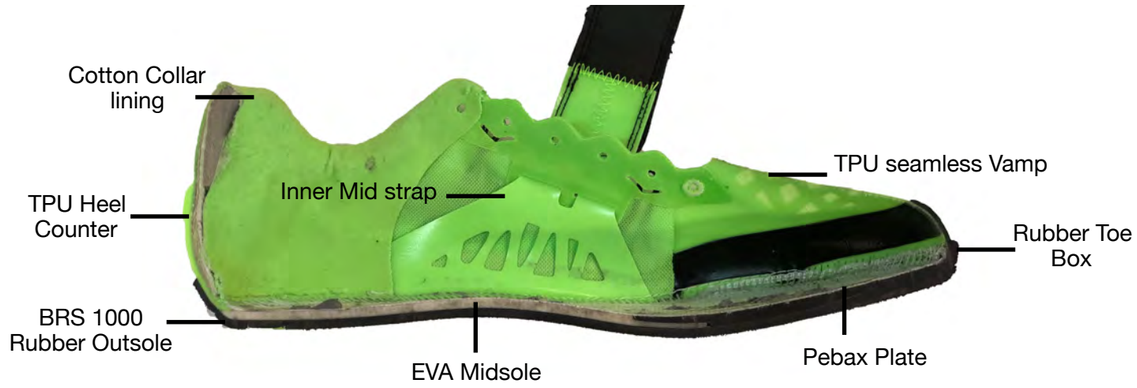
- Full-length PhylonTM midsole offers responsive cushioning .
- Midfoot shank provides stability and propulsion to ignite your step and power your throw.
- Full-length Pebax® plate with 11 spikes ensures powerful traction.

Saucony Lanzar JAV 2 (2016)
$110

- SOFIT upper adapts to the shape of your foot for a snug fit that moves with you.
- Cross strap across the midfoot for secure lockdown.
- EVA midsole cushions and returns energy with every step. Includes 3/8" removable pyramid spikes and a wrench.

Destructive Analysis

Nike Rotational 6: Shot put/Discus/Hammer



Adidas Adizero Discus/Hammer Throw

Nike Javelin Elite 2

Throwing Shoes Rules & Regulations

Javelin Spike Regulations and Rules

Number of Spikes
"The sole and heel of the shoes shall be so constructed as to provide for the use of up to 11 spikes. Any number of spikes up to 11 may be used but the number of spike positions shall not exceed 11".
Dimensions of Spikes
"That part of each spike which projects from the sole or the heel shall not exceed 12mm".

Shot Put/Discus/Hammer Throw

The Sole and The Heel
"The sole and/or heel may have grooves, ridges, indentations or protuberances, provided these features are constructed of the same or similar material to the basic sole itself."
The Purpose of the Shoes
"The purpose of shoes for competition is to give protection and stability to the feet and a firm grip on the ground.

Mentorship Team

Stanley Chang
General Manager of Global Football Category, Nike, ShangHai

“Verify and understand the unmet needs of a certain group of athletes/customers. What do they say that they want? What do they say that they need?

“One of the best ways to understand your competitors is to use their product/services.”

Your need to clarify your unique value proposition, describes why others should use your product and not the competition’s. Tell people how your design and ideas are unique.

Ammo Lee
Express Line Footwear Graphic Designer, Nike, ShangHai

“If you want to really understand the shoes, go to factories, learning the development process, the business side of it all, It is very important for your project.”

“Really understanding the athlete’s needs and discover the story behind throwing sports, it will help you to gain your inspiration.”

“At the end of the day, what really matters is your mind, your work and portfolio。”

Design Brief

Shot Put/Discus

This shoes are designed specifically for the rotational technique shot put/Discus, It combines the specific needs of the spinning technique to provide the best lockdown performance and support.

Season: 2021 Fall

Price: $ 169.99 Retail
$ 42.99 FOB

Environment: Outdoor/Indoor
Throwing circle(Cement/Wood)

Consumer: Professional Athlete
Intermediate
Rotational shot put/Discus

Features & Benefits:

- Specific traction design provides the balance of spinning and the stability.
- Mid foot strap and an external heel counter for best lockdown
- Comfortable midsole for durable cushioning at the specific areas.

Design Brief

Hammer Throw

Specifically designed shoes for hammer throwers, that provides the best performance for executing rapid pivots. The design will help the athlete to absorb shock and enhance stability.

Season: 2021 Fall

Price: $ 139.99 Retail
$ 35.99 FOB

Environment: Outdoor/Indoor
Throwing circle(Cement/Wood)

Consumer: Elite Athlete
Intermediate
Hammer throw

Features & Benefits:

- Upper construction is internally reinforced with a strap for lockdown during fast rotational.
- Asymmetrically designed outsole for hammer throw specific movements and provide individualized traction support.
- Soft collar for reduced pressure on the ankle.

Design Brief

Javelin Throw

This shoes is asymmetrically designed for javelin specific movements and delivers great lockdown and flexibility exactly where athletes need it.

Season: 2021 Fall

Price: $ 179.99 Retail
$ 45.99 FOB

Environment: Outdoor/Indoor
Run-up track (Rubber)

Consumer: Elite Athlete
Intermediate
Javelin thrower

Features & Benefits:

- Midstrap wrap over the foot for the best lock-down fit.
- Removable spikes are conveniently for athletes to install and take out during the competition.
- Midsole cushions and returns energy with every step and power your throw.

Work Calendar For The Next 5 Weeks

	Sunday	*Monday*	*Tuesday*	*Wednesday*	*Thursday*	*Friday*	*Saturday*
Week 6	9	10 HW7 DUE Show: • 20 Ideation sketching • 10 sketching shape of the midsole • 10 sketching shape of the outsole • Totally 40	11 • More 20 Ideation sketching • Shape of the midsole • Shape of the outsole	12 HW8 DUE • Show more Ideation sketching • Show more 20 ideation sketching • Start coloring	13 • 10 Basic Shape rendering • 20 Sketch upper graphics • Rendering the upper • Quick color rendering the midsole and outsole	14 • 10 Basic Shape rendering • 10 Sketch upper graphics & texture rendering • Quick color rendering the sole	15 • 10 Basic Shape rendering • 10 Sketch upper graphics and rendering the textures • Quick color rendering the midsole and outsole
Week 7	16 • Final sketching and color ideation • Final Rendering and graphic design	17 HW9 DUE • Show final sketching and color ideation • Start making mock ups	18 • 5 Materials mockups • Analysis the material for upper • Start modeling	19 HW10 DUE • Show modeling in process • Analysis the material for upper • Start modeling outsole in Rhino	20 • Materials mockups • Analysis the material for upper • Modeling in process	21 • Upper material testing • Upper prototype making • Outsole and midsole modeling in process	22 • Upper material testing • 2 Upper prototype making • Modeling in process • Outsole & midsole modeling
Week 8	23 • Prepare for proofing of concept • Make proofing of concept plan	24 HW11 DUE • Show proof of concept, • show CAD (2 outsole) • Show 2 upper prototypes	25 • Making validation plans • How to test upper? • Outsole really solve the problem? • Midsole offers support?	26 HW12 DUE Proof of the validation plans	27 • 2nd round, 2 outsole in the CAD • More details in CAD(upper) • Grasshopper outsole • Prototype making	28 • 3 Upper prototype Making • More details in CAD (upper) • Grasshopper outsole	29 • Upper sewing, Strobel • Finish details in CAD • Outsole traction in grasshopper • Prototype making
Week 9	1 • Upper sewing, Strobel • Finish details in CAD • Outsole traction • Prototype making	2 HW13 DUE • Show 1st round final prototype • Finish details in CAD • Outsole traction	3 • Updating 2nd final upper prototype • Finish the upper details • Finish the CAD • Ready to 3D print	4 HW14 DUE • 2nd round upper prototype • Finish the upper details • Finish the CAD • Ready to 3D print	5 • 3rd round upper prototype • Midsole casting/Ready to 3D print	6 • 3rd round upper prototype • Midsole casting • Final CAD & renderin/3D print	7 • 3rd round upper prototype • Midsole casting • Final CAD & renderin/3D print
Week 10	8 Midsole casting/outsole 3D printing	9 HW15 DUE • Final previews • Finalizing final prototype • Final presentation prepare	10 • Finalizing final prototype. • Final presentation prepare	11 • Final presentation • Final reviews	12	13	14

Presentation Winter 2020

Final Capstone Project

Shawn Li

Men's Throwing Sports Footwear Innovation

Capstone Project
MS Sports Product Design
University of Oregon
Shawn Li

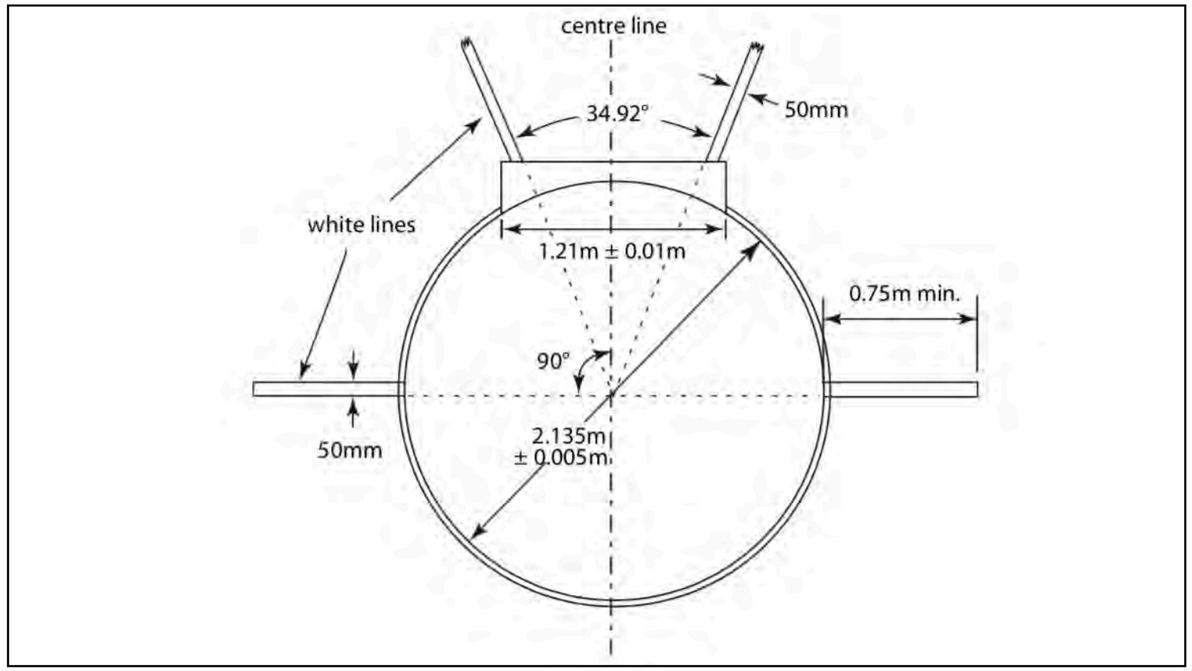
Men's Throwing Sports Footwear Innovation

This capstone project is to innovate new footwear for shot put/discus, javelin and hammer throw. The collection will provide the best footwear performance and support for elite throwing athletes.

The Innovative Nature of Throwing Sports Footwear/Why is important?

- Shot Put, Discus, Hammer Throw & Javelin are all Olympic events.
- All four events have a very long history in track and field.
- The existing throwing shoes have not been updated for many years.

Shot Put/Discus Rules & Competition Field



Shot Put/Discus

The shot, a metal ball which is 7.26kg/16lb for men. The athlete needs to put the shot with one hand. Discus, athletes throw a 2kG and 22cm diameter metal disc.

Shot Put/Discus Throwing Circle

The athletes are required to throw as far as possible while remaining inside a 2.5-meter diameter circle.

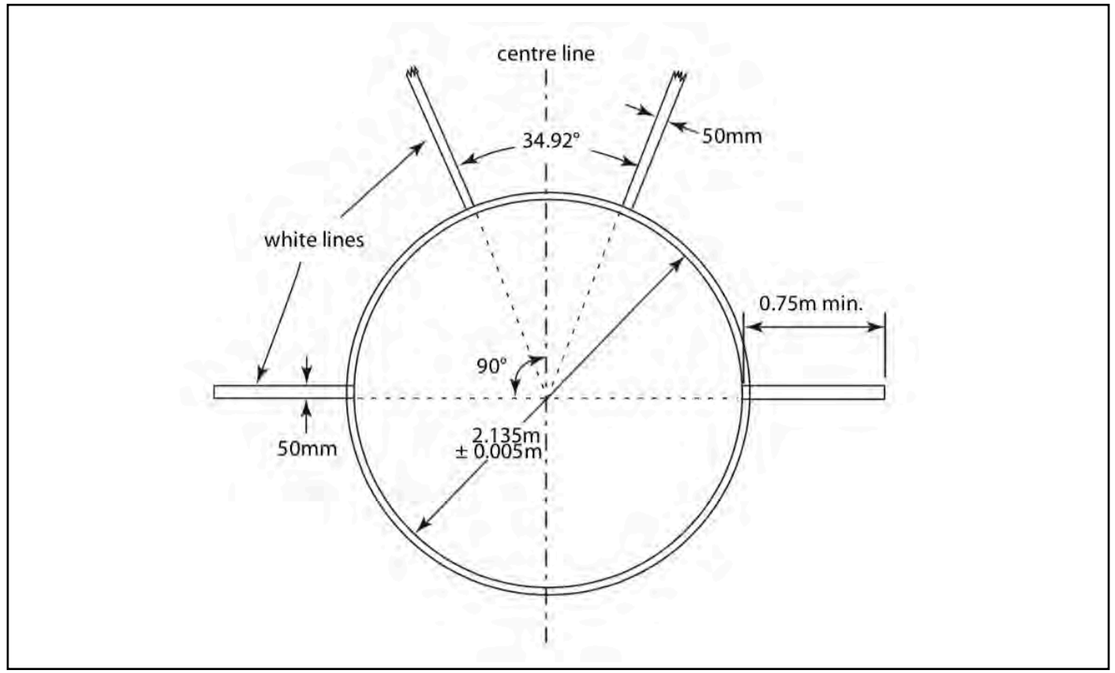
Shot Put/Discus Rotational Technique

In order to get the maximum release velocity, the discus and shot put rotational throwers need to have a stable foot landing and reach a high rotational foot speed to transfer the energy to push the shot/discus. The discus/shot put shoes usually have smooth and rounded edge outsole, with no traction/thread.

Hammer Throw Rules & Competition Field

Hammer Throw

Athletes throw a metal ball which is 7.26kg for men. The hammer is attached to a grip by a steel wire no longer than 1.22m. The thrower usually makes three or four spins before releasing the ball.



Hammer Throw Circle

The diameter of the hammer circle is 2.135 meter. Hammer and discus throws area should be made from an enclosure or cage that should be centered on the circle and with the non-movable cage opening.

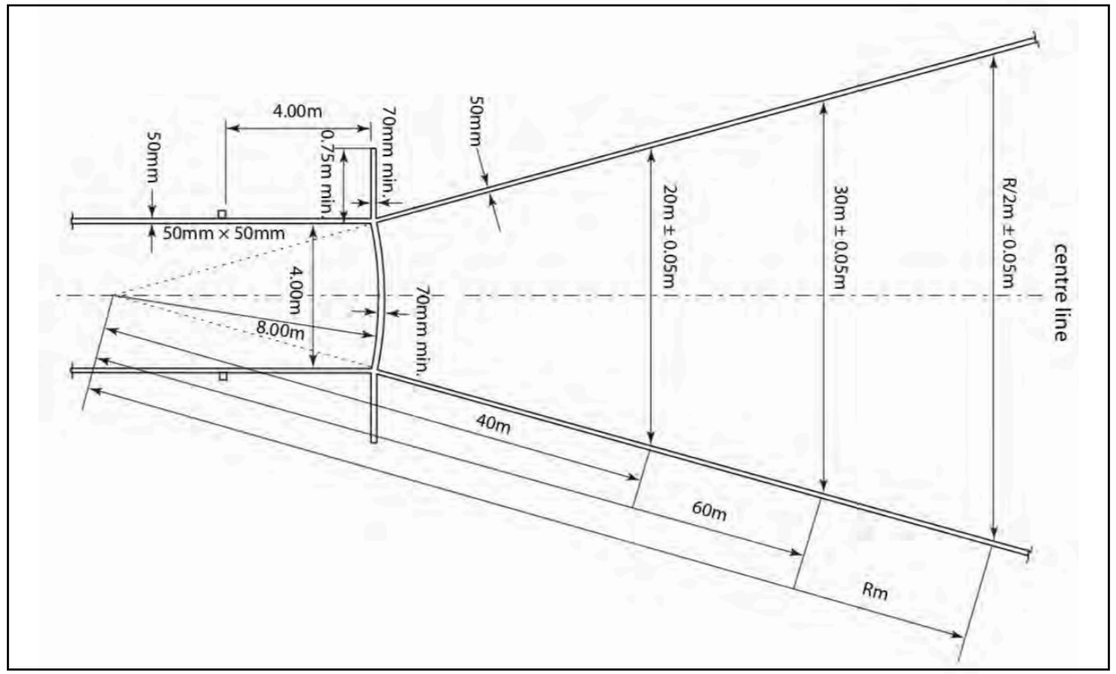
Hammer Throw Rotational Technique

The motions of the hammer thrower's centre of mass are influenced by two forces; gravity, and ground reaction force. So reducing the friction between the outsole and the ground is very important for improving rotational velocity.

Javelin Throw Rules & Competition Field

Javelin Throw

The men's javelin weigh at least 800gram and be 2.7meter long. The athlete begins with run-up, then throw the javelin over the upper part of their throwing arm. The tip of the javelin must land first.



Javelin Throw Runway

The runway javelin should be marked by two parallel lines 5 centimeters in width. The minimum length should be 33.5 meters and the width shall be 4 meters between the inside edges of the marked parallel lines.

Javelin Throw Footwork Technique

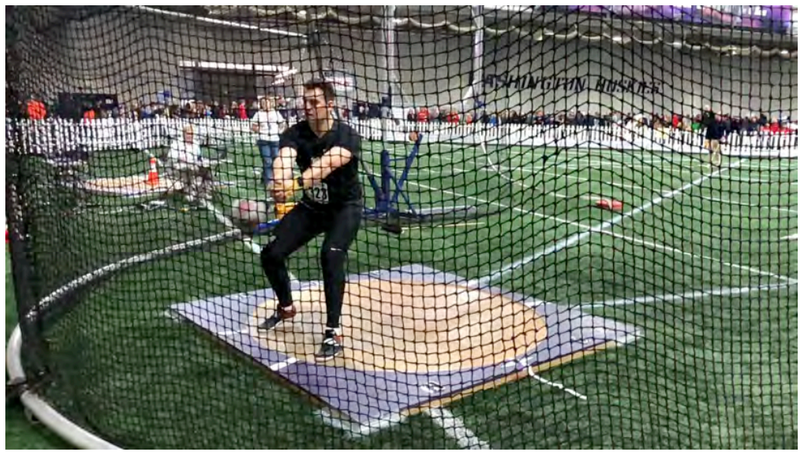
A javelin throw involves a run-up of 6 to 10 steps, followed by two or three crossover steps before the thrower releases the javelin. Sprinting is performed on the balls of the feet, with toes pointing forward. Ensuring that the feet (forefoot) grip the surface will improve the friction and gain the ground reaction force throughout the running strides.

2020 UW Indoor Preview

- Dempsey Stadium at the University of Washington in Seattle.
- The event took place on Saturday, January 18
- Weight/Hammer Throw
- Shot Put

Slow-Motion Video Analysis

Hammer/Weight Throw



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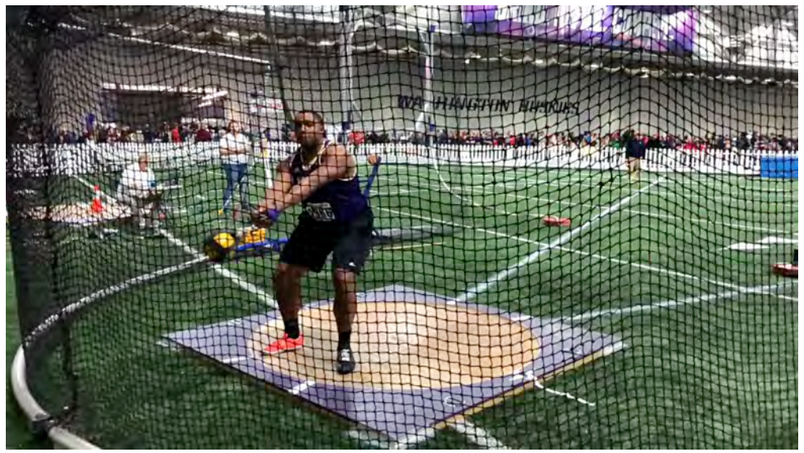

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Hammer/Weight Throw

Some athletes have 4 turns before releasing the ball, some of them have 5 turns. The spinning takes the left foot as the central pivot point, another foot is balancing the body and creating the momentum.

4

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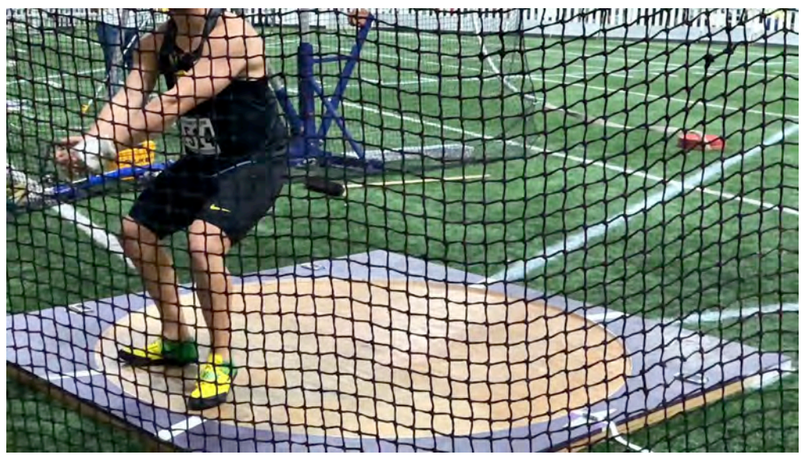

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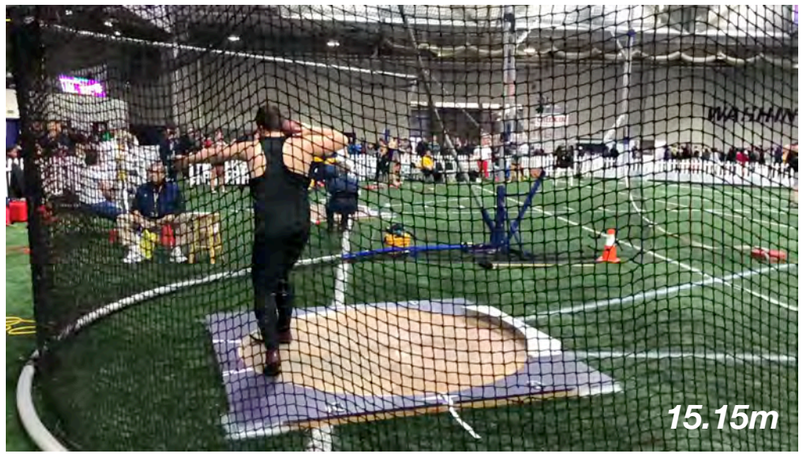
Footwork Analysis

When spinning, the elite athlete will use the edge of the left foot to spin instead of the forefoot or the heel. In order to get fast rotational velocity, athletes need to reduce the contact friction. (Compare video 5 and 6)

Slow-Motion Video Analysis

Shot Put

7



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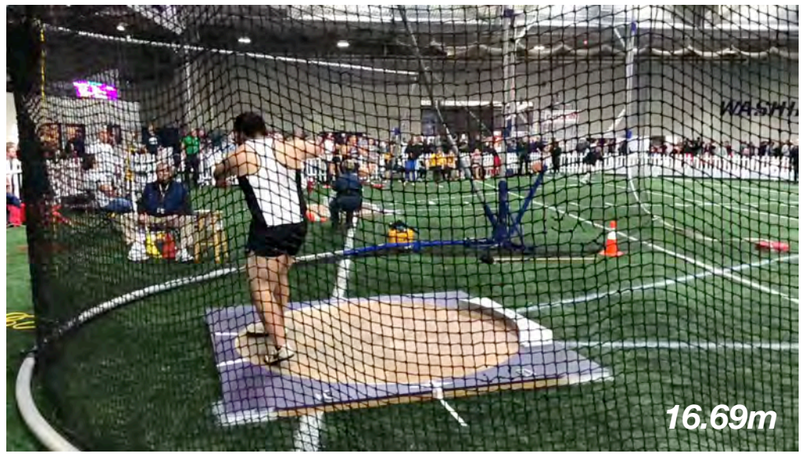

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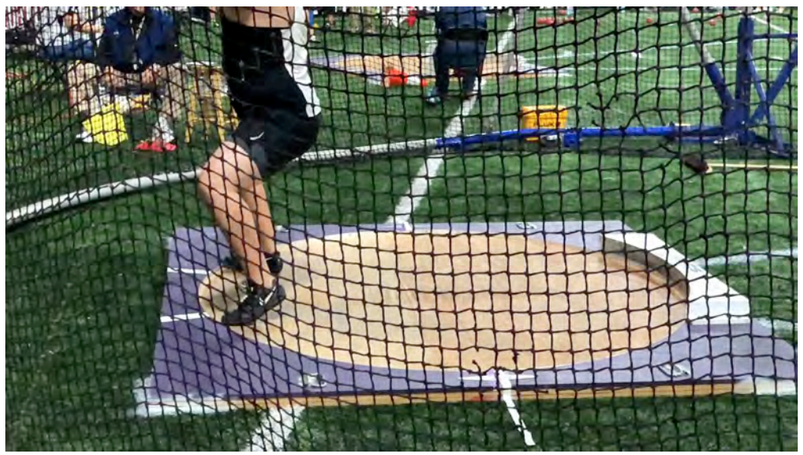
Shot Put Rotational

Left and right feet are alternatively rotate 180 degrees. Spin and release velocity will affect the athlete's performance. (compare video 7, 8 and 9)



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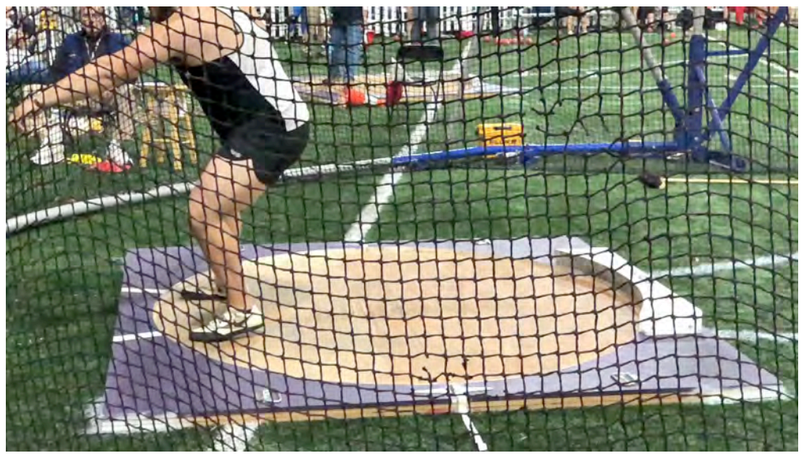

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12

Footwork Analysis

The function of the right foot (landing foot) during the delivery is to manage the body with a heave-up push to give the base for the powerful trunk turn. The forefoot on the landing foot is the area that absorbs body weight and delivers the power of final push.

