

Kɔfa: A Soccer Cleat Designed for The Female Athlete

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Abstract

Many women find themselves playing in cleats designed to accommodate men's movements. This has led to a surge of injuries in the lower extremities for women in football that includes ligaments strains and tears in the knees, ankles, and feet. Black women playing at historically black colleges and universities suffer largely from being unsupported, overlooked, and overwhelmingly underfunded. As a result, these institutions find themselves being incapable of replacing damaged cleats for players who are unable to afford new ones, leading them to play in footwear that not only isn't made for them but, now puts both their health and performance at risk. This research paper will address the designing of cleats that aim to mitigate lower extremity injuries in women's soccer, while also addressing the sport from a socioeconomic standpoint regarding the lack of diversity and representation in the game. The goal is to address this issue on a foundational level in hopes of seeing this minority continue to make their impacts felt on the highest level.

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Terms of Understanding

Throughout this paper there will be terms that are used interchangeably with the words football and soccer being the major two. Please understand that the interchanging of the two terms neither adds or takes away from the value of the topic being discussed. Additionally, there will be terms that are imperative to the understanding of issues and topics within the African American/ Black diaspora. Similar to football and soccer, the terms Black and African American may be used to describe a player of the same race but of a different country of origin. Lastly, there will be conditions of the foot described with names of similarity to define issues occurring in a similar region of the foot.

Black- Often used in place of African Americans but refers to black people from any continent/nation.

African American - black people that are born within the United States.

Bone spur- bony growth that develops on the edge of the bones often forming where bones meet together.

Heel spur- when the calcium deposits build up on the underside of the heel bone, a process that occurs over a period of months.

Haglund's deformity - a bony growth on your heel bone where the achilles attaches

Heel bursitis- A painful condition that affects the bursa located between your heel bone and achilles tendon

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Football: The Beautiful Game

Football, or what Americans call “soccer”, is one of the most popular sports in the world (Mamchii, 2024). It is played on a field that spans about seventy-five yards in width and one-hundred and fifteen yards in length. The game consists of two teams of eleven players passing the ball amongst one another in order to reach the opponent’s end of the field. In route to the opposite end of the field, their objective is to get the ball into their opponent’s net, while the opposing team attempts to stop them and score in their goal. Matches are roughly ninety minutes long in regulation with the possibility of an extra thirty minutes of play; also known as “extra time”, and penalties if a winner is not decided by then. Today, more than two-hundred and fifty million people play the game of football (Bundesliga, 2020). It is a game that has existed in many variations for quite some time, so let's take a look back at its history, shall we?

History of the Sport

The game of football dates back to times as early as 5000-300 B.C., where a variation of the sport was played amongst military forces during the Han Dynasty. At the time, “Tsu Chu” was a popular game with elements similar to today’s variation of soccer. It involved a leather ball stuffed with fur and required players to kick it into a hole much smaller than the current game’s goal. Like modern football, these players were permitted from using their hands. As time progressed the game evolved, and with this came changes that shifted the dynamic of the sport. By the year 1500, “Calcio Fiorentino” was established in Florence, Italy (Wood, 2008). The game included elements of soccer, handball, and rugby in combination. In calcio, players were

required to carry a ball across a goal line by hand. In comparison to its successor, it was played to a much larger scale with teams consisting of twenty-seven players each. Due to the large number of participants, calcio required a lot more strategy (Wood, 2008).

By 1620 the game of soccer would later make its way to North America as the Native Americans in the original Jamestown settlement would begin playing Pasuckuok , which translates to “they gather the ball by the foot”. Taking place on the beach, it was a much more violent game with field lengths as wide as half a mile and goals roughly one mile apart in distance. Pasuckuok, unlike its two predecessors, had extreme demands, rules, and elements as it was often played with as many as one thousand players (Wood, 2008).

It wasn't until 1863 that the game of football was embraced on the competitive level universally. It had grown to the point that the most popular schools in the northeast region of the United States would compete with Harvard University, Princeton University, Brown University, and Amherst College on a consistent basis. The game's exponential growth would then lead to the establishment of many entities; including the formation of the first football association that year. During that year the first ever pro match between Barnes FC and Richmond FC took place, ending in a 0-0 draw (Wood, 2008). The establishment of the federation marked the beginning of a lifelong tradition that would prove to be critical to the foundation of today's game. It would later play a huge part in women being socially accepted to play as it not only empowered women to explore and embrace their physical abilities, but allowed them to realize their true potential in route to achieving milestones and success on the highest level of competitive sports.

The Game Becomes Global

By the year 1904, the conditions of football continued to grow exponentially, as the nations of France, Belgium, Netherlands, Spain, Sweden, Denmark, and Switzerland would soon come together to form the International Federation of Association of Football (FIFA) (Wood, 2008). With the goal of improving and promoting the game of football on a global scale through unification, education, culture, inclusivity, and humanitarianism, FIFA focused heavily on

development programs that supported the youth (FIFA, n.d.). It took quite some time before the federation would extend their efforts to women's professional football, but a major series of events would later kick start that movement. In 1982, the National Collegiate Athletic Association (NCAA) began sponsoring women's sports. Across all three NCAA divisions 1,855 players participated in women's soccer for a total of 80 teams (Lewis, 2023). This sponsorship would go on to contribute greatly to women's soccer in the United States as it would soon produce a series of icons that changed the landscape of the game.

Women's Arrival to the Game: Loud and Clear

The year is 1991. FIFA has reached its peak level of success having produced and supported the highest level of international football. With icons from various nations stepping on to the pitch with bravery, style, and pedigree the association knew that it could elevate themselves even more, and they knew exactly who they wanted at the forefront (FIFA, n.d.) . With the announcement of the first ever 1991 Women's World Cup being held in China, FIFA was giving female professional soccer players the brightest stage to showcase their talent, skill, determination, and pride for their countries. The condition of football had already been in great standing, but the recognition and respect for the women playing the game was much lower in comparison to men. Despite their eagerness to give these women the necessary platform, what FIFA and the rest of the world could have never predicted was the success of the United States. The U.S. women went on to display pure dominance over the next decade, winning the World Cup in its debut season, followed by a victory in the first ever women's soccer tournament at the Olympics in 1996 (Lewis, 2023). While both monumental, it was the USWNT's third and final tournament win of the 1990's that would send a shock through the world of sports.

The Solidification and Impact of a Dynasty

The 1999 World Cup is recognized as one of the biggest sporting events held in the United States during the 1990's (Timm-Garcia, 2019) . Hosted by various cities across the United States, the tournament brought in 40 million viewers in the U.S. alone. It had an

attendance of 1,194,215 people, a 43% increase in attendees from the 1995 World Cup (Timm-Garcia). The championship round held at the Rose Bowl in Pasadena, California generated a turnout of 90,185 attendees and would end in dramatic fashion as the U.S. Women's National Team would go on to win 5-4 in a penalty shootout against China after playing 120 minutes that included two sudden death halves (first team to score wins) (FIFA, n.d.). This victory would mark their third major tournament win in eight years and the solidification of a prolific dynasty. While the thrill of the 1999 Women's World Cup was at a high level, the impact that these women had on the growth of women's sports as a whole cannot go unnoticed. The success of the USWNT launched the beginning of professional soccer leagues in the United States. With this came the establishment of the Women's United States Soccer Association (2001-2003), The Women's Professional Soccer League (2007-2012), and the National Women's Soccer League (2012-Present) (Wikimedia Foundation, 2023). As a result of this exponential growth, the United States general perception and feeling on the sport had increased significantly over the last twenty years. The USWNT have only continued the success of their predecessors winning three Olympic gold medals in 2004, 2008, and 2012 along with two World Cups in 2015 and 2019. With its dominance over the last thirty years the USWNT has without a doubt inspired the generations to follow. Today, 29 million women and girls play soccer across the world with 4.2 million of them playing in the U.S.



Figure 1 USWNT celebrate 1999 World Cup victory (FIFA, n.d.).

The Women Are Here To Stay

The impact of the United States Women's National Team is one that still remains apparent today. They inspired succeeding generations, including those that wear the jersey today. Many of these fellow nations have birthed some of the greatest players the sport has seen and like those in the United States, produced talent from domestic leagues that have existed much longer than those within the states. Women's soccer across the globe is vast with top players hailing from the FA Women's Soccer League (England) , Primeira Liga (Spain) Divisio Feminine (France), amongst many other top flight leagues in Europe, Asia, South America , Central America, Oceania, and Africa (Nwokolo, 2023). Despite its exponential growth , there are a few conflicting issues within women's soccer that are heavily affecting its ability to reach full potential.

The first issue is one that affects all women within the sport is the high rate of knee injuries. While these injuries are oftentimes caused by collisions, a large sum of these female athletes are suffering from non-contact knee injuries. There are many that believe that the high rate of women's injuries in soccer is due to genetics and the differences in which their bodies function in comparison to men (Whitaker et. al, 2023) . While this general belief may or may not have validity to it, what is often overlooked is the need to have footwear designed for these women to accommodate those anatomical and biomechanical differences. The footwear industry has failed to provide women with cleat options that not only consider their comfort and health, but their movements and performance, and as a result have contributed greatly to this epidemic of career altering knee injuries (Lewis, 2022).

The second issue speaks towards the lack of diversity within the sport. While the support for women's soccer has grown immensely around the country, the underwhelming representation of black women within the sport at the professional level is a direct reflection of the ongoing lack of support at the preceding levels of competitive play (The Black Women's Player Collective, n.d.) . While black women will always remain the minority within the sport, there are several ways to improve the foundation of the programs and institutions from which these athletes derive. This includes the way in which talent is evaluated, the amount of provided financial support and funding, as well as the simple need to actually care about black women's existence

in spaces that do not favor them from top to bottom. All of these factors are to be considered, on top of the general issues that these women suffer from as they continue to play in conditions that do not fully prioritize their wellbeing.

Just A Tweak: Women’s Knee Injuries at an All time High

In its current state the condition of women’s soccer can improve in a number of ways. Things preventing it from being labeled great are many: lack of commercial support, low domestic play viewership, unfair wages, and protection of players rights and privileges concerning health. While all of those factors contribute greatly to the hindering of progress in women’s soccer, one that is a common denominator of all of these issues, is the alarmingly high rate of knee injuries in women’s soccer.



Figure II USWNT Megan Rapinoe tears ACL in 2015 (US Women’s star rapinoe tears right knee ligament , 2015)

“Generally there’s this fear. Is this going to be the end? Am I going to come back from this? Am I going to have this pain forever?”said U.S. Women’s national team star Megan Rapinoe, having suffered several ACL tears in both knees in both her early and late career (US Women’s star Rapinoe tears right knee ligament, 2015). For many women like Rapinoe, it is the surgery and the year-long recovery process that oftentimes brings more mental and emotional pain than the actual injury does physically. The injury has become extremely prevalent in the women’s game, plaguing 87 women with ACL tears since the 2021 season. With both extreme

severity and a long term recovery time, it has additionally led to well over 25 women missing the 2023 Women's World Cup (Brockway, 2023).

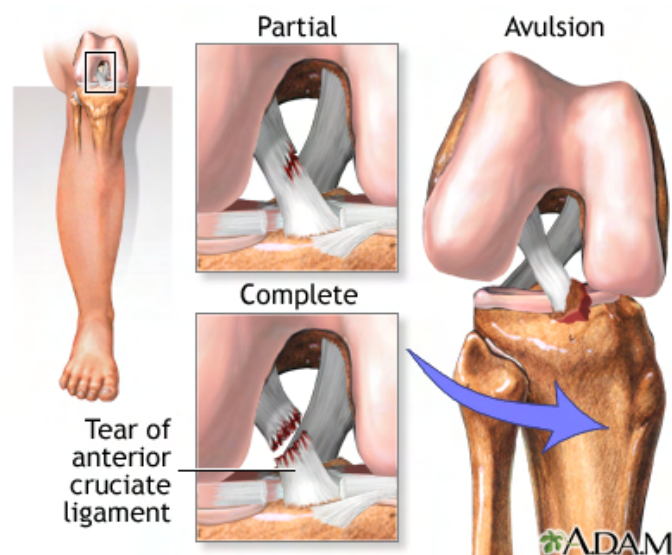


Figure III ACL tears based on severity (Mount Sinai Health System , n.d.)

The Challenges of ACL Tears and other Injuries in the Lower Extremities

While many women throughout the history of the game have suffered from ACL tears and other lower extremity injuries, there has yet to be a conclusive reason as to why they are happening. In cases where the injury is a result of a collision, players can sometimes experience head on collisions that lead to their knee getting caught underneath the leg of an opponent attempting to make a tackle or through hyperextension as the striking of the leg occurs just as foot is making initial contact with the ground. However, in cases where a player suffers a torn ACL in the process of changing directions, pivoting, cutting, or attempting to come to a stop in the action of play, a major contributor to this injury is rotational traction, also known as torque (Thomson, et. al, 2022) . Torque is the measure of force required for an object to rotate. In the athlete's case it is the amount of force required for a player's studs to successfully rotate in the surface of play when one is attempting to change directions. As a player repeatedly makes these quick and sudden movements rotational traction and torque are both occurring at varying levels. When the torque becomes excessive, these forces can load onto the feet and over time lead to overuse injuries that include plantar fasciitis among many others. In the most extreme cases, this

torque can load onto the player's foot in amounts that result in their cleat making deep penetration into the ground (Thomson, et. al, 2022). When this happens, it is very common for the foot to become stuck, while the player is then attempting to carry their momentum in the opposite direction. This in turn results in a twisting of the knee and oftentimes sprained or torn ligaments in the knee.

What to consider en route to mitigating women's injuries

In order to prevent injuries like this, it is important to understand the cleats being worn as well as the athlete wearing them. Male and female soccer players are in no way equal in regard to muscle mass, body composition, anatomical structure or biomechanical function. Due to their differences, each set of athletes requires their own footwear to perform efficiently. In regards to soccer cleats, the amount of power generated by men to successfully execute quick cuts and changes of direction requires a particular amount of traction. This is provided to them through soccer cleat design that takes their anatomical and biomechanical needs into account to appropriately place studs in the boot that will allow the player to move efficiently across the field (Thomson, et. al, 2021).

The difference in generated power between men and women to execute the same moves during high level athletic performance can be seen as anywhere from 10-30% depending on the sport of play (News Detail, 23). When taking that into account, it is clear that women in soccer simply cannot perform efficiently using cleats designed for men. With less power generated in their movements, women require less traction than men in order to balance the ongoing force between their feet and the playing surface to enable efficient movement (Thomson, et, al, 2022). While this has remained the case for quite some time, many brands within the industry of footwear design have failed to design cleats that take these women's performance needs in mind, and instead have left them to wear cleats designed for men in much smaller sizes, ultimately putting their health and performance at risk.

In order to put these women in the best possible position, it is important to design a cleat specific to the anatomical needs and functions of the female soccer player. It must take into

account the areas of the foot relied upon during quick movements to determine efficient placement of studs at locations and depths that will allow for players to move efficiently. Studs that are too shallow can lead to players slipping and having no control of their balance and stability, while studs that are too deep, can lead to over penetration and increase the risk of injuries. During this process, the cleat must also reduce rotational traction/torque considerably in comparison to a men's cleat in order to prevent excessive penetration and force into the playing surface. While doing this, the cleat must also consider these women's needs in regards to fit and overall comfort. The last thing wanted is to provide a player with a cleat that hinders their ability to perform due to being uncomfortable.

The Challenges of Playing Competitive Soccer as a Black Woman

The game of soccer has seen significant amounts of growth regarding the existence and support of women. From its integration of women representing their country on the international level at the 1991 World Cup, to the introduction of the Women's United States Soccer Association in 2001, soccer within the United States of America has reached an extremely high level (Wikimedia Foundation, 2023). While great strides have been made to grow the game, the lack of diversity within the United States domestic league in addition to the few women of color that have represented the United States at the international level over the program's nearly 40 year history has been a topic of discussion for quite some time. For the greater half of the last players like Gotham City midfielder Crystal Dunn and forward Midge Purce have voiced some of these issues as members of the Black Women's Player Collective (Black Women's Player Collective, n.d). There are many people who attribute the lack of diversity within the sport to a large disparity in talent amongst these women. While others see this lack of representation as a foundational issue that is a direct result of unfair opportunities, support, and attention given to black women that like injuries, starts at the youth level of competitive play.

The History of Black Women and the United States Women's National Team

Historically, the United States Women's National team had been largely represented by caucasian women. Between its first World Cup appearance in 1991 and its appearance at the 2020 World Cup, the U.S. Women's national team had fielded just 19 black women in 30 years of play (Baxter, 2023). While this statistic proves to be rather discouraging, 6 of those 19 black women have managed to make impactful contributions that have inspired the progress and current status of the national team that is currently represented by an all-time high of 7 black women. In 1986, Kim Crabbe became the first black woman to represent the United States. Crabbe unfortunately never made an appearance for the team, only being called up for training sessions over the next year (Baxter, 2023). Despite not ever making an international cap, she is remembered as a trailblazer whose call up marked a glimpse of hope for all those that would later follow.

The following year Sandi Gordon, a defender who had been playing for the Tacoma Tigers, a club team in Washington state would become the first black woman to earn an international cap for the U.S. Women's National team. She made her first appearance against Sweden and would go on to make 6 more international appearances for the national team making her last in 1988 (Baxter, 2023). While her tenure with the team was not as long as one would hope, Gordon's place in U.S. Women's soccer history will forever be marked in the nation's history for the rest of time. It wasn't until the 1990's that the contributions of black women to the U.S Women's national team was truly felt by the masses on not only a national scale, but globally.

Briana Scurry, a goalkeeper who made her international debut for the USWNT in 1994 is known as one of the best players to ever wear the uniform for the red white and blue. Her performance in the United States penalty shootout in the 1999 helped them win their second World Cup, and would later go on to help the United States win two gold medals during the Olympics (Baxter, 2023). With 173 total appearances for her nation, she is known as the greatest goalkeeper to play for the United States and without a doubt the greatest black woman to represent the country.

Currently, the United States Women's National Team is led by Crystal Dunn, a versatile midfielder and defender who first made her international debut in 2013. She played an integral part in the nation's 2019 World Cup and today, is one of 7 black women in the current U.S. Women's national team roster. Dunn is recognized as one of the team's best players and most important leaders both on and off the field. While her 143 appearances for her country at just the age of 31 is an impressive feat, it is her off the field leadership as a board member of the Black Women's Player collective that has meant so much to those in need for representation and diversity within the sport a topic of priority within the game of soccer (Baxter, 2023).

The Black Women's Player collective is a non-profit organization that was created by black women playing in the National Women's Soccer league in 2020. Representing just 7.5% (32/440) of the league's population, these players within the league have made it a mission to advance black women and girls in the sport of soccer through mentorship and community in order for black women to elevate their value and presence in the sport (Gonzalez, 2023). This is an extremely important initiative, because to this day the game is still seeing limited opportunities, exposure, and support for black women at the collegiate level, especially to those playing at historically black colleges and universities.



Who We Aim to Serve

In order to see the game grow in diversity, it is important that black women are financially supported, given fair opportunity, provided proper exposure, and prioritized to the same level as women of other demographics. While efforts are being made to grow the game, there are a number of historically black colleges and universities with rosters that consist of more non-black players than black, a dilemma that essentially opposes the purpose of HBCUs initial intentions: creating safe spaces for people of color (Minority education initiatives, n.d.) . This is a direct result of HBCUs (historically black colleges and universities) hiring white head coaches who then recruit players that they are familiar with, which almost always ends up being white players (Bluefield State University, 2024).



Bluefield State University (HBCU in West Virginia) roster

Secondly, black women playing at these schools are often overlooked, having no database that keeps track of the best players within their conferences or divisions like those at predominantly white institutions and Universities. Lastly, these schools are oftentimes underfunded, meaning players are provided with limited resources for equipment like cleats (Hernandez et al., 2020). In comparison to predominantly white institutions that are oftentimes well funded and provided with multiple pairs of cleats per season, these women do not have those same privileges, and as a result are required to come out of pocket to replace cleats that are damaged. Because many of these women are financially burdened, they continue to play in cleats that have declined in quality, ultimately putting their health and performance at risk.

User Focus and the Goal at Hand

As things currently stand, there are very limited options for women-specific soccer cleats. These athletes have significantly different pressure loads, movements, and foot structures in comparison to men and the cleats that they are currently playing with fail to accommodate for that. A study conducted by the European Club Association found that 82% of female soccer players in the top 8 domestic leagues reported having issues with their soccer cleats. Many of them expressed a feeling of pain and discomfort in the heel region, a complaint that was found to be more common with black players (Wrack, 2023). Given the current landscape of women's

soccer cleats, the expressed discomfort and pain experienced by many players including my collegiate test athletes, and the alarmingly high rate of knee injuries occurring as a result of not having cleats that actually consider their needs, my goal is to design women specific cleats that reduce rotational traction and torque in route to mitigating lower lower extremity injuries that include ligament tears . The second product within that line,will include an innovative insole that integrates a more durable foam that provides adequate cushioning for the athlete beyond a season of play.

Golden Circle

Inspired by the many great athletes that I have had the privilege to watch, my goal is to design sports products for the next generation of great athletes. I hope to contribute to their process by designing products that bridge the gap between the physical, mental, and emotional while enabling them to perform at the highest level.

Environment, Rules, and Demands

In the sport of soccer, the environments can vary by country, but the playing field must meet a standard across all leagues and divisions. These women can find themselves playing in various conditions ranging from 100 degrees to below freezing. Whether extremely hot or cold, the only conditions that can stop the game from being played is the existence of lightning striking the field, a player's life being in immediate danger, or coordination and a mutual agreement between the opposing teams, referees, the broadcasting team, and the league itself (Watkins, 2019). Regarding the playing field and its dimensions, soccer fields are usually 75 feet in width and 115 feet in length. The game consists of two teams of eleven players playing for a duration of 90 minutes. During this time, a number of stoppages that prolong the duration of the match in the form of the ball falling out of play, fouls, substitutions, goal and foul reviews, injuries ,and goal celebrations can occur (Mendoza, 2022). This combination of time, also known as stoppage time, is then added back onto the clock at the end of both the 45th minute prior to

half time and the 90th minute prior to the end of the match. Stoppage time can range anywhere as low as 0 to as high as about 10 minutes on average. It is very rare that stoppage time exceeds the 8 to 10 minute time range.



Figure IV: World Cup match between Poland and Mexico awarded 7 minutes stoppage time (Mendoza, 2022)

Product Rules

Players are also allowed to wear any accessories desired to express their own personalities while on the field. Regarding Product rules, players are able to wear any style of cleat that they want. However, these cleats must meet the guidelines of possessing no front stud of any kind (Hutchison, 2019). A front stud or cleat positioned at the tip of the cleats puts opposing players at risk of injury in the action of tackling and is prohibited with no exceptions. For professional players, these studs are often made of metal or manufactured in the form of a spike, putting players at risk of injuries that can be detrimental to their careers. In addition to this, player safety is emphasized further as all players are required to wear shin guards at all times of the match.



Figure V: Team USA Formation (Floyd, 2023)

Pushed to the Limit: The Role of the Player

Given the duration of the match and the physical demands of the sport, the rules of professional soccer allow each team to make as many as five substitutions. Regarding these demands, each position on the field plays a role that in most cases involves player responsibilities that may overlap. Aside from the goalkeeper, whose main objective is to use her hands to prevent the opposing team from scoring, the remainder of the team works in unison at varying rates to defend against and score on their opponent. The back four players are known as the defenders. Their primary job is to work together to prevent the opposing team from penetrating the final $\frac{1}{3}$ of the field and scoring. The three players just ahead of them are known as midfielders. In most cases their job is a hybrid of the defenders and the attackers. They are

commonly seen as the “glue” within the team, and can often determine the outcome of a game. The midfielder can be categorized as “holding” , meaning with more defensive responsibility and “attacking”, with a bit more freedom to create scoring opportunities for the forwards while also joining in on the attack. When both the back line and midfield are clicking on all cylinders, you can expect fluidity and an increase in opportunities for your front three players, also known as your “forwards”. Your forwards responsibility is simple: score goals. The forwards on the right and left are known as “wingers”. They often threaten the backline of the opponent and work in unison to set up the central forward for as many goal opportunities as possible. The constant attack of these three players opens up opportunities for the remainder of the team to assist in scoring these goals or set them up. As discussed, when all three levels of this team are executing their responsibilities, the expectation is that the game results in a win, however, when the opposing team is also executing their responsibility, the result of the game can be left at a stalemate (tie game).

