Alchemy: A Maternity Aerobic Kit Designed to Support Expectant Mothers Maintain an Active Lifestyle Through Pregnancy

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Introduction

Women are the essence of the global population, and yet the sports products that exist for expectant mothers to maintain their health during and after their pregnancies are limited. Regardless of the progress made in recent decades to include women in sports, it seems contradictory that women are encouraged to maintain an active lifestyle during pregnancy and postpartum periods of their life for mental and physical benefits, yet lack adequate sports products suited for their needs.

The purpose of this paper is to describe in depth the concept of a maternity aerobic kit. Aerobics refers to running, jogging, or walking in the context of this project. This aerobic kit considers the existing sports products on the market, the anatomical and biomechanical changes that a woman's body experiences through the terms of pregnancy and postpartum, and the opportunities that could be addressed through a rigorous design process. The Alchemy kit includes a baseline aerobic shoe focused on upper and midsole innovation, a moldable insole for each foot capable of molding to the user's foot anatomy which accommodate changes especially in the 2nd, 3rd, and postpartum periods of pregnancy, and a compression sock with emphasizing support and relief through intentional design. The goal of this project is to provide future moms with products that work in tandem and are specifically designed to accommodate one of the most, if not the most, physically demanding periods of their lives. More specifically, footwear will focus on innovation in the upper design and materials, donning and doffing methods, as well as midsole design and technology. The insole will provide stability for the entire foot by emphasizing support in regions of the foot including arch, lateral, and medial regions. The compression sock will focus on support of the arch and ankle via compression, as well as promote relief via padded support placement based on reflexology of the foot. Additionally, the compression sock will offer improvement to donning & doffing methods.

While there has been significant progress to include women in sports, advocacy continues to be needed for women who desire to maintain active lifestyles during and after pregnancy.

Project Overview

The focus of this project is to create a sports product line that supports anatomical and therefore biomechanical changes that women experience during and after pregnancy. As previously noted, the maternity aerobic kit will consist of athletic footwear that is compatible with the terms of pregnancy and postpartum, including moldable insoles which accommodate anatomical changes to the foot during pregnancy and postpartum, as well as compression socks that have specific benefits for the intended demographic. There is currently no "maternity" aerobic shoe on the market, which poses great opportunity for this project to make a necessary impact. Through the design process, the problem statement that this project intends to address is:

How can we design an effective aerobic kit that adapts to a woman's changing body during pregnancy, offering the support necessary to maintain an active and comfortable lifestyle during this time?

History of Running

The concept of running has existed since the presence of homo sapiens as a method of survival. The sport of running was "invented" in 776 B.C.E. (Brand, 2019). Through the centuries, running has evolved into the sports phenomenon celebrated today, which challenges the physical and mental capacity of human nature. There is expansive history of running, but for the purposes of this project, the history of running is summarized through noteworthy events and historical periods which relate to the inclusiveness of women in the sport of running. Through this evolution, a generalization of how running has evolved into a common everyday activity among the public can be inferred. Related to this project, aerobic exercises – such as running, jogging, and walking – are recommended for expectant mothers to maintain an active lifestyle without much risk to their health or that of their fetus. Of course, working with a physician is recommended prior to partaking in any activity during and/or after pregnancy.

Marathon running has existed since the 19th century and was included for males in

the 1896 modern Olympics (Brand, 2019). There was a woman who unofficially raced in this event, but it did not count for anything beyond her participation (Brand, 2019). The year 1909 was "marathon 'mania'" as New York added five marathon events through the year on holidays (Brand, 2019). However, it was not until 1926 that the first woman had her time recorded running the distance of a marathon. The Olympics slowly but surely began including women in running races by first adding the 100m and 800m track events in 1928. The 800m race was removed from Olympics after 1928 due to risk of injury among female athletes (Wendy, 2022). However, as running became more established and women's participation became more acceptable, the Olympics continued to add races such as the 200m, 800m, and 1500m track events by 1972 (Wendy, 2022). Among the public, women were allowed to race in city marathon events in the 1960s, although in 1967 Boston attempt to eject a woman from racing in the middle of the race. Nonetheless, women's records began to count for something as the 1970s began and recreational running became a challenging phenomenon for the everyday citizen. By 1972, Title XI paved the way for women in sports by expanding opportunities and shifting the status quo for women who desired to participate in sports. By the 1980s, marathon events reached most major cities around the world (Jones, 2003). For example, in 1982, the European Associates established marathon running events for women and in the US the first track and field championship in the NCAA for women allowed younger generations of women to participate in their passion to run (Wendy, 2022). Regardless of the traction running gained, the women's Olympic marathon event was not created until 1984 (Brand, 2019).