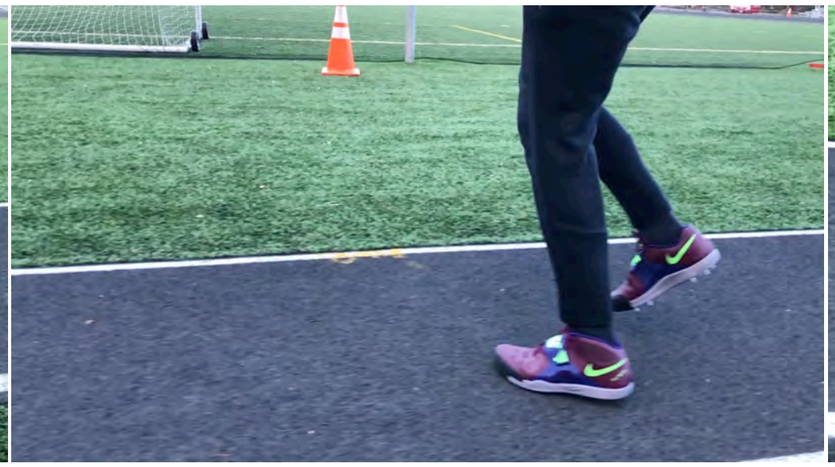
Contact Area

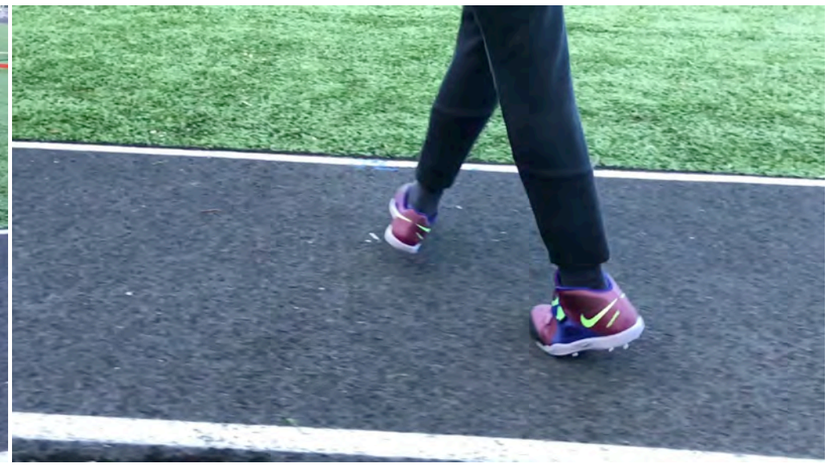
Javelin Throw

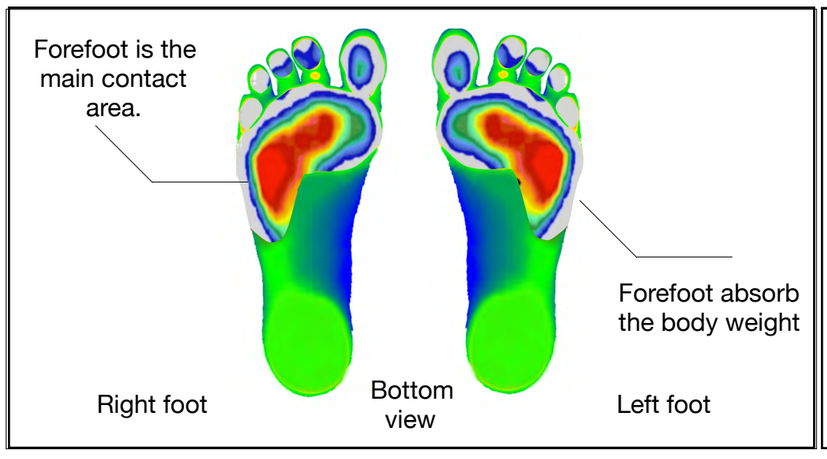
1st Phase: Run up

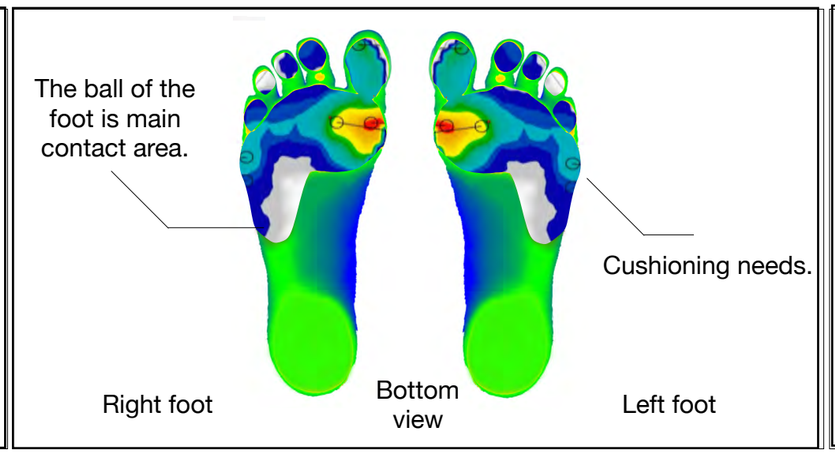
2nd Phase: Crossover Steps

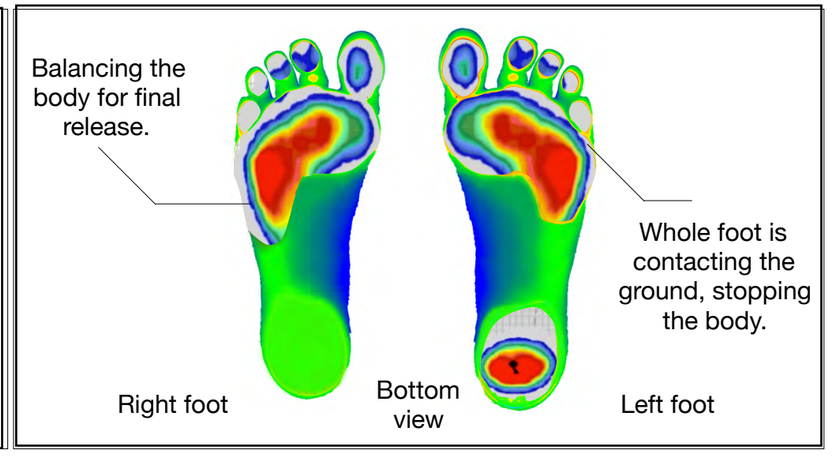
3rd Phase: Final Release











Athlete Insight

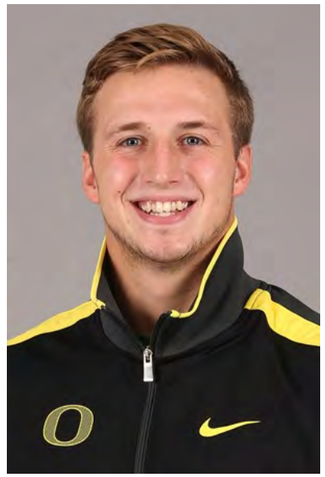
DEREK AKEY
University of Oregon
Shot Put/Discus
Personal-best throw of 55.36m/181-7.5 to win FHSAA 4A regional title

“Throwers are bigger people, we have fat feet, we need bigger toe box, it would be comfortable for us.”

“I want to have stiff shoes upper, don’t make it too flexible, a good pair of shot put/discus throwing shoes usually don’t very flexible which is good for throwers.

“ There is very little arch support in the Nike SD’s, and my ankles pronate a lot in them. That wasn’t as much of a case with the Nike Rotational."

“I like the strap on the zoom rotational 6, really helpful for lockdown.”

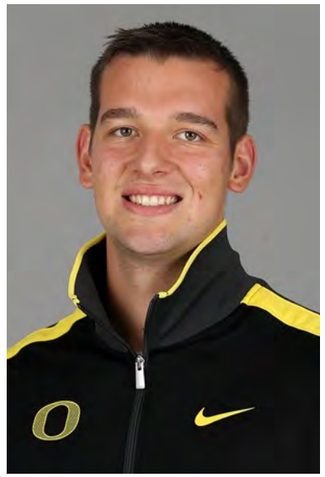


AUSTIN THARP
University of Oregon
Hammer Thrower
-Competed in the hammer throw (173-11/53.00m) at the PAC-12 Championships.

“The three most important areas of strength for a hammer thrower, in my opinion, are the legs, the core, and the posterior chain. Controlling the placement of your feet and legs is essential to a good throw.”

“Shot/discus they are only turning on the toe, a lot more spin at the beginning of the throw. Hammer throw have some spins on the heel.”

“I want to have tighter and breathable upper material for the shoes”



TY HAMPTON
University of Oregon Field & Track Team
Javelin Throw
Won the PIAA District XI 3A Championships title as a junior with a season-best throw of 179-11.

“Spikes do not necessarily have to be super comfortable, they should serve a purpose.”

“ I often take off my spikes in competition. Because they are very tight and stiff. This is good for relaxing my feet and energy recovery.”

“Currently I use a higher top, but not very high left boot, Nike Javelin Elite II.”

“For the durability of the shoes, in normal competition and practice, you can plan with 2 seasons per pair, depending on the technique and practice.”

Destructive Analysis

Nike Rotational 6: Shot put/Discus/Hammer

Adidas Adizero Discus/Hammer Throw

Nike Javelin Elite 2

Design Brief

Shot Put/Discus

This shoes are designed specifically for the rotational technique shot put/discus, It combines the specific needs of the spinning technique to provide the best lockdown performance and support.

Season: 2021 Fall

Price: $ 169.99 Retail
$ 42.99 FOB

Environment: Outdoor/Indoor
Throwing circle(Cement/Wood)

Consumer: Professional Athlete
Intermediate
Rotational shot put/Discus

Features & Benefits:

- Specific traction design provides the balance of spinning and the stability.
- Mid foot strap and an external heel counter for best lockdown
- Comfortable midsole for durable cushioning at the specific areas.

Design Brief

Hammer Throw

Specifically designed shoes for hammer throwers, that provides the best performance for executing rapid pivots. The design will help the athlete to absorb shock and enhance stability.

Season: 2021 Fall

Price: $ 139.99 Retail
$ 35.99 FOB

Environment: Outdoor/Indoor
Throwing circle(Cement/Wood)

Consumer: Elite Athlete
Intermediate
Hammer throw

Features & Benefits:

- Upper construction is internally reinforced with a strap for lockdown during fast rotational.
- Asymmetrically designed outsole for hammer throw specific movements and provide individualized traction support.
- Soft collar for reduced pressure on the ankle.

Design Brief

Javelin Throw

This shoes is asymmetrically designed for javelin specific movements and delivers great lockdown and flexibility exactly where athletes need it.

Season: 2021 Fall

Price: $ 179.99 Retail
$ 45.99 FOB

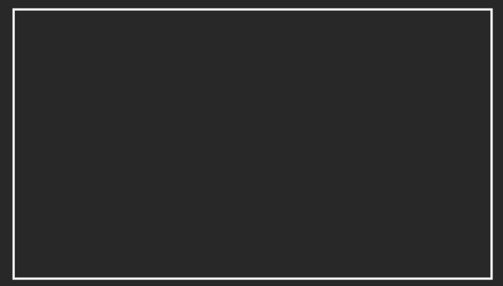
Environment: Outdoor/Indoor
Run-up track (Rubber)

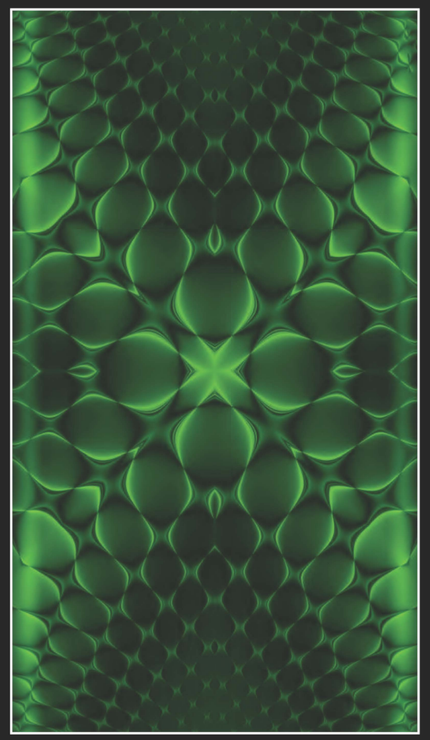
Consumer: Elite Athlete
Intermediate
Javelin thrower

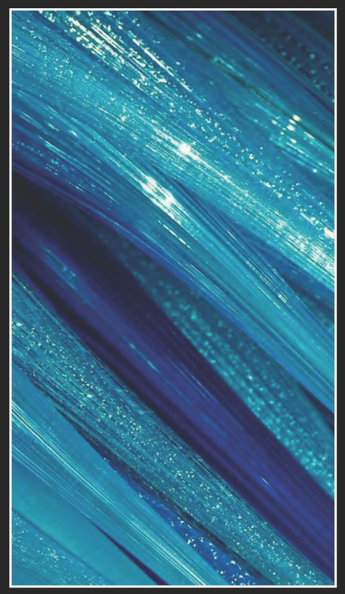
Features & Benefits:

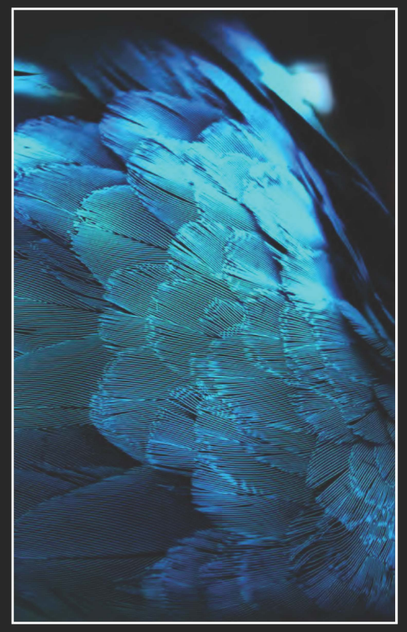
- Midstrap wrap over the foot for the best lock-down fit.
- Removable spikes are conveniently for athletes to install and take out during the competition.
- Midsole cushions and returns energy with every step and power your throw.
- Asymmetrically shoes top designed for the different needs of the stability.