The Physical Demands of a Player

In the case of a regular season match, when a game ends in a draw or tie that is the end of the game. However there are a few occasions where a winner must be decided. During playoff and tournament matches, any game that ends in a draw after the 90 minutes of regulation requires extra time to play. Extra time consists of two 15 minute halves, allowing the competing teams the additional opportunity to settle the score. By this time, all, if not most of the 22 players on the field are near exhaustion. Chances are each team has used most of their substitutions and the winner can only be decided by one team’s desire to win being more than the other. If at the end of extra time a winner is still not decided, the two teams then go to penalty kicks. In this scenario, the two teams are no longer in open play. Each team takes a shot at the opponents goal with the sole responsibility of the goalkeeper’s ability to stop the shot determining the outcome. Each team gets five chances to score against the opposing team, unless one team is able to take an unassailable lead. In the situation that both teams are still drawn by the end of the tenth penalty kicker's attempt, the game then converts to sudden death; in which the first team to miss a penalty shot loses (Nag, 2022). These are the rules of the game. Each team put to the test

physically: being required to run, jump, make sudden changes of direction, and progress the ball forward repeatedly until a goal is produced. While on the mental side, needing to stay composed, remember responsibilities in a split second, and make the correct decisions to determine the outcome of a match..



Figure VI: USWNT wins penalty shootout vs. Netherlands in the 2021 Olympics (Das, 2021)

Based on the Demands, Who Are We Serving?

Given both the mental and physical demands of the sport, there is a general understanding that these female athletes must be in excellent physical shape. In addition to this, there is an understanding of the movements required within the process of playing at a high level. These movements include running, jumping, acceleration and deceleration, sudden changes of direction, pivoting and cutting amongst many others. In the past, women have been expected to perform at the highest level wearing men's cleats that are essentially sized down and altered in color to give players the impression that they are women's cleats. However, doing this has only been a notion of disrespect to female soccer players at every competitive level. In order to properly support the health and performance of these women, it is important that they have cleats that actually support their functions. The lack of this form of footwear has led to far too many ACL tears at the professional level, and without a doubt has had the same effect on young women playing on the levels that precede it. Because of this, the project aims to serve women

playing Division I , Division II, and National Association of Intercollegiate level soccer whose dreams and aspirations of playing professionally stand in grasping distance.

While the intended target demographic is women playing on the collegiate level, I want to use this project to additionally raise awareness, show my appreciation, and contribute to the development of the position that black women within the sport find themselves in. With this in mind, I want to highlight the potential of women playing collegiate soccer at historically black colleges and universities in hopes of emphasizing the importance of seeking black talent that exists in largely ignored black spaces in route to diversifying a rapidly growing game. Despite being the minority, black women have managed to make their presences known and their impacts felt, as the U.S Women’s national team brought a record high 7 black women to the 2023 World Cup in June of last year. Nearly a year later, those same 7 women helped the U.S. defeat Brazil en route to a Gold Cup final victory in March of 2024.



Figure VII: USWNT celebrate their win vs Brazil in 2024 Gold Cup Final (Purce, 2024)

Investing In the Future

While the ultimate goal is to design a cleat that allows female collegiate athletes to perform at the highest level without it being in exchange of their health, the secondary motive behind this

project is inspiring the generations that follow those leading our country to success. It can oftentimes be hard for black women in various spaces to see the light at the end of the tunnel. Many of them feel as if they are unsupported and that they have no chance at possibly representing their country. The underlying purpose of this project is to show them the opposite. It's to give them the motivation to continue to strive, while setting those of the professional level as the precedent of what they can truly be if they exhaust their potential .



Figure VIII: 8 black of the USWNT's black players pose for post game photo (Purce, 2024)

How Can We?

How can we design firm ground cleats that consider the anatomy and biomechanics of the female athlete to enable efficient movement while mitigating lower extremity injuries in women's soccer ? When doing this we want to provide these players with a cleat that enables them to move efficiently on the surface of play. For this reason, I would like to provide firm ground cleats that provide optimal rotational traction to efficiently execute pivoting, cutting, and sudden changes of direction. In addition to this, insoles in current cleat offerings utilize EVA foam, which lacks the needed durability to sustain cushioning for a long period of time and has been known to thin out after a season. As a result of this, I would like to design an innovative insole using foam that

sustains its physical properties and enables players to have proper arch and heel support beyond a season of play.

State-of-the-Art Product

The Importance of Supportive Footwear

When the discussion of sports and their respective athletes is had, one of the first things that comes to mind is what they are wearing. In most cases this includes jerseys, armbands, and other accessories that really define the character and personality of a particular player. However in soccer, while those same factors still apply, one of the most monumental forms of expression for players is through cleats. Cleats are important because they allow players to really express who they are as people and can do so in a number of ways. With the flashiness of these cleats is the need for them to perform well. Cleats must provide the athlete with comfort as well as the ability to remain light on their feet, make seamless transitions, and strike the ball cleanly. In order for this to occur, a player must have the appropriate cleats for the surface that they are playing on. As a soccer player, one's environment will always vary based on the geographical location of the stadium. Depending on where they are in the world, these players may be required to wear a specific cleat that suits either grass or turf fields. As designers, it is important that the athlete is being put in the best position to excel on that field of play. In response to this, a discussion about the plan to design a collection of footwear that enables optimal performance, while prioritizing their comfort and health will be had.

Initial line Plan

When designing a successful collection of footwear for these soccer players it is important to be sure of a few things that will keep the overall objective achievable. The first thing is making sure that this footwear is cohesive. These products should complement one another and speak the same design language. Ideally, one would like to have a variety of products that differ in intent, but still look like they are part of the same family. Secondly, it is important to make sure that this line of products speaks for themselves. This means making sure that others can look at these products and understand the message being conveyed. This also means understanding the significance of this footwear. It is important that in the process of designing these products that they empower the intended user and in doing so, express the value of said empowerment to those seeing them. Third and most importantly, this line of footwear must serve the intended user appropriately and effectively. In the case of this project, the goal is to provide a cleat option that properly accommodates the movements and functions of the female athlete's foot. In order to do this, it is important that we analyze the player's tendencies and most frequent movements, while also understanding the forces exerted in particular areas of the foot. Within that process, it is important to then understand how the athlete feels while executing these movements.

Products in the Market

Firm Ground Cleats

The first product that will be designed for these players is a firm ground cleat. Firm ground cleats are intended for natural grass fields that contain harder, rougher, dryer, and less treated surfaces. A good example of this is a natural grass field with a hard base and a dry surface. Most of these fields are played on by amateur players due to their ease of maintenance (Chanis). While the most common for amateurs, they are a bit unpleasant to play on, which can ultimately affect the user's experience. Firm ground cleats are best for these kinds of fields, because their outsoles possess the properties to penetrate deeply into grass. While not suggested, firm ground cleats are additionally seen as the primary choice of cleat for a lot of college players

due to their ability to perform adequately on multiple surfaces. These cleats are ultimately effective on firm ground, soft ground, and sometimes, but not always, artificial turf/grass. Most of, if not all brands within the sport of soccer provide firm ground cleat options.

The cleats identified as the state of the art competitor products are cleats used by my test athletes, understanding that they have a sense of brand loyalty that often prevents them from purchasing cleats from other brands. To broaden the amount of cleat options, additionally added was the Nike Phantom Luna, a cleat that's design was led by female athlete research and released just weeks before the 2023 Women's World Cup.

The first cleat presented is the Adidas Predator Edge. It is a firm ground cleat that utilizes Adi's Primeknit for the upper. It is a cleat of laceless construction to provide an easy dawn and doff for the athlete. Additionally, it provides zone skin rubber touch zones along the upper to increase ball touch control and feel. The Adidas Predator Edge is available for a retail price of \$135.00.



Figure X: Adidas Predator Edge (Adidas, n.d.)

The second firm ground cleat option comes from a brand that makes female specific footwear. The women's IDA Rise FG/AG is a women's specific cleat that includes custom stud configuration to support female pressure loads (Idasports.com, n.d.). This is extremely important because it addresses another underlying issue in the sport in relation to women's higher risk of injury. This particular configuration of stud

takes into account the differential in movement between female and male players, creating a cleat that makes quick and sudden movements extremely fluid . Many brands are currently designing with the man's foot in mind, so it is very interesting to see that IDA was able to use their research and technology to account for the movements of this boot. This cleat can be purchased at a retail price of \$159 (Odera,2023).



Figure XI: IDA Rise FG/AG (Idasports.com, n.d.)

The third firm ground cleat option is another variant of the Nike Zoom Mercurial Superfly 9. Like its soft grounded counterpart, its features include an internal speed cage structure designed with multi-ground outsole and a zoom air bag. Of the three cleats, this mercurial has a middle ground price of \$170 (Odera, 2023) .



Figure XII: Nike Zoom Mercurial FG (Nike, n.d.)

The fourth and final cleat state of the art cleat is the Adidas Crazyfast.1. Like the Predator Edge, the Predator Edge utilizes a Primeknit laceless upper providing an easy fit and a clean look. It is designed to be extremely lightweight and features a speedframe outsole and aeroplate designed to enable propulsion dynamic movement. The Adidas Crazyfast .1 is a firm ground cleat that can be purchased at a retail price of \$156.00 (Adidas, n.d.).



Figure XIII Adidas Crazyfast .1

Adaptation

Despite the disdain for firm ground fields on the professional level, there are many cases in the collegiate ranks where they are the best available. As things currently stand, many division 1 schools have home fields made of artificial turf, while others play on grass fields. Due to the fact that there are few turf specific cleats for the sport of soccer, it is very common for players to just use their firm ground cleats instead. While not suggested, these cleats possess enough traction ability for players to move efficiently on the turf surface. While most professional players find themselves playing on soft ground fields, there are occasions where teams may be required to play on a surface that they are not used to playing on. This can occur when playing against teams in the U.S. that use football stadiums as venues. Regardless of what a player is used to, they must always be ready for change and adaptation. To do this, it is important to provide these women with cleats that allow them to play comfortably at the highest level on both soft and firm ground playing surfaces.



Figure XIII Anatomy of a Firm Ground Cleat

Anatomy of a Cleat: Jobs to Be Done

The Upper

The upper is one of the most important parts of the cleat. It restrains the foot of the athlete, and hosts the tongue and laces of the boot enabling proper securement and stabilization of the top of the foot. The upper of a cleat can vary in style and oftentimes based on the brand making it. For the Tiempo Legend 10 the upper is constructed of kangaroo leather. This leather was utilized for the sake of providing players with a lightweight material that increases touch and connection with the ball (Nike, n.d.).

The Heel Counter

The heel counter is located at the back of the cleat. It provides the necessary stability at the rear side of the foot so that the athlete's movements are always supported throughout the actions of walking and running. The heel counter can be made of various materials, but in cleats is commonly made of thermoplastic polyurethane (Nike, n.d.).

The Tongue

The tongue of the cleat is located on the top of the upper. It cushions the top of the foot and prevents the laces from digging into a player's skin. The tongue can be adjusted and pulled for a more comfortable and secured fit. The tongue of the Tiempo utilizes the same kangaroo leather as the remainder of the cleat's upper (Nike, n.d.)

Toe Box

The toe box of the cleat is the section that surrounds the toes of the user. In soccer cleats it not only protects players toes, but allows them to move their toes freely as desired in the action of walking and running. It is important that the toe box is spacious so that players are not put at higher risks of injuries.

Outsole/Sole Plate

The outsole or sole plate of the cleat is located at the bottom. It houses the studs that provide the necessary traction in the action of high intense movement that include changes of direction and establishing one's overall footing. This plate is made from flexible thermoplastic polyurethane (Nike n.d.).

Cleat/Stud

For both firm and soft ground cleats, the studs are the most important for high level performance. They allow the player to dig into the grass, turn, or other player surface and have full control of their movements. They also provide players with traction to be in full control in the action of changing direction. Depending on the type of cleat being worn, the studs can come in the form of aluminum or plastic to allow players to have full control of the varying surfaces played on. It is very common for firm ground cleats to have plastic studs, while soft ground cleats can be found to have metal studs made from aluminum.

Cleat Manufacturing

The Upper

The cleat manufacturing process can be executed in a number of ways, but in relation to how these specific cleats were , the process was completed by lasting. The first step in the process is cutting out your upper and liner patterns. Because the cleat needs both an outer and inner material for its' upper, one will oftentimes cut this same butterfly pattern out of a liner material that is gentle to the skin. While the same material can be used, it would be preferable that a more comfortable material and moisture resistant material is utilized. After this second pattern has been drawn, the patterns will then be put against one another, but inside out similar to any garment that is typically made, and sewn together. It is important that in the process of sewing, the back end of the boot is left open to allow you to insert a heel counter. Heel counters, currently made of internal thermoplastic polyurethane, serve as a rigid barrier of protection against impacts to the foot in the action of play. They also provide additional structure to the back of the cleat. When the boot has been flipped back out the heel counter can be inserted, and then stitched closed. At this stage, the upper of the cleat has been completed.



Figure XIV: Singular Pattern of cleat

Soleplate Tooling

The tooling process in cleat manufacturing is arguably the most important for a number of reasons. Firstly, in our specific case where these cleats are being made for women, it is important to take their range of movements into consideration. A general understanding of the loads of pressure exerted and distributed throughout the foot, and strategically placing the

studs/cleats accordingly to create a balance that opposes those forces will prevent slippage or over penetration. Doing this successfully will allow players to make a wide range of movements without any concern of losing balance. Secondly, we want to be mindful of both the shape and the depth of these studs (Thomson, et. al, 2021). Different shapes have varying effects on the playing surface regarding traction. Picking the most efficient shape combination with the appropriate depth, can have a huge impact on the athletes ability to move efficiently. Having studs that are too shallow can lead to the athlete losing control of their balance, while having studs that are too deep can lead to their foot becoming stuck in the ground; increasing the risks of serious injuries (Thomson, et. al, 2021). As a result it is important to understand gait analysis and pressure loading of the athlete to appropriately place studs in ways that assists their movements.

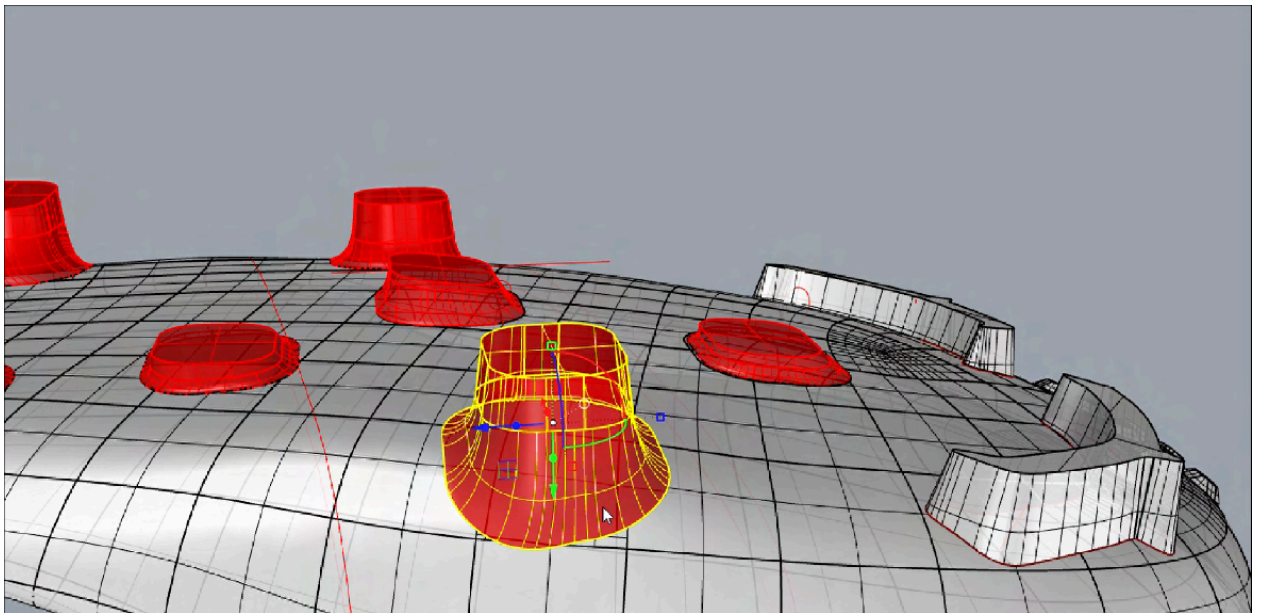


Figure XV: Tooling of Soleplate and Traction

To execute these details perfectly, we will utilize a 3d computational software like Rhino or Solidworks that allows us to model the soleplate and studs as needed. These software will additionally allow us to configure a variety of forms that can be attached to the plate and give us a visual understanding of how the cleat would work for the user. This process is not easy, as it

often will depend solely on the user's needs. The first iteration will be made for the athlete to test and then adjusted as needed based on athlete feedback.

Lasting

The upper has been completely sewn and the soleplate and cleat tooling has also been finished. At this point you are now ready to put this boot together. In many modern factories, the lasting process is completed by computed machinery that perfectly forms the patterns made to a foot last. However, in this case the shoe will be the last fashioned way. This means grabbing the same last used to draw the pattern on, inserting into a clamp, and staple lasting it to a strobel board. This lasting process will require a couple of additional tools, as the liner and upper will be pulled to form around the last for a seamless fit. These tools include a stapler, lasting pliers, and barge or any contact glue which will eventually dry after configuration. Once the last has been placed in the clamp, the butterfly pattern is pulled on top of the foot last and is pulled and stretched to form around it. Once pulled to the greatest extent, the leather is then stapled to the insole placed at the bottom of the last. When this has been done around the entire an initial fit check is done to confirm that the patterning, construction, and alignment of the upper is all correct.



Figure XVI : Initial Fit Check and Stapling Process

Gluing

After the alignment and fit has been confirmed the upper is now ready to be fully lasted and permanently glued. Removing each staple, contact glue will then be applied around the entire sole of the last and strobel board for both the liner and upper to sit tightly. The final step in construction is gluing the lasted upper and the soleplate together with a contact glue.



Figure XVII: Lasted Upper and Printed Soleplate

The Insole

Up to this point we've discussed the performance and manufacturing aspects of a soccer cleat that will be needed for the female athlete: a cleat that enables optimal performance on both grass and turf surfaces. However, what remains to be discussed is how to enable these players to not only play at the highest level, but do so comfortably. A lot of aspects factor into player comfort. One is fit: making sure that the player is provided with a cleat that forms well to the foot, provides enough space for the toes to move and can be worn for several hours. One part of

a cleat that is integral to comfortable and effective high performance are insoles. For many athletes, the cleats they originally buy often have insoles that are exchanged for custom ones that better suit their needs (Wrack, 2023) . For players that have lower arches or are flat-footed, they may want to wear an insole with a much lower profile to better support their movements.

Current Insole Offerings

There are a number of insole options available on the market. Some insoles prioritize responsiveness and enable the user to have great propulsion and explosiveness with each step. While others focus on making the user feel as if they are standing on a cloud valuing aspects of the insole that provide a more plush feel. These insoles often emphasize the importance of cushioning and support that prevents foot pain For soccer cleats, the goal is to remain as light as possible. As a result, many cleats provide an insole that is extremely light in weight, but in the same breath fails to properly cushion the athlete's feet or support each critical moment. They often utilized ethylene vinyl acetate (EVA) , a foam that is commonly used in sports products and equipment.

At the cost of weight, these insoles often fail to support athletes with a level of cushioning and support that can be sustained for a long period of time. As a result they often turn to a variety of insoles on the market that offer and maintain characteristics that best suit the athlete's wants and needs.

The first insole among the state of the art products is that of the Adidas Predator Edge. Made of a thin EVA, it is designed thin and aims to enable players to retain touch and feel of the ball while providing the necessary cushioning and support to absorb impact.



Figure XVIII: Adidas Predator Insole

The second insole among the state of the art products is that of the Adidas Crazyfast.1. Like the Predator it is made of a thin EVA that aims to enable players to retain touch and feel of the ball while providing the necessary cushioning and support to absorb impact. It includes dye-cut perforations that provide some breathability for the foot during play.



Figure XIX: Adidas Crazyfast .1 Insole

The third insole is that of the Nike Mercurial Superfly. It is made of 50% recycled content including rubber powder and polyurethane. It is designed to provide high density and low rebound for superior shock dampening and energy absorption.



Figure XX: Mercurial Superfly Insole

The IDA Rise Firm Ground cleat insole is made of GRS approved dual density recycled foam. It is designed to provide low rebound and shock absorption to enable performance on grass and lush synthetic surfaces (Idasports.com, n.d.). With the cleat designed specifically for women, its design was heavily influenced by the feedback and input of the female athlete to provide optimal cushioning. .



Figure XXI : IDA FG Rise Insole

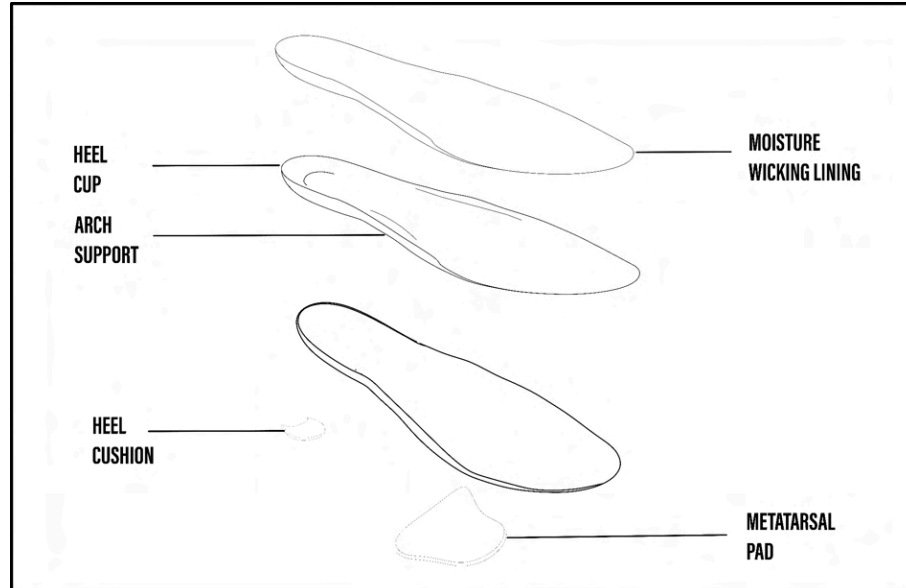


Figure XXII: Anatomy of an Insole

Anatomy of an Insole: Jobs To Be Done

Moisture Wicking Liner

The liner of the insole covers the top of it and directly touches the foot. It is intended to wick away moisture that accumulates while the user is sweating. It additionally can provide grip for players that want to prevent any slippage and prefer to have grip (Roach, 2023).

Arch Support

The arch support plays a huge role in the ability to provide the athlete with optimal stability for the arches. With its existence more force can be equally distributed during activities that require large amounts of load bearing weight, such as running (Roach, 2023).

Heel Cup

The heel cup is intended to provide stability and a nice feel for the back of the foot. Its structure enables the heel to fit snugly into it without trouble. It additionally prevents lateral and side movements (Roach, 2023).

Heel Cushion

The heel support is typically made of poron foam and is meant to serve as the support that reduces shock and provides great impact absorption in the heel region of the foot. The heel cushion best absorbs impact during the heel strike, one of the most frequently occurring moves executed while playing (Roach, 2023).

Metatarsal Pad

The metatarsal pad is typically made of a foam (ethylene vinyl acetate, polyurethane, or memory foam) as well as rubbers or gels. Its job is to cushion the forefoot as it makes contact with the ground in the action of walking or running (Roach, 2023).

Manufacturing of an Insole

The first stage: 3D Scanning

The first step in the manufacturing process for a custom insole is 3D scanning. Understanding the contours of the user's feet is extremely important, as it will enable optimal fit and maximum comfort. In addition to this, accurate mapping of the foot is a must-have if an athlete's orthopedic needs are to be met. Every athlete's foot is different, and as a result requires a separate analyzation process to adequately serve them.

3D Modeling of The Insole

After the athlete or user's foot has been scanned it is loaded into a 3D CAD software that will set the reference/base in which the insole will be modeled on. During this process, parameters that

include width, thickness, and height of the insole can be determined and modified as needed (Raise3D, 2020).

3D Printing

After the insole has been modeled to fit the athlete's foot, it can then be 3D printed. It is best to print these insoles out of TPU (thermoplastic polyurethane), an elastomer that possesses great elasticity and the ability to retain its physical properties and shape over a long period of time (Raise3D, 2020).