This overview of major events accounts for the history of running and highlights how participation among women have expanded. The 21st century has continued the momentum of the running phenomenon on a global scale so that women around the world continue to have access and encouragement at an elite level as well as the common level to participate. With increased participation though, sports products only recently have become more specific to a woman's anatomy and still lack innovation in certain areas.

As documented in history, women have not always had adequate support to

participate in running sports. Society believed that women were “too dainty and fragile for distance running” and other hesitations stemmed from societal norms of how women should conduct themselves (Wendy, 2022). In general, there is a lack of research regarding the effects of a woman exercising while pregnant and/or during postpartum, which may contribute to her own fear and beliefs about the risks of activity while pregnant or recovering from childbirth. The lack of innovation for sports maternity products demonstrates the lack of this research and the resulting fears and beliefs. While sports products for women have evolved significantly in recent decades as participation has soared, normalizing their participation in sports at any stage in their life is crucial and continues to be an ongoing conversation.

The historical context provided in this section is helpful to reference when designing the maternity aerobic kit because it provides a foundation for current running products made for women and highlights why research and innovation in the maternity space requires further advocacy.

Sport Environment

While running, jogging, and walking are sports that can be done in most climates, the intended use and testing of this maternity aerobic kit will be in the moderate climate of the Northwest United States. This decision is due to the year-round climate that rarely reaches extreme highs and lows regarding temperature and humidity. More specifically, Portland, OR is known for its active culture and has temperature ranges of 35 – 85 °F and a humidity range of 63 – 83% (Weather & Climate, 2024 & Weather Spark, 2024). These conditions are important when considering the guidelines provided for expectant mothers who require acute awareness to maintain comfort while staying active. Furthermore, the maternity aerobic kit is recommended for use on level surfaces such as roads, sidewalks, or paved routes to avoid risks of falling.

Guidelines

Guidelines for staying active while pregnant vary based on the individual and the term, it is highly recommended to consult with appropriate medical professionals throughout pregnancy and postpartum to ensure safety and awareness when partaking in exercise. In general, it is recommended by medical professionals that women maintain 150 minutes of aerobic exercises per week during pregnancy (Luminis Health, 2020). For activities, it would be helpful to prioritize warm-ups and cool downs before and after exercise, wearing supportive and comfortable shoes and active wear, staying hydrated, maintaining body temperature, and taking rest as needed.

Each term has its own unique guidelines based on how the body may change and react to physical stimulus. For example, the first term typically has fewer physical limitations, however, women tend to experience more nausea and morning sickness which may prevent them from participating in aerobic exercises. If active prior to pregnancy, it is typical that women maintain their routines. If not active prior to pregnancy, it is recommended to add 15 - 30 minutes of walking each day (Luminis Health, 2020). During the second term, nausea may be resolved, however, training on level surfaces is encouraged due to the loosening of ligaments as hormones release and ligamental laxity occurs. Avoiding high impact activities and paying attention to levels of exertion become more important at this stage (Luminis Health, 2020). As the fetus begins to grow and greater changes occur to the body, reduction of impact is encouraged, and monitoring rate of exertion becomes more important (Luminis Health, 2020). The risk of falling becomes greater as well, due to shifts in the center of gravity and pressure. After pregnancy, recovery is most important for women to prioritize. Activity can be reintroduced into routines around 6 weeks after giving birth, which is around the time of the first postnatal checkup (NHS, 2022).

These general guidelines for each stage of pregnancy and postpartum are important considerations when designing the maternity aerobic kit. Further research will be considered to account for unique situations since experiences in each phase may vary.