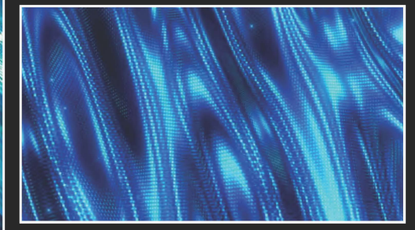
Color Inspiration



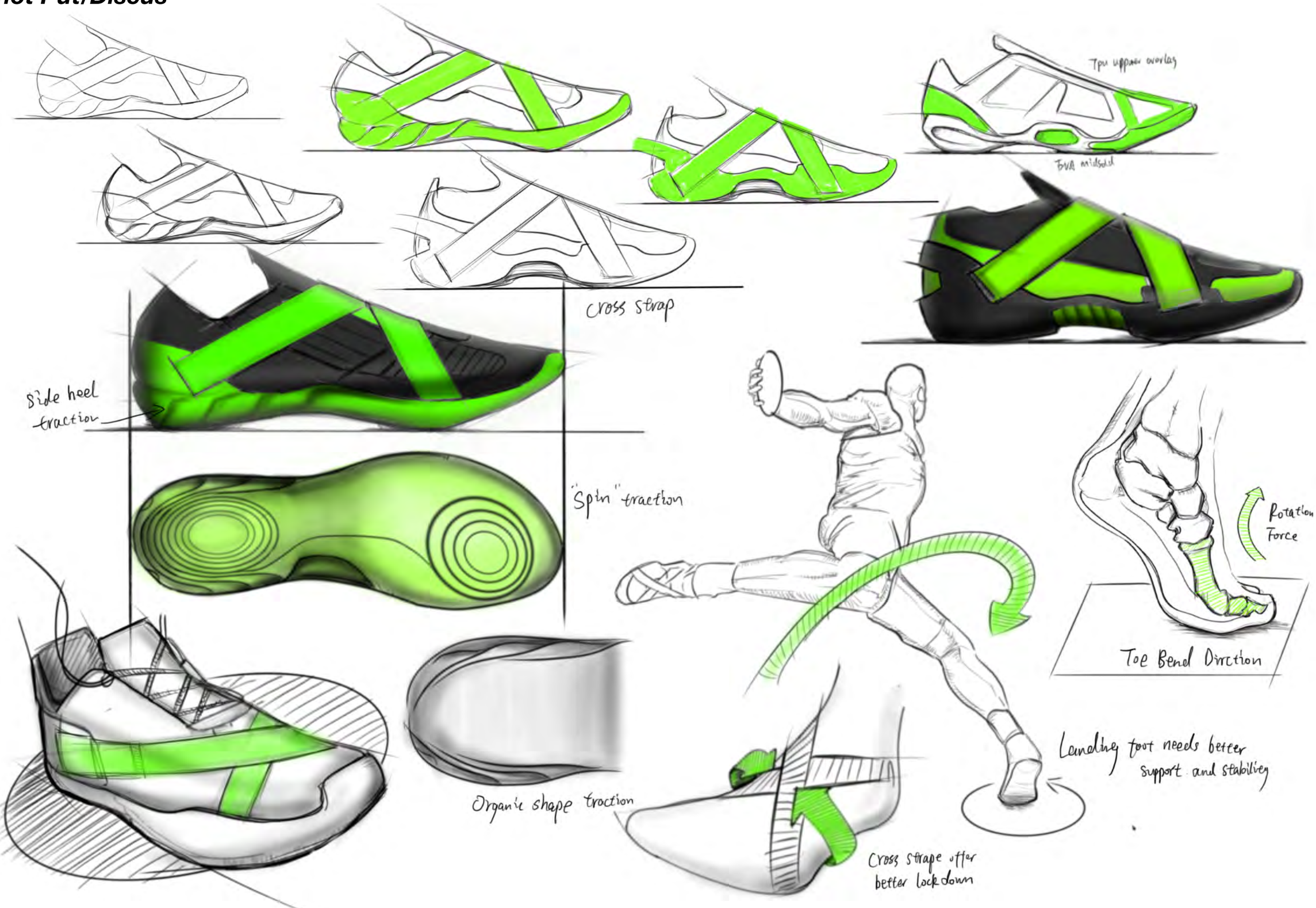




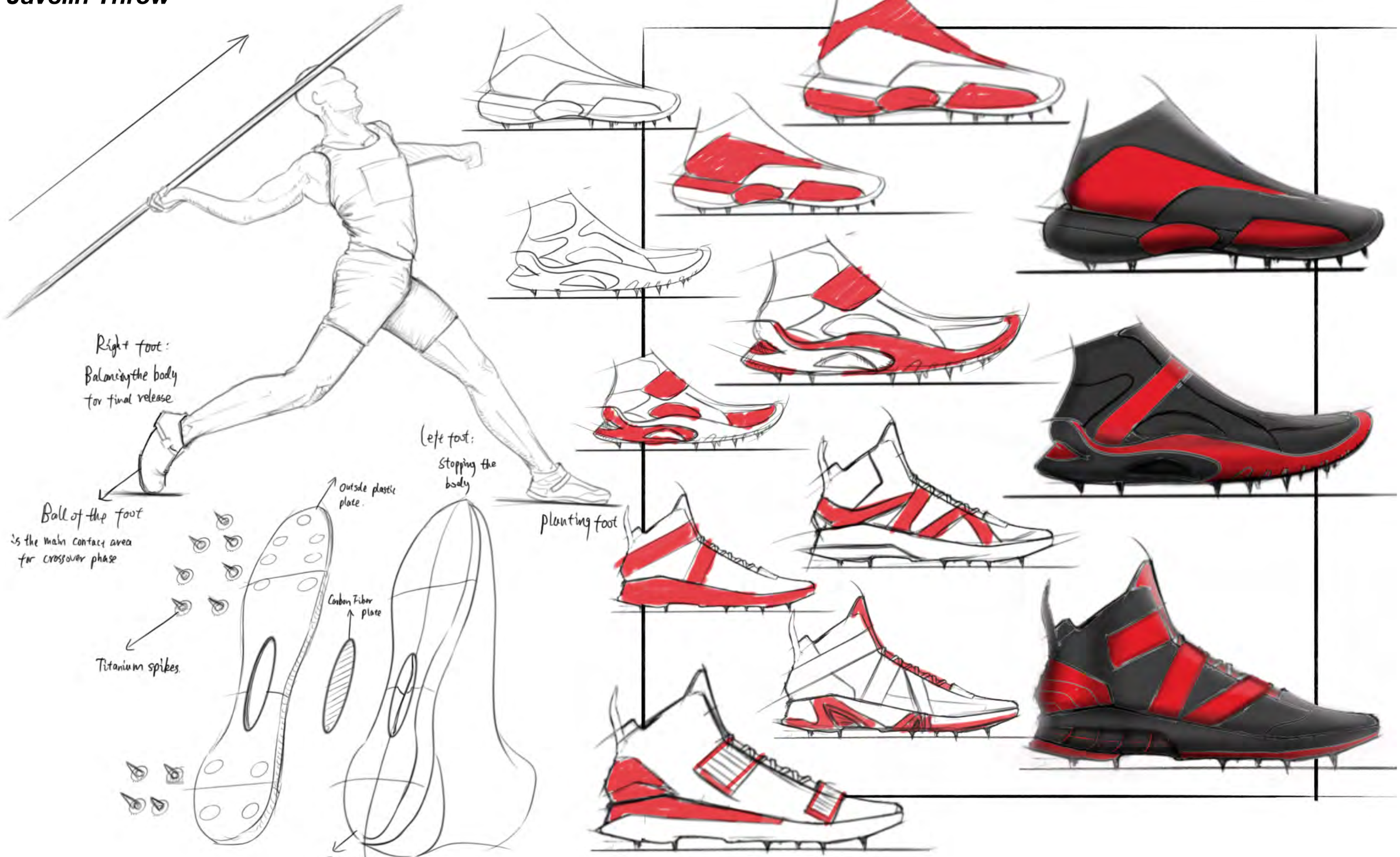




Shot Put/Discus

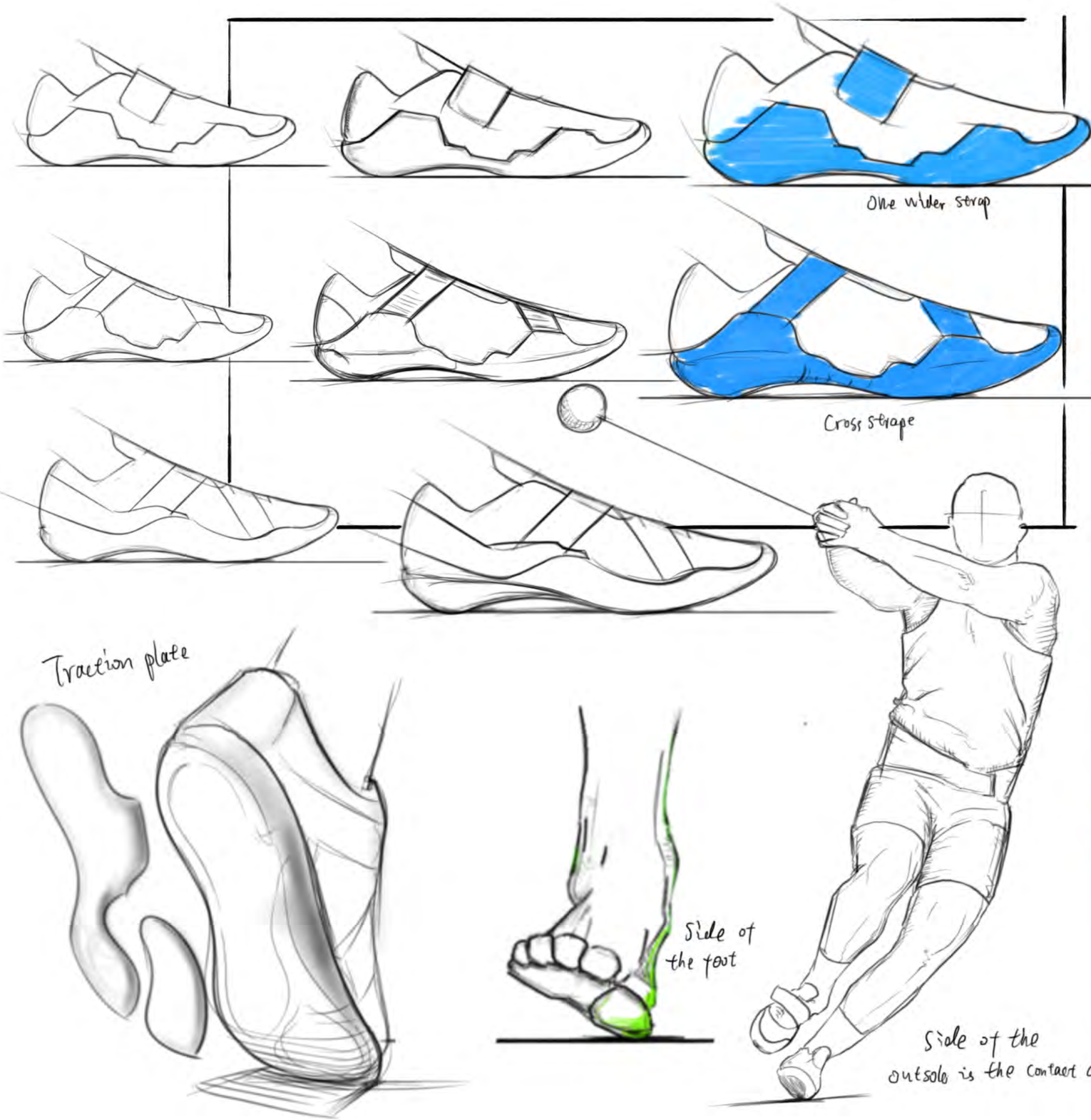


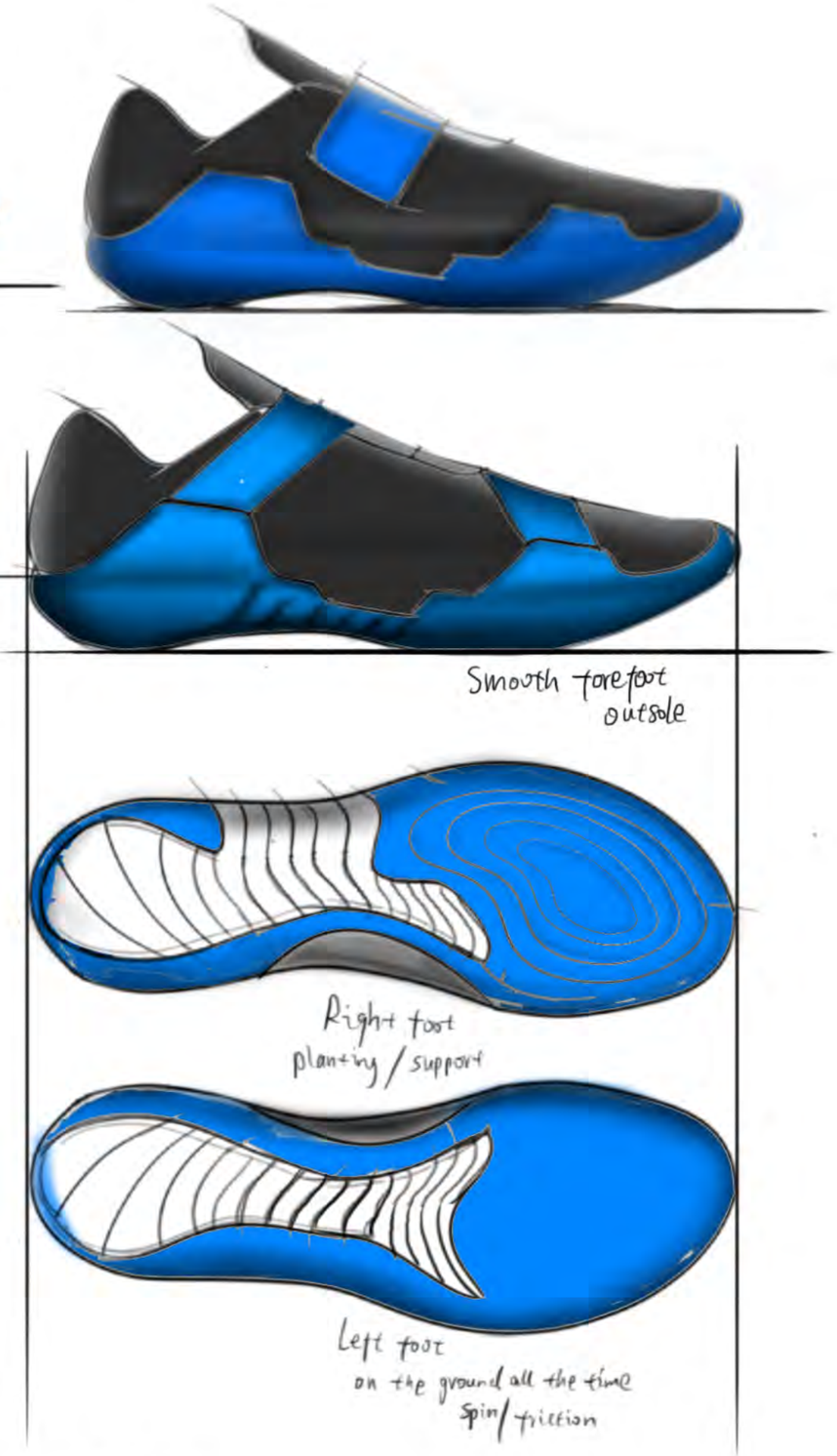
Javelin Throw



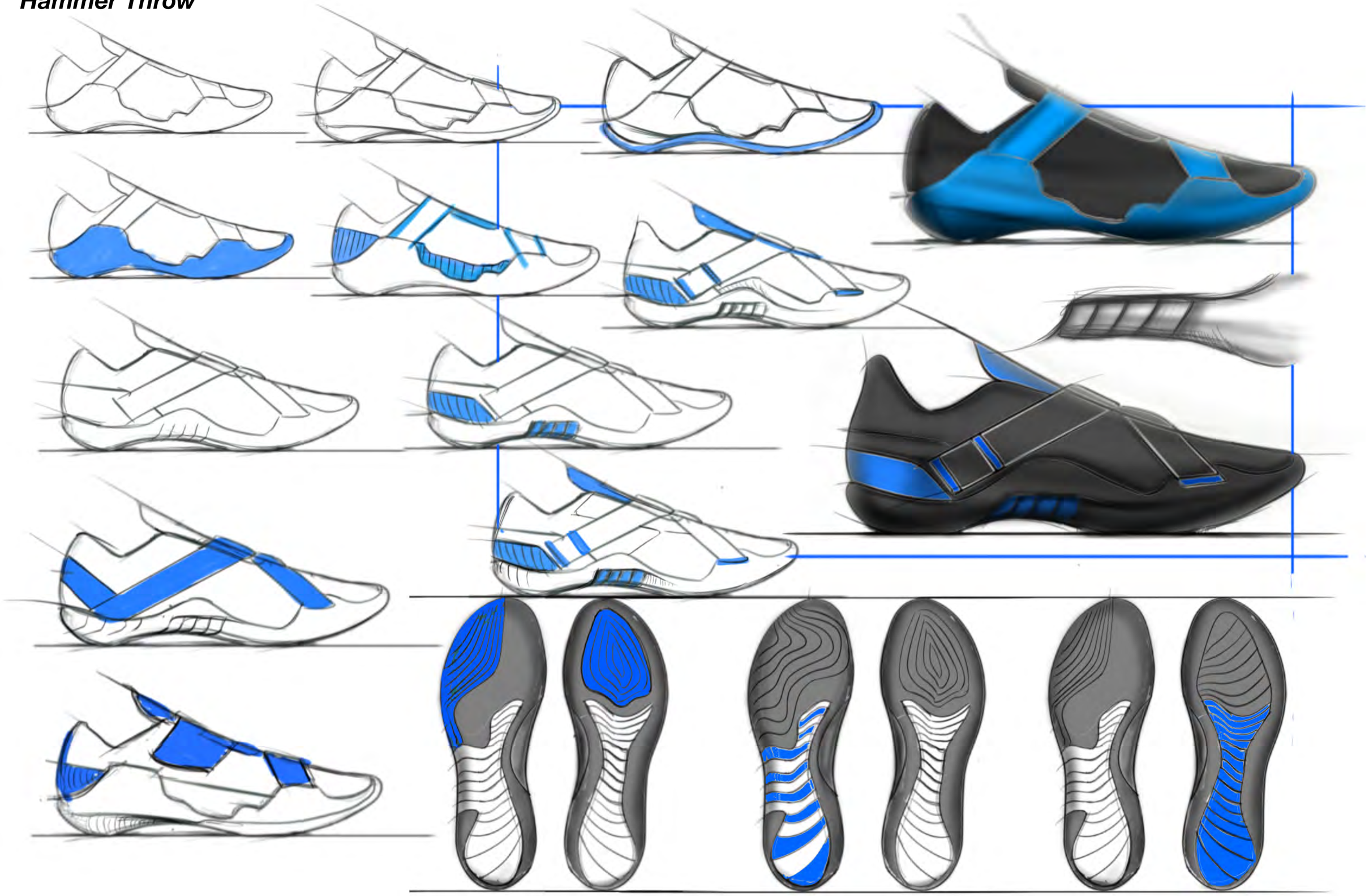
Javelin Throw

Hammer Throw





Hammer Throw



Making Prototype

Try different shapes of straps, find out the best solution for heel lock down.

Different shape and colors prototypes were iterated, leading into final patterns.

Heat press machine was used to make graphic pattern on the upper surface, followed by adding details onto the upper.

Final Upper Direction

Shot Put/Discus

Straps go all the way down to the heel counter, which can lockdown the dorsal and heel. Also quick tightening and wear on.

Hammer Throw

TPU straps holder on the dorsal foot secures the straps and shoe laces together. Built in foam for reduced pressure on the ankle.

Javelin Throw

Triangle lockdown system stabilize dorsal foot and heel at the same time, offers better foot lock-down.

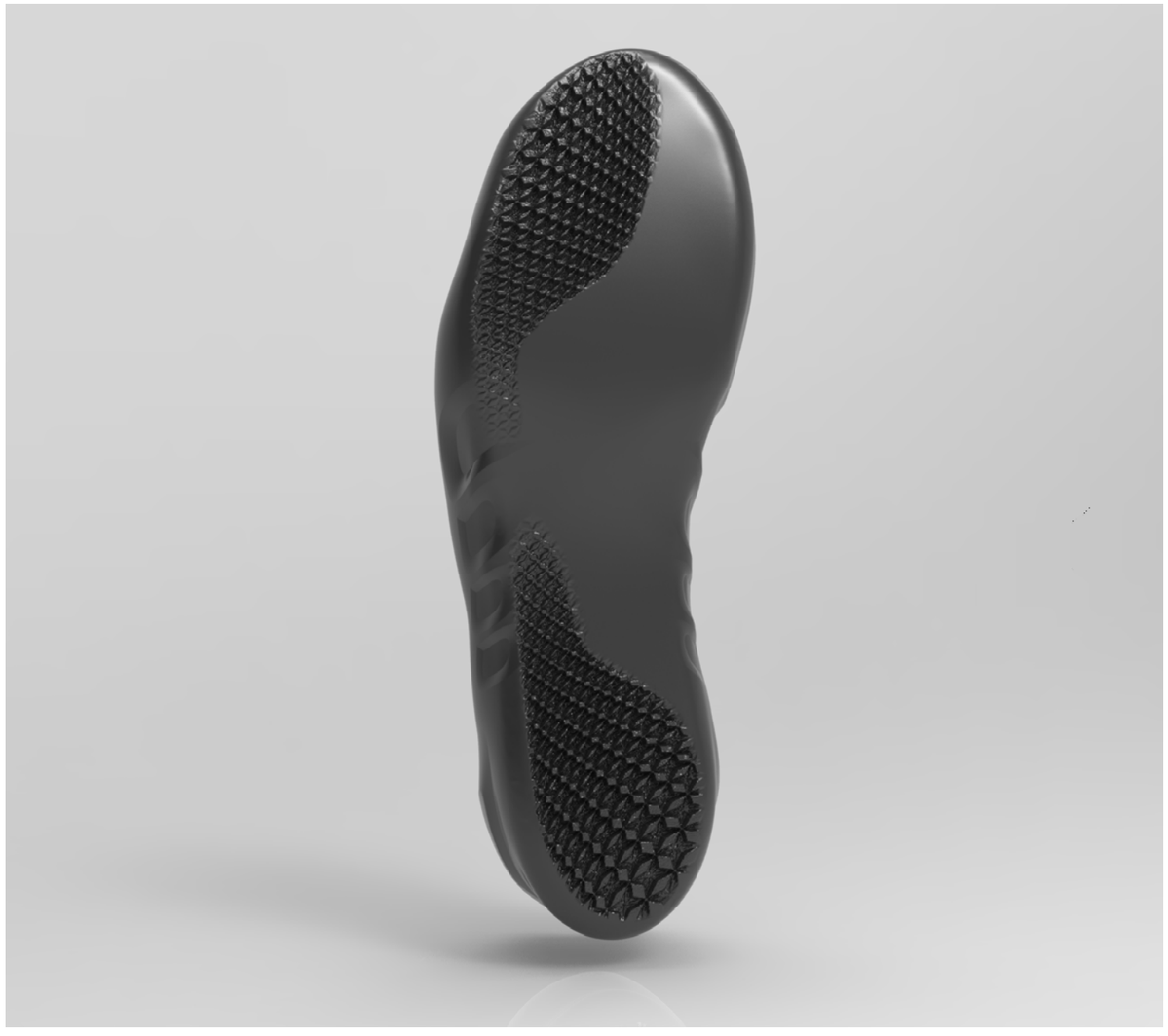
Final Midsole-Outsole Direction

Shot put/Discus

Rounded edge and smooth forefoot outsole enhance spin technique.

Medial and lateral traction will effectively reduce the rotation momentum after throwing.

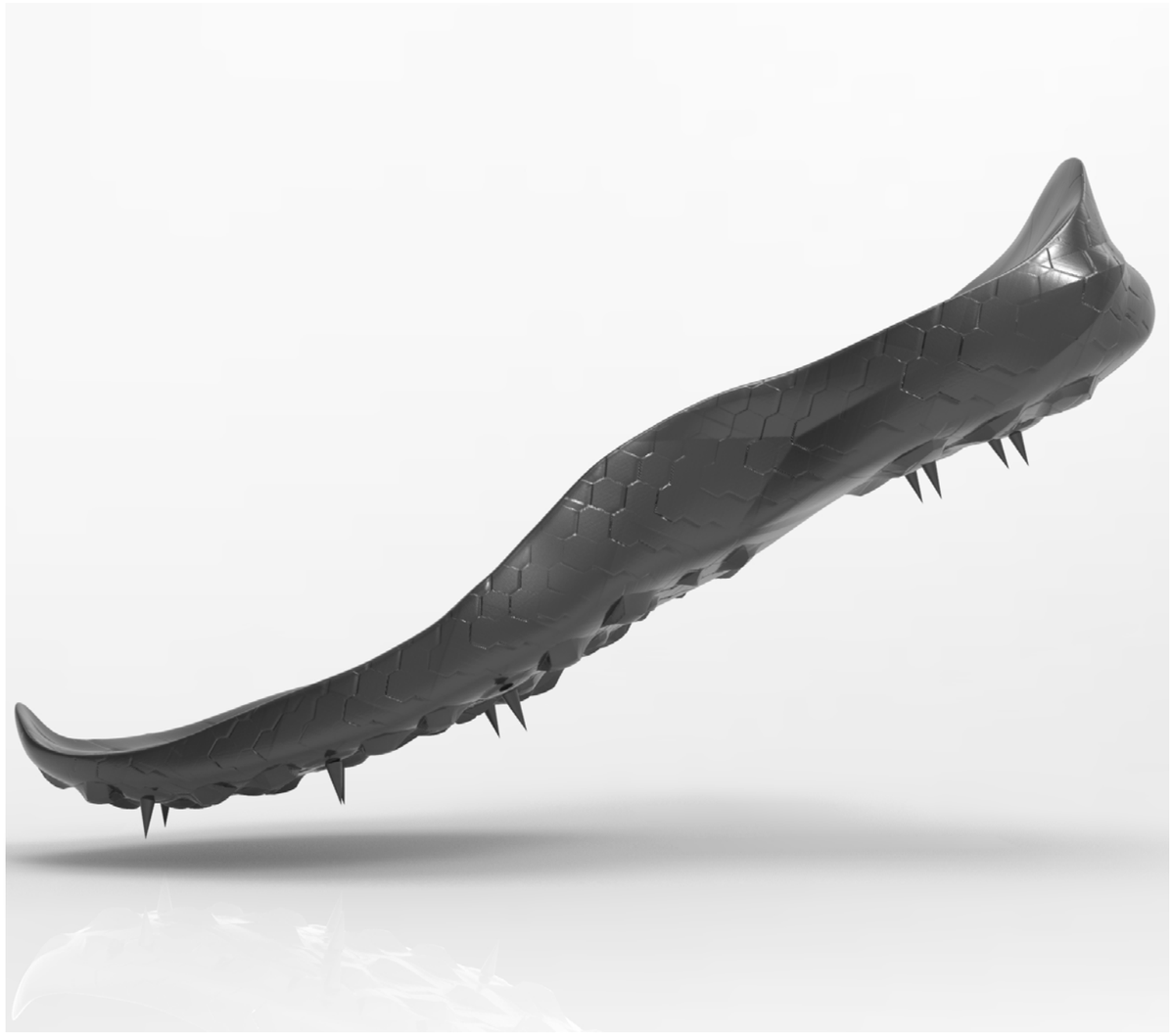
Hammer Throw



Asymmetrically designed outsole for hammer throw specific movements.

Localized traction provides the specific traction support.

Javelin Throw



Removable spikes are conveniently for athletes to customize during competition.

Spikes and traction will ensure the feet grip the ground improve the friction.

Re-made Upper

Use very durable material to make toe cap. The toe cap also is the reinforced piece for fixing straps.

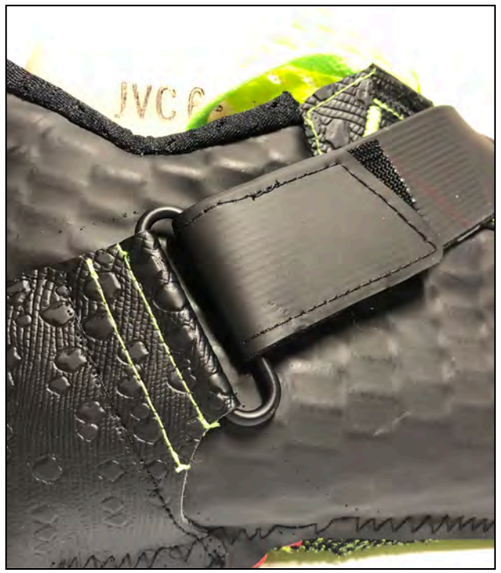
Re-made eyelet, the eyelet holes are vertical which can tighten the upper easily for athlete.

Reinforced zigzag stitches to make sure the eyelet part is solid and durable. “Square ring” strap holders are located at the side of the heel which is stitched with durable materials

Final Shot Put/Discus Upper

Straps made with synthetic material film and attached velcro

“Vertical” eyelet



Strap holder made by hard aluminum ring and synthetic leather with double stitches to make sure 100% solid

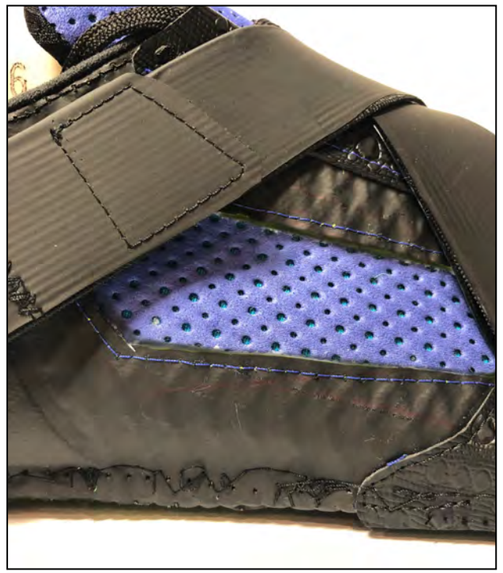
Straps are fixing at the front side of the upper and strobel with the bottom piece together.

Easy tightening and wear on

Final Hammer Throw Upper

“Vertical” eyelet holes

Strap holder made by hard aluminum ring and synthetic leather with double stitches to make sure 100% solid



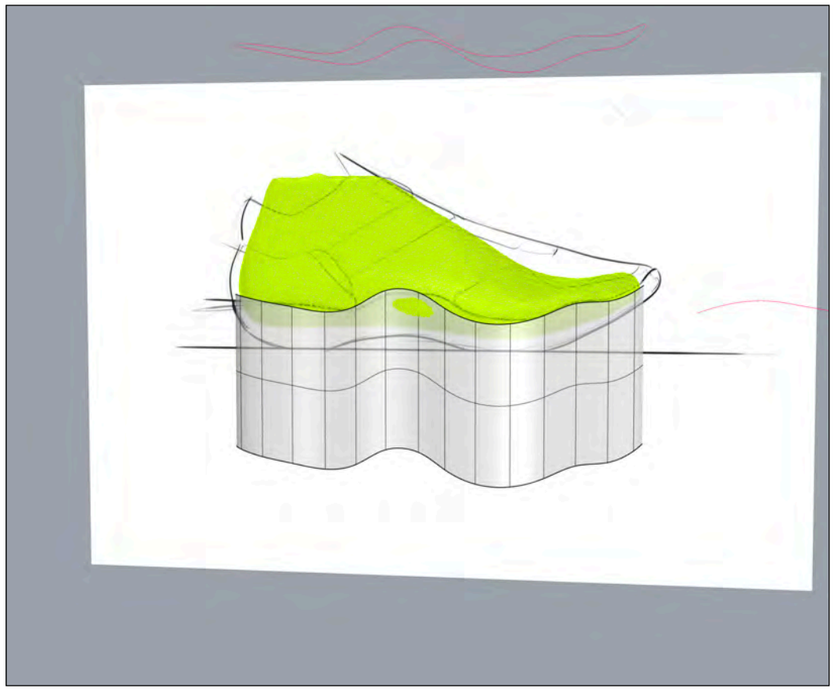
Ventilation mesh offer better breathability

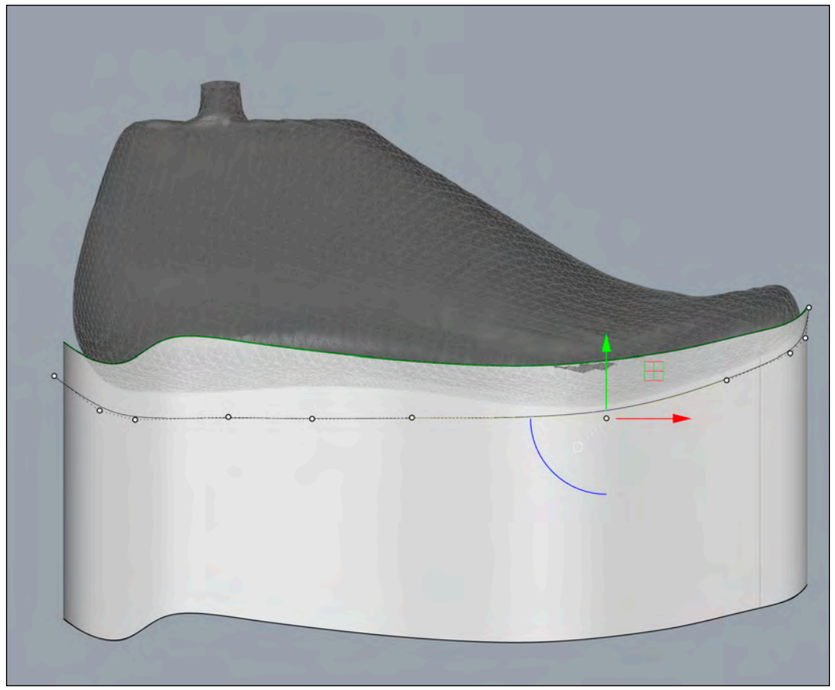
Straps go inside the part of the toe cap and strobel with upper together to make sure solid and durable

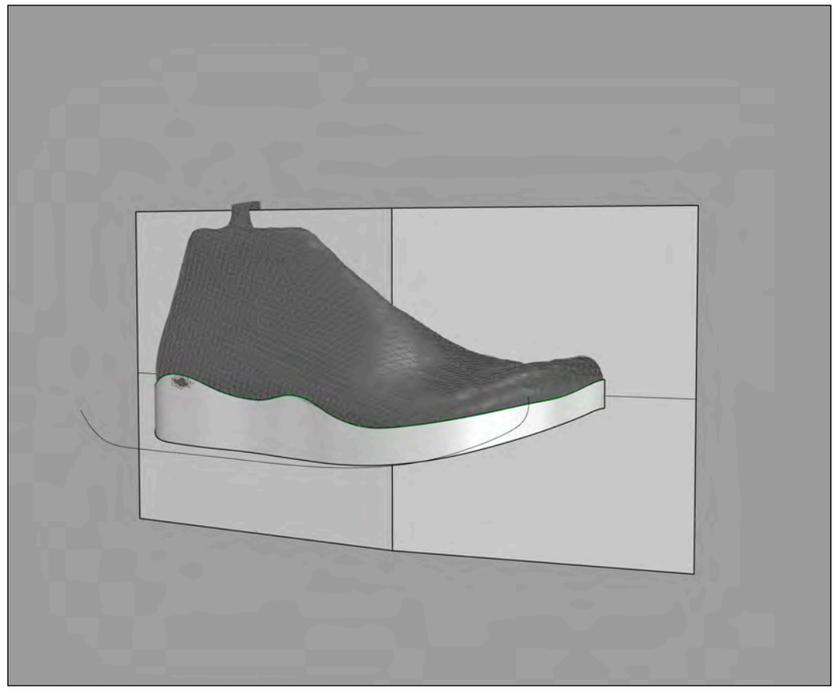
2nd Round Prototypes

3D CAD in Rhino

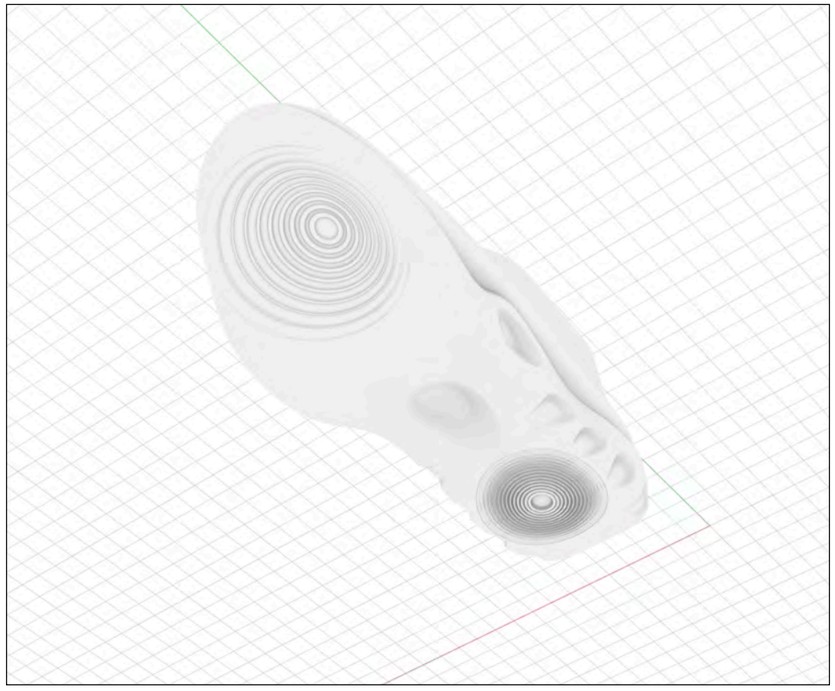
All 3D CAD re-made in Rhino. The outsole is built on the 3D scan shoe last to make sure the measurement is 100% correct.