Processing and Finishing

After the insoles have been printed, they are now ready for finishing. In most cases an EVA (ethylene vinyl acetate) foam of some kind is used as the source of support of the foot. This foam is cut exactly to the shape and form of the 3D print for a perfect fit (Raise3D, 2020). The insole is then dressed or covered with a moisture wicking fabric on the top layer where the foot will rest. This layer will allow for sweat and additional moisture accumulation to remain minimal, as well as provide some sort of breathability for the user.

The Insole Being Designed

Regarding the insole being designed, the objective is providing the athlete that not only properly cushions and supports their feet, but is able to do so for a long period of time. Each and every step of the insole making process will be followed as listed previously. This insole will integrate a heel cup to provide increased heel stability and fit, a poron heel cushion to absorb the impact that occurs during each and every step of the athlete in addition to critical steps of impact that occur when the athlete is striking the ball. While most insoles utilize EVA, this newly designed insole will integrate a more durable foam that can further support the stability of the athlete's arches.

A Collective Line

As mentioned earlier, the goal is to create a cohesive line of products. With the successful completion of an insole, there will be an integral innovation that further improves and completes the entire system that is the cleat. In addition to the intended user and scenario of usage, it is

ideal to make sure that each of these products speak the same language from an aesthetic point of view, while also being the best possible solution in terms of functionality, fit, and comfort. Only then can it be said that a successful line of products has been created for these female athletes.

Cleat Patents

Like any other product, cleats were once a new idea. They began as effective footwear solutions for athletes whose sport took place in grass, mud, and other like-surfaces. They allowed athletes to play with a bit more control despite the challenges posed by the elements. However, as time and the skills of athletes progressed, the demand for improved equipment grew larger. As a result of this demand, cleats have gone through a series of innovations that's solutions for overcoming challenges on the field of play have warranted the need for patents. We'll discuss some of these patents, their functions, and why they contribute so well to the overall performance of an athlete.

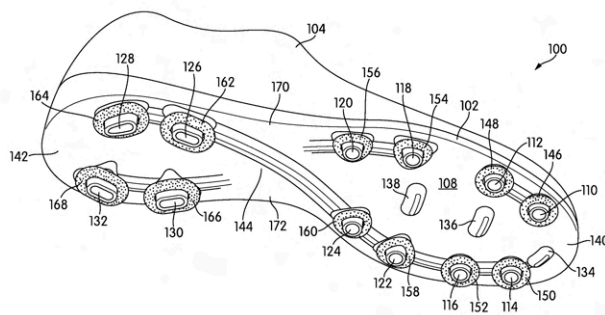


Figure XXIII: Self-cleaning cleats (Baudin et al, 2020)

Self Cleaning Cleats

As you may know by now, soccer is played on a number of surfaces. These include natural grass, artificial grass, artificial turf, and at times even mud when the natural grass has been oversaturated by water. It is during these times that cleats are put to the test. While cleats allow you to play on muddy surfaces, over time that mud builds on to the cleat; eventually

decreasing its ability to aid the user in making quick cutting movements, changing direction, and keeping balance. To combat this build up, Nike developed self cleaning cleats that would later be patented in 2020. This application utilizes a sole plate with resilient members that prevent mud from accumulating on the cleats or a bottom surface of the sole plate. This is done by compressing against a surface of the ground and then springing back, preventing mud from sticking to the resilient member (Baudin et. al, 2020). This innovation is extremely unique, because it essentially allows players to play in some of the worst conditions possible without losing balance, time and ability to react, and generally improves the athlete's experience and performance. Additionally, it is a great innovation because it can be applied to sports beyond soccer like, rugby, baseball, and American football. This would prove beneficial to our athletes, because it allows them to play for longer periods of time in muddy conditions without concern for losing connection to the field.

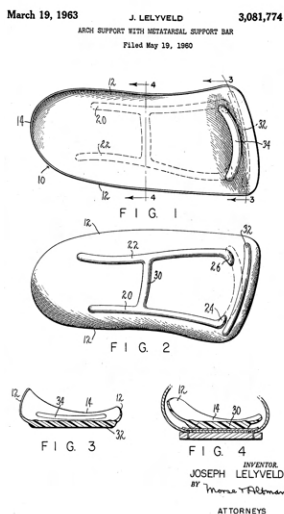


Figure XXIV: Flexible Metatarsal Support Plate (Joseph, 1963)

Arch Support with Flexible Metatarsal Support Plate

The second patent discovered in relation to cleats, is designated for the arch support of the athlete. Many people, both athlete and non-athlete, deal with issues in the foot. Oftentimes these issues involve the arches of the feet, a common problem amongst many. In most cases, the

solution for many is to buy custom insoles that can be inserted into whatever shoe is being worn by the user. These insoles alleviate the pressure being induced onto the arches in the action of walking or running, creating a more comfortable experience. This patented innovation was designed as a flexible metatarsal support plate that consists of a moderately flexible synthetic resin shaped to fit within the heel and shank portions of the plate being turned up. It would include additional ribs on the underface that would be a bit thicker for added support. These ribs would extend lengthwise and would support both the medial (inside) and the lateral arches of the foot (Joseph, 1963). This design is great ,because each of its parts work in tandem to essentially relieve pain in both the longitudinal and transverse arches of the foot. For an athlete that is constantly running, the arches of their foot will take a lot of the load and pressure exerted onto the ground in the action of running. With this support, the amount of shock absorbed can be reduced, ultimately allowing the players to perform for long periods of time without discomfort. Considering that the athletes of intended use will be flat footed, portions of this innovation can be implemented into the new design. If done, there would be more emphasis on the heel region, to allow these flat footed athletes to have the support they really need in order to mitigate the risks of heel spurs and other conditions in the backend region of the foot. This design solution was developed by Lelyveld Joseph in 1960 and was granted patenting in 1963. It has since expired for 43 years and is open to being used or modified.

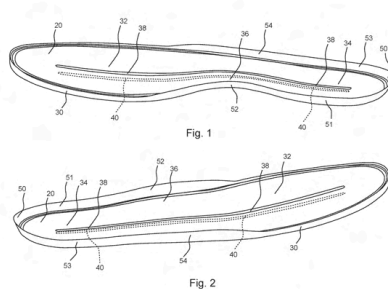


Figure XXV: Shoe Leveling Insole (Joseph, 1963)

Shoe Leveling Insole

The third patented innovation discovered also focuses on the insole of the shoe. With a user that is flat footed, it was extremely important that the focus was on the support of the user's foot, in addition to the ability of the studs. The shoe leveling insole, invented by Todd Alviso in

2016 had a negative-heel consisting of a substantially tapered body of material, having a predetermined thickness for the forefoot portion of the insole. The base of the insole was to be made of a flexible material that would allow for pressure and force to be exerted on to it without giving in. (Aviso, 2016) The intention of this innovation was to make it so that the front and heel of the foot were made level. Unfortunately, this innovation had a patent application file, but was never granted and as a result has been abandoned.

The innovation of cleats has progressed immensely since the beginning of their existence. Both the game and modern technology have advanced so much that control of each playing surface is approached differently. While many design solutions have been found for each, the existing competitors in the soccer cleat market have done so with the male player in mind. With a focus on the female athlete, we are accounting for a differentiation in loads exerted, movement, and structure, given the particular user being a flat footed woman. With that in mind, it is important to break down the user at hand and overcome the underlying problems in route to designing a successful cleat for the female athlete.

Cleats: Color and Graphic Trends

We previously discussed the innovations that have taken place in the football boot space in relation to their stud's ability to overcome environmental elements as well as the types of insoles created to help relieve player's foot pain and discomfort. While those innovations tend to stand strong until new and better solutions are created, there are two aspects of the cleat that tend to change no matter how much success the current solution is having. These are colors and graphics. In just the last 50 years, we've seen some of the world's greatest players to ever play, dawn the pitch with some of the most iconic and memorable cleats. Some are so special that they've marked monumental moments in the timeline of great football cleats. From David Beckham's gold and white Adidas Predators to Cristiano Ronaldo's safari Nike Mercurials, each and every cleat released has come at a time where a certain color or graphic was in high demand and popularity. In today's game those demands still run true, and as we enter the month of November, the industry is preparing to head out with the "old" and in with the "new" trends.

With this in mind, we'll discuss both current color and graphic trends in the game as well as future color and graphic trends that will align with the cleat that will be designed for these athletes.



Figure XXVI: David Beckham's Adidas Predator (Jones, 2020)

Current Color Trends

The summer of 2023 was headlined by the monumental drop of Nike's Phantom Luna; the first cleat from the brand designed with the female anatomy in mind. This shoe, in its white and orange colorways, headlined the 2023 Women's World Cup along with its brand counterparts in the Mercurial and Tiempo, all coming in a similar color scheme. The Phantom Luna also came in a turquoise color, another popular summer color. Like Nike, many of their competitors released cleats that also aligned with the bright, fluorescent tones you would associate with the summer, aligning themselves with the upcoming tournament in Australia. Colors for these cleats also included bright green, blue and pink hues from PUMA, light blue from Adidas, and white from New Balance. All of these colors played a huge role in the promotion of new collections for each of soccer's most prominent brands (Odedra, 2023) . Along with these, were cleats from the spring season, that also correlated well with the colors of the summer. These cleats were showcased at an all time classic Women's World Cup that brought in a total viewership of over 2 billion people.

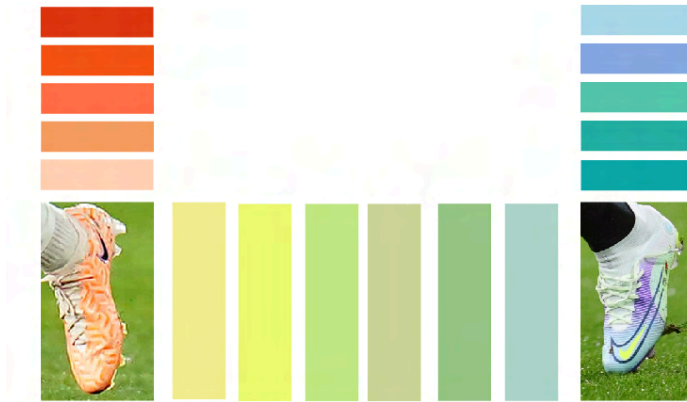


Figure XXVII: Color Trends for the Spring and Summer of 2023

The tournament's conclusion in August marked the beginning of new releases for the upcoming fall season. These were headlined by the Nike “ready pack”, featuring bright red, black, and white renditions of the Mercurial Superfly 9, Phantom GT, Phantom Luna, and the next gen Tiempo (Chris, 2023). Along with these came player exclusives at other brands that also came in the same hues, including New Balance’s Furon v7; the signature boot of Arsenal’s Bukayo Saka. Constant cleat colors that will always remain in trend no matter the season are white and black boots. These white boots will often come with brief stints of color, while the black ones tend to be solid for the most part.

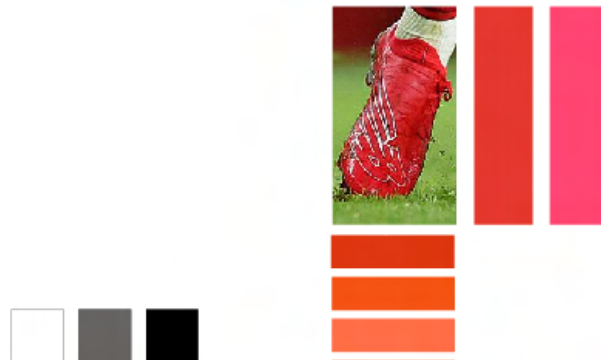


Figure XXVIII: Current Color Trends for the Fall of 2023



Figure XXIX: Nike's Fall 2023 Ready Pack (Chris, 2023)

Current Graphic Trends

In today's game, graphic trends tend to be extremely energetic. This comes in the form of vast material changes that include combinations of leather and polyurethane, as well as dramatic lines and concentric circles of bright colors on neutral colored cleats. In addition to this are subtle additions like a built in sock liner that transforms a low top cleat into one that now looks like a mid or high-top boot. While these graphic trends remain viable options for players, the most popular by far at the moment are the wild moments of pop being worn by the game's top players. The Nike Mercurial line for years has mastered the art of almost treating the shoe like a blank canvas and putting a variation of colors that you typically wouldn't wear out in public on a normal garment or piece of footwear. This has always been intriguing, because it provides a bit of insight in regard to player's personalities. One of the best examples of this is Real Madrid winger Vinicius Junior, who wears highlighter yellow Mercurials with several moments of bright red as the complementary accent.



Figure XXX: Current Graphic Trends (Soccerbible, 2023)

Future Color Trends

For future color trends, the goal is really honing in on the empowerment of the athlete. Understanding and leaning into the fact that the cleat is for a special and largely underserved demographic within the sport: black women who suffer from flat footedness and other conditions in the foot. In the process, we want to execute the understanding of that particular individual, designing a boot that accommodates the needs of the women's anatomy and movements from a functional standpoint, while also looking nice in style. Because of this, the goal is to implement color psychology into my cleat's design direction. Getting more insight and perspective on the player as a person as well as their mindset, how they would describe their game and mentality when approaching the game, and really integrating their character into the aesthetics of the cleat could be something that really makes them feel empowered. Color psychology is a great way of doing so, because it really reflects the person's mood or state of mind without any further explanation. After conducting interviews with these players, colors that reflect what they've described will be used to create a cleat that differs from what has been seen in the past. In today's day where mental health has become an even more important aspect of sports, it would be a nice way to highlight the importance of seeing a player for more than just what they do on the field. As a result of this, some colors that are strongly being considered are more neutral tones. These

tones speak to the future in a sense, but still align with the popular base colors we have seen in the past. With this concept, the goal is really honing in on these women as both athletes and human beings.

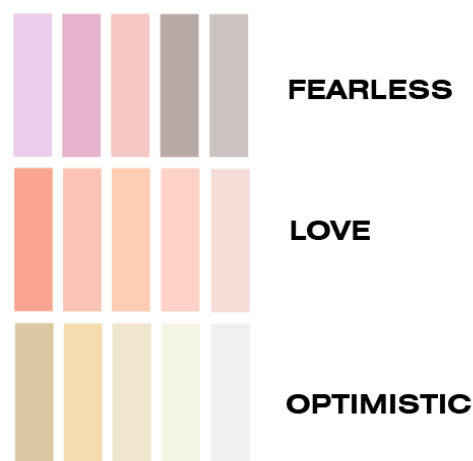


Figure XXXI: Future Color Trends for the Boot, Inspired by Color Psychology

Future Graphic Trends

Regarding the graphics of this cleat, the goal is to channel a combination of both the old and the new styles of soccer cleats in the game today. Regarding the cleats of the past, this would feature patterns and shapes that overlap one another. These details would be reminiscent of David Beckham's Adidas predators from the early 2000's. In terms of the future, it would be nice to lighten the load on the athlete and perhaps remove the need to tie the shoe. A lot of the next generation cleats being released now are laceless, creating a more seamless silhouette that really speaks to the concept of minimalism (Soccerbible, n.d.). For athletes, it will be important to blend the two, while drawing on inspiration from the great architecture around the world. By visualizing the cleat as a building for the foot, there will be demonstrations of the same principles to really give the shoe character. At the end, the goal is creating a cleat that stands the test of time.



Figure XXXII: Future Graphic Trends (Soccerbible, n.d.)

Insole Patents and Innovations

Insoles have for long been an essential part of footwear. They enable the foot to rest comfortably in the shoe, and provide points of relaxation where pain and discomfort often arise after miles of walking. For soccer cleats, insoles are often designed to be thin to enable the athlete to remain light on their feet, while also retaining close control and touch with the ball. As a result of this, it is very common for players to exchange the insoles that come in their cleats with ones that are a bit more comfortable and fitting for their particular feet. In most cases, the insole that comes with the purchased cleat fails to consider factors like athlete arch height, areas of pain, and discomfort, and needed areas of additional cushioning to enable the player to operate with the utmost comfort. With this consideration in mind, a number of footbed solutions were analyzed to get a better understanding of things to consider when designing for player comfort. While these innovations are not necessarily insoles, they are solutions that aim to soothe the feet, which is the overall goal to achieve for our female athletes.

Shoes for Pressing the Reflex Zone

The first innovative patent to be discussed is one from JaeHyung Hong that focuses on relief of the foot by way of accommodating the reflex zone. The shoe includes an acupressure function to selectively stimulate the foot by composing multiple reflex zones and pressing bars corresponding to the reflex zone (Hong, 2006). The idea behind the reflex zones is essentially the understanding that each part of the foot has the ability to trigger different reactions to separate parts of the body. Because of this, the foot is broken up into four distinct zones that correspond to various parts of the human body. From front to back these zones are tied to the head, chest, abdominal organ, and the pelvic area (Wilson, 2022). While a bit difficult to understand, this patented innovation is interesting, because while trying to accommodate the foot, the designer had in mind what the responses and sensations of the corresponding regions of the body would be.

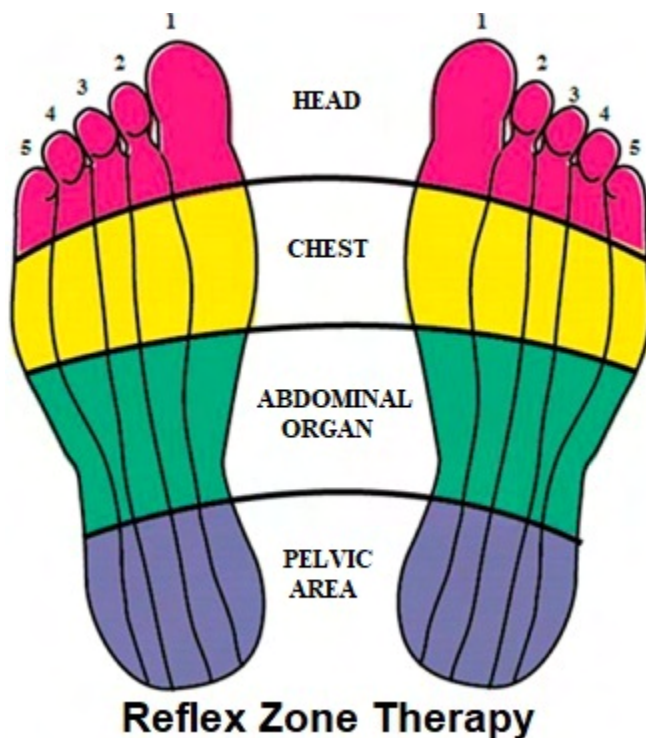


Figure XXXIII: Origins of Reflexology (Wilson, 2022)

Magnetic Therapy Massage Slipper

The second innovative patent more so aligns with the goal: to create a slipper with a footbed that allows these players to feel relieved of pain after several hours of running. This design is a magnetic therapy massage slipper created by the same designer, JaeHyung Hong. The upper surface of the sole is provided with various magnets and evenly distributed projecting massage columns, and the magnets are inlaid on the sole through hollow columns. When the slipper is worn by a user, the magnetic therapy function of the magnets can be released naturally to a foot sole, so that acupoints and main and collateral channels of the foot sole are stimulated, and foot sole reflective areas are fully massaged by the projecting massage columns on the sole. The magnetic therapy and massage to the foot sole are performed by the aid of the magnets and the projecting massage columns, and the acupoints of the foot sole corresponding to all organs of a human body are stimulated, so that microcirculation of a foot is improved, and human body fatigue is relieved (Hong, 2006). This innovation seems to be in direct correlation to the shoe that accommodates the reflex zone.

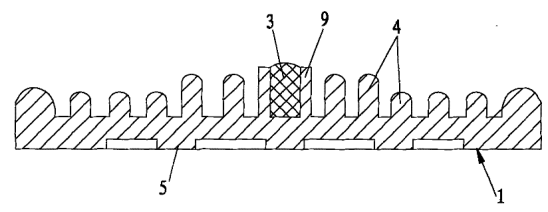
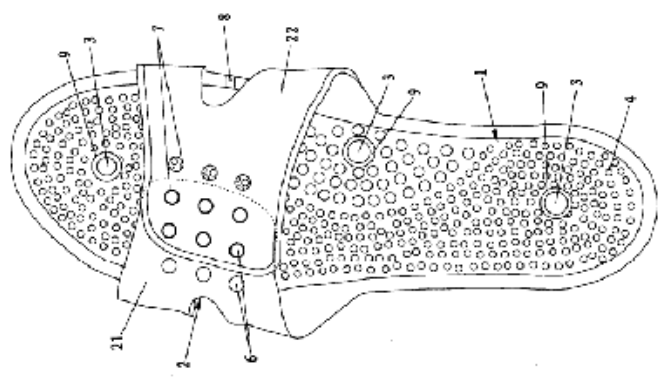


Figure XXXIV: Magnetic massage therapy slipper (Hong,2006)

Oofos Ooahh Patented Footbed Technology

The third patented innovation is Oofos Ooahh's patented footbed technology. Of the three patents selected, this one has been the most private, as the actual patent has been unable to be found, and very little information has been released about the specific things being done to make the slippers one of the best recovery slides in today's market. What has been shared is that they utilize a closed cell foam that they've named Oofoam (Ooofos, n.d.) . The actual patent is said to be the actual footbed rather than any additional mechanisms in addition to the closed cell foam that is not being shared with specification. This product is a good reference point in regard to designing a great recovery slide, and because of it has been deemed as a top slide in the market. Staying clear of designing a footbed that resembles the one of Oofos is the best way to go about designing a recovery slide. In addition to that, to stay clear of potentially using the same foam as they do, it is important that open cell foams are explored to possibly achieve the same goal in comforting these athletes throughout as they exert repeated pressure on the footbed of the insole.

Insoles: Current and Future Color Trends and Graphics

Insoles: Current Color Trends

When it comes to the color of the current cleat insoles in the market, people tend to buy cleats with eye popping colors. Oftentimes the color of the insole for a cleat is the same color as the cleat's primary color. In cases where the two colors on the cleat are white and a bright color, the insole is oftentimes white. However , when the cleat features two bright colors, the insole is typically the color of the secondary tone of the shoe. Because of this current color trends for

soccer cleat insoles will fall directly in line with current color trends of cleats. These colors come in forms of white, black and bright green.

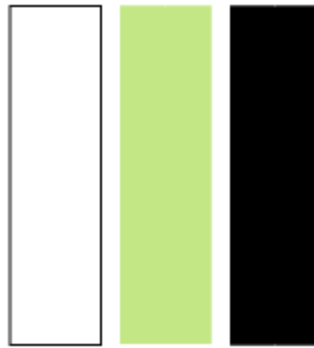


Figure XXXV: Current Color Trends for Insoles

Insoles: Future Color Trends

As mentioned earlier in the paper, designing footwear that work as a collective unit is extremely important. Given those intentions, along with the color and silhouette of the newly designed cleats stated in the future color and graphics sections, the insoles must correlate with the cleats to communicate a cohesive project. In order to do so they will either be the same color of the cleat or match that of the cleat's secondary color.



Figure XXXVI: Future Color Trends in Relation to the Cleat and Insole

Insoles: Current and Future Graphic Trends

The most interesting thing about the current and future graphic trends for soccer cleat insoles is that they have always been and will always be designed to remain minimal. As currently constructed, soccer cleats do not have a midsole. When they are designed, the goal is making sure that the athlete feels the lightest, can run the fastest, and is free of any excess material that can be seen as a threat to being as explosive as possible. Without a midsole, the insole is left to perform its job: absorbing impact to support the athlete's each and every step. However, because it remains minimal, the athlete's comfort comes at a cost. As you can see in the image below, the insole looks extremely thin and sleek. It possesses minor perforations to provide breathability, but in the same breath, removes additional material to further lighten the weight of the insole. Lastly, most if not all insoles for soccer cleats are marked by symbols, a singular logo, or words that represent the overall branding and aesthetic of the cleat.



Figure XXXVII: Oofos Ooahh Slide Sandal

State of The Art Current and Future Logos and Branding

Current Logos and Branding

In modern day soccer, logos and branding are everything. The greatest players in the world have used their talents and the platforms their talents have created to propel themselves as brands. Whether it be branding from a company or branding by an individual, many of the logos and brands in today's game follow the same style: minimal, but bold, always making a statement with very clear indication of who is being represented. Whether it's eight time Ballon D'or winner Lionel Messi; who incorporates the existing Adidas signature three stripes into the M in his last name, or the next generation's star in Kylian Mbappe; who simply uses his initials, every player establishes a brand for themselves and typically follows a model that keeps the message clear and simple, while separating themselves from their peers.