Intended Demographic

The intended demographic for this product consists of women who become pregnant and wish to maintain an active lifestyle during and after pregnancy, especially interested in aerobic activity. To narrow the scope of the potential consumer, careful review of statistics is considered. Based on initial research, global trends indicate that in recent decades the age range women who experience pregnancy has expanded. Women are not only delaying motherhood, which in part is due to the ability to continue motherhood later in life than ever before. According to data that has been collected, women are starting families in their late 20s or early 30s and have the potential to continue bearing children in their late 30s or early 40s (*Mean age of women at birth of first child,* n.d.). For this reason, the intended demographic for the maternity aerobic kit will be for the age range of 20 – 40 years old.

Market Research

Within the intended demographic, it is important to consider the market that currently exists for maternity sports products as well as running products, also used for jogging and/or walking. Insight into these two markets will provide context for the future success of the maternity aerobic kit. In 2024, the running shoes global market was valued at $51.3 billion which is projected to reach $64.22 billion in 2033 (Company, 2024). Regarding maternity active wear in 2024, the market was currently at $7.2 billion, which is forecasted to reach $11.9 billion in 2032 (Maternity Active Wear Market Size, Growth & Forecast 2032, 2024).

Both markets are expected to grow 5-5.8% in the next decade. There are various considerations that could explain the increase in female sports products for running and maternity activewear. These reference data points are encouraging to consider when developing the maternity aerobic kit because of the potential impact it could have on major markets. With these markets in mind, and considering the total global population of women, 86% of whom are expected to be pregnant by the time they are 44 years old, and that 60% of women now account for participants of 5K races, this equates to about 2

billion potential consumers benefiting from the maternity aerobic kit (Anderson, 2024).

In general, the maternity aerobic kit intends to reach athletes who prioritize taking care of themselves not only physically, but mentally by participating in aerobic exercise such as running, jogging, and walking. The opportunities for women to participate in sports has expanded tremendously in recent decades, and the traction that maternity sports products have received in recent years highlights the need for more innovation in this space.

As the guidelines touched on the physical aspect of maintaining an active lifestyle during pregnancy and/or postpartum, the market research demonstrates through data that more women are adhering to these guidelines. The growth that is predicted in running and in maternity sports products indicates that there will be a real need for innovation in the future, and this maternity aerobic kit intends to be part of the solution. The other aspect the kit addresses is that it may bridge the gap and provide expectant mothers with better tools to prioritize caring for themselves mentally during this period of their lives. When provided the right sports products, women have the opportunity to care for themselves in ways that can revolutionize the sports industry.

State-of-the-Art Insoles

The maternity aerobic kit will include a moldable insole designed for use throughout all terms of pregnancy and postpartum. To develop a design that innovates current products, it is important to consider what exists. There are three companies discussed in this section which have developed insoles specifically for expectant mothers which are useful to reference when designing the insoles for the maternity aerobic kit.

The first company for reference is called “MommySteps,” and has developed two insoles for pregnancy. One insole is called “Athletic & Active”, and the other is called “Casual & Flat” shown in Figure 1 below (MommySteps, n.d.).

Figure 1
MommySteps "Athletic & Active and "Casual & Flat" Insoles



Currently, the price point is $39.95 according to their website. The benefits of these designs are that both insoles are made for two separate occasions. They both are moldable up to three times to accommodate changes that may occur to the body throughout pregnancy and/or postpartum (MommySteps, n.d.). The goals of these insoles are to support balance and position, as well as allow for cushion and comfort.

The second company to consider when designing insoles for pregnancy is known as "Foot Levelers." This company has created three separate insoles designated for the 2nd, 3rd, and postpartum periods of pregnancy as shown in Figure 2.

Figure 2
Foot Levelers Mommy Nurture Insoles



The price point is not listed online and requires the customer to call the company to get a quote. The benefits of these designs vary, but overall, they are lightweight, thin, and flexible for added comfort and stability (Smiroldo, 2024). An interesting component for consideration is to designate varied materials to the different periods of pregnancy

and/or postpartum to accommodate anatomical changes.

The third company to consider when assessing insole designs is called "FootDirectClub." This company has developed two insoles specific to the 2nd and 3rd trimesters, shown in Figure 3 (FootDirectClub, n.d.).

Figure 3
FootDirectClub 2nd & 3rd Trimester Insoles



The price for this product is listed on their website at $240 for each option of insole. The features of this insole include alleviated pain and discomfort regarding "feet, ankles, knees, and back," as well as reducing swelling of feet and ankles, improving balance and stability. The insoles also claim to have "firm arch support" for user (FootDirectClub, n.d.).