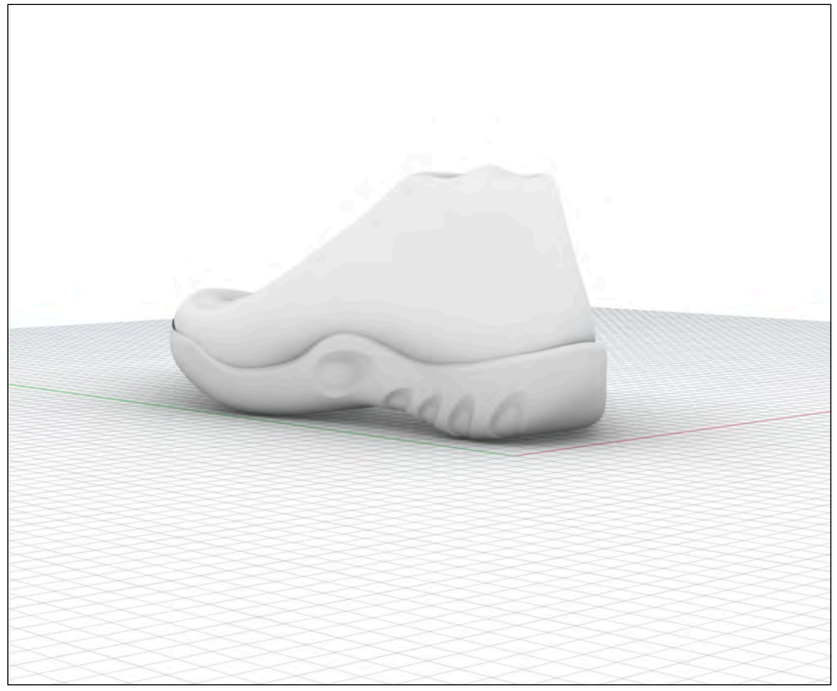


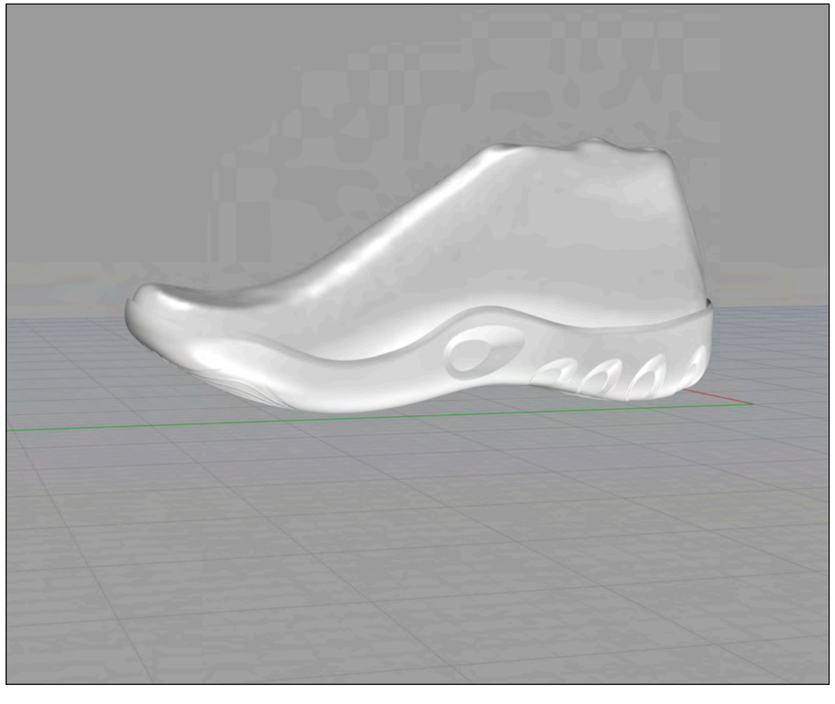


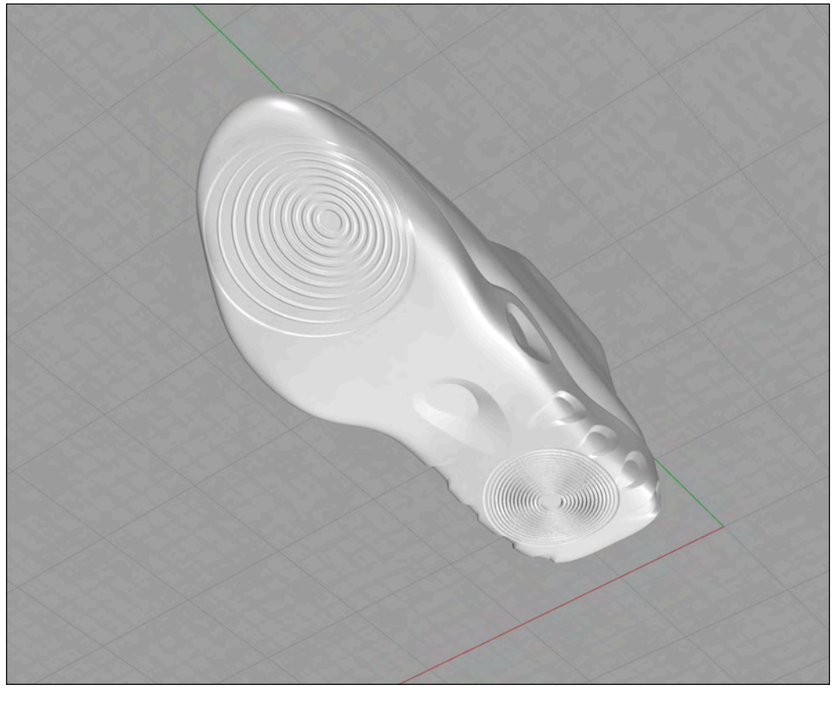


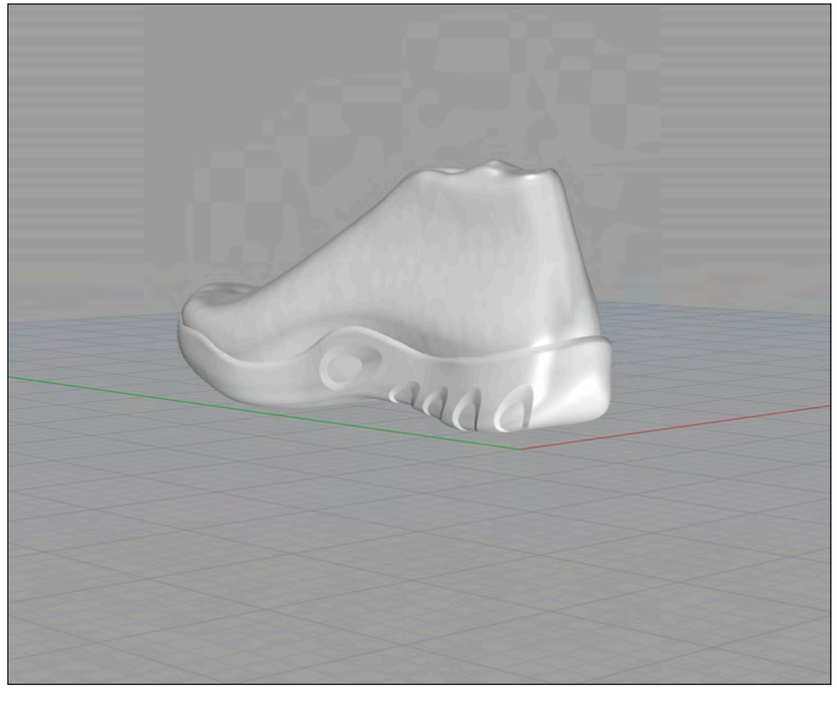
Shot put/Discus



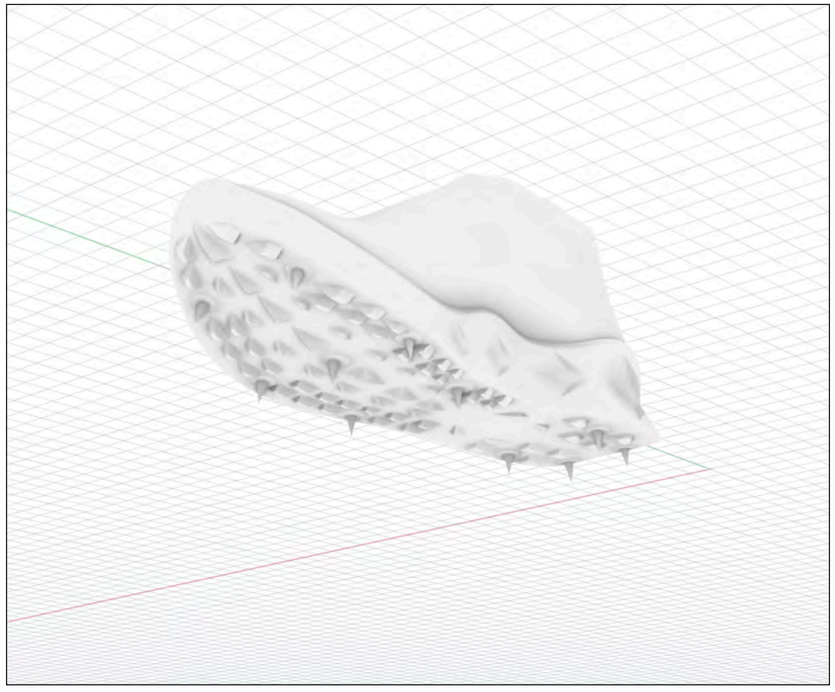


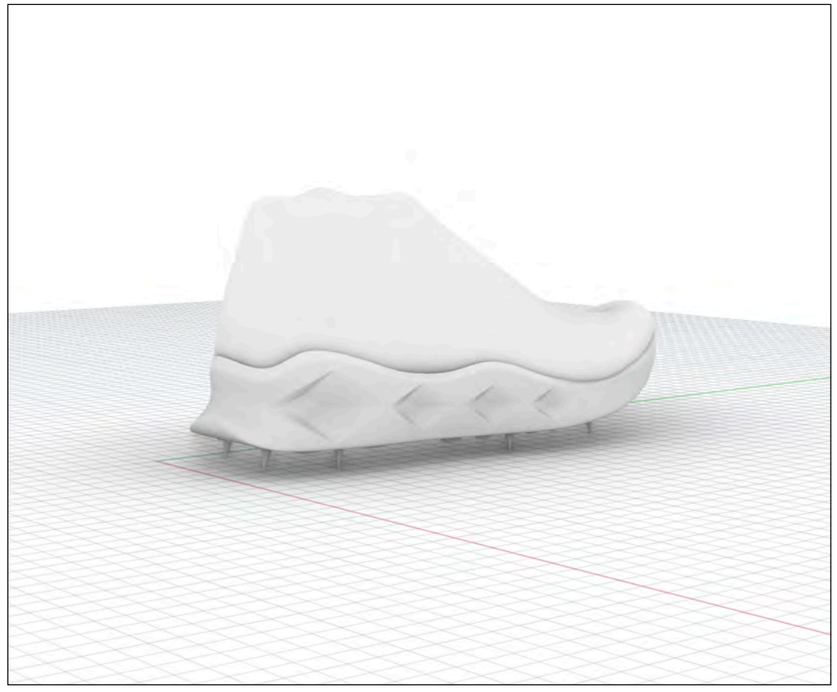


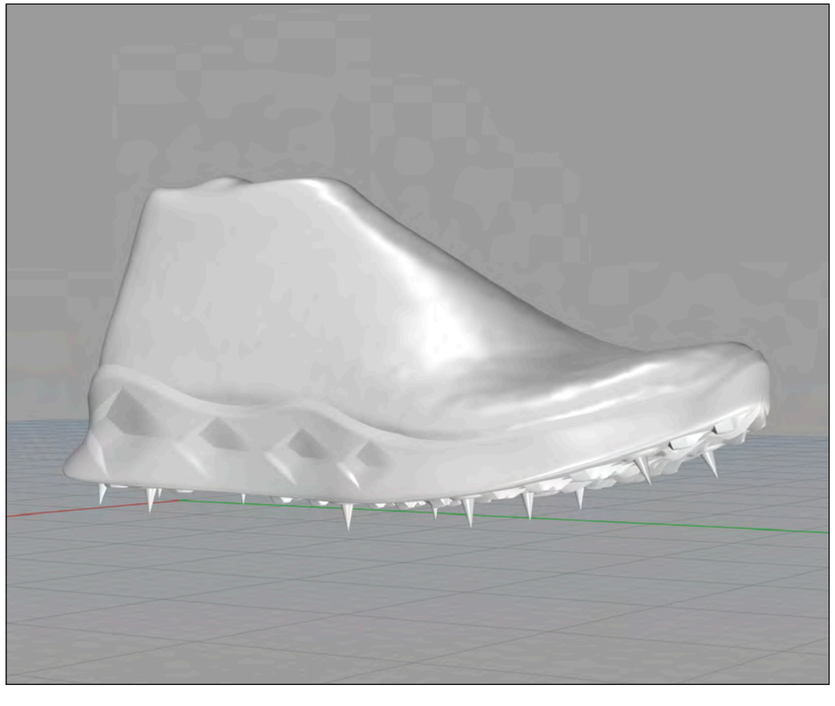


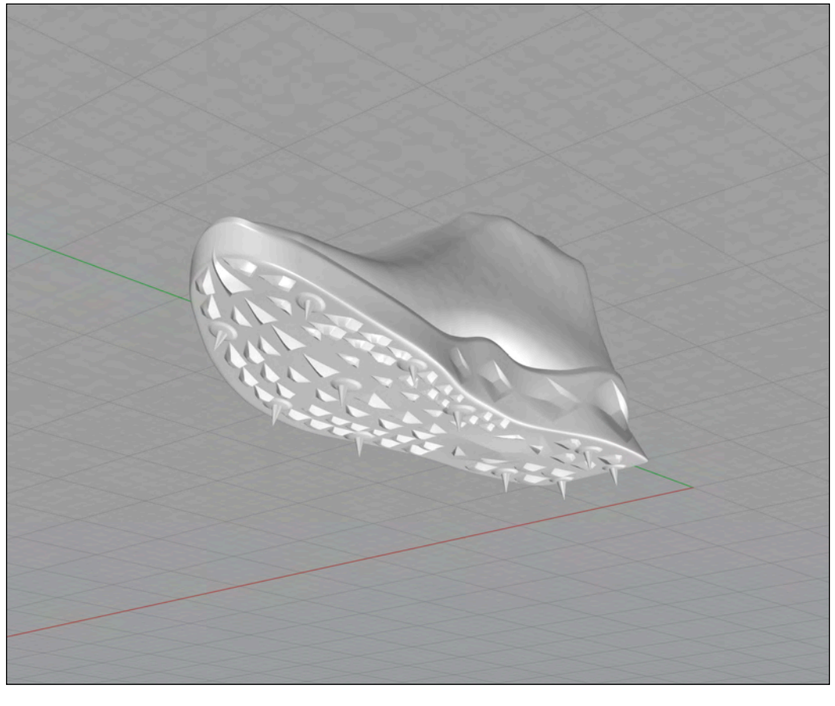


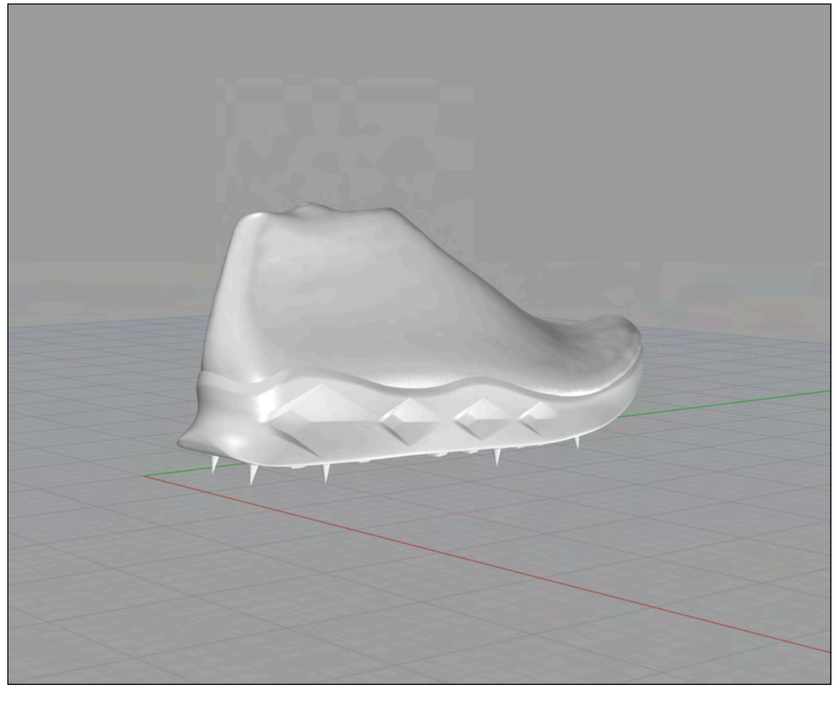
Javelin Throw



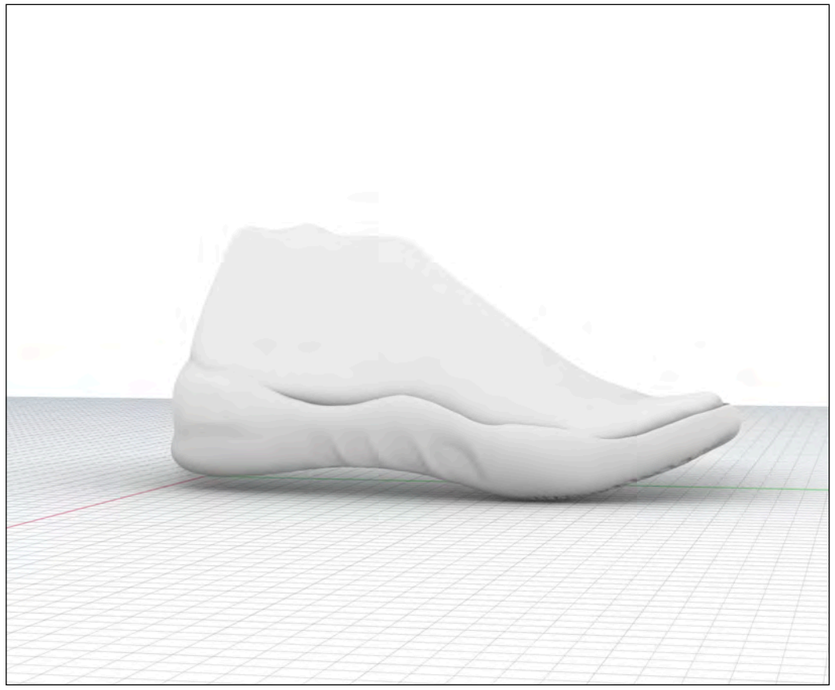


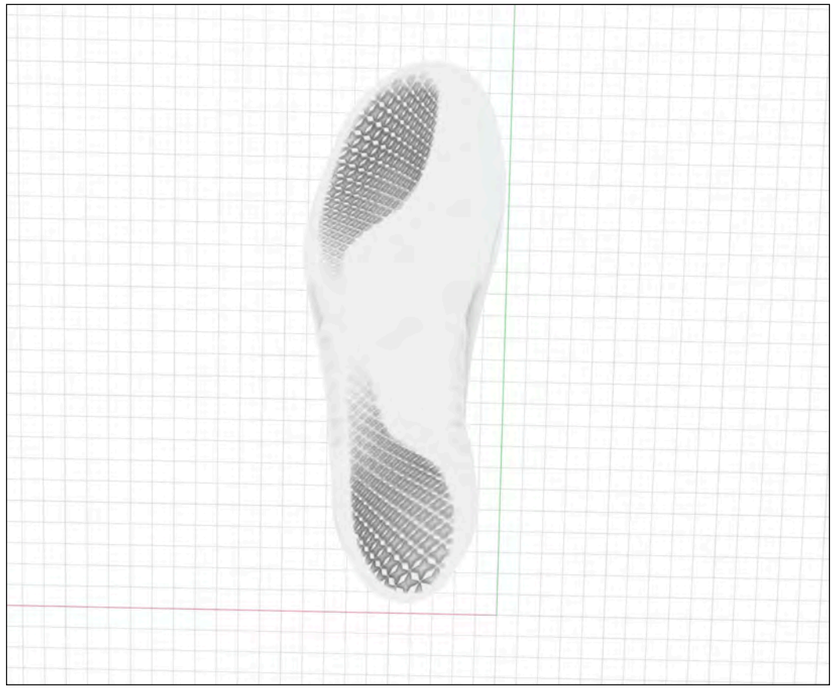


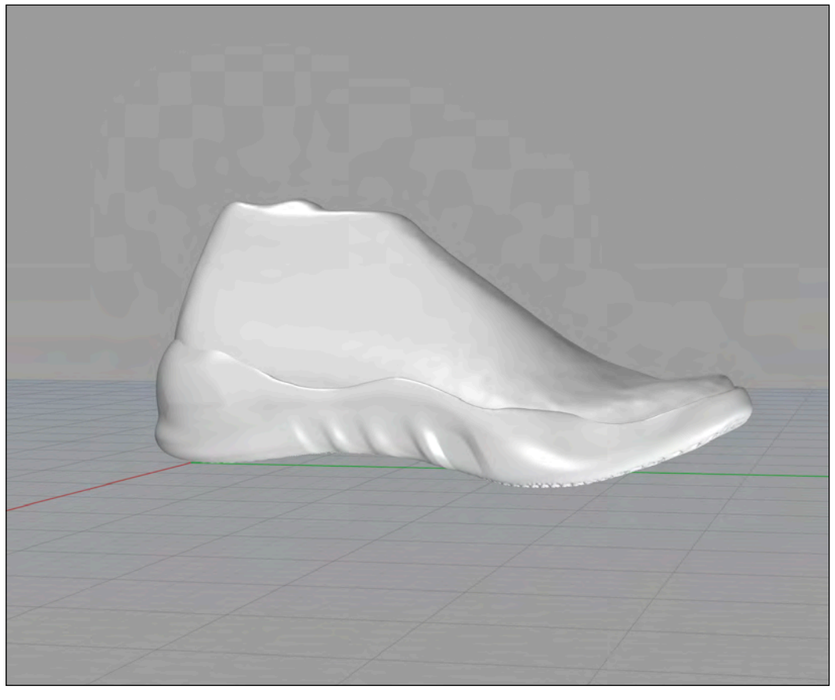


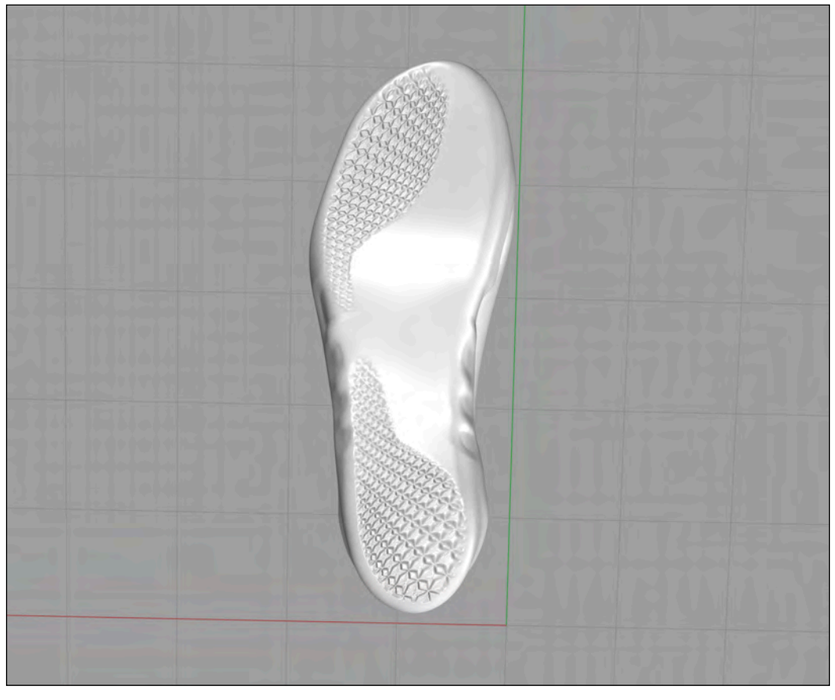


Hammer Throw









Lockdown Straps

Polyester Bemis film with elastic straps and attached velcro. Secure dorsal and heel.

Shoes Upper

Bemis film bonded with synthetic mesh upper material in order to offer better breathability and durable.

Midsole “upper”

Higher part of midsole will wrap around the upper to protect the upper when athlete spin their feet.

Toe Cap

Reinforced synthetic leather. Straps are fixing at this toe cap and strobel with upper together.

Outsole

Synthetic rubber outsole with smooth edge enhance spin technique

Midsole

Carbon fiber mixed with EVA foam to offer stiffer cushions and support

Traction

Medial and lateral traction will effectively reduce the rotation momentum after throwing.

Straps Holder

TPU straps holder will help to fix the straps on the upper

Shoes Upper

Bemis film bonded with synthetic mesh upper material in order to offer better breathability and durable.

Midsole “upper”

Higher part of midsole will wrap around the upper to protect athlete’s blocking feet.

Front Midsole

Carbon fiber with polyurethane foam offer better support and stability for athlete ’s blocking feet,

Traction Plate

TPU traction will ensure the feet grip the ground improve the friction.

Spikes Holder

Offer better lockdown and stability for spikes

Straps Holder

Rear TPU straps holder will help to tighten the the straps on the upper

Built-in cushioning

Located at the heel part to offer better protection and support

Rear Midsole

Carbon fiber mixed with EVA foam to offer stiffer cushions and support

Carbon fiber Plate

Carbon fiber plate offer better stability when athlete run up with fast acceleration

Spikes

Removable spikes are conveniently for athletes to customize during competition.

Shoes Upper

Bemis film bonded with synthetic mesh upper material in order to offer better breathability and durable.

Toe Cap

Reinforced synthetic leather. Straps are fixing at this toe cap and strobel with upper together.

Straps Holder

Strap holder made by hard aluminum ring and synthetic leather with double stitches to make sure 100% solid

Midsole “upper”

Higher part of midsole will wrap around the upper to protect the upper when athlete spin their feet.

Arch-Support Plate

Carbon fiber arch-support plate offer better stability when athlete spin with high speed.

Midsole

Carbon fiber mixed with EVA foam to offer stiffer cushions and support

Outsole

Synthetic rubber outsole with smooth edge enhance spin technique

Rear Traction Plate

Localized traction provides the specific traction support for hammer throw specific movements..

Front Traction Plate

Localized traction provides the specific traction support.

Process Book Sprint 2020
Final Capstone Project

Shawn Li

Proof of Concept

These shoes are designed for throwing sports specific movements and delivers great lockdown and stability. The “x” shape cross straps design will wrap around the dorsal foot. Straps go all the way down to the heel counter, which can lockdown the dorsal and heel. This system will stabilize dorsal foot and heel at the same time, offers better support and lockdown performance which help athletes to control their foot placement for executing rapid pivots and sprint,

Shot Put

Lockdown Straps

Polyester Bemis film with elastic straps and attached velcro. Secure dorsal and heel.

Rear Straps holder

Reinforced synthetic leather. Straps go through here

Shoes Upper

Bemis film bonded with synthetic mesh upper material in order to offer better breathability and durable.

Midsole Sidewall

Higher part of midsole will wrap around the upper to protect the upper when athlete spin their feet.

Toe Cap

Reinforced synthetic leather. Straps are fixing at this toe cap and strobel with upper together.

Outsole

Synthetic rubber outsole with smooth edge enhance spin technique

Midsole

Carbon fiber mixed with EVA foam to offer stiffer cushions and support

Traction

Medial and lateral traction will effectively reduce the rotation momentum after throwing.

Hammer Throw

Shoes Upper

Bemis film bonded with synthetic mesh upper material in order to offer better breathability and durable.

Toe Cap

Reinforced synthetic leather. Straps are fixing at this toe cap and strobel with upper together.

Midsole

Carbon fiber mixed with EVA foam to offer stiffer cushions and support

Outsole

Synthetic rubber outsole with smooth edge enhance spin technique

Front Traction Plate

Localized traction provides the specific traction support.

Straps Holder

Strap holder made by hard aluminum ring and synthetic leather with double stitches to make sure 100% solid

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Javelin Throw

Straps Holder

Rear TPU straps holder will help to tighten the the straps on the upper

Built-in cushioning

Located at the heel part to offer better protection and support

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Carbon fiber mixed with EVA foam to offer stiffer cushions and support

Front Midsole

Carbon fiber with polyurethane foam offer better support and stability for athlete 's blocking feet,

Carbon fiber Plate

Carbon fiber plate offer better stability when athlete run up with fast acceleration

Traction Plate

TPU traction will ensure the feet grip the ground improve the friction.