Figure XXXIX: Signature logos in the game of soccer

Logo and Branding

For the design of these cleats, the logo and branding was extremely vital to the symbolism of the athlete and the things that they represented. With a focus on the black female athlete, the goal was to find an animal that shared similar qualities to them both on and off the field. The lynx was chosen as the logo for that very reason. Despite their smaller stature in comparison to other big cats, they possess the speed, power, and resilience to overcome obstacles within their “ecosystem” in route to achieving their goals. The agility of the lynx was intended to be the power or ability that the cleats provided to this female athlete, allowing them to quickly maneuver on the field. The alternative logo would be the five claw marks of the lynx. These marks would be a symbol of the ferocity that these women play with similar to this predator.

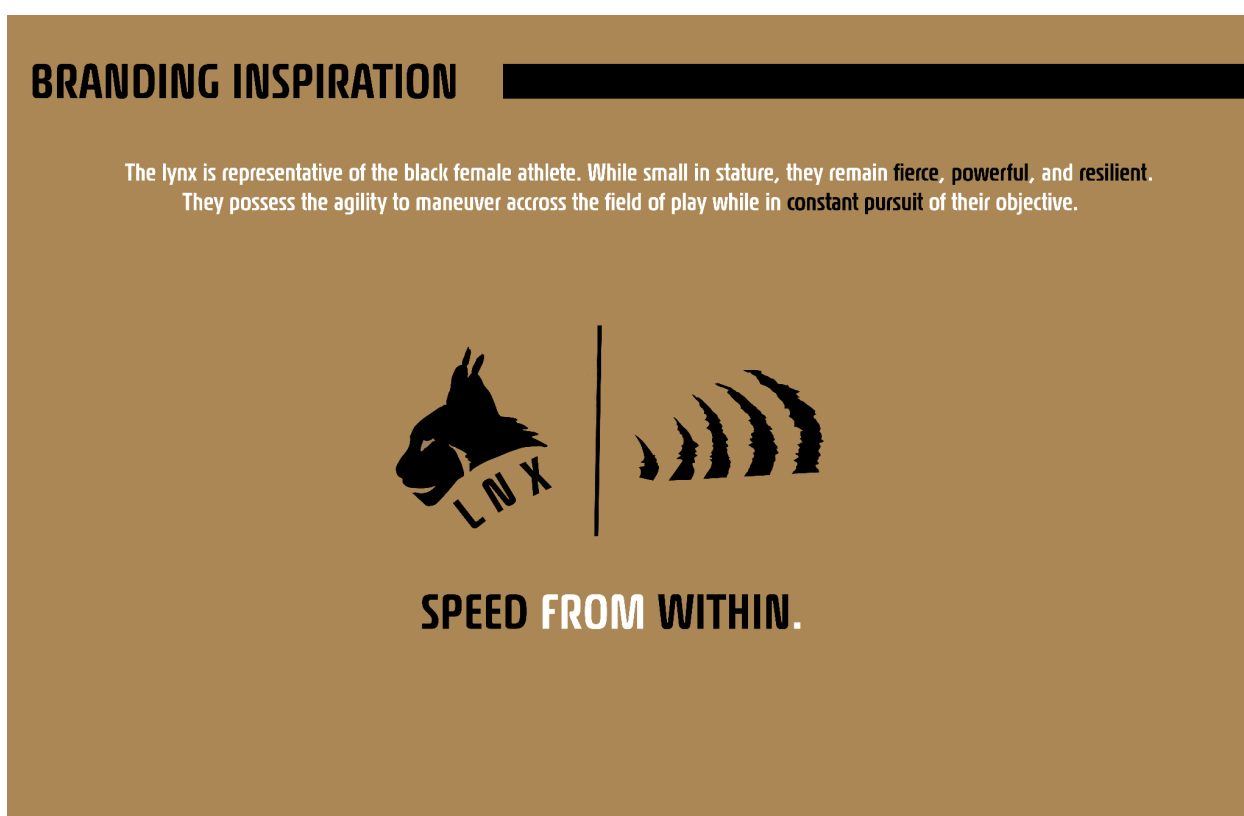


Figure XL: Branding Inspiration and Slogan

Physiological, Biomechanical, and Psychological Research

Physiological Research : The Problem

One of the biggest existing issues in women's soccer is a lack of cleat options. Aside from Nike's recent release of the Phantom Luna, Ida Sports' women specific cleats, and PUMA's recent release of the women's specific brilliance pack, there are very few cleats in the game that are designed to accommodate the structure, functions, and needs of a woman's foot. With the game growing exponentially, this is an alarming concern, because it shows the overall lack of consideration for women's wellbeing within the sports product industry. This has been an issue for far too long and is putting women's careers at risk and lives in jeopardy. These problems cannot continue for much longer, and immediate action must be taken.



Figure XLI: 60% of women's injuries occur in the lower extremities (Wrack, 2023)

Physiological Research: Structural differences, Lack of Comfort, and Impact of Race

The problem at hand is pretty straightforward: female soccer players are not being provided with adequate cleat options to play with comfort. As things currently stand, a majority of women play in cleats that are not designed with the female anatomy in consideration. This means they are simply wearing cleats designed for men at a much smaller size to fit their feet (Lewis, 2022). This is extremely inconsiderate due to the fact that men and women have significant structural differences in the foot. These structural differences result in a variation of

movements and functions that require a different set of design considerations and solutions. Some of these differences include women's tendencies to have shallower toes, a more curved inner foot, a shorter outer foot length, smaller plantar distribution, and higher arches (Footalk, 2019). When players wear cleats that don't account for these differences, they are putting themselves at greater risk of discomfort, pain, and eventual injury.

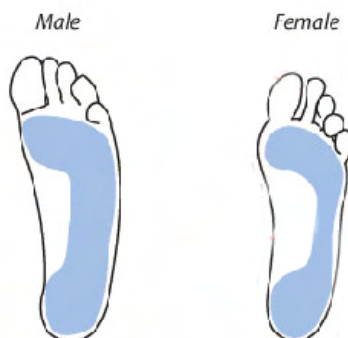


Figure XLII: The Difference Between a Man and Woman's Foot (Hiking for Her, n.d.)

In June of 2023, a survey was taken by 350 women playing in Europe's top domestic soccer leagues. Of those women, 82% expressed experiences of pain and discomfort while wearing current offerings of women's football boots. $\frac{1}{3}$ of players said that they would typically customize their cleats, a majority of which, utilized special insoles. Many players also stated that they made efforts to increase the comfort in their cleats by cutting holes in the back to widen the heel. In addition to that, 18% of the surveyed players stated that they did not select their own boots and that they were picked by the brands or teams they represented (Wrack, 2023). With that being said, it is time that designers acknowledge how unacceptable it is for an athlete of any kind, and more so at the professional level to have to go through something like this.

Results of the player survey also revealed that there were distinct player experiences and factors of comfortability between races. Of the black women surveyed, 48% of players expressed feelings of discomfort and pain in the heel region of their foot (Wrack, 2023). This particular statistic stands out due to the history of common foot conditions found in black women, as well as the increased risk of injury as a result of discomfort and pre-existing structural differences that

go unaccounted for. Historically speaking, black people have been found to be three times more likely to have flat feet by the age of 45 (Zohaib, 2018). With that in mind, it is fair to consider that prior to that age, many women were already flat footed to begin with. This would mean that as they grow older, their already pre-existing flat footedness is developing into something much more severe. When you factor in pre-existing conditions for a large sum of players, as well as players whose feet will later develop these conditions with age, there are many soccer players that need a cleat to accommodate the needs of their particular foot. Refusing to accommodate the needs of these black women is extremely harmful, because it can lead to injuries like bone/heel spurs; a bony growth that develops on the edge of the bones where they meet, plantar fasciitis; a condition where the tissue underneath the foot becomes inflamed, and more serious conditions like osteoarthritis, tendonitis, and haglund's deformity; a condition that can later lead to a tearing of the achilles (Gupton et. al, 2023).



Figure XLIII: Flat foot vs High Arch (Adult-acquired flatfoot, n.d.)

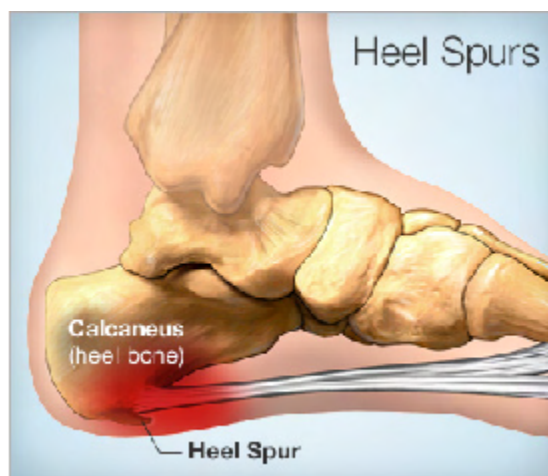


Figure XLIV: Heel Spur in the Back of the Foot (Admin, 2022)

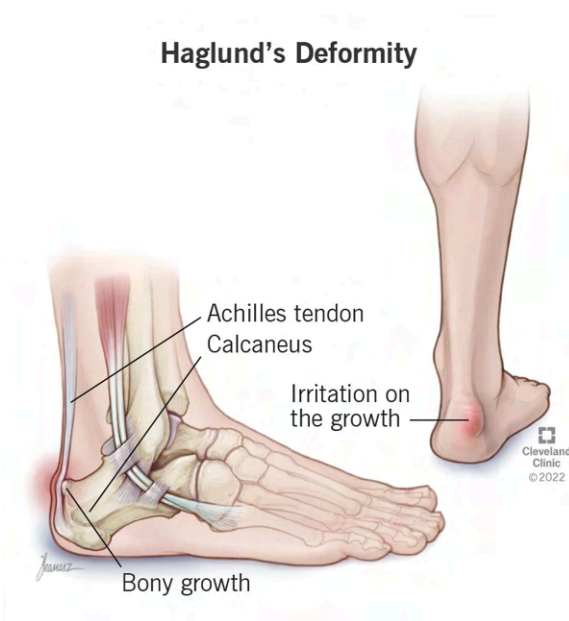


Figure XLV: The effects of Haglund's deformity (Gupton, et. al, 2023)

Biomechanical Research and Factors

The Arches

When we factor biomechanics into the conditions of a player's feet and the need for adequate cleat options, it is important to analyze the gait cycle and the parts of the foot that work together to enable athletes to make the high intensity movements that they do. The gait cycle is a series of phases that the foot goes through when walking and running. The three most important phases within this cycle are the heel strike; the initial contact point made between the back of the foot and the ground, the loading response/midstance; where the foot has come nearly into full force and contact with the ground in the action of walking or running, and the toe off; the point in which the power generated during the previous phase allows an athlete to launch or propel themselves off the ground (Tekscan, n.d.). To get a better understanding of this function, a discussion about the arches must be had.



Figure XLVI: Heel strike, Midstance, and Toe off in the Gait Cycle (Plantar Fasciitis, 2019)

The human foot has a total of three different arches. The first is the medial longitudinal arch. This arch runs down the inner side of one's foot. The medial arch plays a major role in shock absorption upon contact with the ground in the action of walking or running, transferring ground reaction forces on the foot through the arch structure to lessen impact on the foot when it hits the ground. Additionally, it supports an athlete's body weight during these intense movements (MASS4D® Foot Orthotics, n.d.). The medial arch is the most important arch of the three. The second arch is the lateral longitudinal arch. This arch runs down the outside of the foot. The lateral arch enables movement of the little toe through flexion. While important for an athlete's gait cycle, the lateral arch is not nearly as significant as the medial arch. The third arch is the transverse arch. This arch runs front and center, essentially connecting the medial and lateral arches together. The transverse arch allows the longitudinal arch to be flexible, serving as a lever while also making the arch of the foot rigid enough to behave like a stiff spring. While they all play distinct roles, the three arches work together as a system; allowing soccer players to run, turn, and make sudden changes of direction (Physiopedia, 2017).

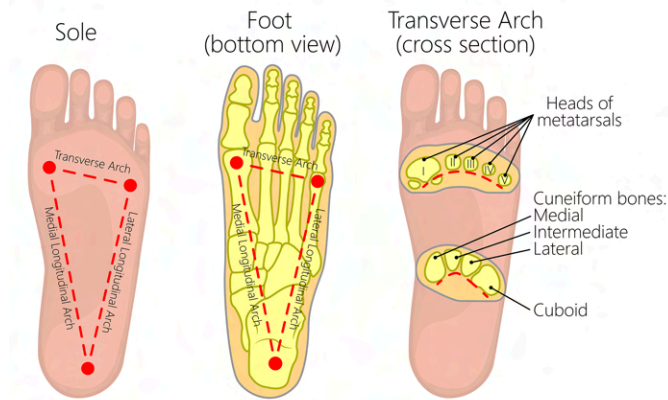


Figure XLVII: Medial, Lateral, and Transverse Arches (Teach me Anatomy, 2022)

The Problem to Be Solved

It is important to understand the significance of the three arches in the foot as a system. These arches work together, allowing the athlete to run efficiently. When they work together, the three arches provide adequate shock absorption so that the pressure exerted upon the ground is distributed evenly throughout one's foot. However, when there is no arch in an athlete's foot, problems begin to rise. As mentioned before, the significance of the arch in one's foot is the ability to absorb necessary shock in the action of running. Lack of an arch means that most of the bottom of the foot is coming into complete contact with the ground. Over time this continuous contact can put stress on the foot of the athlete leading to increased discomfort as the athlete runs more. (Physiopedia, 2017). For flat footed athletes in soccer, this is a huge concern given the amount of running that is demanded in the sport. When looking at average distance traveled for players by position in soccer, forwards can be found running an average of at least six miles a game. Meanwhile, midfielders have it the worst of all positions, as their duties demand them to run an average of at least 7.4 miles per game. Defenders run an average that can vary in between those of both the forwards and midfielders, as they average around 6.2 miles of running per game (Tooby, 2023). While the amount of running required by each position varies, it remains imperative to provide flat footed soccer players with comfortable cleats that support their feet to run several miles.



Figure XLVIII: Distances traveled by Forwards, Midfielders, and Defenders (top to bottom)

In addition to that, we want to be able to support these athletes in the recovery stage, understanding that while we have provided an adequate cleat option, further support is given with a comfortable recovery slide. The recovery slide will serve as an extension of the support provided on the field, serving as a sign of relief off the field for athletes as they prepare for training sessions and games, where their feet will be required to meet varying extents of these same demands.

Psychological Research and Factors

Supportive Cleats

One of the most important aspects of sports is the psychological. Without the right state of mind, it is nearly impossible to perform at the highest level. In relation to adequate cleat

options, a player wants to go into every game knowing that they are wearing equipment that protects and supports them in the act of performing. When they feel a lack of support, they start to second guess their movements and decisions, causing them to play with caution and sometimes fear. Playing in this state of mind can often lead to severely underperforming, which can lead one's teammates and coach to lose faith and trust in their ability to be dependable (Cohn, 2023). To prevent this from happening, the cleat must possess qualities that almost make these flat footed players forget that they even have a condition of any kind. The goal is leveling the playing field and making the players feel as if their condition is no longer a disadvantage for them, that it won't affect their functions and movement, and that they can play with full comfort and confidence in any environment.

Demands of a Player

There are many athletes that believe that the mental aspects of a sport are the most important. From Cristiano Ronaldo to Kobe Bryant athletes in various sports have stressed the importance of mentally preparing ones' self for challenges and situations during training that will arise during the game. Soccer is a sport that requires a number of skills both physical and mental. While both separate, the two work hand in hand and are the determining factors in a player's ability to succeed. To really understand what the demands of the sport are, three of the biggest skills required will be discussed.

The first skill that is required for a player is coordination. This means having the ability to mentally process the necessary moves to put your team in the position to win. Players work on these kinds of scenarios in training, understanding that the unpredictable can always play a factor in a game and preparing themselves to instantly react to each and every situation. This understanding is then translated and executed in real time during matches (Exploring your mind, 2020).



Figure XLIX: Netherland's Lineth Beerensteyn Dribbles Around the Keeper (McMorann, 2023)

The second skill is directly connected to the psyche. This is the mentality that a player has throughout a game. The mentality of a player is heavily based on their will to win even when things are not going their way. It's about having the ability to remain positive and understanding and accepting that mistakes made don't define the position they find themselves in, but rather present the opportunity to grow and overcome..



Figure L: Colombian national team scores goal tying goal at Women's World Cup

The third skill is composure. This is arguably the biggest of the psychological factors within a game, because it often symbolizes the difference between a win and a loss. Composure is about being able to step up in the game's most pivotal moments. A team was down big at the half, but they remained positive, understanding that there was still plenty of time to come back. Time has gone by and ten minutes remain in the game. The team that was once losing at the half has tied this game. They have been awarded a penalty to take the lead and advance their team

into the next round. With the biggest opportunity available to them, how will they respond? Will they fail to convert or will they rise to the occasion and overcome the pressure?






*Figure LI: France's Kadidiatou Diani Penalty Puts the Team Back in the Lead
(Rice-Coates, 2023)*

Analyzing and Understanding The Product

When designing new footwear, it is important to analyze those that exist and serve as general competitors in the market. By analyzing their features, benefits and attributes, one can understand what is necessary to meet the general standard for adequate design. Additionally, one can understand what metrics to focus on for the sake of key design decisions and eventual testing during the design process.

Competitor SWOT Analysis

FIRM GROUND CLEATS

		
<p>PUMA FUTURE ULTIMATE FG BRILLIANCE</p>	<p>IDA RISE FG/AG WOMEN'S</p>	<p>NIKE ZOOM MERCURIAL SUPERFLY 9</p>
<p>PRICE: \$ 260 STYLE: Firm ground</p>	<p>PRICE: \$ 159 STYLE: Firm ground</p>	<p>PRICE: \$ 170 STYLE: Firm ground</p>
<p>MATERIALS : Engineered dual mesh, Puma PWRTAPE, peba base material, carbon fiber, and plastic.</p>	<p>MATERIALS : Synthetic leather, elastane, GRS dual density 100% recycled material,</p>	<p>MATERIALS :Transparent mesh, cotton, silk, plastic, carbon fibre, and plastic</p>
<p>FEATURES AND BENEFITS :</p> <ul style="list-style-type: none"> - Micro-perforated heel padding keeps the heel locked in and comfort. - Engineered 3D texture at key contact zones enhance ball grip and control for dribbling, passing, and finishing. - Lightweight dynamic motion system outsole enhances traction and agility for unpredicted changes of pace and direction. 	<p>FEATURES AND BENEFITS :</p> <ul style="list-style-type: none"> - Built in ankle sock liner provides secure fit - Wider toe box provides needed comfort and breathability for the toes. - GRS approved dual density recycled insole provides a more responsive and cushioned experience. - Designed using women's specific last for fit the anatomical needs of the female foot. 	<p>FEATURES AND BENEFITS :</p> <ul style="list-style-type: none"> - Minimalist knit upper to reduce weight of cleat. - Speed cage within the structure secures foot to the outsole for optimal lockdown. - Zoom air unit provides additional explosion under the foot. - Unique traction pattern offers supercharged traction for quick release on wet grass.

SWOT ANALYSIS

STRENGTHS	WEAKNESSES
<p>All cleat options support desired dynamic movement and quick changes of direction.</p> <p>Each cleat provides a built-in sock liner for added security and support.</p> <p>The Nike Zoom Mercurial Superfly 9 possesses a traction patten that provides adequate surface control for firm ground fields.</p> <p>The IDA Rise FG does a great job of providing insole comfort for players.</p> <p>Provide supreme stability and lockdown for the foot.</p>	<p>Only the PUMA Future Ultimage FG Brilliance and IDA Rise FG/AG are designed with the woman's foot in mind.</p> <p>None of these cleats are made to accommodate women that deal with flat footedness</p> <p>IDA Rise's use of synthetic leather is not the best option in regards to sustainability.</p> <p>The mercurial and PUMA brilliance do not emphasize the importance of an insole that supports the user.</p>
OPPORTUNITIES	THREATS
<p>The mercurial has the opportunity to focus more on the female athlete.</p> <p>All of these cleats have the opportunity to create a line that focuses on the challenges of the flat footed female athlete.</p> <p>The IDA Rise could use a better, more environmentally friendly leather alternative.</p>	<p>Brands like IDA and PUMA pose a threat to the mercurial line in regards to considering the female anatomy.</p> <p>The mercurial utilizes an engineered leather that is much more environmentally friendly in comparison to IDA's choice of synthetic leather.</p> <p>IDA threatens PUMA in the sense that it also is designed with the female's foot in mind and is available at a much more affordable price.</p>

Firm Ground Cleats

Strengths

When comparing competitor products in the PUMA Ultimate FG Brilliance, the IDA Rise FG/AG Women's, and the Nike Zoom Mercurial, they all possess a number of strengths that make them the top competitors in the current women's soccer cleat market. All of these cleats are great at supporting dynamic movement. They allow players with a play style that relies on quickness and agility to change direction with ease. They provide supreme lockdown and stability, so that players can make tight turns without any concern of losing their balance. Additionally, they all provide a built in sock liner that provides players with added security and support in the ankle. Many players want to feel just as secure in the ankle as they do in the foot. This is so they are assured of stabilization and comfort while making unpredictable movements.

Weaknesses

While these cleats all possess great strengths that enable players to play with confidence, they also have weaknesses that speak towards design choices that included intended users and materialization. Of the three competitors, only the Puma Ultimate Brilliance and the IDA Rise FG/AG are designed with the woman's foot in mind. This means multiple things. The first is that both PUMA and IDA Sports have identified and acknowledged that women in soccer are provided with limited options that suit their needs. IDA took advantage of this, and to this day make footwear exclusively for women. The Rise FG/AG is their latest release of cleats that has long since been designed using a women's specific foot last (idasports.com, n.d). PUMA however, has not been designing women specific cleats for too long, but saw the opportunity and since has released an entire pack dedicated to women. Nike's cleat has been designed with the men's foot in mind and although the Mercurial is considered a great firm ground cleat, it doesn't account for the differential in movements between men and women to provide the needed comfort.

While IDA does a great job of designing a cleat to accommodate the movements and functions of the female athlete, the FG/AG utilizes a synthetic leather that is not the best material for the environment (idasports.com, n.d) . Synthetic leathers, although great in function, are not recyclable and oftentimes end up in a landfill after usage. Regarding weaknesses, all three of these competitors do a poor job of providing a cleat option for players with foot conditions that may differ from the common athlete. With the issue at hand being flat footedness, a lot of athletes probably feel that they are not cared for.

Opportunities

One thing all of these companies can do is capitalize on their weaknesses. For the Nike Mercurial, designing the same shoe to accommodate the difference in structure and function of a woman's foot is a huge opportunity for growth. Considering the impact they already have in the sport, a pack of women led designed Mercurials would change the dynamic of the iconic line.

As stated earlier, the IDA Rise utilizes synthetic leather, a material that's manufacturing process actually does more harm to the environment than natural leather given the power to create it (Jeff Mandel, Personal Communication, 2024). There are several leather alternatives that can be used to achieve the same performance functions that the athlete desires (idasports.com, n.d).. A huge opportunity for all three of these cleats is the possibility of a line that focuses on the challenges of the flat footed athlete. Many don't realize the impact being flat footed can have on an athlete. It puts them at a higher risk of injuries and at the current moment gives them very limited, if any options to choose from.

Threats

Each of these competitor cleats possess features and benefits that pose a threat to one another. Both Puma and IDA pose a threat to the mercurial line in regard to considering female anatomy. Because of this, potential users may see them as viable options for supporting women's feet. The mercurial line utilizes engineered leather that is much more environmentally friendly in comparison to IDA's choice of synthetic leather. For those that are more caring about the environment, this alone can be seen as a reason to always choose the mercurial over the Rise, even if it isn't women specific. .

Insoles

Strengths

The cleat insole competitors consists of those all within the IDA Rise Firm Ground cleat, the Mercurial Superfly 8 , the Adidas Predator Edge, and the Adidas Crazy Fast.1. Made of ethylene vinyl acetate foam, their strengths appear the most in regards to weight. They each allow players to move effectively while making them feel extremely light on their toes.

Weaknesses

Weaknesses identified within all of these cleats is the type of foams used for these cleat insoles. While players are made to feel their lightest, the quality of the insoles are rather sub-par. The foams used are effective within the first couple of months of usage, however, they cannot be relied upon to provide the same amount of impact absorption and cushioning after a season of play. Because of this, players will either have those insoles replaced after a period of time, or have them substituted upon purchase knowing that they won't be capable of serving them in the long-run. The general problem with the design of these insoles and cleats as a whole, is that they prioritize being lightweight at the cost of being comfortable. This can be dangerous, because it now puts the comfort of the athlete at risk, which can have psychological effects that eventually impact performance.