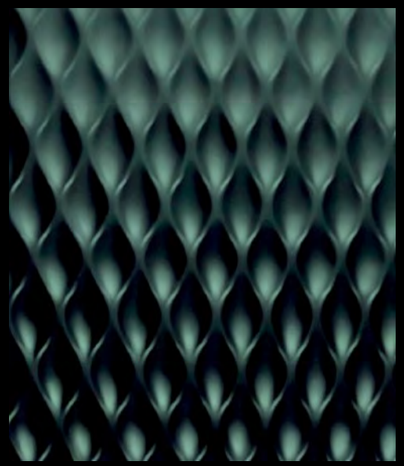
Spikes

Removable spikes are conveniently for athletes to customize during competition.

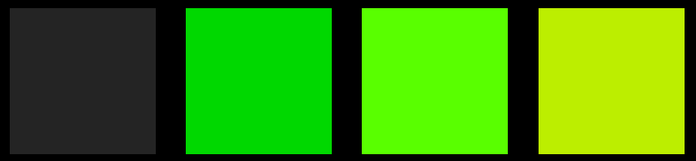
Spikes Holder

Offer better lockdown and stability for spikes

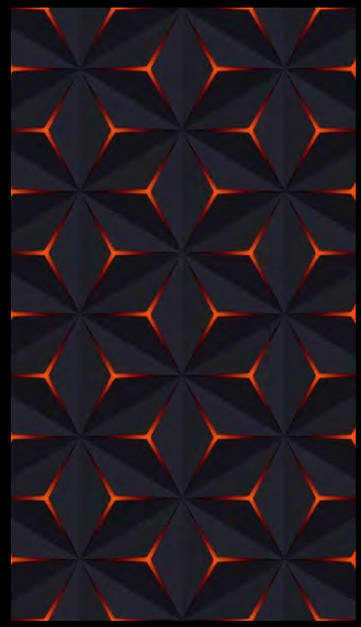
Shot Put
Strength Power Spin



Color Palette

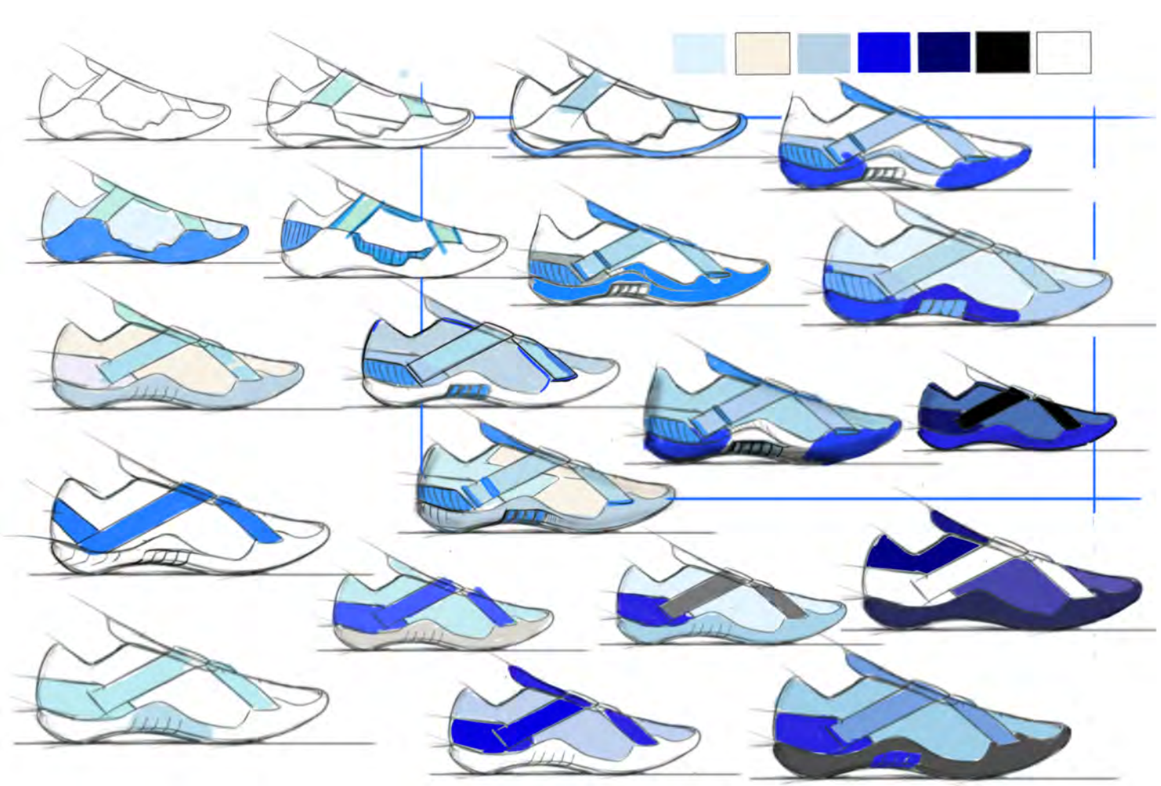


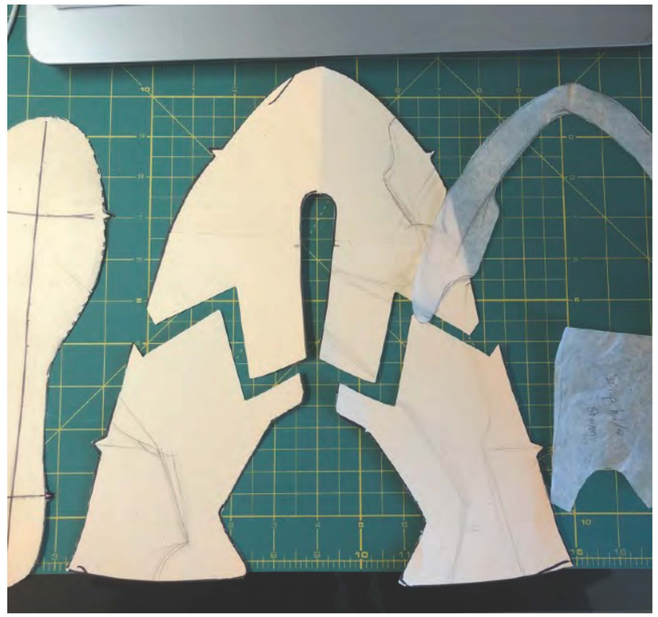
Javelin Throw
Fast Explosive Solid

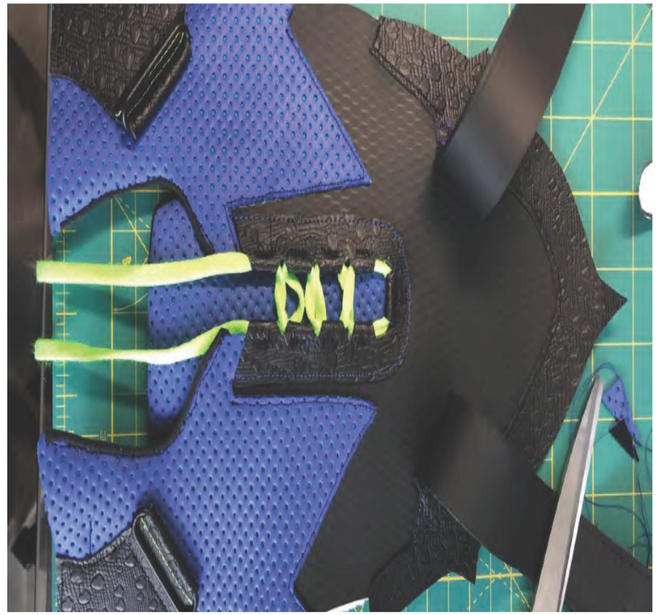


Color Palette

New Color Exploration







Updated Shot Put Upper

Shot Put Outsole Molding

- Making silicone mold
- Rubber outsole casting

Mold & Casting Making Process

Making box for silicone mold

Taking out the silicone mold

Colored rubber outsole

Acts-Like Prototype

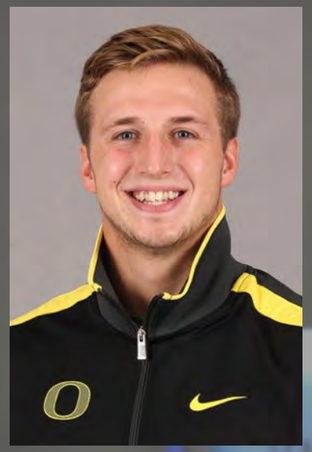
Shot put

Javelin 3D Printed Midsole & Outsole

How does strap go under the upper?

Javelin Throw

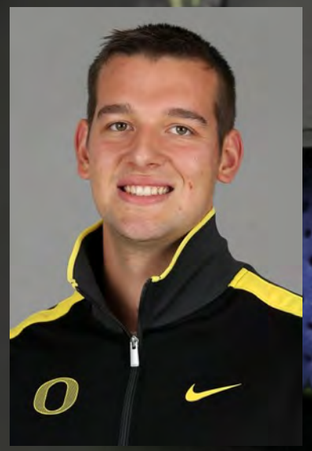
Athletes Feedback



AUSTIN THARP
University of Oregon
Discus Throw

“I love the way that how the straps wrap around the foot. This is a really cool concept if the straps works well”

“I like this blue and black color! Really want to try them on!”



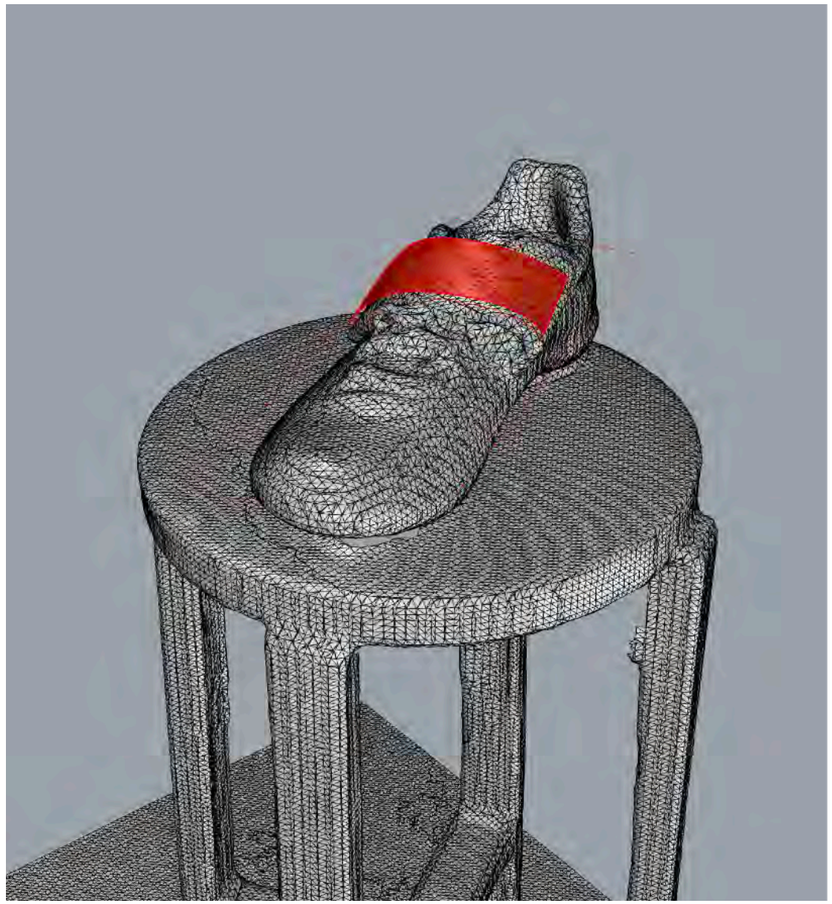
TY HAMPTON
University of Oregon Field & Track Team
Javelin Throw

“If the shoes is rigid that would be helpful, because the athletes can instantly stop themselves with the block.”

“I like this ankle lockdown system, because the ankle support in javelin is a critical component. The goal for ankle protection is to have strong support to hold the ankle in place for the block foot.”

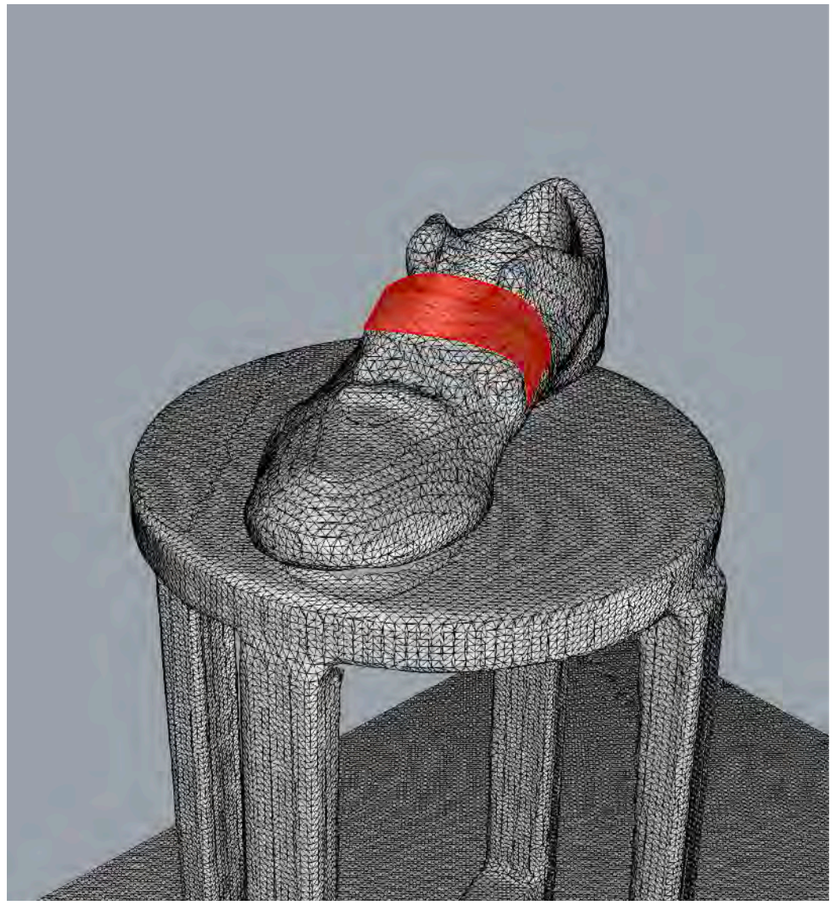
Validation Plan

Area calculation



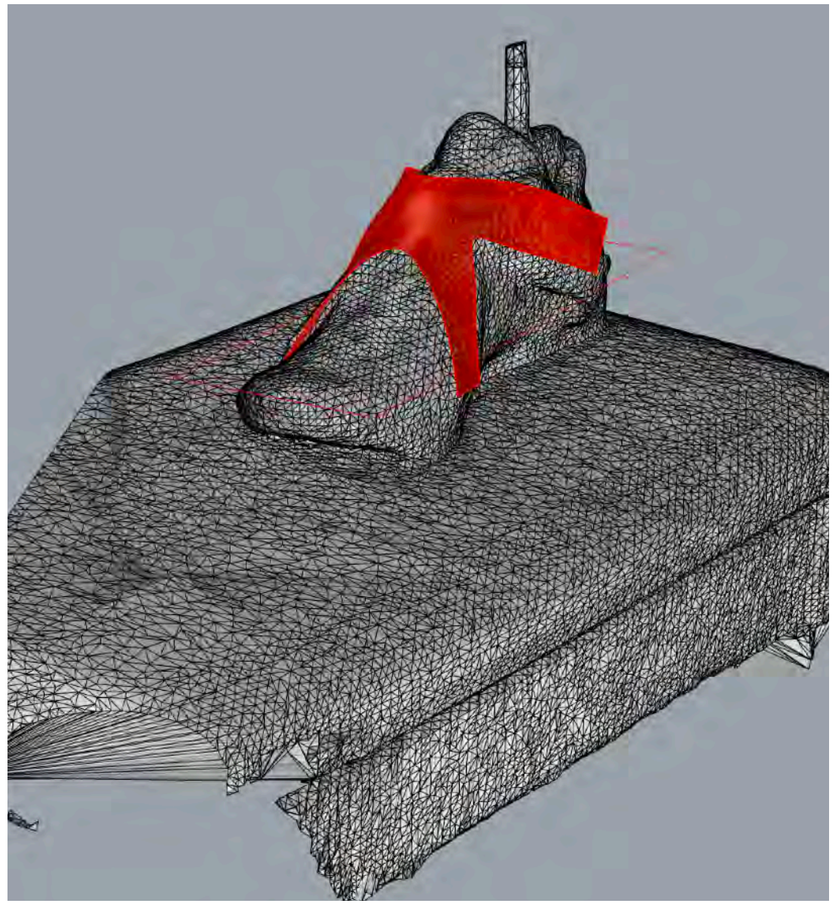
Adidas AdiZero

Red Area: 4608.23673 (+/- 0.00045) square millimeters



Asics

Red Area: 3804.52649 (+/- 0.00013) square millimeters



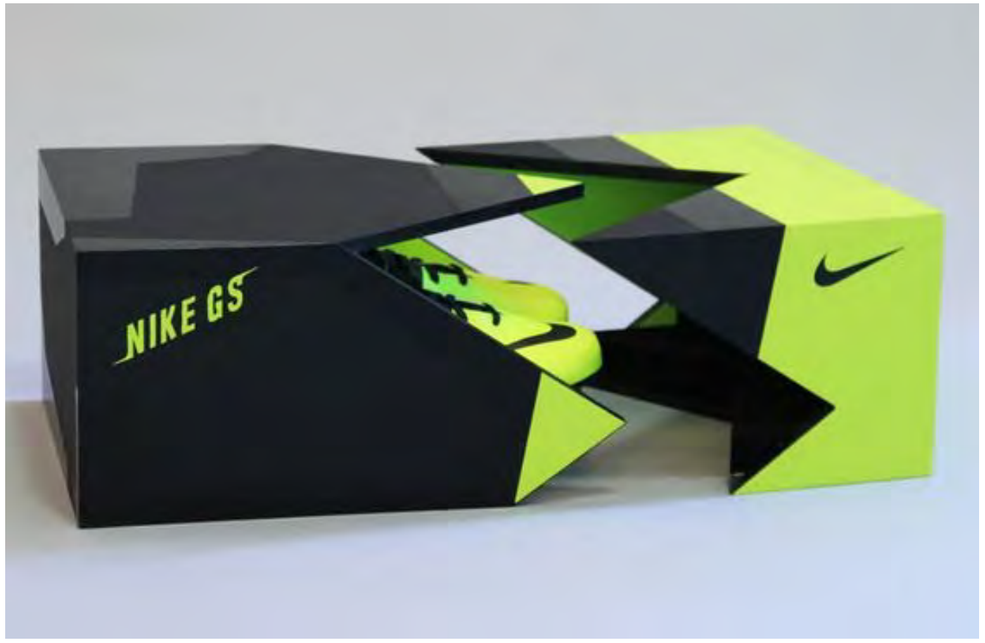
New Shotput Prototype

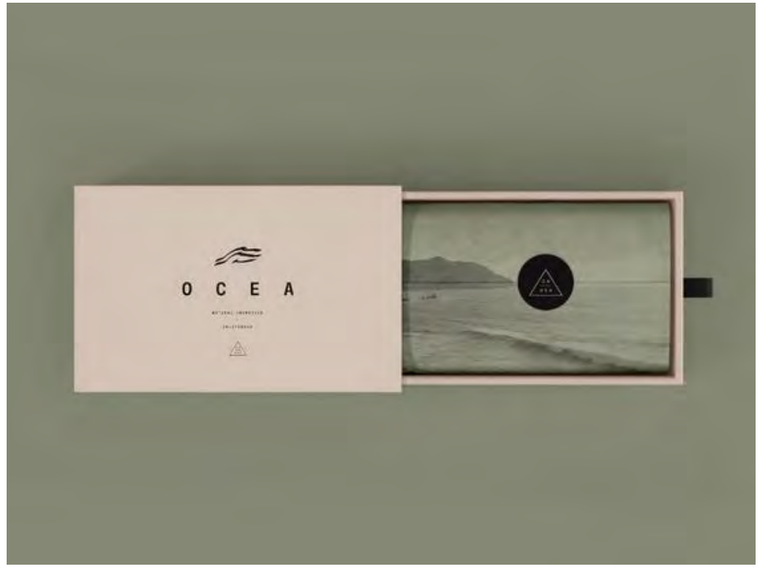
Red Area: Area = 11939.393 (+/- 0.0015) square millimeters

Remaining Prototyping & Validation Plan

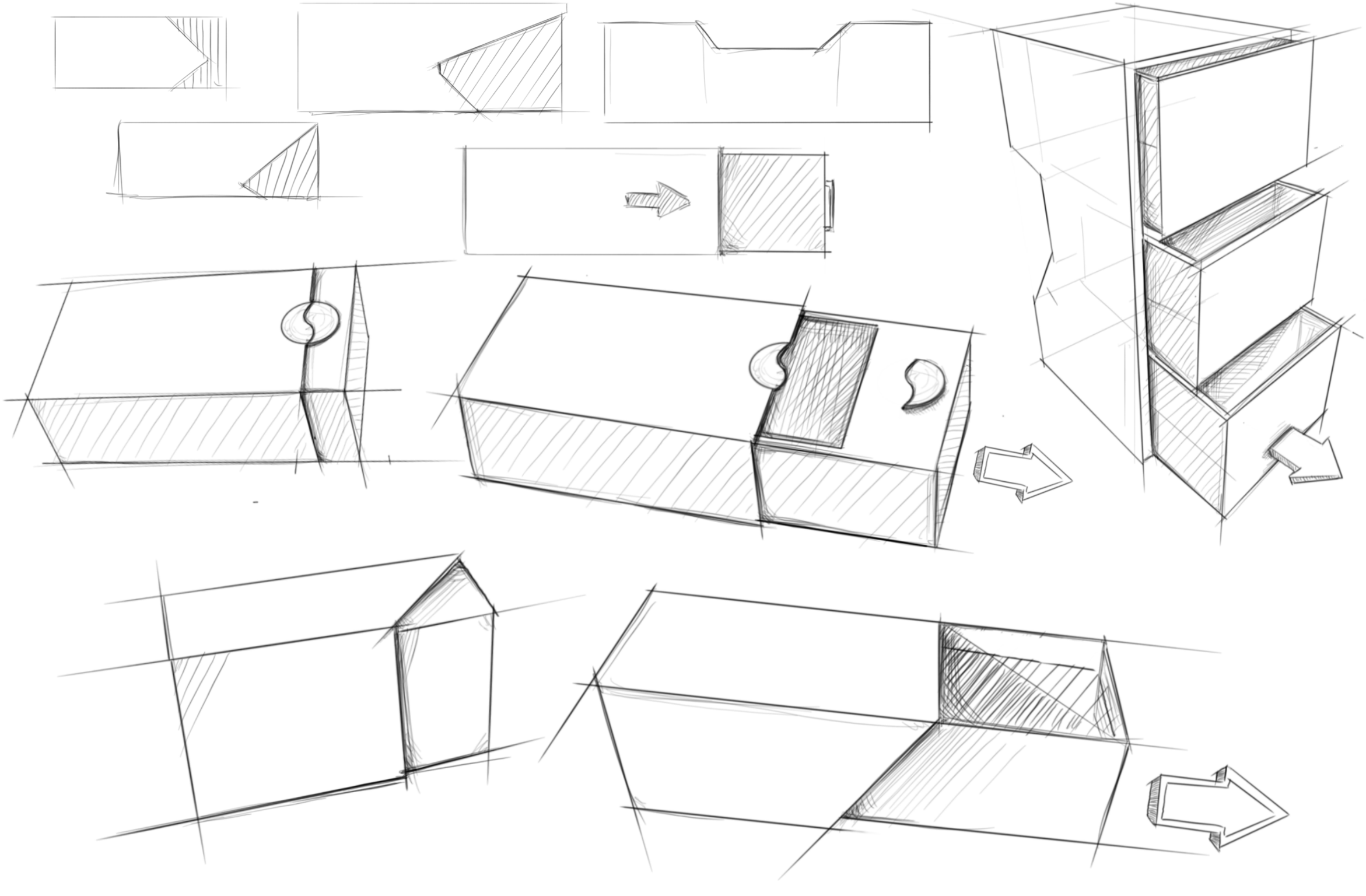
	Sun	Mon	Tue	Wed	Thu	Fri	Sat
Week 6			• Hammer throw final CAD rendering • Upper making • Javelin shoes 3d Scan for validation	• Hammer throw final CAD rendering • Upper making • Javelin shoes 3d Scan for validation	• Hammer throw final CAD rendering • Upper making • Javelin shoes 3d Scan for validation	• Hammer throw final CAD rendering • Upper making • Javelin shoes 3d Scan for validation	• Hammer throw final CAD rendering • Upper making • Data analysis
Week 7	• Hammer throw final CAD rendering • Upper making • Data analysis	• Javelin Throw final upper prototype making • Javelin Outsole casting • Data analysis	• Javelin Throw final upper prototype making • Javelin Outsole casting • Talk to experts for validation	• Javelin Throw final upper prototype making • Javelin Outsole casting • Talk to experts for validation	• Javelin Throw final upper prototype making • Javelin Outsole casting • Data collection base on feedback	• Javelin Throw final upper prototype making • Javelin Outsole casting • Data collection base on feedback	• Packaging making for three different shoes • Data collection base on feedback
Week 8	• Packaging design sketch • Packaging details rendering • Final data comparison and analysis for validation	• Packaging design sketch • Packaging details rendering • Final data comparison and analysis for validation	• Packaging design sketch • Packaging details rendering • Final data comparison and analysis for validation	• Shot put outsole refine • Final Presentation making Final data comparison and analysis for validation	• Shot put outsole refine • Final Presentation making Final data comparison and analysis for validation	• Shot put outsole refine • Final Presentation making	• Hammer throw outsole casting • Final Presentation making
Week 9	• Hammer throw outsole casting • Final Presentation making	• Hammer throw outsole casting • Final Presentation making	• Hammer throw outsole casting • Final Presentation making	• Refine prototypes	• Refine prototypes	• Refine prototypes	• Refine prototypes
Week 10	• Refine prototypes	• Refine prototypes	• Refine prototypes	• Refine prototypes			

Packaging Moodboard





Packaging Ideation



Helix

Throwing Sports Footwear

Presentation Spring 2020

Final Capstone Project

Shawn Li

Men's Throwing Sports Footwear Innovation

Capstone Project
MS Sports Product Design
University of Oregon
Shawn Li

Men's Throwing Sports Footwear Innovation

This capstone project is to innovate new footwear for shot put/discus, javelin and hammer throw. The collection will provide the best footwear performance and support for elite throwing athletes.

The Innovative Nature of Throwing Sports Footwear/Why is important?

- Shot Put, Discus, Hammer Throw & Javelin are all Olympic events.
- All four events have a very long history in track and field.
- The existing throwing shoes have not been updated for many years.

Shot Put/Discus Rotational Technique

In order to get the maximum release velocity, the discus and shot put rotational throwers need to have a stable foot landing and reach a high rotational foot speed to transfer the energy to push the shot/discus. The discus/shot put shoes usually have smooth and rounded edge outsole, with no traction/thread.

Hammer Throw Rotational Technique

The motions of the hammer thrower's centre of mass are influenced by two forces; gravity, and ground reaction force. So reducing the friction between the outsole and the ground is very important for improving rotational velocity.