Opportunities

There are many opportunities for these brands regarding insole design. For one, they can prioritize player comfort for the sake of remaining lightweight. While having a lightweight cleat is important, playing in a cleat, much less any type of footwear should prioritize creating a positive user experience. Using foams that lack durability only makes for a good **short term** cleat option, when in theory, a cleat that can last as long as possible should be desired. With this being the case, each cleat has the opportunity to integrate foams that are able to resist compression and impact for longer periods of time. If they have to risk a couple of grams of weight in exchange for a healthier foot, then it should be done by all means.

Threats

The threats to these cleat insoles are insole brands that prioritize the health and wellbeing of the athlete's foot. Insole companies like Currex and Superfeet design insoles specifically for

soccer players. Knowing that cleats generally will provide an insole that cannot sustain its physical properties, they bank on that opportunity and are able to serve a number of soccer players and athletes who are dissatisfied with the quality of their original insoles.

The Impact of This Project

This project is extremely impactful because it addresses issues in a sport that is continuously growing, while focusing on a special group of athletes that are oftentimes the most underserved. It is a direct reflection of my passions and required documentation, story-telling, problem identification, and the development of an adequate solution that is advertised as a product line that empowers black women in soccer. I believe that great demonstration of these skills will allow brands I see myself working in become aware of my potential as well as my vision as a designer.

User Research Goals and Collecting Insight

What to Learn

Before a product of any kind is created, there must be a process. This process usually begins with initial research. Initial research allows the designer to understand the product they aim to make, its parts, functions, intended users, and features and benefits. This is important, because it allows the designer to identify the problem and eventually the solution in route to improving user experience. When the product already exists, oftentimes research is done to understand not only the product, but the intended user and how it affects them. With the current product being soccer cleats for women, and those at risk of suffering lower extremity injuries headlined by ACL tears, we have to identify the contributing factors to this problem and later develop adequate solutions for a successful design.

There are a number of factors that contribute to these injuries. One being the result of a collision or full on contact occurrence. In these situations, a player can find themselves in an awkward position where their own body weight or the weight of a fellow athlete is exerted upon them in a way that creates an imbalance in their stability, loading all of that force onto the knee, leading to a serious injury. The second possibility is by way of a non-contact occurrence. These types of injuries are quite common in the sport, a player can find themselves planting their foot in the ground and twisting at awkward angles or tweaking a ligament or muscle in the action of trying to regain their balance at high speeds and tight angles (Sheridan, 2023). These injuries are largely caused by footwear that is unable to account for their movement and provide the necessary traction to move efficiently across the field (Thomson, et. al, 2022) . Ideally we want to understand the science behind cleat design and identify which factors contribute to these incidents in order to prevent them in the near future with hopes of mitigating serious injuries.

As mentioned, there are very few women's specific soccer cleats currently in the market for professionals to play in. Because of this, many women are playing in cleats designed with the men's anatomy and functions in mind, and as a result are suffering from it (Lewis, 2022). Of the professional players surveyed in Europe's top leagues, 48% of black women at the professional level expressed feelings of pain and discomfort in the heel region of the foot with the current offering of cleats (Wrack, 2023). This issue speaks to cleat comfort and the need to distinguish the differences in comfort between each gender respectively.

The Margin of Opportunity

In addition to this, there seems to be a durability issue amongst many of these women's cleats. When a cleat lacks durability, problems concerning both player comfort, health, and eventually performance then become at risk. On the collegiate level, there are many women playing soccer at institutions that possess the buying power to replace athlete equipment on demand. Institutions like the University of Kansas are able to use their multi-million dollar deal

with Adidas to supply their players with 2 to 3 pairs of cleats per season and a minimum of 10-12 pairs throughout their 4 year careers (Office of the Chancellor, 2019).

KU announces 14-year agreement with adidas

WED, 04/24/19

SHARE:    

Dear Jayhawks,

We are writing to share exciting news about a partnership that will benefit the University of Kansas for years to come.

Today we are pleased to announce the renewal of KU's sponsorship and apparel agreement with adidas. This 14-year agreement is worth \$14 million annually – which is more than double the annual value of our previous contract with adidas – making it one of the largest apparel partnerships in college athletics. Notably, it includes an unprecedented \$500,000 annual commitment to educational programming at KU. This is a tremendously beneficial agreement for our university, and it speaks well of KU's status in the higher education landscape.

Recognizing the size and scope of this agreement, today we want to share with you some context on the partnership and explain why it will benefit KU in meaningful ways.

University of Kansas inks \$500,000/year deal with Adidas

While a lot of institutions are blessed with lucrative deals that see their players being supported on all ends, there are many women playing at schools that receive far less support. Examples of these are women playing collegiate soccer at historically black colleges and universities like Prairie View A&M in Texas. These women are given a pair of cleats prior to the start of the season and are rarely able to have them replaced by the school. Due to the demands of the sport, it can be easy to run through a pair of cleats before the season even comes to an end. Due to their school's unfortunate financial circumstances, players are oftentimes having to come out of pocket to replace their damaged cleats, which also cannot be done at times. As a result, these players then play in cleats way past their preferred time of usage ultimately putting their comfort, health, and eventual performance at risk.

So if low-majors aren't getting cash, what's the point? Lots of equipment.

Even if you're a relatively small athletic department, you're going to need equipment. That means balls, shoes, helmets, travel bags, gloves and more, for hundreds of athletes across a department. If you just walked down the street and bought all of that stuff from your local Dick's Sporting Goods, it's going to cost a *lot* of money. Take it from me, a guy that recently spent a lot of money at Dick's Sporting Goods.

Even the smallest D1 schools get hundreds of thousands of dollars worth of equipment, plus discounts on buying additional stuff. At the low end, that might be \$100,000 worth of apparel and equipment (Prairie View A&M), to \$3 million at the high end for a mid-major, like at UNLV.

Prairie View A&M among many other HBCUs sign miniscule deals that prevent proper support of athletes

As things currently stand, black women in soccer are faced with challenges that pose a threat to their development from a health ,performance, and socioeconomic standpoint. Regarding health, they like the general population of women are forced to play in cleats that are designed for men. Without proper footwear that addresses their anatomical and biomechanical needs, these women will continue to be at risk of lower extremity injuries that can threaten their careers. From a socioeconomic standpoint, these women are additionally faced with systematic disadvantages that ultimately shorten their already small window of opportunity to reach the highest level of competitive soccer. In order to truly understand the dynamics of these challenges both on and off the field, we must find athletes that deal with the very issues at hand.

This search began by identifying historically black colleges and universities with women's soccer teams. Being from Texas, the first schools that came to mind were Prairie View A&M and Texas Southern University; two HBCUs located in the greater Houston area. Other schools that came to mind were Hampton University, located in Virginia , and Howard University in Washington D.C. With those schools in mind, a survey asking questions centered on the types of cleats being played in and the experiences of black women when playing in them were developed to get a better understanding of player needs and preferences.

The goal of these questions is to first understand the commonality of flat footed black women in college soccer. This is important because it not only identifies potential target users, but identifies the number of players at risk or already suffering from a multitude of issues in the foot. After identifying those players, the next goal would be to understand the comfort-level, fit, and other features of their current cleats to identify problems and later develop solutions for an improved soccer cleat.

USER RESEARCH AND TESTING PLAN

SURVEYS: I will be sending a survey to black women in collegiate soccer to get a better understanding of the conditions and experiences of current cleats. I then got a better understanding of the players experiencing issues and how many of them were flat footed to draw inferences based on my problem statement.



INTERVIEWS: After my target athletes are found and narrowed down, I will conduct individual interviews to get a better understanding of areas of discomfort for the players , as well as understand how they are continuing to overcome their challenges as flat-footed athletes and continue ton play.

User Testing Plan

User Research: The Questions

Basic Player Information

The survey questions created first began with asking for basic information about the players. This included their names and the school they attended. This was important because it shows the survey takers that you value their time and who they are as human beings, and are not simply conducting the survey to get what you want. The third question asks the players to state the position they play to get an understanding of the average distance they run per game. player per game.

Understanding the Cleats Being Used and the Surfaces Being Played On

The next set of questions focused on the style of cleats these players prefer: low top or high top, and the type of cleats they currently own, which is often a reflection of those preferences. Asking for player preferences creates an understanding of additional design considerations to make including ankle security, lacing systems, and overall silhouette. Asking what cleat they currently own allows for the identification of existing products in the market to evaluate, as well as understand their features and benefits.

It was then asked whether the player's designed to be played on soft or firm grounds to get an understanding of the type of playing surface these players typically play on. Firm grounds typically consist of short-cut drier grasses that are not often maintained, leaving players with a much more firm feel underfoot (Hodgson, 2021). Examples of these fields are those at recreational parks and natural fields. Soft ground fields are those that are much less common. They are oftentimes a bit wet and muddy, but are more cushioned, as they typically have a base of either sand or dirt (Hodgson, 2021) .

The seventh question asked players which surface they play on the most. While the players might have previously stated the type of playing surface their cleat is intended for, it is very common to find players that wear the wrong cleats for a particular playing surface. This question is also important, because it will validate the reasoning behind designing both a soft ground and firm ground cleat. This will provide the opportunity to design a comfortable cleat option for flat footed players regardless of the surface being played on.

Comfort and Desired Features

The next set of questions were some of the most important to the success of this project. The first question asks players to describe the comfort level of their current cleats. This question was made a free-response question with the expectation that cleat experiences can vary by athlete, brand, and style. It also provided insight into the comfort level of a player's cleats, what parts of the shoe are bothering them, what areas of the foot are being affected, as well as understanding what they are doing in order to make things work and continue to play with those cleats.

As mentioned in the article surveying professional player's cleat experiences, many of the black women stated that they were cutting the back of the cleat to widen the heel support. This is an indicator of current cleats not being able to support the difference in structure of their feet (Wrack, 2023). It's possible that these collegiate athletes are also coming up with ways to play in cleats that are not the best for them, so we want to be prepared for that possibility and develop solutions to prevent it from happening in the future.

After understanding existing issues in these player's current cleats, it would be ideal to know what kind of features they would like in a cleat for a more comfortable experience. This question is great, because it can make players think about things they have not yet considered and potentially help them realize and understand what the most important parts of a cleat are for optimal performance. These features can include a more cushioned insole, a different stud/cleat variation, added ankle support, and more stability among many others. This question essentially creates design opportunities and additionally raises attention to certain areas of the cleat that may have been initially considered. Another question that will be asked is the player's preference between metal and plastic cleats. Plastic cleats are the most common in the game today. They have a high density and provide the foot with better weight distribution in comparison to metal cleats, which tend to dig deeper into the ground due to their strength (Semenza, 2023).

Flat Footed vs High Arch

One of the more important parts of the survey was finding out how many of the players were flat footed. The answer to this question would infer a couple of things. It signified the potential focus users as well as the frequency in which these users were having uncomfortable experiences with cleats in comparison to their high arched counterparts. With further research and testing, a better understanding of what is actually happening to their feet could then be discovered.

The second is an understanding of what kind of support is needed for the foot in comparison to a shoe made for someone with a high arch. Understanding the user's foot to properly accommodate for its structure and the conditions it may find itself in is extremely important. This would create the opportunity to develop an insole system that is a bit more plush or inflated, and supportive of the steps that they take. High arched athletes rely heavily on the arch to take explosive steps, however, without an arch the back of the foot is essentially making complete contact with the ground after every step. This repeated occurrence can lead to discomfort, pain, and eventual injuries, especially considering the amount of distance traveled per player.

While flat footed players are the target users in this project, it is also good to know that the product can be validated by the unintended. This is critical, because while it is great to have flat footed athletes validate the success of the cleat made for them, it is just as impactful to have someone outside of the focus group vouch for it as well. It's important to create a product with the capability to satisfy the intended user, while also winning over those that it isn't necessarily made for. If a player that is high arched can say that a cleat that wasn't intended for them is better than a cleat actually made for them the project can be deemed more than successful.

How Do You Play?

Another big contributor to the way a cleat is designed, is the style of play or player it is intended for. Certain cleats are designed with features that are intended to complement players' tendencies and frequent moves. This can be a metric that determines a certain tread pattern or

placement of cleats. Understanding style of play can have a huge influence on the type of insole used, points of increased stability, lacing systems, among many others. These are all features of cleats that can vary based on the player's tendencies. Understanding a player's style can lastly have an effect on the aesthetics of the shoe. This can be expressed through choice of material as well as symbols to signify certain aspects about the player. When designing a cleat it's important to understand as much about the player as possible common movements so that each and every one of them can be accounted for.

Are You Satisfied and How Much Would You Pay?

The thirteenth and fourteenth questions focus on players' willingness to volunteer as test athletes for the product. The goal is providing them with a cleat option that allows them to play with full comfort at the highest level. Conducting validation tests with a works like prototype will allow for validation of the cleat's performance while confirming the players' level of satisfaction.

Most of the players surveyed were unwilling to pay more than around \$300 for cleats. Current firm ground cleat competitors sell boots roughly around the \$200 range, while soft ground cleats can be found at nearly double the price due to the expenses of metal cleats (The Soccer Sideline, 2019). Finding a middle ground between existing competitors, while also considering the added benefits that make the newly designed cleat better seems to be the ideal thought when determining its retail price. However, it is important to know the value behind a product and understand that people will spend reasonable amounts of money on products that perform exceptionally well and accommodate for significant needs that had been ignored years before.

User Research: Survey Results

Basic Player Information

The initial goal of this survey was to get an understanding of the current condition of soccer cleats available to African American women playing on the collegiate level. The first requirement was finding a sample size of black women playing college soccer and understanding the kind of cleats they are wearing as well as the experiences they have playing in them.

In order to find the target user(s), I reached out to women’s soccer teams at historically black colleges and universities within the country and was able to get my survey out to them.

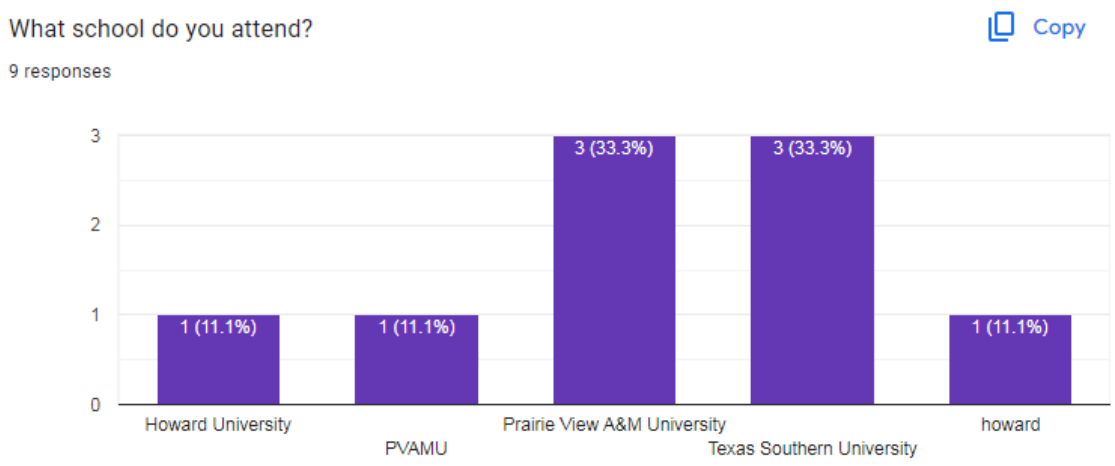


Figure LII: Survey of Players from HBCU Women’s Soccer Teams

I then was able to get an understanding of positions being played by these players, so that I have a rough approximation of the distance in miles they are running on average.

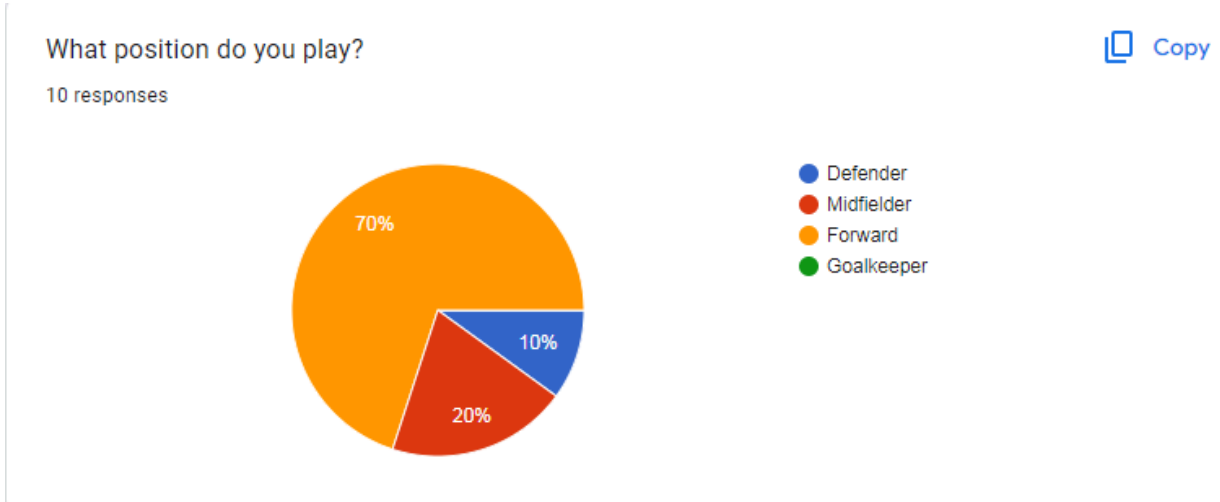


Figure LIII: Understanding Player Positions

Understanding the Cleats Being Used and the Surfaces Being Played On

The next step was identifying which cleats these players were using in relation to the surface that they were both practicing and playing on. This would allow me to understand the current cleats in use in comparison to the state-of the art products. It also would allow me to understand which player is wearing the correct cleat in relation to the surface.



Figure LIV: Types of cleats worn by players

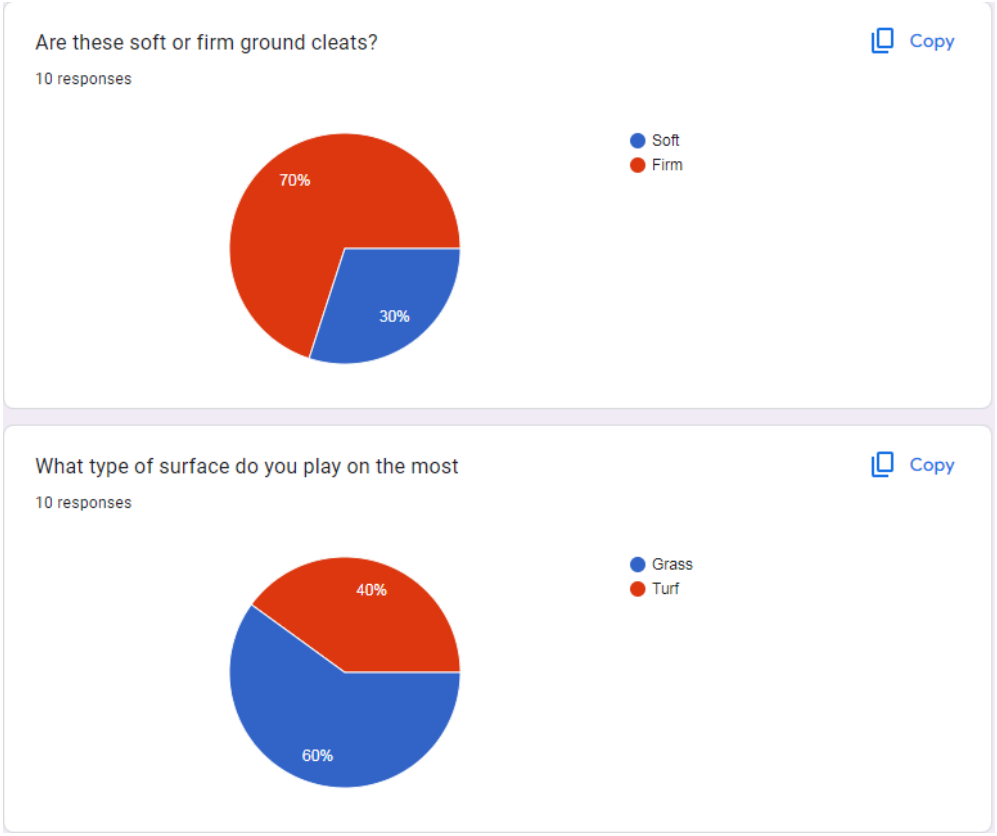
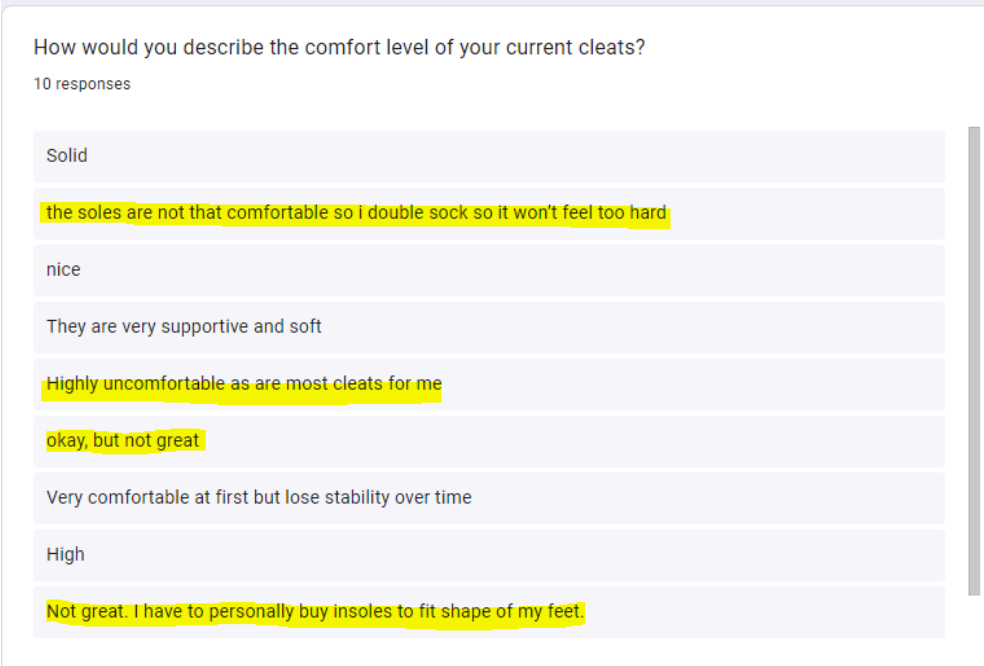


Figure LV: Types of cleats in relation to playing surface

After getting an understanding of the type of cleats being worn by these women and the surfaces that they play on, I then had them describe their experiences with their current cleat options. This was headlined by their expression of comfort or discomfort.



How would you describe the comfort level of your current cleats?

10 responses

- Solid
- the soles are not that comfortable so I double sock so it won't feel too hard
- nice
- They are very supportive and soft
- Highly uncomfortable as are most cleats for me
- okay, but not great
- Very comfortable at first but lose stability over time
- High
- Not great. I have to personally buy insoles to fit shape of my feet.

Figure LVI: Players described experiences with current cleats

Having identified which players were having unpleasant experiences with their cleats, I needed to further understand what was wrong with them. This led to me having players describe what they would like to see in a new cleat to improve the overall comfort and experience.

What are some things/features you wish current cleats provided?

9 responses

softer soles
flexibility
Cooling gel insole
More arch support , wider toe box
Comfort, stability, cooler colorways
Better arch support and ankle support.
Ankle stability but not super high on my ankle and better studs
Insoles with arch support for flat feet
softer soles, slip resistance (idk how to word it but i slip a lot in my cleats)

Figure LVII: Desired qualities in a cleat

Flat Footed vs High Arch

Four athletes that expressed discomfort or below average experiences wearing today's offering of soccer cleats. Because of this, finding out whether or not these athletes were flat footed was the next step. After asking players about the structure of their feet, it was discovered that 80% of the players surveyed were indeed flat footed athletes. Additionally, it was found that three of the four players expressing discomfort in their foot while playing in today's cleats were among those.

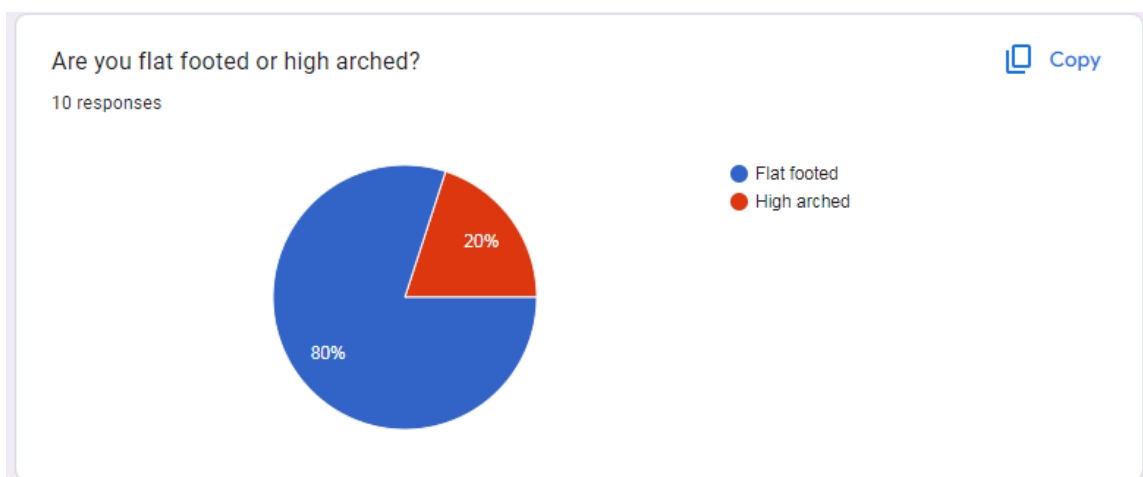


Figure: LVIII 8 of the 10 Surveyed Athletes Found to be Flat Footed

Of the ten athletes surveyed, eight of them were found to be flat footed. It was later discovered that of the four players that described discomfort or unpleasant experiences, three of them were flat footed. These findings enabled the identification of three target users: an athlete who suffers from flat footedness or another structural difference in the foot; that can have a cleat designed to alleviate their foot pain in route to achieving comfortable high level performance. These findings also allowed for the identification of one player that was not flat footed, but still had an unpleasant experience as the athlete that would serve as the user to sway over during the validation testing of the newly designed cleat.

Survey Conclusion

As a result of the conducted survey, a total of four black female soccer players from Prairie View A&M and Texas Southern have been identified as the initial test athletes. Initial testing will occur in December during the break in the cities of Arlington and Houston, Texas. The three flat footed athletes and one high-arched athlete will participate in a series of initial tests that will create a better understanding of their foot structure, player tendencies, areas of indicated pain, common plantar pressure distribution points in the foot, and physical attributes.

Conducting these tests will allow for the identification of things that are not working in their current cleats of use. It will also determine adequate solutions for a cleat design that considers the differentiation of movement between men and women while providing the overall comfort they need in response to their particular feet and bodies. This will also create the opportunity to successfully design a recovery slide that not only fits their specific foot type, but aids them in the recovery phases of both pre-game and post-game activities and operations.

The goal is to validate these design decisions by then returning to the initial test sites to conduct the same procedures with the newly designed footwear products in March. Using the metrics and data collected from the initial testing phase, comparisons can be made to identify

areas of hopeful improvement. In the process the hope is to provide these flat footed athletes with a cleat that provides them with comfort as they play at the highest level, while providing the same experience for the high-arched athlete that was not the intended user. Achieving these goals would result in a successful thesis project.

Κατά: A women's specific cleat- Works Like Phase

The Work Before The Work: Understanding Women's Experiences

The winter term would mark the beginning of the work- like phase of the project. With the goal of designing women specific cleats that accommodated for the anatomical needs and biomechanical functions of these athletes, there was already a general understanding that current cleats in the market for women had done a poor job in allowing them to move across the field efficiently. Knowing this, it was important to understand areas of discomfort, indicated areas of pain, and parts of the cleat that these women felt could be improved so that non-negotiables could be established early into the design process. In order to get this information, surveys were created for and taken by 15 female collegiate soccer players that focused on the best and worst aspects of current soccer cleat offerings.

Insole Quality: Poor Cushioning

Of the 15 athletes surveyed 10 of them had expressed dissatisfaction with the insoles in their current cleats. "I shouldn't feel the bottom of my cleat when running, they need better

cushioning”, stated Jada Davis, a defender at Prairie View A&M. Many of the women felt that the insoles lacked proper support for the arches, and failed to support their soles when running and jumping. Indicated areas of the pain had been represented in a majority of the foot, as surveys showed a heavy emphasis on the arches and balls of the feet.

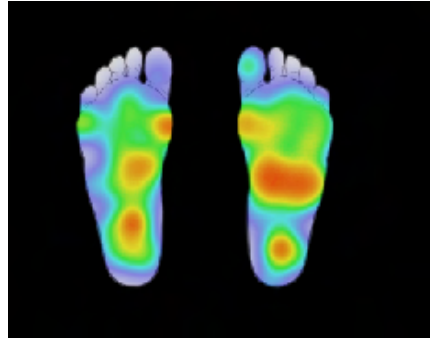


Figure LVIII: Indicated areas of pain in the foot surveyed by 15 athletes

“Not Enough Room” : Toe Box Width

Another area of discomfort or pain indicated by the athletes was in the toes. Many of the players felt as if they were not provided enough room for their toes to spread out. Soccer cleats are generally designed to be narrow. While many players have grown accustomed to this style of shoe, preferences between demographics often tend to vary. Some players prefer their toes to remain close to one another, as they enable them to feel like they are in more control of the ball. Other players, on the other hand, prefer a wider toe box that enables their toes to spread. Of the players' survey, 8 women expressed that their toe box was too narrow, indicating several areas on the foot in which they felt the most pain and discomfort.

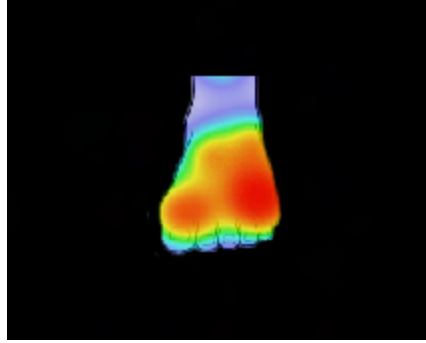


Figure LVI: 55% of athletes surveyed indicated pain or discomfort in the toe box region.

A Nip in the Heel : Heel Pain

Of the 15 athletes surveyed, 45% had expressed feelings of discomfort or pain in the heel with all of the athletes that did so being black. While the sample size was much smaller in comparison, this info appeared to be a slight indication of differences in anatomical structure between ethnicities. However, a much larger sample size would be required to confirm or deny those suspicions.

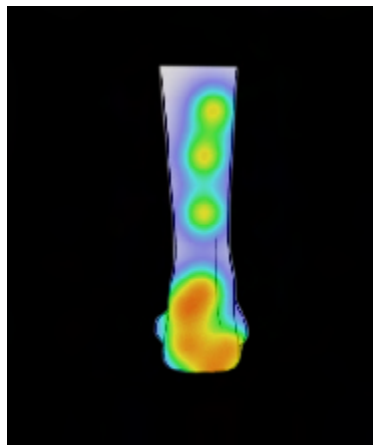


Figure LVII: Areas of indicated pain in the heel region wearing current cleats

Understanding Women's Movements

In relation to the feelings expressed by these athletes it was important to understand the tendencies, common movements, and most relied upon areas of the player's feet during critical moments in a game. These moments include running, cutting, pivoting, and making sudden changes of direction; all critical movements that are frequently demonstrated several times per minute within a game. To get the best understanding of these women's biomechanics, a training circuit consisting of six different drills would be conducted with 4 different collegiate female soccer players. Each athlete would wear pressurized insoles that would track their plantar pressure, overall gait, and areas in the foot most relied upon during varying game-like scenarios.

Learning these factors would enable proper decision making in relation to the best location, depth and shape of studs for female athletes to have optimal traction and control of the playing surface.

Training Circuit (Drills)

1. Stationary dribbling
2. Quick cut dribbling
3. Agility and balance
4. Stationary dribbling
5. Box Shooting
6. 40 yard sprint

Put to the Test

On December 23rd and December 25th a two hour training session was held for four collegiate soccer players attending historically black colleges and universities. These sessions were instructed by a licensed trainer/specialist and were documented for research purposes that would be essential to efficient cleat design. The athletes were put through various game-like

scenarios that put their physical capabilities to the test and revealed the most vital needs of attention regarding women-specific cleat design.

Learned Outcomes

Depending on the forefoot

After completing the training session and continuing research, there were several factors regarding women's performance needs that were discovered. The first was the importance of the forefoot in every executed move. Whether running, jumping, planting the foot, or demonstrating a burst of explosion, the forefoot remains the common denominator in every player movement. Throughout the session the forefoot generated the most force and power amongst all areas of the foot, enabling each athlete to make smooth transitions between cones.

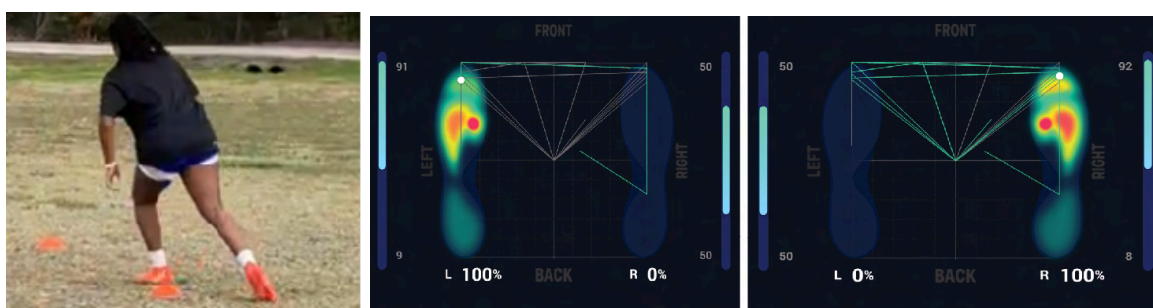


Figure LVIII: Athlete #1 planting foot and exemplifying burst in agility and balance drill

The Importance of Rotational Traction and the Center of Rotation

In the action of making sudden changes of direction, pivoting and cutting the center of rotation in one's foot is critical for efficient movement. Cleats are designed with studs that allow the player to exert loads of weight to this general area while propelling forwards. Rotational traction is the torque required to release the studs of one's cleats in a rotational manner in the

action of pivoting, changing direction, and cutting (Thomson et al, 2022) . While essential to efficient movement, excess amounts of it can lead to over exertions of force onto the foot and remaining proximal structures, which overtime increases the risks of lower extremity injuries that include plantar fasciitis. In the most severe cases, when rotational traction is excessive, a player's cleat can over penetrate the playing surface and can get stuck in the ground, opposing the direction in which the remainder of the body intends to go. The effect of this action is a twist of the knee at a high speed, that oftentimes results in the tearing of one or combination of the anterior cruciate ligament (ACL) , the medial collateral ligament (MCL), posterior cruciate ligament (PCL), or the lateral collateral ligament (LCL).

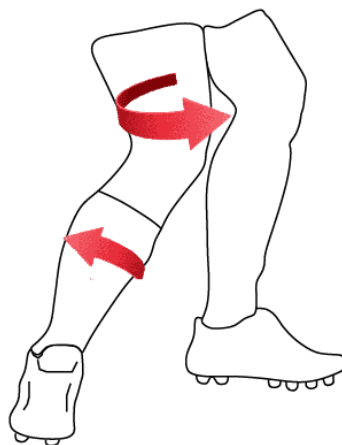


Figure LIX : The extreme result of excessive rotational traction

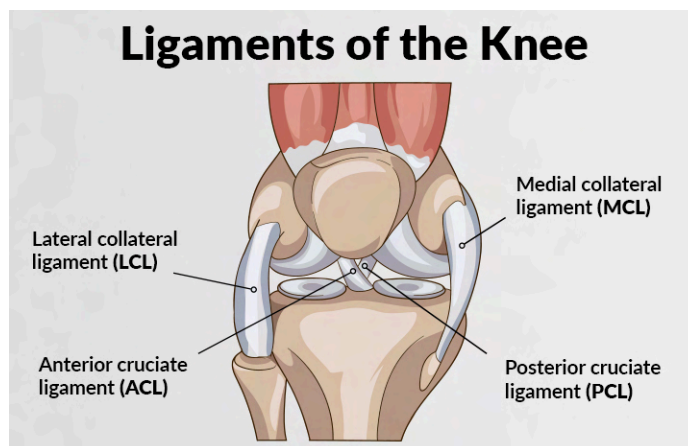


Figure LX: Ligaments of the knee (PT Health, n.d.)

How Can These Injuries Be Prevented?

This interaction between cleat and playing surface has become a common occurrence on every level of competitive play within women's soccer, so much so that one of the athletes that participated in the testing can attest to through personal experience. The unfortunate truth is that many women are forced to play in cleats that provide excessive traction to accommodate the movements of men, whose actions require more of it in response to their difference in generated power (ACSM, 2023). In order to reduce the likelihood of these injuries for women, cleats must be designed to reduce rotational traction to the perfect amount that enables quick release from the playing surface without slipping (Thomson, 2021).



Athlete #1 tearing her ACL as a result of excessive rotational traction/ torque

Research Guided Design

Effectively Reducing Rotational Traction: Applying, Designing, and Testing

After conducting athlete testing and watching a cleat traction video from Unisport that provided insight into the abilities of different stud shapes and traction patterns, an adequate

design was developed to enable these athletes to move efficiently on grass surfaces while mitigating the excessive rotational traction that has caused several of their injuries in the past

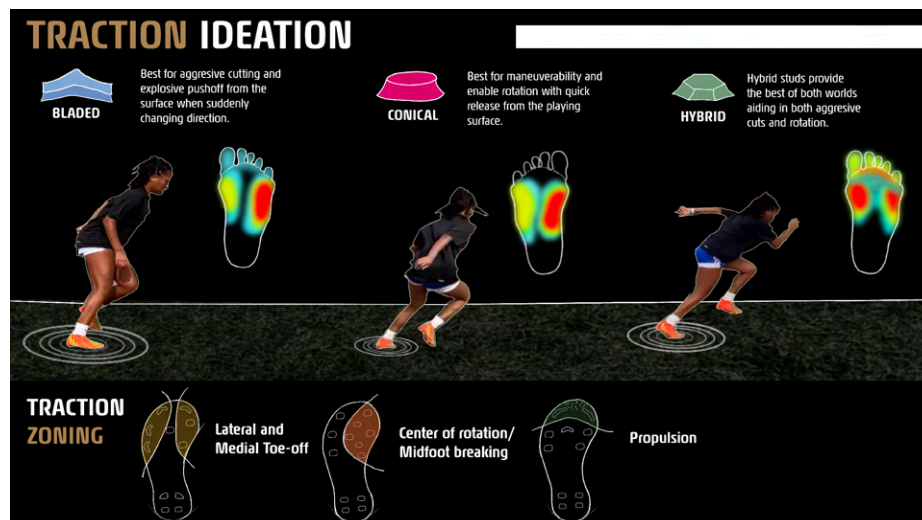


Figure LXII: Identifying critical movements

Stud Location

The first action applied was identifying the needed areas of traction. This was determined by analyzing points of contact with the ground during the test athlete's various movements. Understanding the importance of lateral push off, medial push off, and forefoot striking/propulsion during the athlete's quick changes of direction, there needed to be studs placed along the lateral forefoot, medial forefoot, and the center of rotation. The studs placed on the lateral and medial forefoot would aid in aggressive cutting and pivots, while the studs located in the center of rotation would enable the athlete to rely on that critical area through each and every move they make.



Emphasis on center of rotation

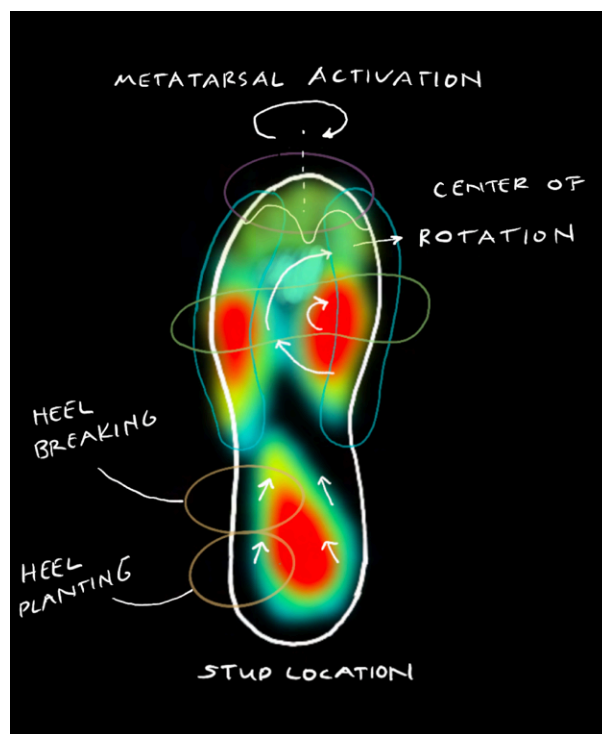


Figure LXIII: Stud location in relation to plantar pressure

Stud Shape

By way of numerous studies conducted by sports researchers along with the advocacy of many male and female professional athletes, the conical stud had been deemed the best possible

stud for traction control on a given surface. The conical stud is typically in the form of a circle or round form. Its shape and form allow it to penetrate the playing surface just enough, while still providing the rotation needed to aid directional change and activate a quick release from the surface (Greenburg, 2019). Studs that are in the shape of a chevron or diamond are ones meant for aggressive cutting. While they enable quick and powerful cuts, they do not enable the rotation desired by a player. When running and attempting to cut with these stud types in grass, one's foot can get stuck in the grass and lead to the excessive twisting of the knee when an effort to change direction is made. This exact occurrence is what led to Athlete #1 tearing her ACL.

Platform Technology: The Archangel

Knowing the importance of rounded elements in a stud pattern to provide that desired rotation, and the effectiveness of an angled stud for aggressive cuts, a stud possessing both qualities was created to provide the best of both worlds for this female athlete. The archangel was designed in the form of a crescent moon with a pointed moon. Its sharp head enables quick-cut multidirectional movement, while its leading edge provides ease of rotation and quick release from the surface allowing the player to seamlessly get in and out of breaks.



Figure LXIX: Archangel blade

Stud Depth

Arguably the most important aspect of the cleat's design, is the depth of each stud. Studs that are too deep can lead to over penetration in the surface, while studs that are too short can lead to a lack of balance and increase the risk of player injury (Greenburg, 2019). With its largest studs of 14.1mm on both the lateral and medial side of the forefoot, the goal was creating optimal dig into the surface of play during lateral and medial toe off . The studs on the lateral side are designed to decrease in depth incrementally (14.1 mm, 12.1mm, 10.1mm) until reaching the stud that lies beneath the fifth metatarsal, where the stud then increases to a height of 12.4mm. This method of stud variation was organized in a way that enables the player to be quick and explosive.



Figure LXX: Stop N' Go Traction Speed Plate

Traction Name

Designed to reduce rotational traction and enable quick transitions and efficient movement along firm grounds, the organization of studs is known as the Stop N- Go speed plate.

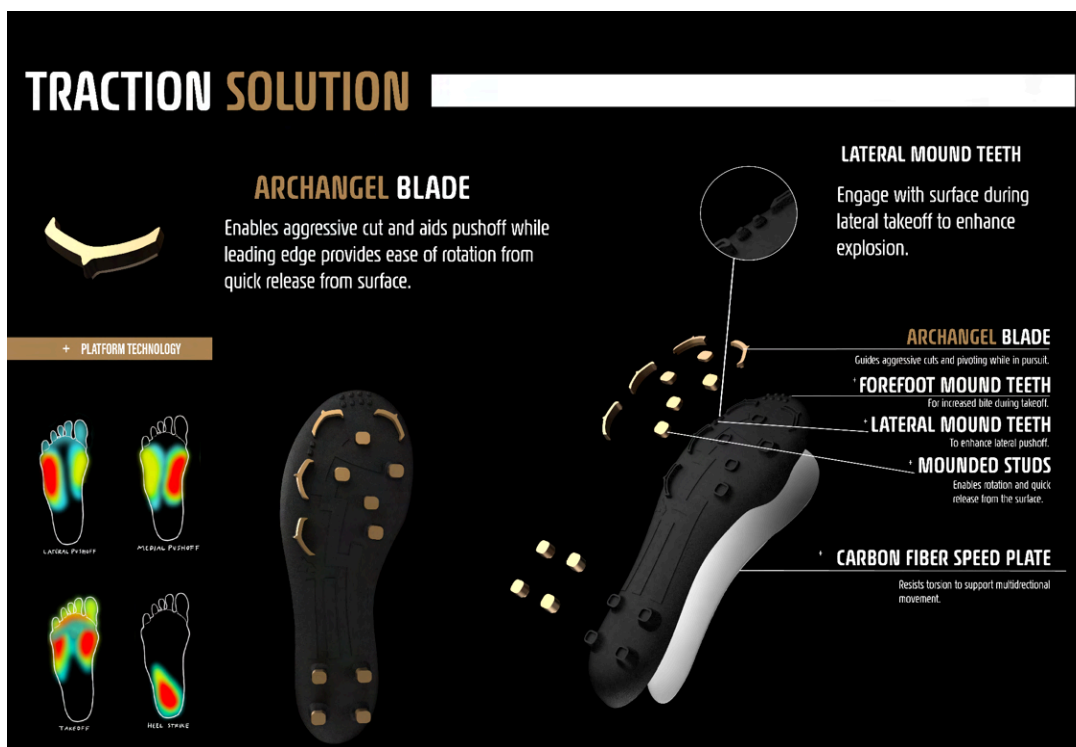


Figure LXXI: Stop N' Go Traction Speed Plate in relation to plantar pressure

Traction Testing

To confirm the validity of the developed traction a traction test was conducted to determine the amount of force required to generate rotation; a simulation of pivoting and changing directions. The higher the force required for rotation, the worse for the player because it signified more effort being required to execute a quick-twitch action. The goal of this test was to reduce that required force in comparison to the cleat worn by the test athlete when she tore her ACL. This result would be proof of possible injury prevention.

Testing Procedure

In most cases, shoe surface traction testing is conducted using an official surface traction testing machine. However, due to limited resources, rotational traction was measured using an alternative method that was created with the help of Brad Winn, a sports performance engineer at Nike. The comp products selected during this process were the Adidas Predator Demonskin; identified as the cleat in which the test athlete suffered her torn ACL, the Adidas Predator Edge

as the cleat she currently plays in, and the Nike Phantom Luna; the cleat regarded as the best for for the female athlete, that is a bit more expensive for women playing at HBCUs. The reasoning behind this selection was setting up the newly designed plate to be the one that could prevent the injury from occurring again. The procedure of testing and equipment used are listed below:

Equipment: Force gauge, shot put ball, power drill, thread, Adidas Predator Demonskin (cleat of athlete injury) , Adidas Predator Edge (athlete current cleat), Nike Phantom Luna, Kofa Stop N' Go plate

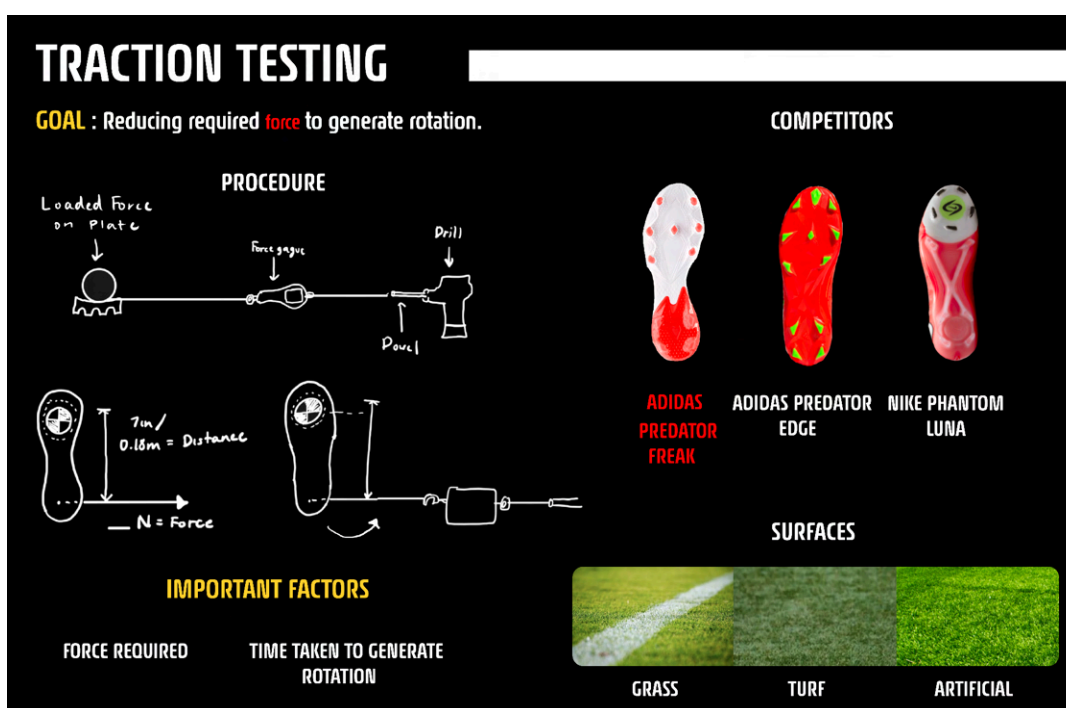


Figure LXXII: Traction Testing Procedure and Comp Products

Procedure: A 6lb shot put ball is placed on the forefoot of each cleat plate. A hole is then drilled exactly 7 inches from where the center of the ball rests. A piece of thread is then tied to the back end of the plate where the hole lies , which is then tied to a force gauge perpendicular to the cleat plate. This is then tied to a dowel that has been inserted into a power drill. Linked by one end to

another (cleat to thread, thread to force gauge, force gauge to thread, thread to dowel, dowel attached to power drill, the drill is then set to its maximum power of 15 Newton meters of force. When pulled at maximum power perpendicular to its rear end, the plate will then begin to turn relying solely on the studs located in the forefoot region. The required amount of force needed to generate this rotation would be indication of existing torque. The more force required to generate rotation or a release from the surface, the more torque. To solve for torque, the distance between the point of perpendicular pulling and point of weight is multiplied and measured in meters. It is then multiplied by the number required to generate the rotation measures in Newtons. The torque should be valued as Nm². This was repeated 3 times at four separate power levels (15Nm, 10Nm, 6Nm, 2Nm) on three different surfaces: grass, turf, and artificial grass in order to get the most fair and consistent results.