PIVOT FOOT

CENTER OF GRAVITY

Javelin Throw Footwork Technique

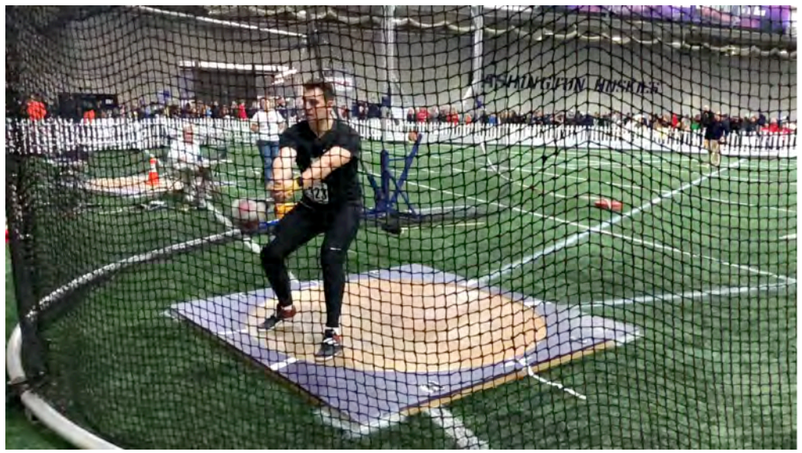
A javelin throw involves a run-up of 6 to 10 steps, followed by two or three crossover steps before the thrower releases the javelin. Sprinting is performed on the balls of the feet, with toes pointing forward. Ensuring that the feet (forefoot) grip the surface will improve the friction and gain the ground reaction force throughout the running strides.

SECOND PHASE: MAKE RHYTHM

CROSSOVER STEP

Slow-Motion Video Analysis

Hammer/Weight Throw



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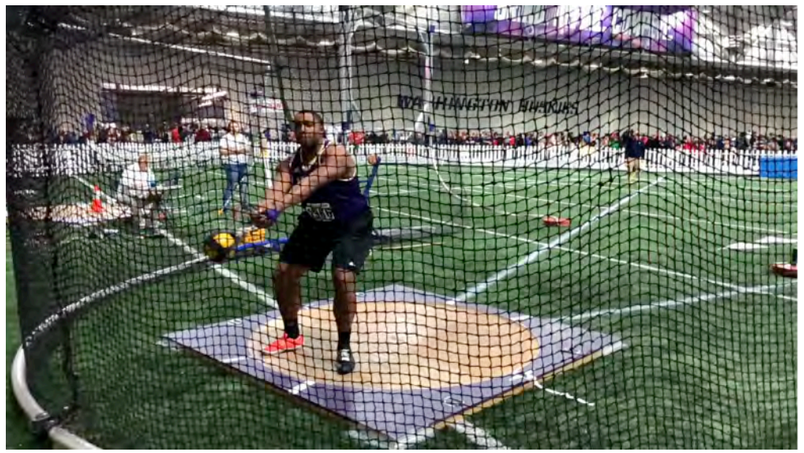


2

3

Hammer/Weight Throw

Some athletes have 4 turns before releasing the ball, some of them have 5 turns. The spinning takes the left foot as the central pivot point, another foot is balancing the body and creating the momentum.

4

5

6

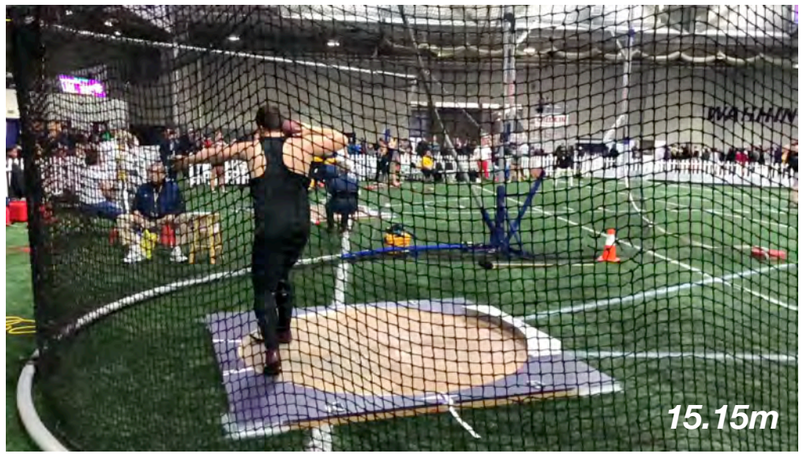
Footwork Analysis

When spinning, the elite athlete will use the edge of the left foot to spin instead of the forefoot or the heel. In order to get fast rotational velocity, athletes need to reduce the contact friction. (Compare video 5 and 6)

Slow-Motion Video Analysis

Shot Put

7



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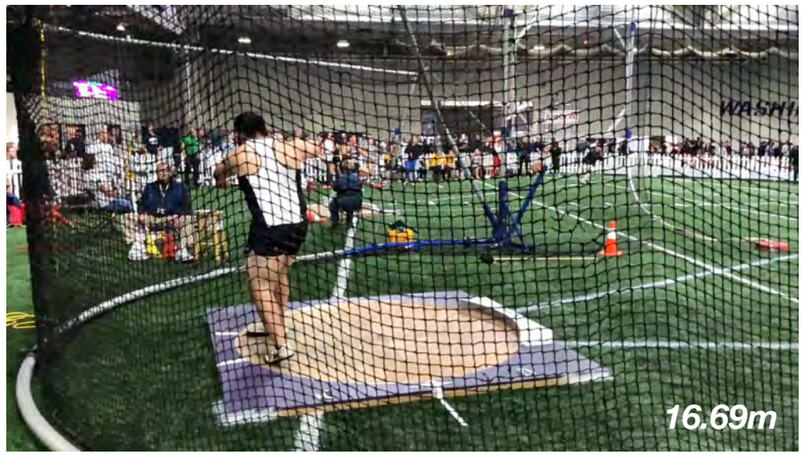
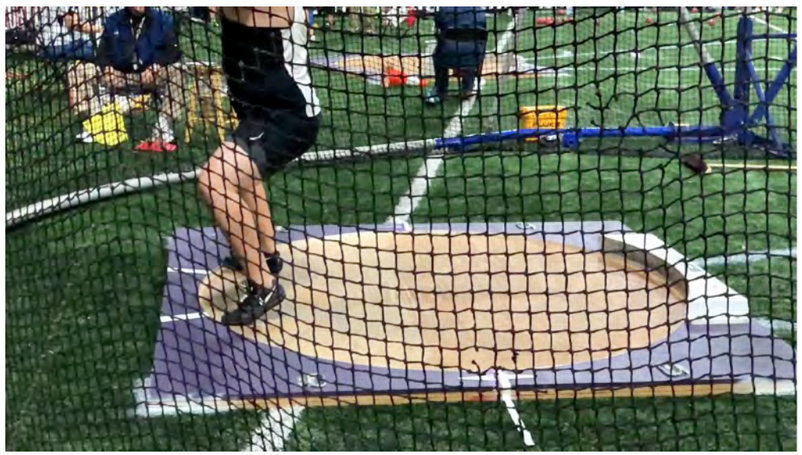


9

Shot Put Rotational

Left and right feet are alternatively rotate 180 degrees. Spin and release velocity will affect the athlete's performance. (compare video 7, 8 and 9)



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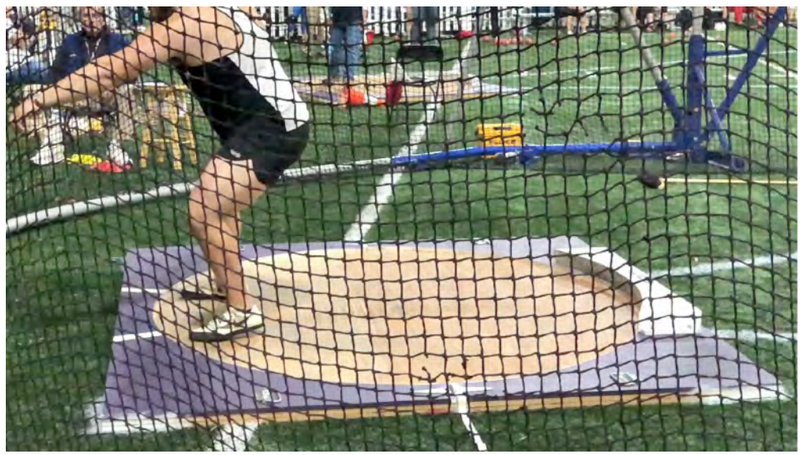


11

12

Footwork Analysis

The function of the right foot (landing foot) during the delivery is to manage the body with a heave-up push to give the base for the powerful trunk turn. The forefoot on the landing foot is the area that absorbs body weight and delivers the power of final push.

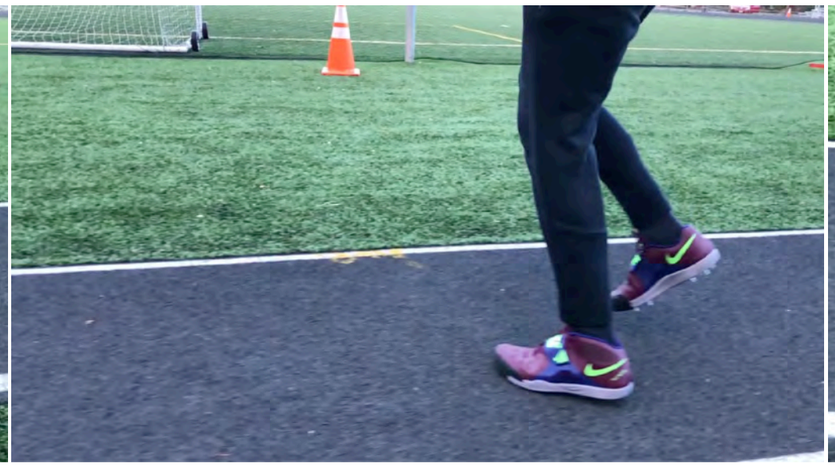
Contact Area

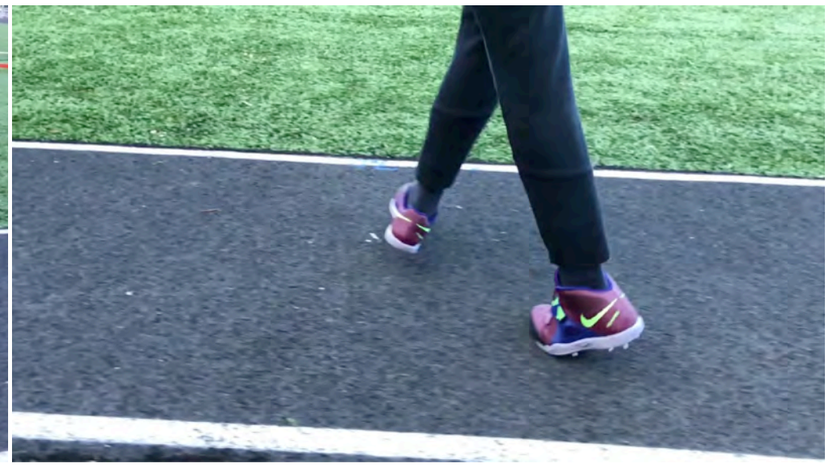
Javelin Throw

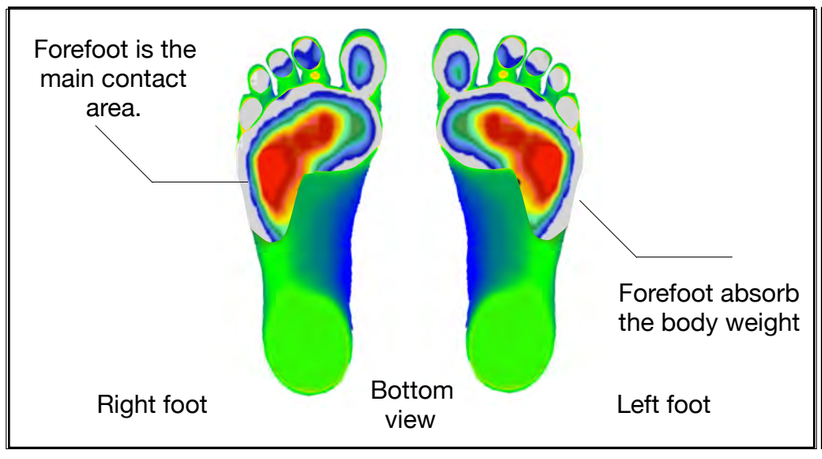
1st Phase: Run up

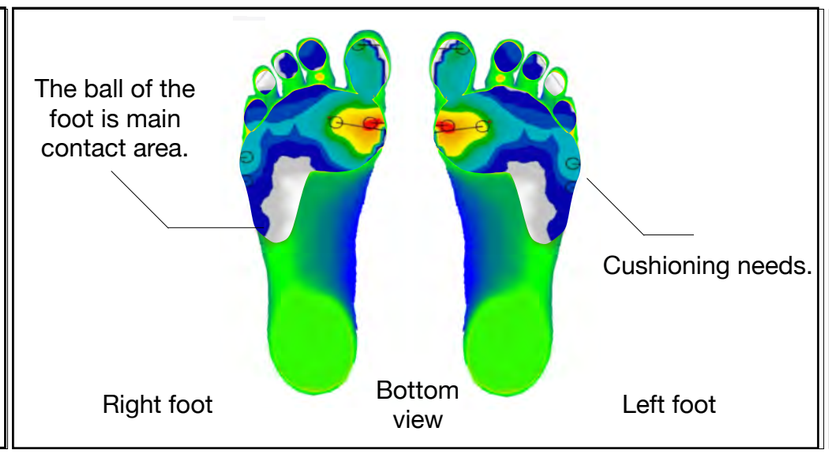
2nd Phase: Crossover Steps

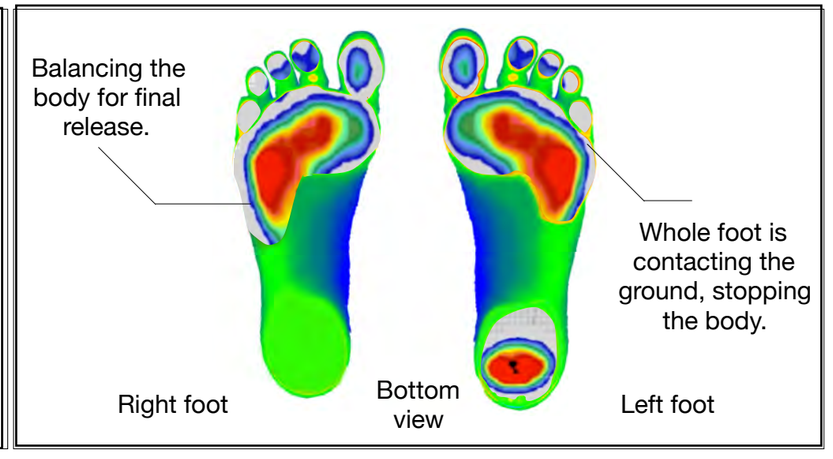
3rd Phase: Final Release











Athlete Insight

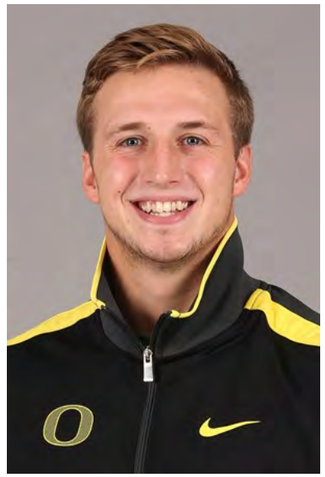
DEREK AKEY
University of Oregon
Shot Put/Discus
Personal-best throw of 55.36m/181-7.5 to win FHSAA 4A regional title

“Throwers are bigger people, we have fat feet, we need bigger toe box, it would be comfortable for us.”

“I want to have stiff shoes upper, don’t make it too flexible, a good pair of shot put/discus throwing shoes usually don’t very flexible which is good for throwers.

“ There is very little arch support in the Nike SD’s, and my ankles pronate a lot in them. That wasn’t as much of a case with the Nike Rotational."

“I like the strap on the zoom rotational 6, really helpful for lockdown.”

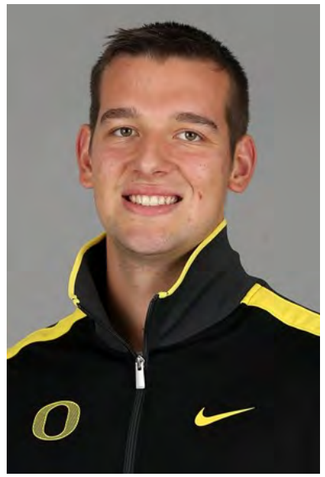


AUSTIN THARP
University of Oregon
Hammer Thrower
-Competed in the hammer throw (173-11/53.00m) at the PAC-12 Championships.

“The three most important areas of strength for a hammer thrower, in my opinion, are the legs, the core, and the posterior chain. Controlling the placement of your feet and legs is essential to a good throw.”

“Shot/discus they are only turning on the toe, a lot more spin at the beginning of the throw. Hammer throw have some spins on the heel.”

“I want to have tighter and breathable upper material for the shoes”



TY HAMPTON
University of Oregon Field & Track Team
Javelin Throw
Won the PIAA District XI 3A Championships title as a junior with a season-best throw of 179-11.

“Spikes do not necessarily have to be super comfortable, they should serve a purpose.”

“ I often take off my spikes in competition. Because they are very tight and stiff. This is good for relaxing my feet and energy recovery.”

“Currently I use a higher top, but not very high left boot, Nike Javelin Elite II.”

“For the durability of the shoes, in normal competition and practice, you can plan with 2 seasons per pair, depending on the technique and practice.”

Problem Statements

Shot Put

- Better Lockdown performance needs.
- Lack of cushioning for toe/forefoot.

Hammer Throw

- Lockdown needs for executing rapid pivots.
- Outsole specific areas need specific traction .

Javelin Throw

- Lack of ankle protection.
- Outsole needs more traction to improve sprinting .

Lacing System Ideation




Try different shapes of straps, find out the best solution for shot put/hammer throw heel lock down.

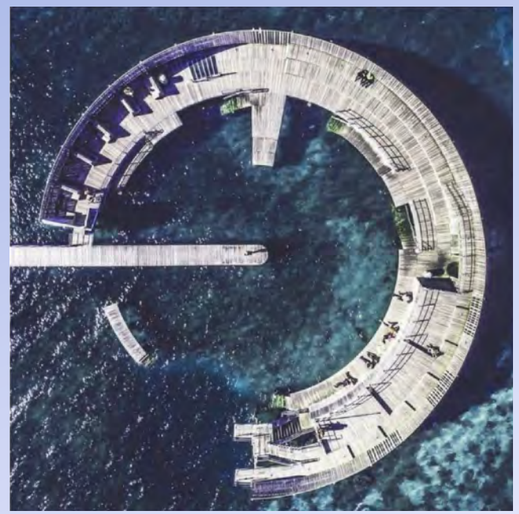


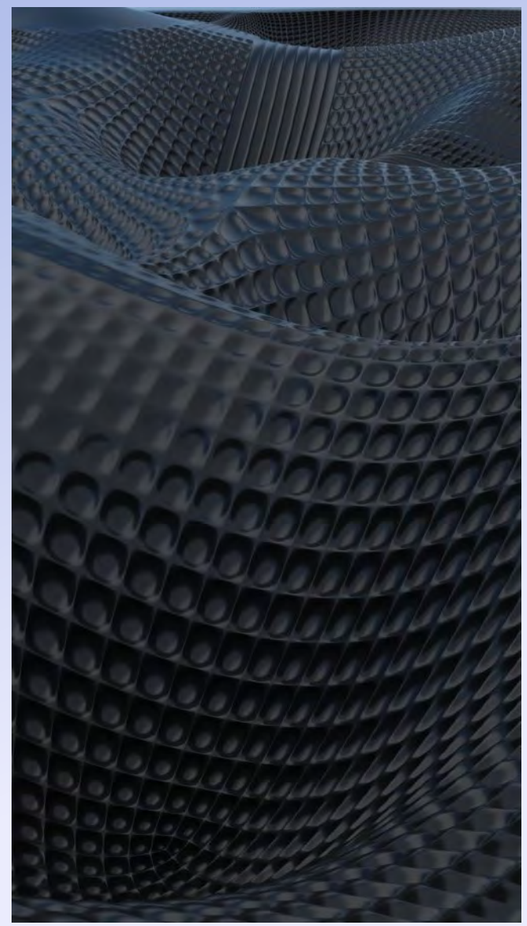

Try to figure out the best solution for high top javelin lacing system

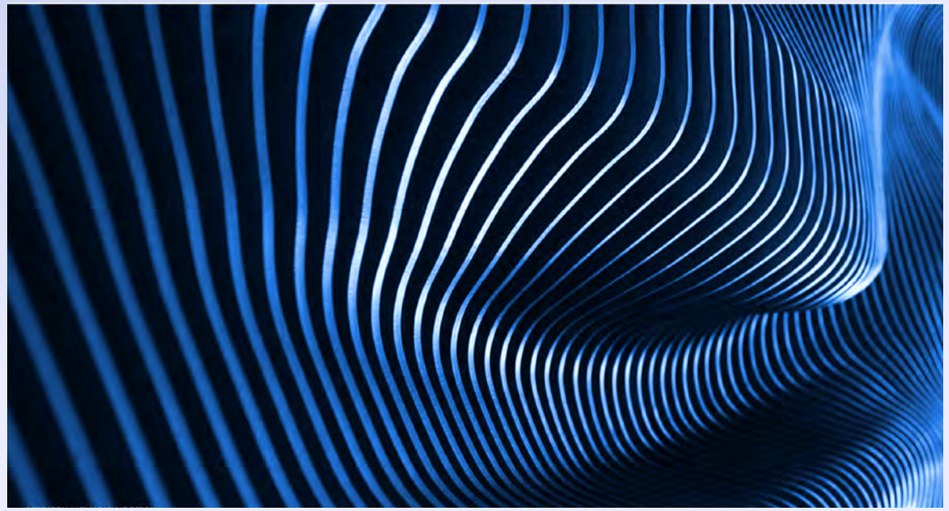


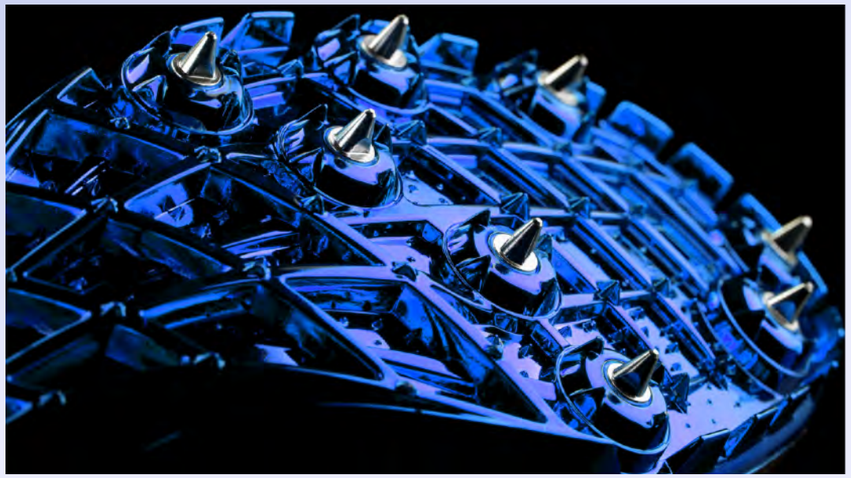

Make some quick mock ups and more prototypes were iterated, leading into final shape of the straps.