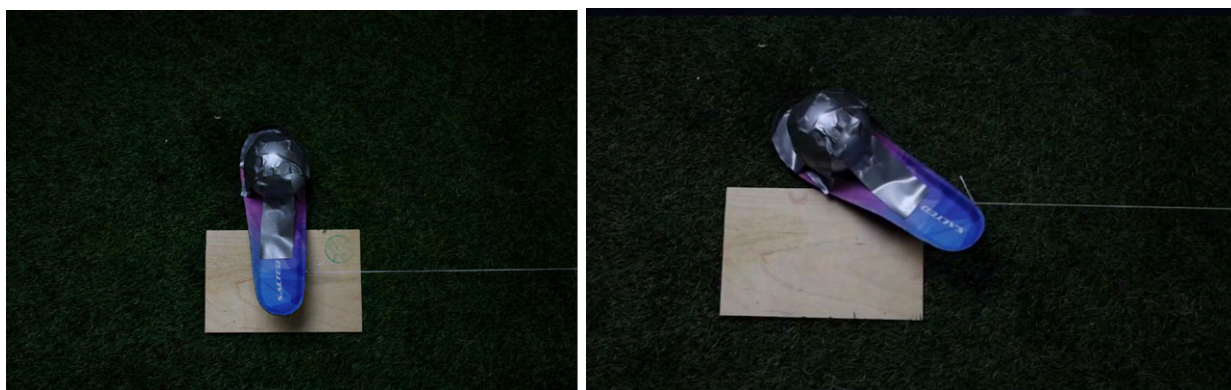


Figure LXIII: Plate is rotated using force from power drill

In this case, the goal is reducing rotational torque. In the case that the force required to generate rotation in the designed traction plate is less than that of the IDA Rise and Adidas Predator Freak, the product would be considered unsuccessful.

Traction Test Results

After conducting the test between all of the plates, the Kōfa successfully reduced the required amount of force and ongoing torque required to successfully rotate. Out of all the results, the biggest takeaway was the 64% reduction on grass between the Kōfa and the Adidas

Predator Demonskin, the plate worn when the test athlete suffered her torn ACL. This is significant, because it would allow the athlete to successfully execute a change of direction while exerting almost three times less force and stress on the body to do so. Accumulated relief of stress put on the athletes body can additionally lessen the load and decrease the likelihood of overuse injuries on the lower extremities.

Average Force Required for Rotation (Newtons/meter)				
Surface	Adidas Predator Demonskin	Adidas Predator Edge	Nike Phantom Luna	Kofa Agilita
Grass	21 Nm	17.66 Nm	9.5 Nm	7.5 Nm
Turf	17.76 Nm	11.08 Nm	5.33 Nm	5.49 Nm
Artificial	12.16 Nm	12.16 Nm	7.42 Nm	7.08 Nm

Significant Change: Reduction of required force on grass by 64% between the Kofa Agilita and the Adidas Predator Demonskin

Figure LXIV: Traction Test Results

Addressing the Toe Box

As mentioned earlier, there were a lot of players surveyed that stated that their cleats were too narrow. Although this aspect of the cleat is preference based, there are several benefits concerning the female athletes foot health and function that indicate the need for increased toe splay.

Toe Splay: Why Is It Important?

Proper toe splay is important for a number of reasons. To name a few, it provides stable support for the arches when carrying weight bearing loads. Secondly, it creates an even base for the toes and the rest of the foot to exert power evenly. This enables natural and desired gait without concern of pain or discomfort. Additionally this allows the arches to relax and perform their sole functions as a collective system that supports the foot as a whole (Pitts, 2023) . When

the toes are bunched together during high performance, the result can be overuse injuries such as stress fractures as well as conditions that can pose a threat to the wellbeing of the athlete during and after their playing days.



Figure LXV: Desired Toe Splay

Increasing Toe Splay

With overall foot health and proper function in mind, this newly designed cleat aims to increase toe splay for athletes with the hope of allowing their toes to move. Considering the amount of running demanded within the sport, the last thing wanted is for these women to be risking the health of their toes and feet when competing at the highest level. As a result, the goal was increasing the toe box width to a distance of 90mm to provide these athletes with the adequate toe splay for their feet to function naturally and without any restriction.

Modifying the Last

In order to successfully widen the toe box, this women's specific cleat was built off of a modified last that emphasized providing a wider toe box. During the modification process, 3D scans of each test athlete's foot were used to prevent the toes from being cramped as they previously were before.



Figure LXVI: Modified Women's Size 8 and 10.5 Lasts

Prototyping the Upper

In order to analyze the effects of the last modification and increase of toe splay, the upper iteration process had begun. This process included cutting out several patterns and building the upper off of this newly modified foot last. Modifications to the last were made to the point where the upper's new toe box would show noticeable changes without looking totally unnatural in comparison to most soccer cleats. Through each iteration, the upper began to look more and more solidified.

The Press Box

The name adopted for this toe splay increase is the press box, with the goal being to provide female athletes with adequate space to distribute weight evenly across the foot.

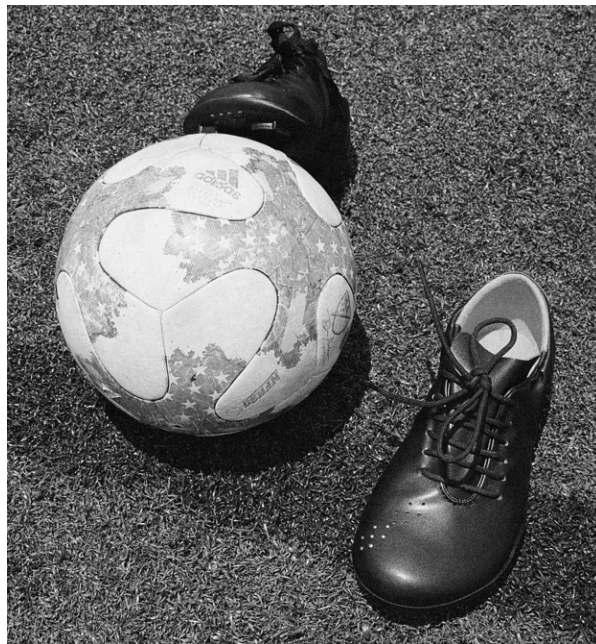


Figure LXVI: Prototype with integrated widened toe box

Considering The Athlete

Testing: Athlete Wear Testing

The testing process for the newly integrated features of the cleat was conducted with one of the HBCU athletes currently playing at Texas Southern University. A trip was made to Houston, Texas where she wore the cleat and provided feedback on the widened toe box and the several other features integrated. Positive feedback was received regarding this new toe box width, as she felt that she now had more space to spread her toes, something that she had not experienced with cleats in the past.



Figure LXVII: Athlete Wear Testing

Abrasion Testing

Considering Feedback and Analyzing the Product

When conducting user research and understanding player experiences, it had been made clear by almost half of the surveyed athletes that heel comfort was a problem. As mentioned before, 45% of athletes expressed feelings of pain or discomfort in the heel region of their cleats. After analyzing the cleats of the test athletes, fabric deterioration had become extremely evident. Within a season of play, these athletes' cleat heel lining had been worn down to a point that not only failed to support their heel, but then began work against them, causing a lot of discomfort. To better understand how to overcome this challenge the current used materials and their abrasion resistance must be identified.

Identifying the Materials : Brushed Synthetic Suede

Materials identified within the heel lining of these participant cleats had reasonably varied. Their ability to resist abrasion or in the athlete's case, friction with heel is extremely important and played a huge part into why athlete's felt discomfort in that particular region over time.

Current materials used by the Adidas Crazyfast.1 and the Nike Mercurial Superfly 8 was a brushed synthetic suede; a dry but durable material that is used in a large sum of soccer cleats. While they did provide some physical characteristics that appeared satisfactory for the athlete upon purchase, the conflict ensues when the athlete repeatedly wears and sweats in them. One of the biggest disadvantages of the brushed synthetic suede is that it loses its strength when mud, water, or any type of moisture make contact with it. The moisture softens it up, leaving it vulnerable to any ongoing friction with the heel. The abrasion resistance of this material is said to resist about 50 cycles meaning that in roughly 50 repetitions of friction with a revolving drum it can be expected to have thinned out. Due to its low abrasion resistance, and its susceptibility to tearing when exposed to moisture the brushed synthetic suede is simply not good enough to serve these female athletes for longer periods of time.

Identifying the Materials: Film coated microfiber

The second material identified amongst competitor cleats is a film coated microfiber. Used in both the IDA Rise FG and the Adidas Predator Edge , this material possesses an abrasion resistance of 120 cycles; over two times as much of an improvement then the Mercurial and Crazy Fast.1. After Speaking with Sabrina Mallen, a materials expert within the design industry, it was learned that soccer cleats and other high performance footwear should use materials with an abrasion resistance of 160-200 cycles. While this material microfiber provides a bit more durability, it still is not enough to resist the friction that the heel creates when rubbing up against that lining.

Material Improvements: Tirrenina Suede

In search of materials that could both resist abrasion and remain comfortable to support the heel of these athletes, several discussions were had with Mia Mazzaco, another materials expert working at Clarino, introduced tirrenina suede, a material made specifically for high performance footwear with the ability to provide both support and durability. When asked about abrasion resistance she stated that it could resist well over 160 cycles. She additionally stated that the suede possessed the ability to unlike, the brushed synthetic suede, become more reliable in response to moisture. When moisture is applied, tirrenina suede increases in grip, enabling increased heel lockdown and a more secure fit.

The tirrenina suede was a new and improved material innovation made to really improve the cleats overall durability. In regards to comfort it sustains its physical properties to serve as a comfortable support for the athlete's heel. Regarding durability, it possesses the abrasion resistance to resist the ongoing friction between the heel and itself, and in extreme cases increases lockdown when moisture is added to it. Ideally, you want a high performance shoe to utilize materials that can resist at least 120 cycles during abrasion testing (Sabrina Malen, 2024) . With an abrasion resistance of 160 cycles, the Kōfa Agilitá now provides the athlete with that needed comfort and then some.

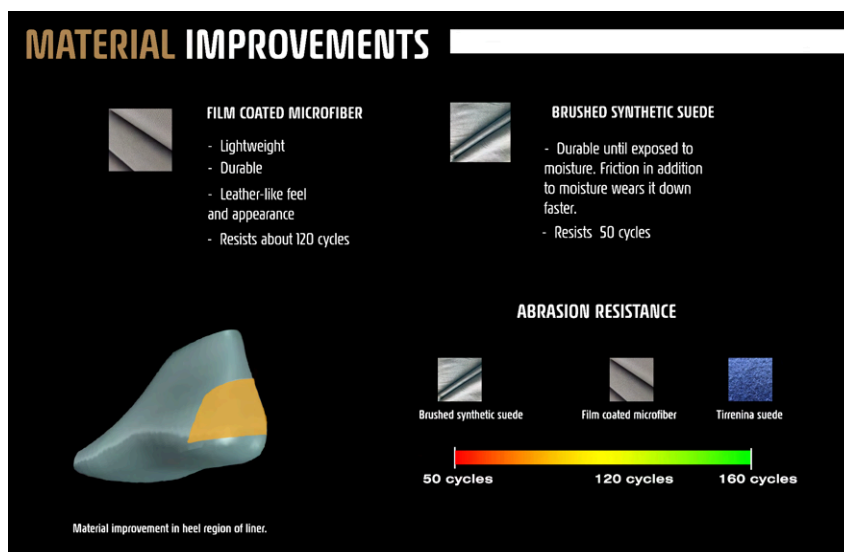


Figure LXVIII: Abrasion Resistance of Liner Materials

Supporting the Feet: The Insole

Understanding the Current Insole Landscape

In surveys taken that asked about the quality of current soccer cleat insoles, 63% of participants expressed pain or discomfort in their heels. This remains an ongoing issue within soccer cleat design, as they are designed to remain thin to enable ball touch and feel. As a result, these insoles are never supportive for the foot, and in almost every case provide minimal arch support of any kind. Using ethylene vinyl acetate, most if not all of these cleats possess insoles that simply cannot maintain their physical properties.

Uncomfortable Insoles

During the initial testing that took place in December, live feedback was provided by athletes participating in the series of drills. One of the athletes who was wearing the Adidas Crazyfast .1 expressed that during the training sessions she could “feel” the bottom of the cleat. After the session was completed, her insoles were analyzed to identify what may have been the problem. When the insoles were removed from her cleats, the issue had become very clear. Upon review, the player’s insole had almost completely thinned out.

When they had been further investigated it had been discovered that her insoles utilized ethylene vinyl acetate (EVA), a foam that can provide cushioning for the foot, but for very short periods of time. Learning that she had owned the cleats for just a year, and had played just 18 games in them, it was fascinating to see just how quickly the insole had thinned out.

When a new pair of the same cleats were purchased for competitive product analysis, major differences between the fresh insoles and the game-worn insoles were seen and felt.



Game-worn insole

Unused insole

When analyzing the two insoles, the rapid deformation that had occurred over a season of play was quite evident. The outer edges had been completely smoothed out, the footbed has lost most of its contours, and the overall density of the foam has decreased significantly most notably in the heel, where the athlete expressed the most pain while playing.

The Goal at Hand

After reviewing surveys, considering live feedback from athletes, and analyzing the competitor products in use, it was very clear that major insole improvements were needed to support the comfort, health, and performance of these women's feet. With those things in mind, the goal was to design an insole that not only provided arch support and cushioning for the indicated areas of pain and discomfort expressed in the surveys, but did so for a longer duration than just a season. To successfully do this an insole with a more durable foam needed to be made.

Material of choice : Polyethylene

The material of choice for this newly designed insole was polyethylene. Commonly used in yoga mats and other forms of sporting equipment, this foam is extremely durable, impact resistant, and extremely firm, providing a nice source of cushioning. The insole additionally features a poron foam heel cushion to provide impact absorption, a heel cup for secured fit, and a jersey knit fabric as its top layer to wick moisture. This insole, while not the most lightweight, would instead prioritize the comfort of these female athletes.

Understanding that this insole would prioritize comfort through the usage of a much more durable foam, the thought behind the material choices was allowing the player to reuse the insole in various forms of footwear, including cleats that they buy later down the line.

Insole Testing

Durability Testing

To ensure that the insole had fulfilled all of its performance goals, it was important to understand the durability of the material innovation being made. One of the many indicators of a foam's durability is its compression set. Compression set, is a parameter for evaluating foam that describes how much deformation or height loss a material experiences after being subjected to a particular compressive force for a given time. It describes the material's ability to recover back to its initial shape. A foam with a low compression set indicates that it is capable of retaining a majority of its physical properties after taking various compressions. When the compression set of ethylene vinyl acetate (EVA), the material used for the test athlete and that of polyethylene are compared, the margin is significant.

Polyethylene possesses a compression set of 25% after 24 hours of compression. This means that it is able to retain 75% of its original shape and capabilities once it has recovered. EVA possesses a compression set of 70% after the same amount of time in compression. This

means that after enduring repeated pressure, it only retains about 30% of its original shape . This disparity in compression set can prove to be vital to every aspect of the performance. Having an insole with a longer shelf life can prove to be extremely beneficial. It provides players with adequate cushioning and support, absorbs shock during critical moments when excessive forces are exerted, and can continue to do so for a much longer period of time, ultimately improving user comfort, health, and performance in the long run .

Athlete Wear Testing

To further validate the effectiveness of the Midas Touch insole a second trip was made to Texas for athlete wear testing with the HBCU athlete. The test consisted of a circuit of drills that would force the athlete to demonstrate bursts of explosion and quick changes of direction both with and without the ball. The athlete provided positive feedback stating that it was the first time she had felt comfort in the heel region of an insole. “This is the first time I’ve worn an insole in a cleat and I wasn't thinking about it because it was *actually* comfortable”. She rated her overall comfort an 8.5/10, a 325% improvement in comparison to her original cleat insoles and rated the provided arch support an 8/10.



Insole Testing Conducted with Athlete

Improvements In Response To Athlete Feedback

While most of the initial feedback from the athlete was positive, there was additional insight given that allowed the Midas Touch Insole to be improved significantly. The athlete stated that she felt like wearing socks that provided extra grip would help her toes adjust to the

added space provided in the toe box. To prevent her from having to change her socks, the Midas Touch Insole integrates a Bemis touch zone in the forefoot, providing grip and restricting excessive movement in the toes to accommodate for the cleats' widened toe box.



Figure LXIX: The Midas Touch Insole

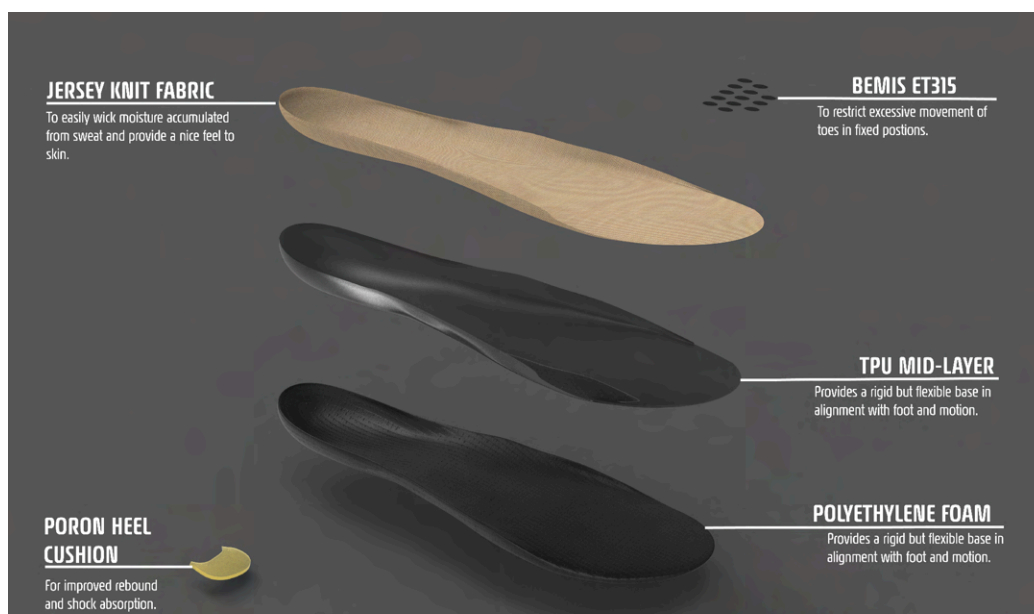


Figure LXX: Features and Benefits of Insole

The Kōfa Agilitá: A Soccer Cleat Designed For The Female Athlete

The Kōfa Agilitá: Features and Benefits

The Kōfa Agilitá is a soccer cleat designed for the female athlete and inspired by the black female athlete. It features a traction design led by female athlete research and testing allowing them to have complete control of their movements on the field. In addition to that, it features asymmetrical lacing for improved fit, a wide toe box for increased toe splay and lateral and medial touch zones that enable an exceptional first touch and close control dribbling with the ball. Additionally, it includes the Midas Touch Insole, made of polyethylene foam for greater impact absorption and sustained comfort. The insole additionally includes a non-slip forefoot zone that accommodates for the cleats widened toe box to keep the female athletes toes stable during intense movement.



Figure LXXI: Kōfa Agilitá Features and Benefits

The Kofa Agilitá : Aesthetic Vision

In its appearance the Kofa Agilitá is gold and black. The gold symbolizes the value seen in black women as the minority playing soccer. It represents the potential they have and the call for them to be invested in for the future of the sport as they continue overcoming the everyday obstacles they face. These women are fierce, resilient, and talented athletes that are unfortunately unsupported and underrepresented. The color choice is meant to empower them, while allowing them to stand out on the field with a cleat that enables them to play at the highest level.



Figure LXXII: Moodboard and Aesthetic Vision



Figure LXXIII: Kofa Agilita



Figure LXXIV: Right Foot stance as player prepares to take penalty shot

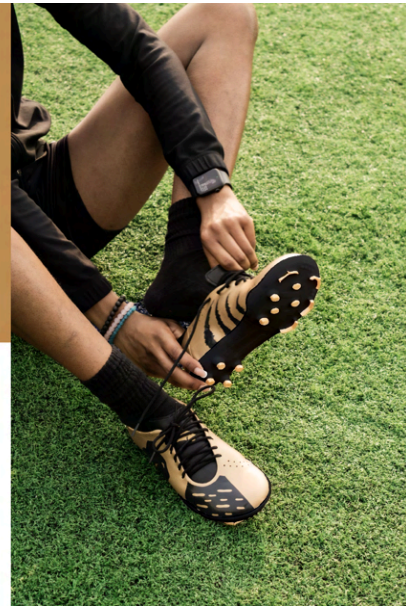
On the collars of each cleat features the phrase : “In Pursuit” . It represents the repetitive action of the lynx as it hunts for its prey, while also symbolizing the constant chase of these black women as they embrace the constant pursuit of achieving their goals en route to reaching

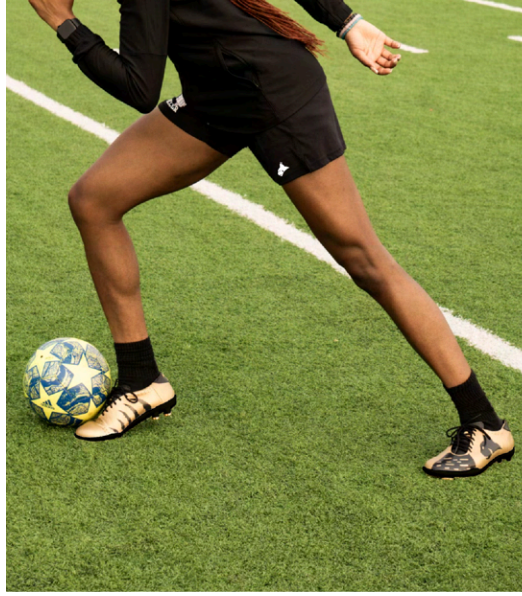
the same heights as the current and past black women in soccer that have achieved great things in the sport.

Conclusion: What It Means

When asked what it meant to be a black woman playing soccer and how it felt to have a project dedicated to prioritizing their health, performance, and representation within the sport, the athletes surveyed showed several emotions. They expressed gratitude for the designing of cleats that actually considered their bodies and prioritized their wellbeing to enable them to feel secure in their every move. In regards to the existence of black women within the sport, they acknowledged the underwhelming amount of black representation within the sport, but still emphasized the importance of persevering, achieving their goals, and inspiring the following generations of black women in soccer.

“Being a **black** woman, playing soccer feels like a **privilege**, because not only are we **inspired** by professionals, but we hold the **responsibility** to be the **inspiration** for young black girls scared to play in a primarily white sport”.





“A very underrated aspect of the game is **confidence**. It’s built over time and it starts with cleats that allow you to feel **secure** in every move you make”.

“Accumulated confidence prepares you for those **critical moments**, and that’s what the game is all about”.



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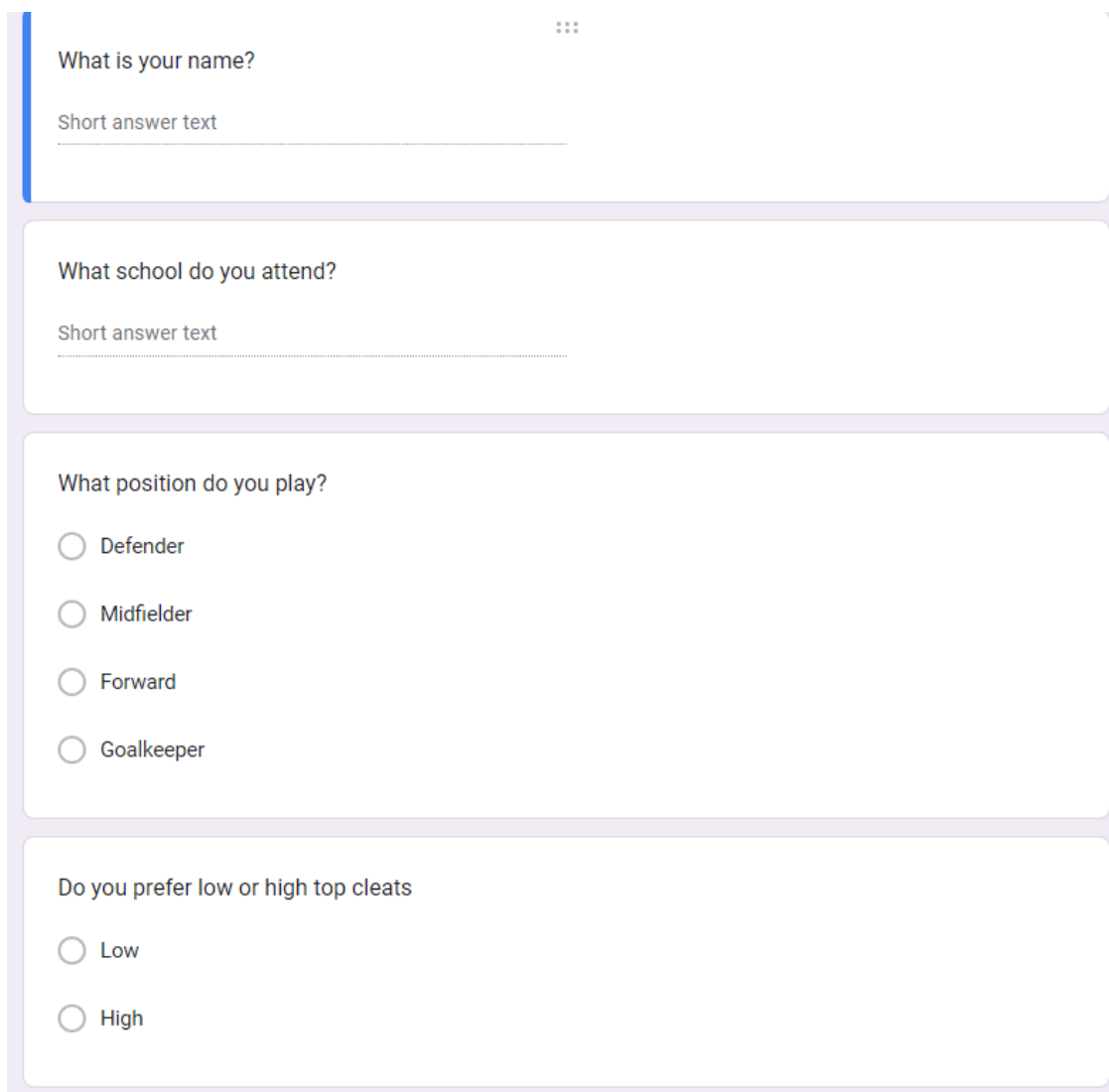
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Initial survey Questions

1. What is your name?
2. What school do you attend?
3. What position do you play?
4. Do you prefer low or high top cleats?
5. What type of cleats do you currently own?
6. Are these soft or firm ground cleats?
7. What type of surface do you play on the most?
8. How would you describe the comfort level of your current cleats?
9. What are some features you wish current cleats provided?
10. What words would you use to describe yourself/your game?
11. What is the most you would be willing to pay for cleats?
12. Do you prefer cleats with metal studs or plastic?
13. Are you flat footed or high arched?
14. Would you be open to being a wear tester for a cleat designed specifically for black women? If so, how can we contact you?

Appendix 1: Initial Survey Questions (google forms)

Below are the actual questions from google forms. This shows the depth of questions asked as well as the type of questions that allowed for survey responses to be received as they were.



The image shows a screenshot of a Google Form with four questions. The first question is a short answer text field. The second question is also a short answer text field. The third question is a multiple choice question with four options: Defender, Midfielder, Forward, and Goalkeeper. The fourth question is a multiple choice question with two options: Low and High.

What is your name?
Short answer text

What school do you attend?
Short answer text

What position do you play?

- Defender
- Midfielder
- Forward
- Goalkeeper

Do you prefer low or high top cleats

- Low
- High

What type of cleats do you currently own? ☰

Short answer text
.....

Are these soft or firm ground cleats?

Soft

Firm

What type of surface do you play on the most

Grass

Turf

Other...

How would you describe the comfort level of your current cleats?

Long answer text
.....

What are some things/features you wish current cleats provided?

Long answer text
.....

What words would you use to describe yourself/your game?

Short answer text
.....

What is the most you would be willing to pay for cleats?

Short answer text
.....

Do you prefer metal studs or plastic cleats?

- Metal Studs
- Plastic Cleats
- Other...

Are you flat footed or high arched?

- Flat footed
- High arched

Would you be open to being a wear tester for a cleat designed SPECIFICALLY for black women?

Yes

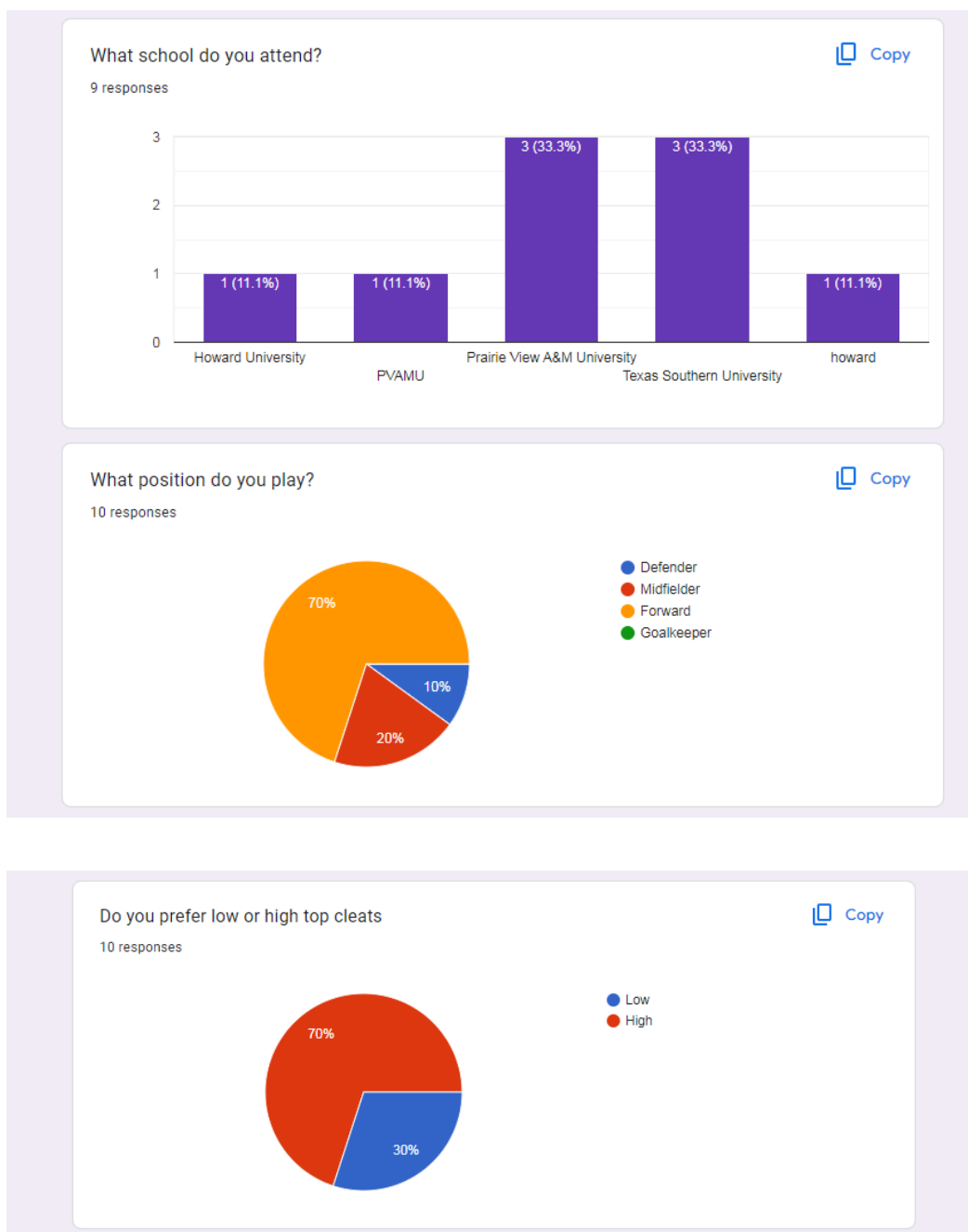
No

If so, what is your email/best way to contact you?

Short answer text

Appendix 2: Initial Survey Responses

Below are the **visual** responses of the survey questions via google forms.



What type of cleats do you currently own?

10 responses

Tiempo

Nike

nike

High phantom luna

Adidas predators

Adidas Predators

Nike Phantom

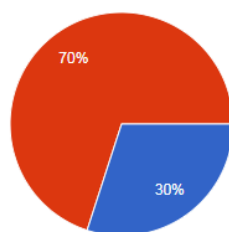
Low top adidas

Nike Superfly Mercurial Elite

Are these soft or firm ground cleats?

 Copy

10 responses

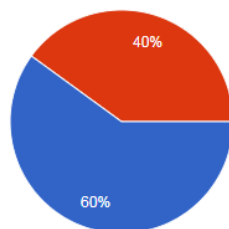


● Soft
● Firm

What type of surface do you play on the most

 Copy

10 responses



● Grass
● Turf

How would you describe the comfort level of your current cleats?

10 responses

the soles are not that comfortable so i double sock so it won't feel too hard

nice

They are very supportive and soft

Highly uncomfortable as are most cleats for me

okay, but not great

Very comfortable at first but lose stability over time

High

Not great. I have to personally buy insoles to fit shape of my feet.

uncomfortable soles

What are some things/features you wish current cleats provided?

9 responses

softer soles

flexibility

Cooling gel insole

More arch support , wider toe box

Comfort, stability, cooler colorways

Better arch support and ankle support.

Ankle stability but not super high on my ankle and better studs

Insoles with arch support for flat feet

softer soles, slip resistance (idk how to word it but i slip a lot in my cleats)

What words would you use to describe yourself/your game?

9 responses

very fast and dynamic

fast

Dynamic, agile, lefty

Passionate

Unique

High speed, lots of cuts, high mileage

Quick transition and lots of turning

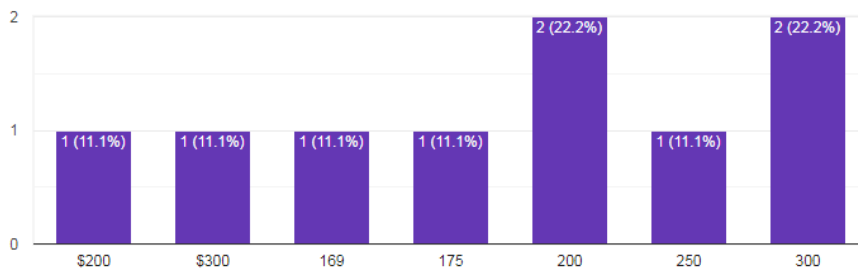
I would say I'm a really technical, calculated, and fast paced player.

dynamic and fast

What is the most you would be willing to pay for cleats?

 Copy

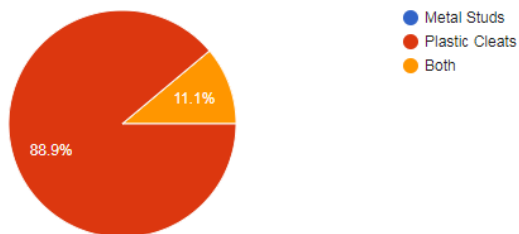
9 responses

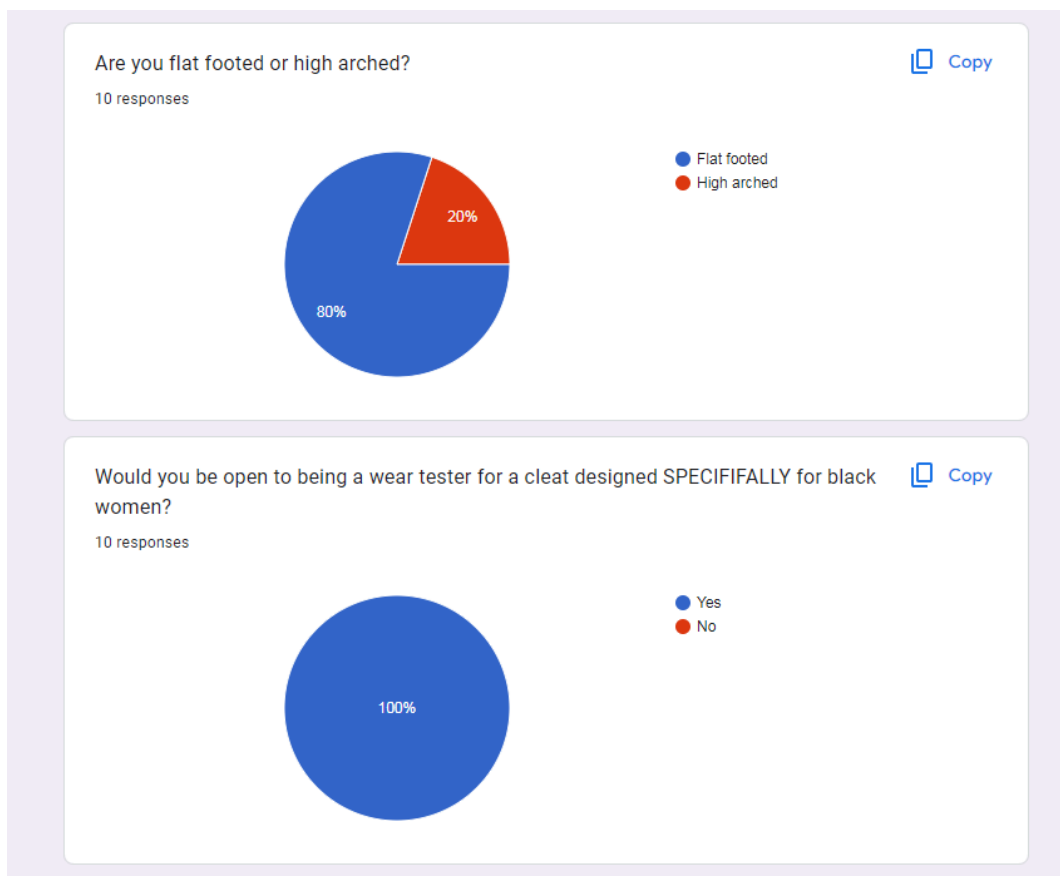


Do you prefer metal studs or plastic cleats?

 Copy

9 responses





Asking if players were flat footed or high arched towards the **end** allowed for the final selections on who would be the athletes for testing to be made.

With consideration of survey participant privacy, names remained undisclosed.

Appendix 4 : Ethylene Vinyl Acetate Data Sheet



17500 23 Mile Road
Macomb, MI 48044
Tel: (586) 627-3626
Fax: (586) 627-5830
www.thefoamfactory.com

Product General and Technical Information

Date: 10/3/2017

Name: Cross-Linked Polyethylene Foam

General Information

Cross-Linked Polyethylene foam is a good-quality foam with a firm feel. Common applications can be found [Here](#).

Property	Test Method	2.0 LB	3.0 LB
Density (LB/Cubic Ft.)	ASTM D3575	2	3
Tensile Strength (PSI)	ASTM D3575	55.4	70.4
Tear Resistance (lbf/in)	ASTM D3575	12.5	17.7
Elongation at Break (%)	ASTM D3575	290	319
Shore Hardness (00 or A)	ASTM D2240	50 (00)	58 (00)
Compression Deflection 25% (PSI) 50% (PSI)	ASTM D3575	8.2 17.1	10.5 19.8
Compression Set 25%, 1/2 hr (% Max)		18	---
25%, 24 hr (% Max)	ASTM D3575	7	---
50%, 1/2 hr (% Max)		42	32
50%, 24 hr (% Max)		16	13
Working Temperature Range (°F)	Internal	-76 to 194	-94 to 194
Water Absorption, 7 days % Vol (max))	Internal	1	1
Thermal Conductivity, 176°F (80°C) (BTU-in/hr-Sq.Ft-°F)	ASTM C177	0.26	---
Flammability, >1/4" (4"/min)	FMVSS302	PASS	PASS
Thermal Stability, 24hrs at 158°F (70°C)(%)	ASTM D3575	2	2

Property	Test Method	4.0 LB	6.0 LB
Density (LB/Cubic Ft.)	ASTM D3575	4	6
Tensile Strength (PSI)	ASTM D3575	99.0	137
Tear Resistance (lbf/in)	ASTM D3575	21.8	30.1
Elongation at Break (%)	ASTM D3575	306	268
Shore Hardness (00 or A)	ASTM D2240	71 (00)	27 (A)

Appendix 5: Ethylene Vinyl Acetate Foam Data Sheet

Overview of materials for Ethylene Vinyl Acetate Copolymer

Categories: [Polymer](#); [Thermoplastic](#); [Ethylene Vinyl Acetate](#); [Ethylene Vinyl Acetate M](#)

Material Notes: This property data is a summary of similar materials in the MatWeb database. The data points used to calculate the average. The values are not necessarily 1

Vendors:

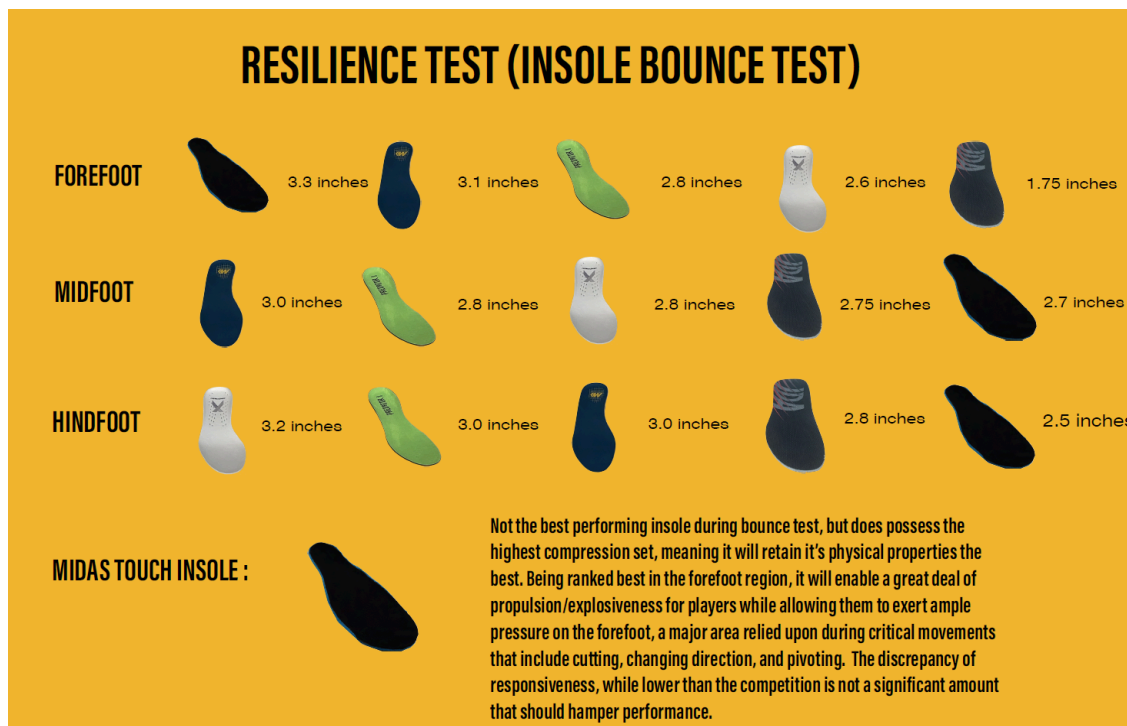
Available Properties

- Density, Average value: 0.901 g/cc Grade Count:167
- Particle Size, Average value: 494 µm Grade Count:7
- Viscosity, Average value: 864000 cP Grade Count:20
- Environmental Stress Crack Resistance, Average value: 423 hour Grade Count:13
- Vinyl Acetate Content, Average value: 20.3 % Grade Count:139
- Melt Flow, Average value: 58.2 g/10 min Grade Count:162
- Hardness, Shore A, Average value: 80.2 Grade Count:125
- Hardness, Shore D, Average value: 35.8 Grade Count:94
- Tensile Strength, Ultimate, Average value: 12.6 MPa Grade Count:124
- Tensile Strength, Ultimate, Average value: 19.8 MPa Grade Count:11
- Film Tensile Strength at Yield, MD, Average value: 4.86 MPa Grade Count:3
- Film Tensile Strength at Yield, TD, Average value: 4.17 MPa Grade Count:3
- Tensile Strength, Yield, Average value: 6.87 MPa Grade Count:28
- Film Elongation at Break, MD, Average value: 513 % Grade Count:6
- Film Elongation at Break, TD, Average value: 695 % Grade Count:6
- Elongation at Break, Average value: 676 % Grade Count:135
- Elongation at Break, Average value: 607 % Grade Count:11
- Elongation at Yield, Average value: 151 % Grade Count:6
- Modulus of Elasticity, Average value: 0.0952 GPa Grade Count:29
- Modulus of Elasticity, Average value: 0.157 GPa Grade Count:11
- Flexural Modulus, Average value: 0.0807 GPa Grade Count:71
- Flexural Modulus, Average value: 0.128 GPa Grade Count:11
- Secant Modulus, Average value: 0.220 GPa Grade Count:6
- Tensile Impact Strength, Average value: 565 kJ/m² Grade Count:17
- Tensile Impact Strength, Average value: 490 kJ/m² Grade Count:11
- Elmendorf Tear Strength MD, Average value: 231 g Grade Count:3
- Elmendorf Tear Strength TD, Average value: 324 g Grade Count:3
- Dart Drop Test, Average value: 922 g Grade Count:5
- Compression Set, Average value: 70.0 % Grade Count:11
- Film Tensile Strength at Break, MD, Average value: 32.6 MPa Grade Count:7
- Film Tensile Strength at Break, TD, Average value: 26.5 MPa Grade Count:7
- Electrical Resistivity, Average value: 6.00e+14 ohm-cm Grade Count:5
- Surface Resistance, Average value: 133 ohm Grade Count:3
- Comparative Tracking Index, Average value: 600 V Grade Count:3
- Melting Point, Average value: 82.5 °C Grade Count:119
- Vicat Softening Point, Average value: 62.8 °C Grade Count:97
- Brittleness Temperature, Average value: -82.8 °C Grade Count:53
- Flammability, UL94, Grade Count:3
- Ring & Ball Softening Point, Average value: 113 °C Grade Count:47
- Haze, Average value: 3.09 % Grade Count:8
- Gloss, Average value: 83.2 % Grade Count:5
- Transmission, Visible, Average value: 80.0 % Grade Count:6
- Processing Temperature, Average value: 158 °C Grade Count:17
- Melt Temperature, Average value: 200 °C Grade Count:18

Appendix 6: Insole Resilience Test



Insole Key



Insole Resilience Test Results