Inspiration



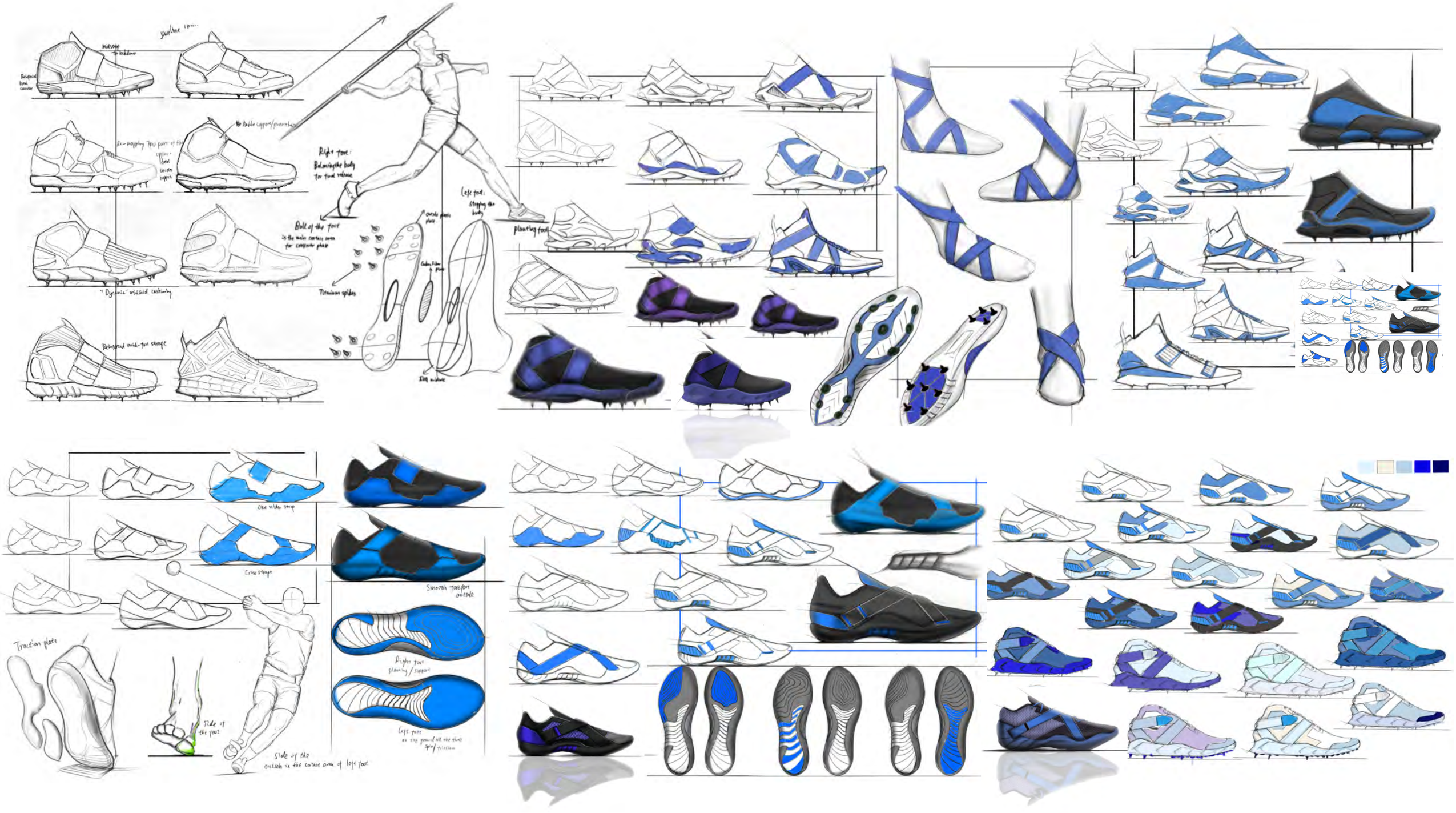






Color Palette

Ideation & Sketches



Final Sketches direction

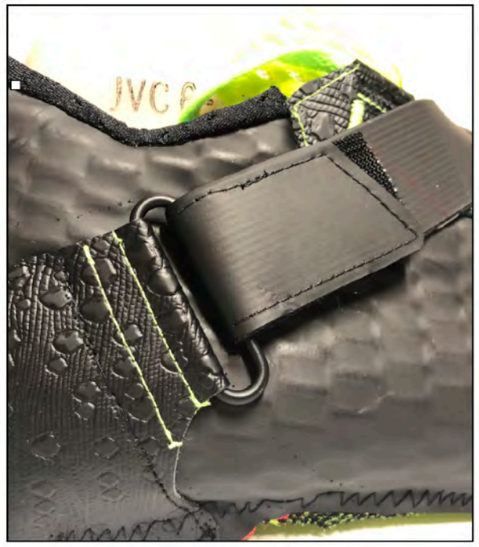
Shot Put

Hammer Throw

Javelin Throw

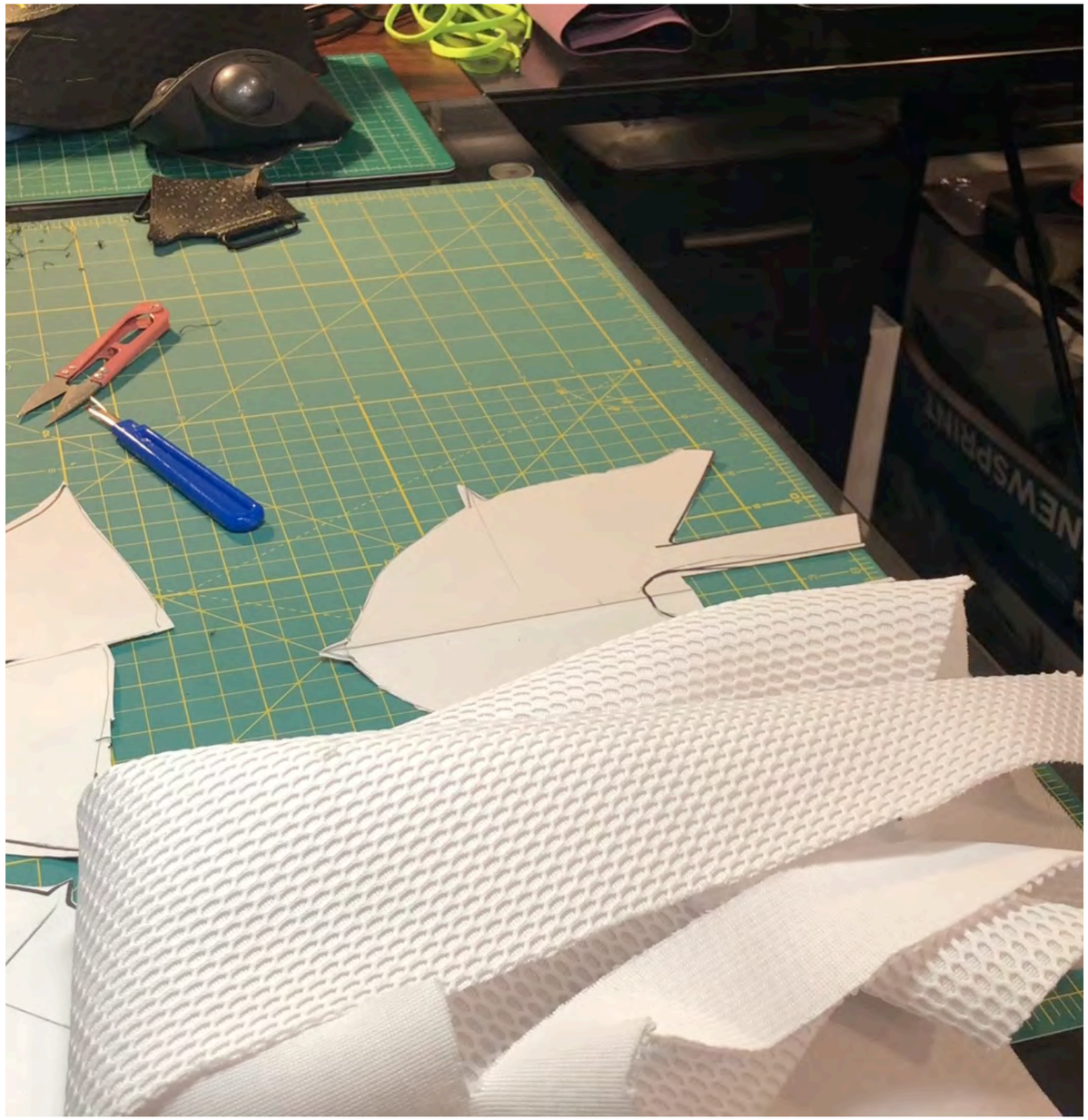
Proof of Concept

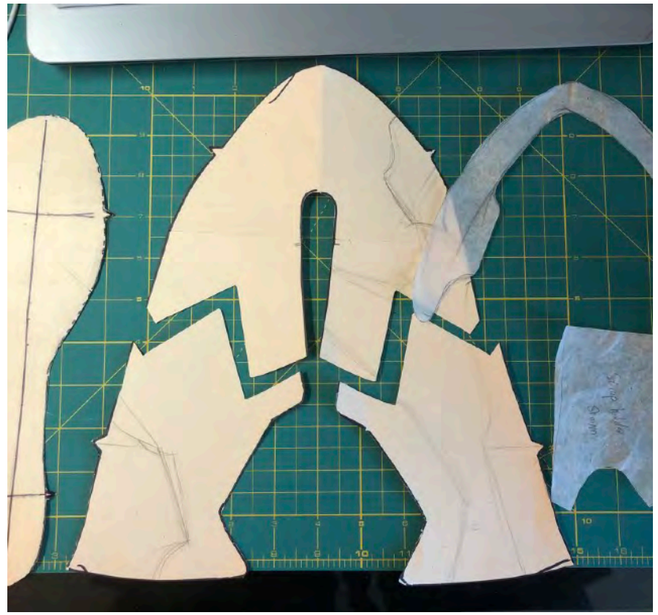
The “x” shape straps design will wrap around the dorsal foot. Straps go all the way down to the heel counter, which can lockdown the dorsal and heel. This system will stabilize dorsal foot and heel at the same time, offers better support and lockdown performance which help athletes to control their foot placement for executing fast pivots and sprinting.

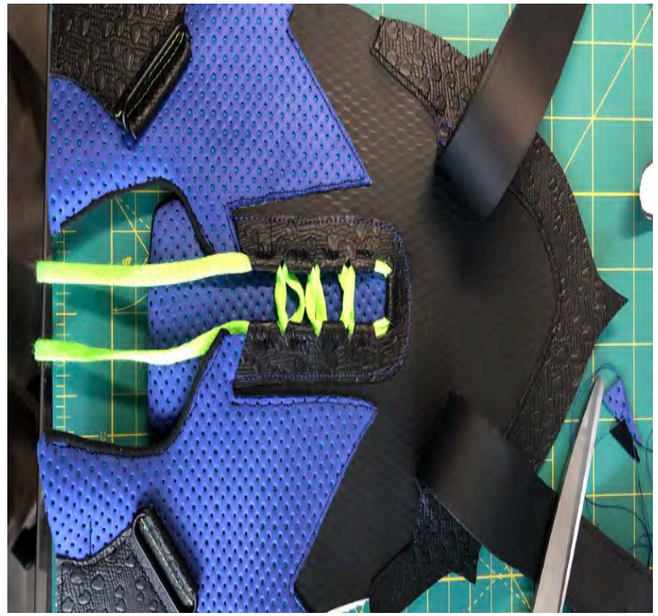


Colorways Exploration

Shot Put Upper Making Process





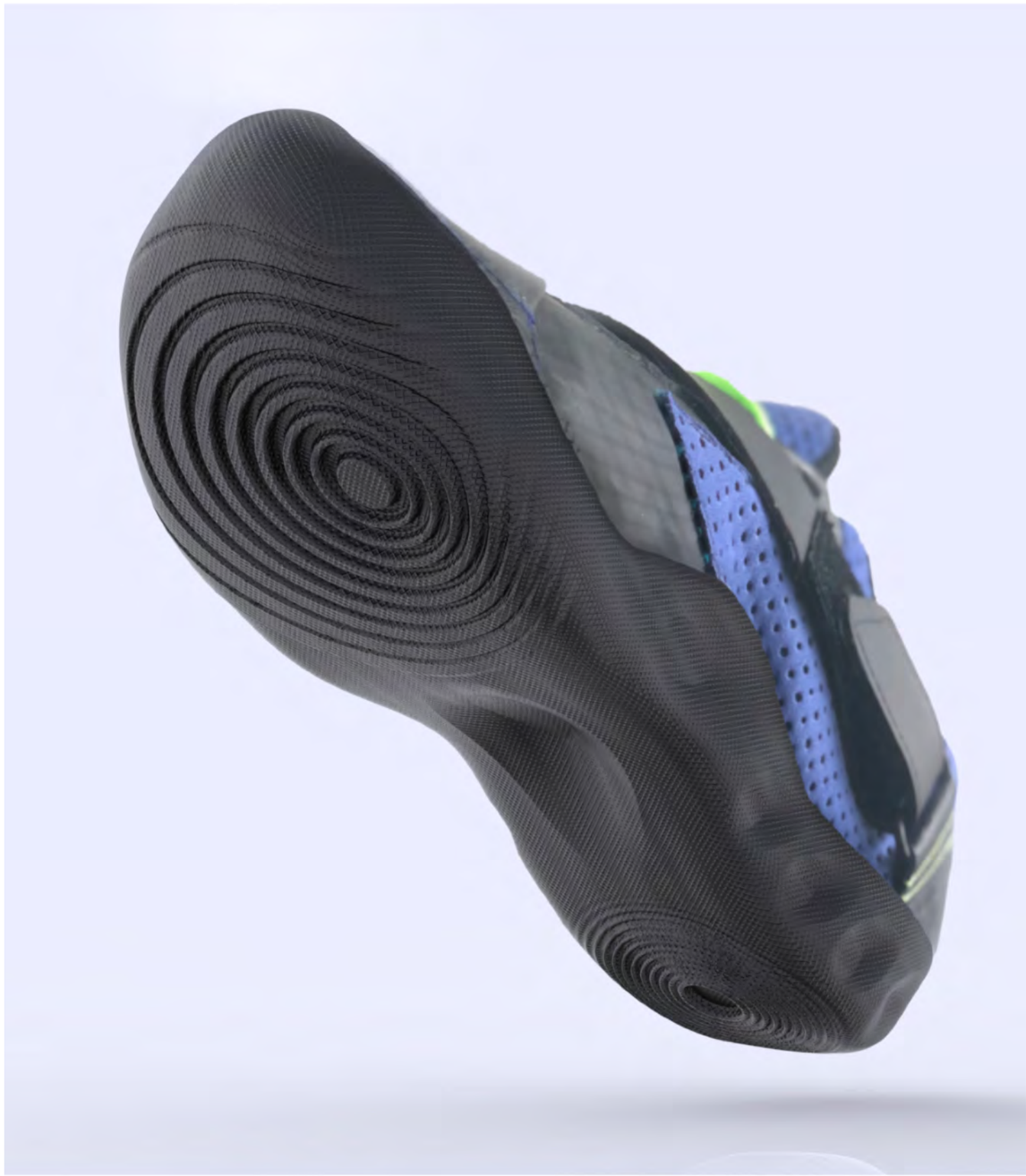


Shot Put Outsole Molding

- Making silicone mold
- Rubber outsole casting

Final Prototype

Shot put



Lockdown Straps

Polyester Bemis film with elastic straps and attached velcro. Secure dorsal and heel.

Heel Counter

Also hold the straps. Made by synthetic leather with double stitches to make sure 100% solid.

Straps Holder

Strap holder made by hard aluminum ring.

Shoes Upper

Bemis film bonded with synthetic mesh upper material in order to offer better breathability and durability.

Sidewall

Higher part of midsole will wrap around the upper to protect the upper when athlete spin their feet.

Toe Cap

Reinforced synthetic leather. Straps are fixing at this toe cap and strobel with upper together.

Outsole

Synthetic rubber outsole with smooth edge enhance spin technique

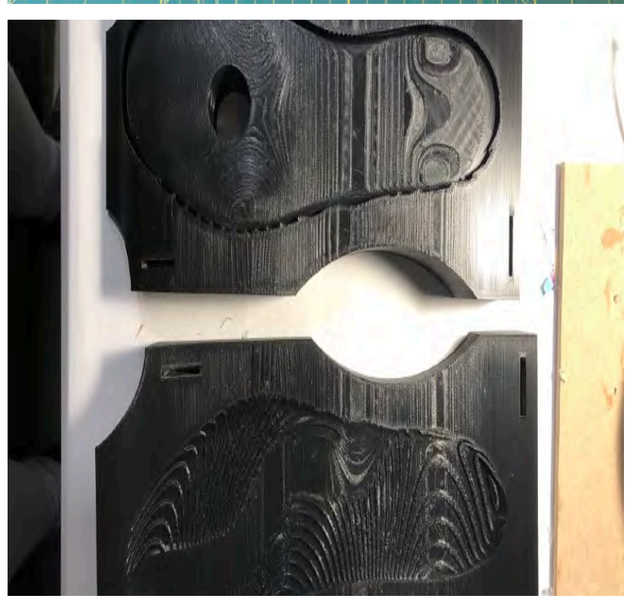
Midsole

Carbon fiber mixed with EVA foam to offer stiffer cushions and support

Traction

Medial and lateral traction will effectively reduce the rotation momentum after throwing.

Prototype making-Hammer Throw



Final Prototype

Hammer Throw

Hammer Throw

Straps Holder

Strap holder made by hard aluminum ring and synthetic leather with double stitches to make sure 100% solid

Shoes Upper

Bemis film bonded with synthetic mesh upper material in order to offer better breathability and durable.

Toe Cap

Reinforced synthetic leather. Straps are fixing at this toe cap and strobel with upper together.

Midsole Sidewall

Higher part of midsole will wrap around the upper to protect the upper when athlete spin their feet.

Arch-Support Plate

Carbon fiber arch-support plate offer better stability when athlete spin with high speed.

Midsole

Carbon fiber mixed with EVA foam to offer stiffer cushions and support

Outsole

Synthetic rubber outsole with smooth edge enhance spin technique

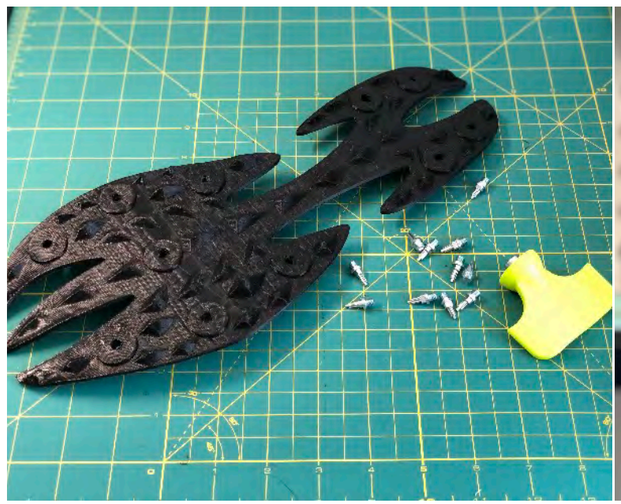
Rear Traction Plate

Localized traction provides the specific traction support for hammer throw specific movements..

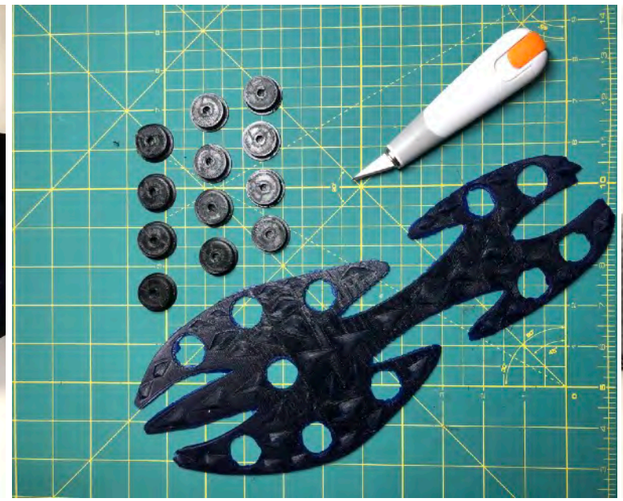
Front Traction Plate

Localized traction provides the specific traction support.

Prototype Making-Javelin Throw

3D printed midsole, outsole and spikes holder, make sure the spikes are removeabble.



Molding and casting the rubber outsole. Figure out the solution of how straps go under the upper.

Final Javelin Throw

Javelin Throw

Mid-foot Straps

Triangle lockdown system stabilize dorsal foot and heel at the same time, offers better foot lock-down.

Straps Holder

Strap holder made by flexible TPU

Shoes Upper

Bemis film bonded with synthetic mesh upper material in order to offer better breathability and durable.

Heel Counter

TPU Plastic heel counter offer better heel and ankle protection

Toe Cap

Reinforced synthetic leather. Straps are fixing at this toe cap and strobel with upper together.

Midsole

Carbon fiber with polyurethane foam offer better support and stability for athlete 's blocking feet,

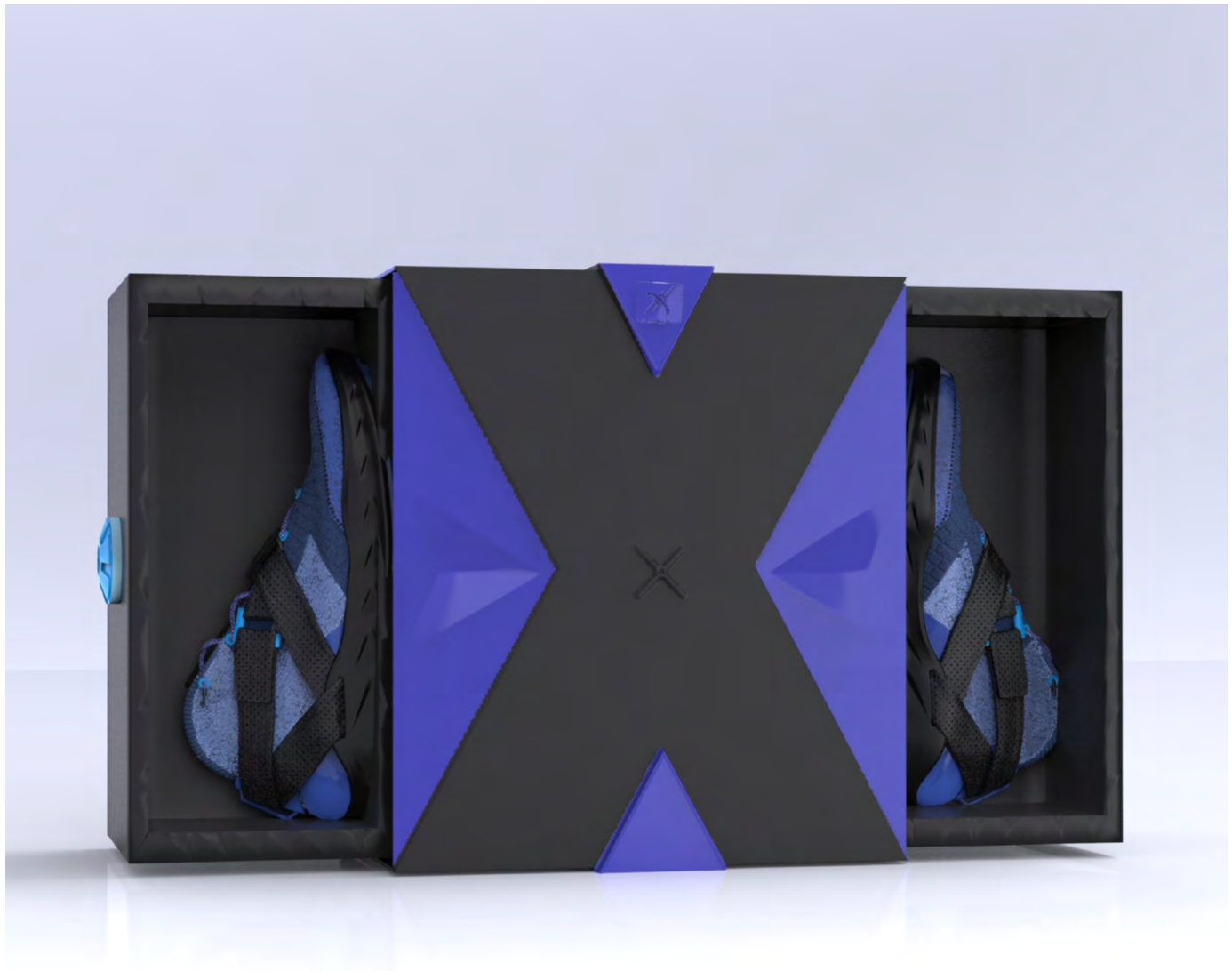
Traction Plate

TPU traction will ensure the feet grip the ground improve the friction.

Spikes

Removable spikes are conveniently for athletes to customize during competition.

Packaging



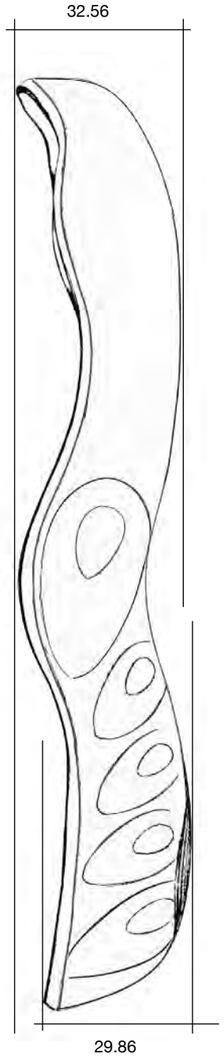
Brand Logo Ideation

Helix

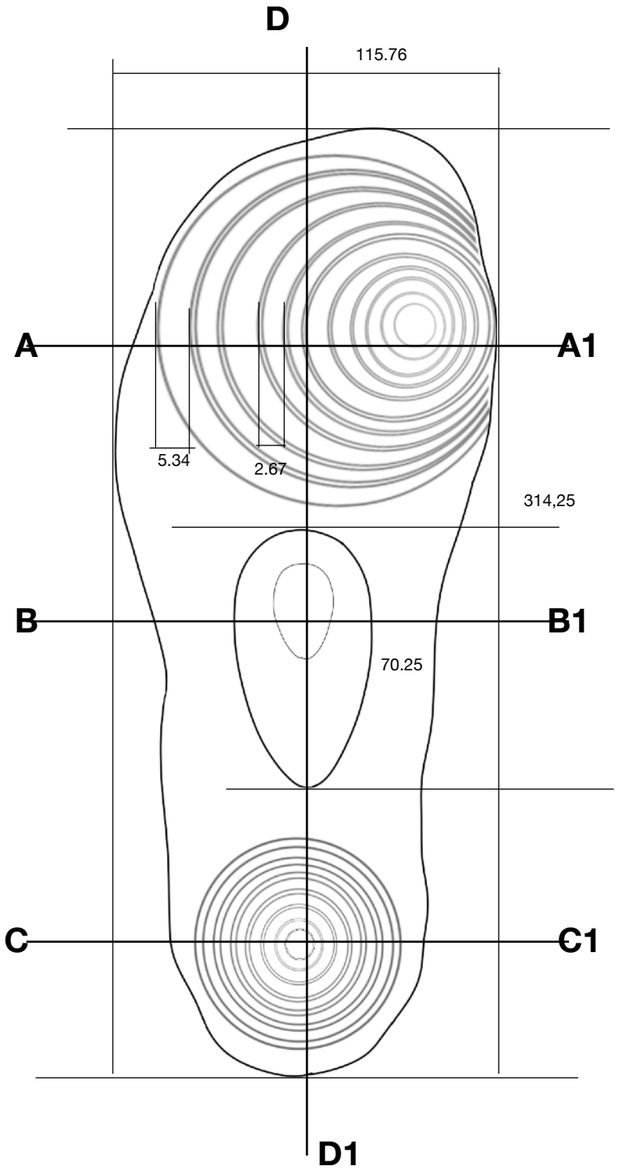
Throwing Sports Footwear

Tech Drawing-Shot Put

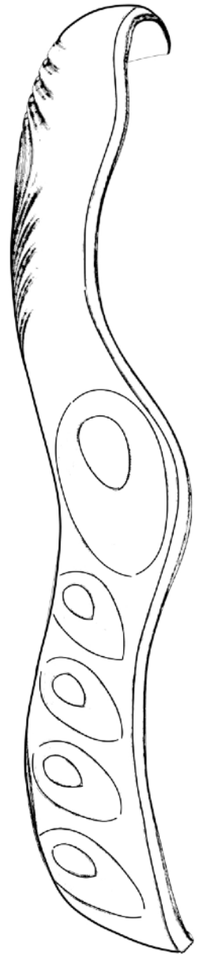
Section DD1



Lateral View

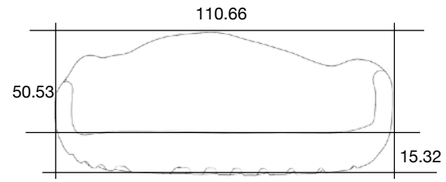


Bottom View

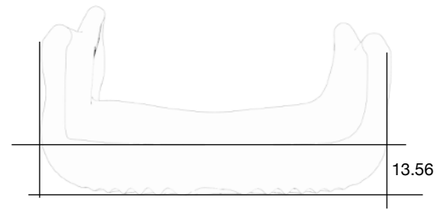


Medial View

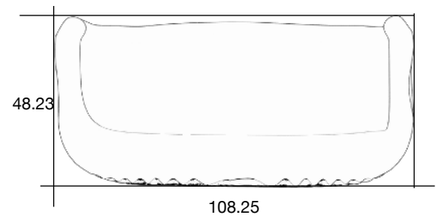
Section DD1



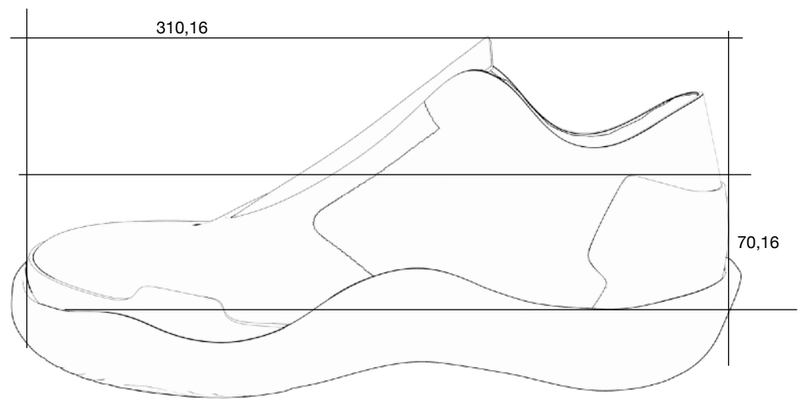
Section A



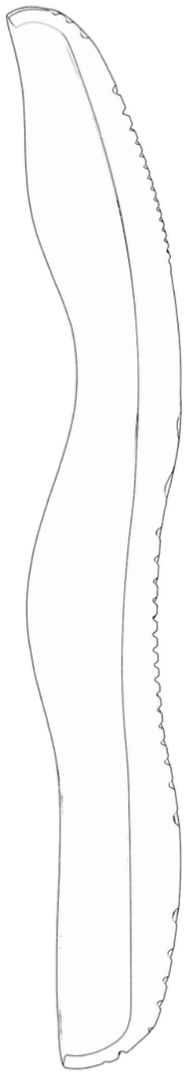
Section B



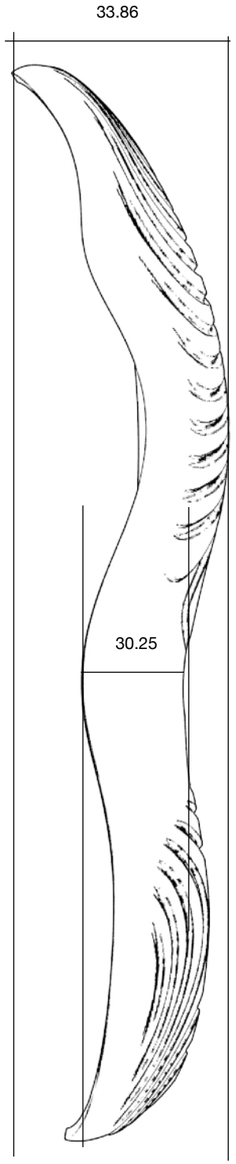
Section C



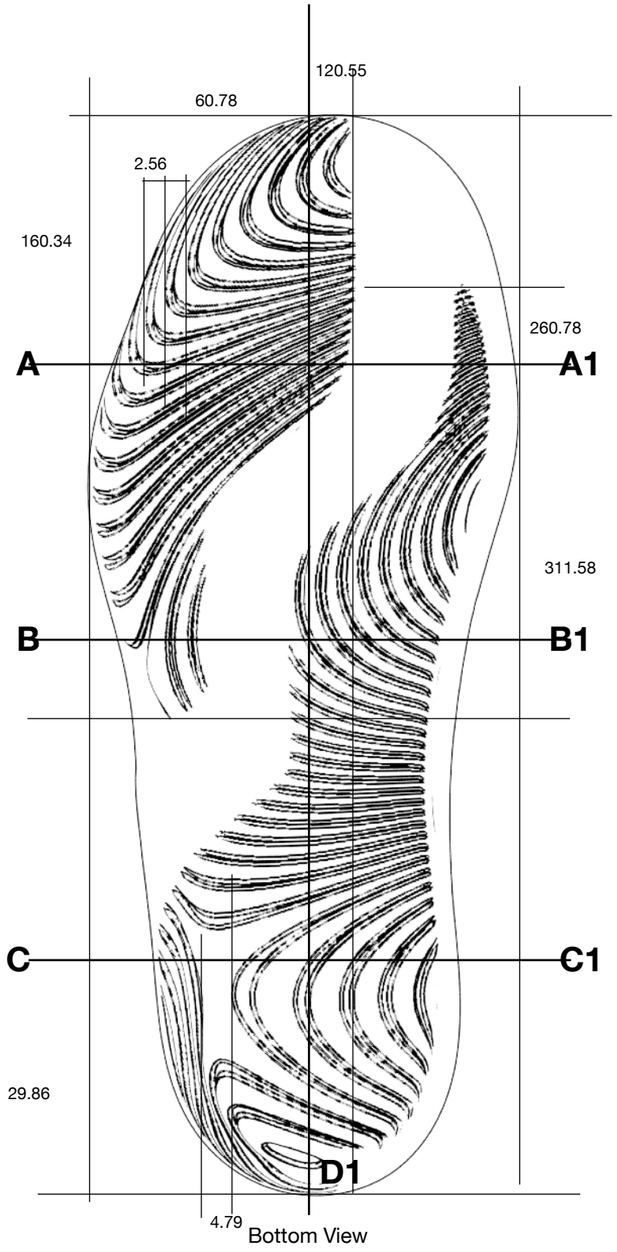
Tech Drawing-Hammer Throw



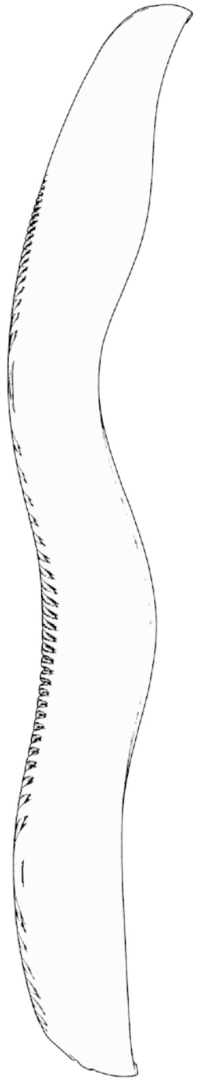
Section DD1



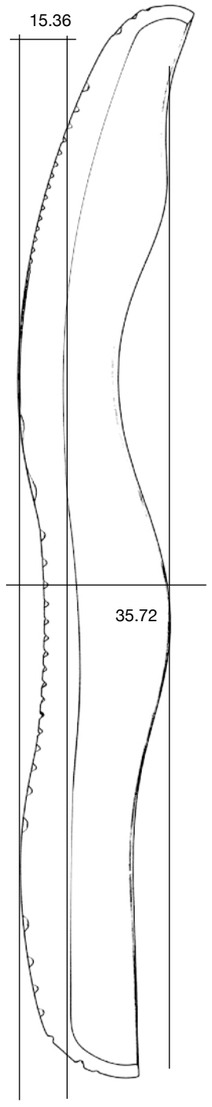
Lateral View



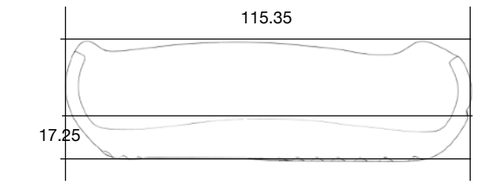
Bottom View



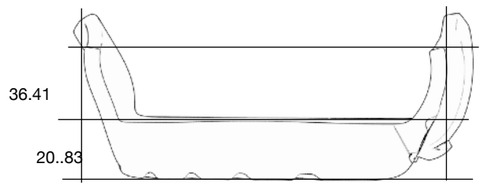
Medial View



Section DD1

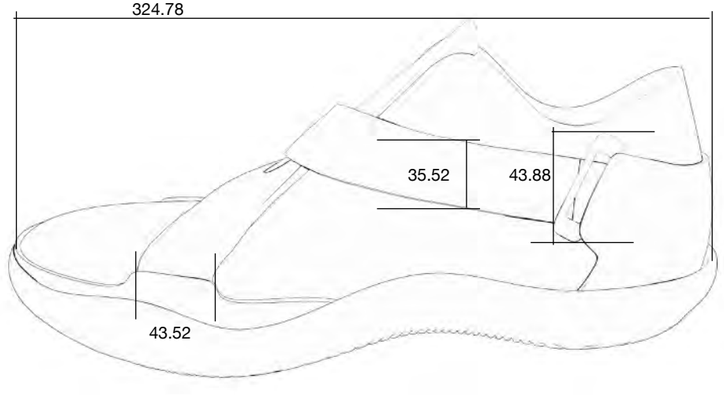


Section A A1

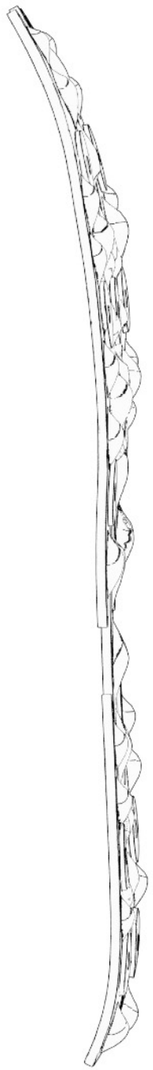


Section B B1

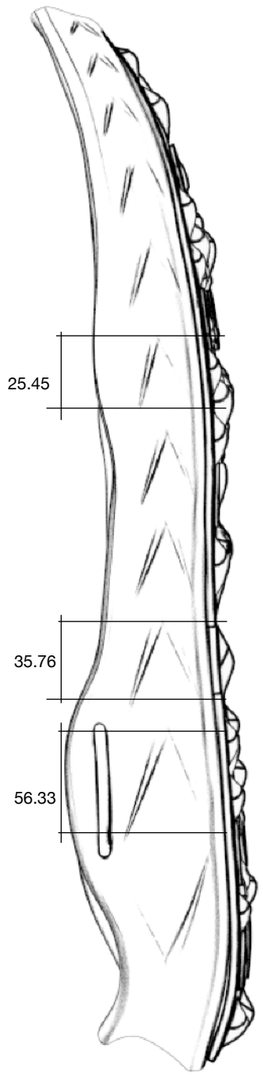
Section C C1



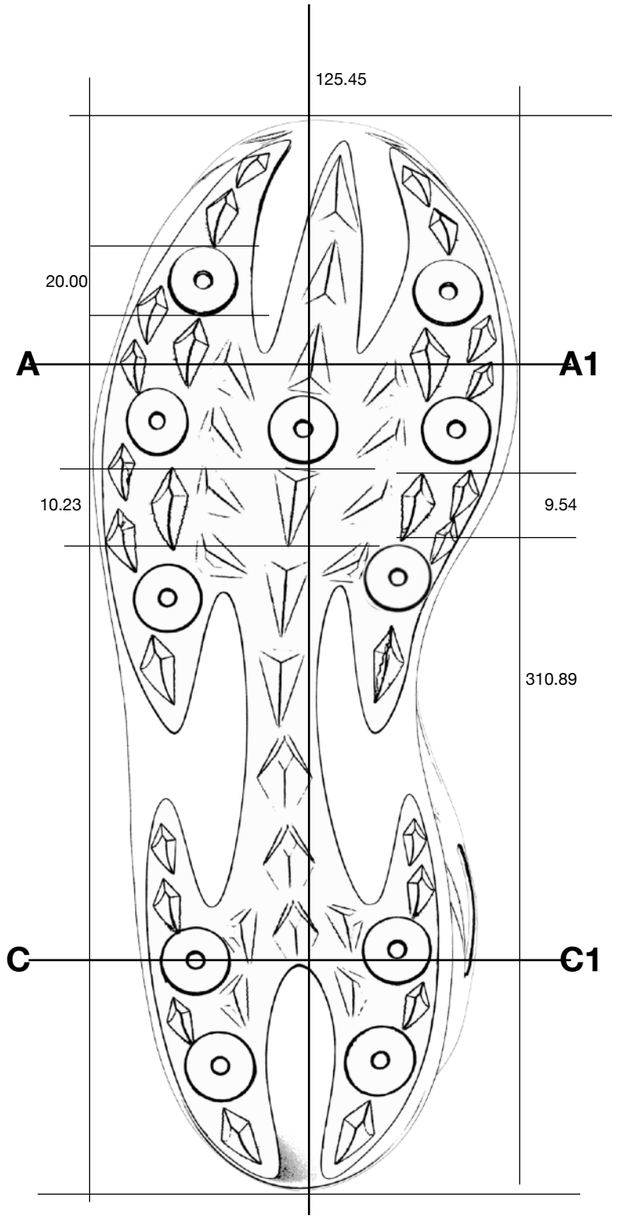
Tech Drawing-Javelin Throw



Lateral View Outsole

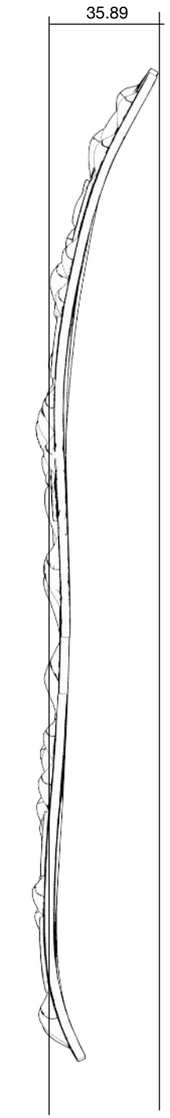


Lateral View Midsole

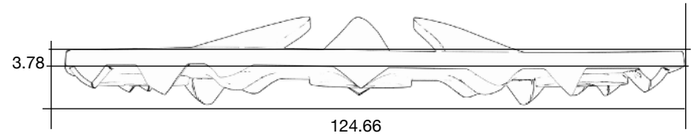


Bottom View

Medial View Midsole



Medial View Outsole



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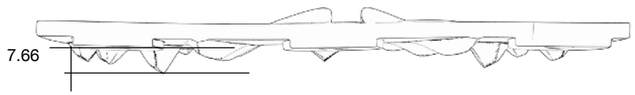

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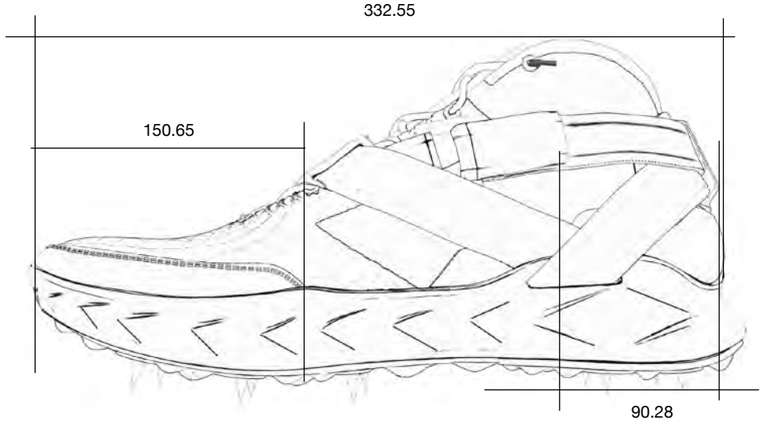
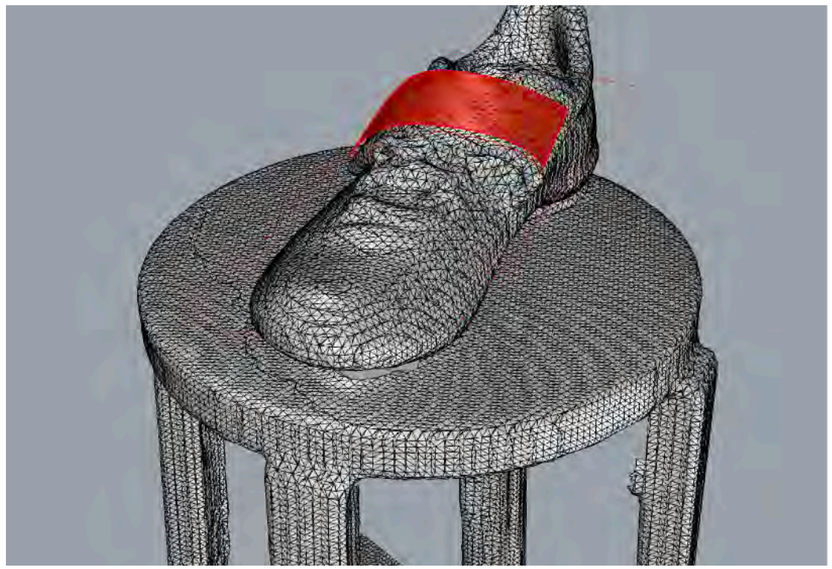


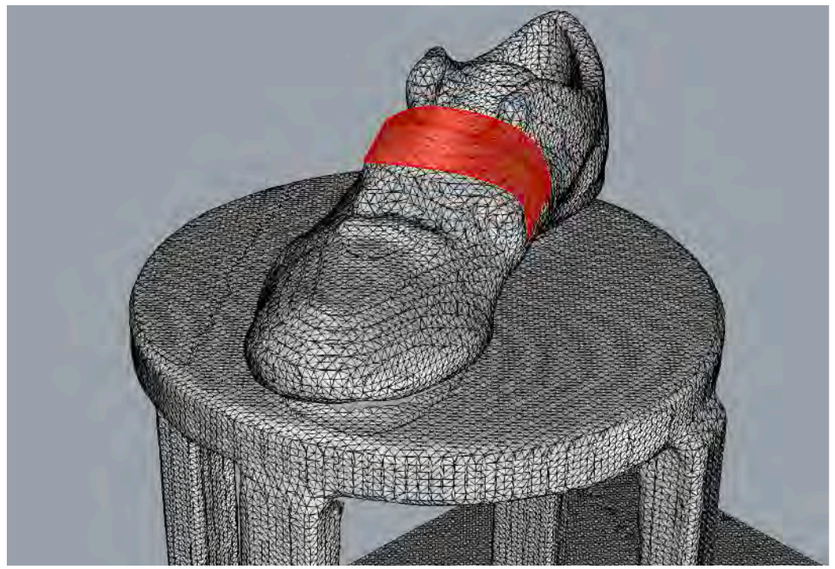
Validation

Area calculation



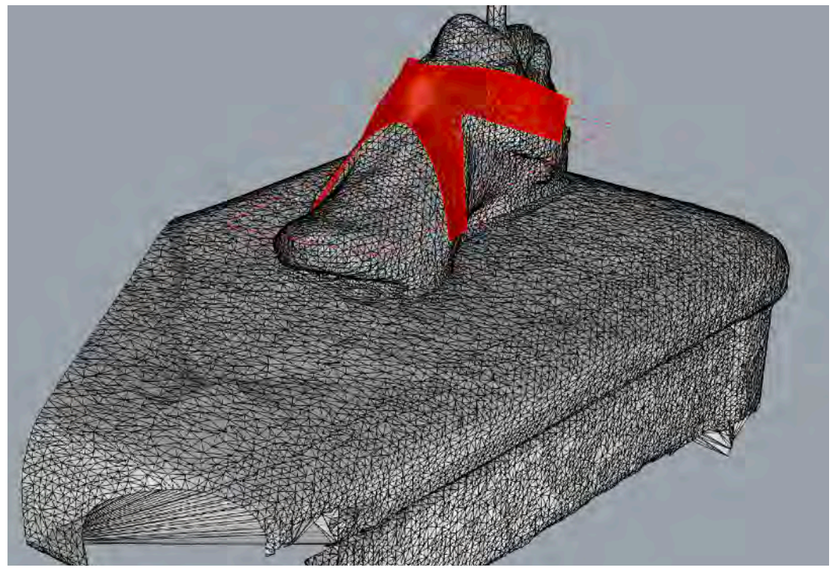
Adidas AdiZero

Red Area: 4608.23673 (+/- 0.00045) square millimeters



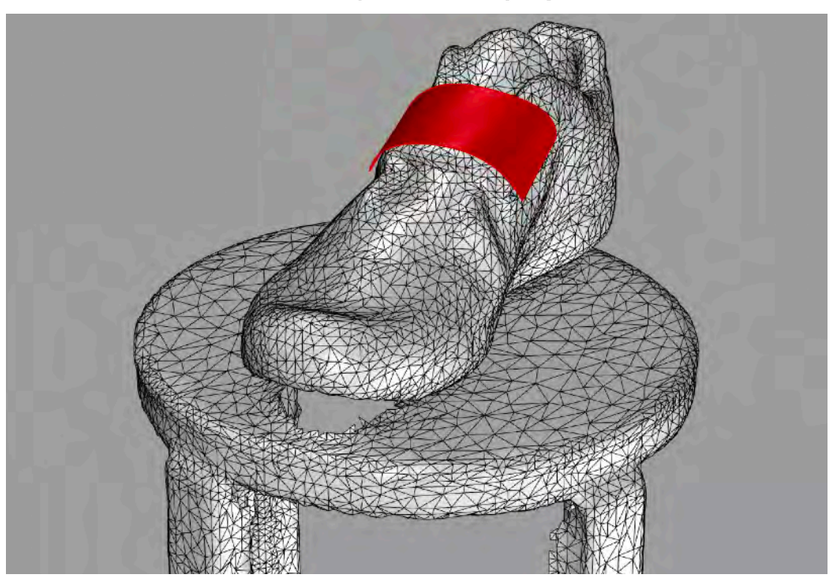
Asics

Red Area: 3804.52649 (+/- 0.00013) square millimeters



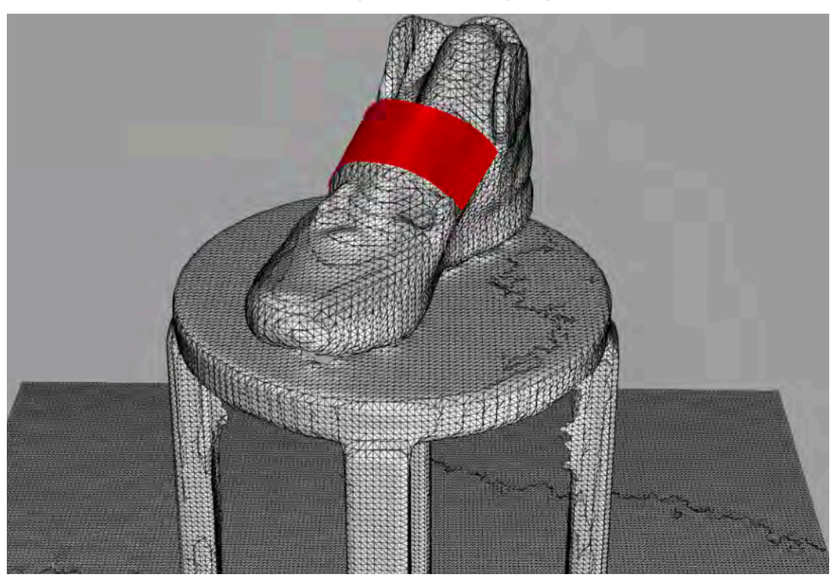
New Hammer Throw Prototype

Red Area: Area = 11939.393 (+/- 0.0015) square millimeters



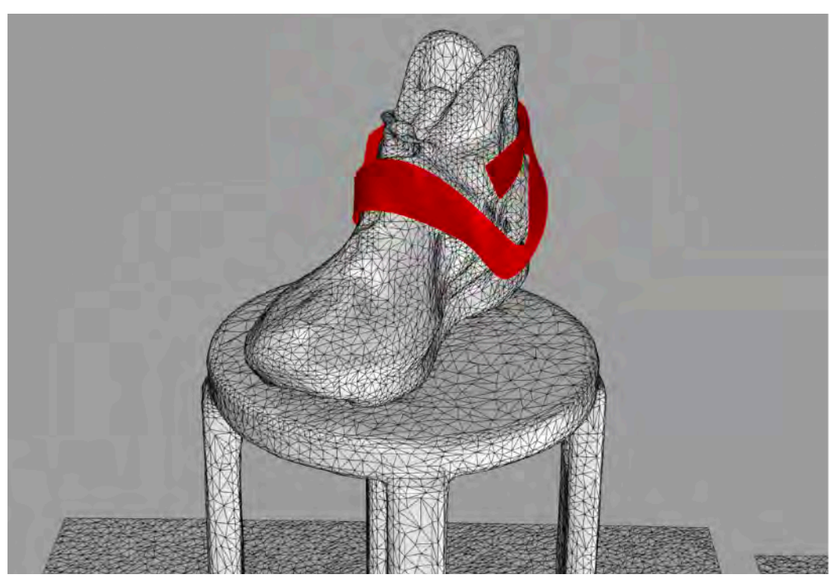
Nike Zoom Javelin Elite 2

Red Area: 5208.34689 (+/- 0.00025) square millimeters



Saucony Lanzar Jav

Red Area: 5683.63799 (+/- 0.00016) square millimeters

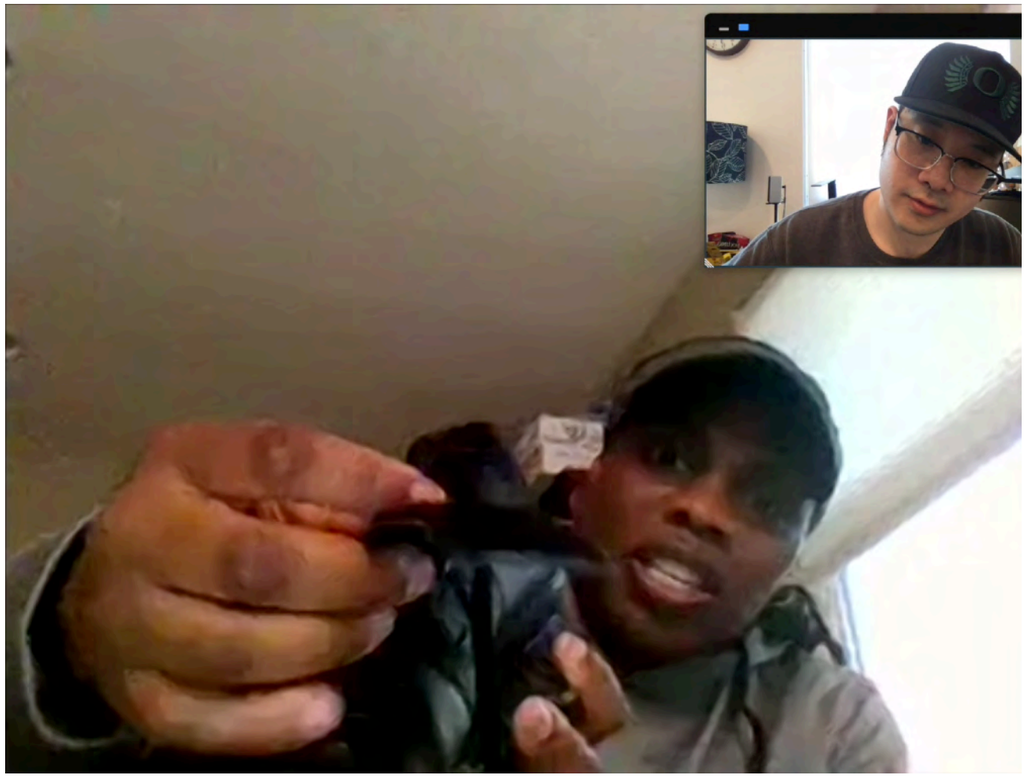


New Javelin throw Prototype

Red Area: Area = 15688.518 (+/- 0.00035) square millimeters

Validation

Athlete/Expert Feedback



OLA ADENIJI
University of Oregon Track Team Coach
PHD, Human physiology

“I like this ankle lockdown system, because the ankle support in javelin is a critical component. The goal for ankle protection is to have strong support to hold the ankle in place for the block foot.”

“If the shoes is rigid that would be helpful, because the athletes can instantly stop themselves with the block.”

DEREK AKEY
University of Oregon
Shot Put/Discus

“I love the way that how the straps wrap around the foot. This is a really cool concept if the straps works well”

“If the shoes can help athlete to hold the position before the final release, that would be super helpful.”

Athlete Outcome

These shoes are designed for throwing sports with specific movements that require great lockdown and traction support. This collection of throwing shoes combines the specific needs of throwing techniques to provide the best support performance exactly where athletes need it, to help them throw further.

Thank you for your time!

Sports Product Design
University of Oregon
Shawn Li