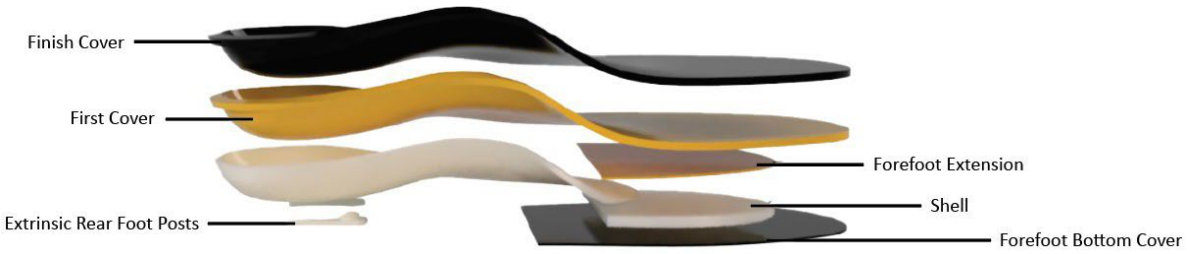
These companies have created a great baseline for reference when conducting research and developing innovative ideas for the maternity aerobic kit that will eventually transition the sports industry.

Purpose of Insoles

The insole part of a shoe is typically removable, made from malleable materials, and has additional features and benefits dependent on intended use. The purpose of the insole is to provide additional support and comfort to the bottom of a user's foot within a shoe. The arch and the foot type of a user, as well as the functionality they may be looking for, will determine the type of insole that may help them with their goals (Helios, n.d.). For example, the insole has multiple parts of anatomy, shown in Figure 4 (Find the Perfect

Insoles, n.d.). The jobs-to-be-done for each part are referred to in Table 1 (Helios, n.d.).

Figure 4
Anatomy of an Insole



Note: Not all insoles have all these components, anatomy of insoles may vary.

Table 1
Jobs-to-Be-Done: Insole

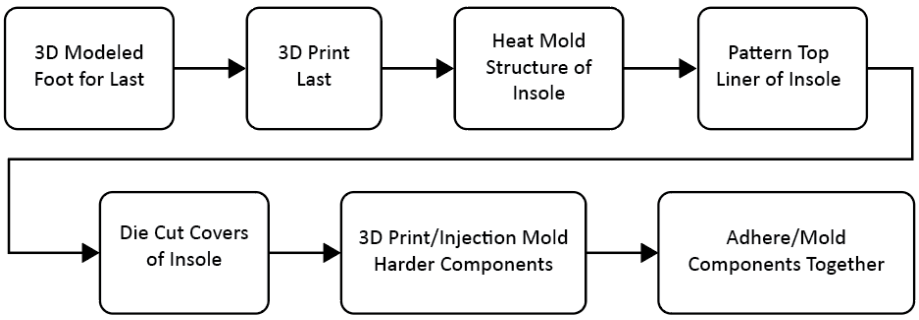
Part of Insole	**Jobs-to-Be-Done**
Finish Cover	Provides comfort and prevents friction against the foot and can have additional moisture wicking properties
First Cover	Added cushion for comfort and arch support
Shell	Structure of midsole to hold shape
Extrinsic Rear Foot Posts	Heel supports stability and avoids slippage
Fore Foot Bottom Cover	Reduces friction against shoe
Extrinsic Fore Foot Post	Provides stability for metatarsal bones
Fore Foot Bottom Cover	Corrects for varus and valgus tendencies

Materials & Manufacturing: Insoles

As previously noted, the materials of insoles are malleable, with few components made of plastics for structure and support. These materials make the manufacturing of the insoles straightforward and simple. Once a 3D model of a foot is chosen, the "Last," which is a 3D printed foot-like form, is used as reference for the shape of the insole.

The components detailed in the section above vary since insoles may be designed for various applications, but the method of manufacturing narrows down to die cutting, injection molding, heat molding, and adhering the components together. For example, the materials that could make up the covers of the insole include cork and leather or foam and gel (Tsoules, 2023). An additional material that has been recently used is a viscoelastic polymeric material known as sorbothane (Sorbothane, Inc., 2024). If applicable, the cover materials are die cut to the pattern of the insole. Other materials may be heat molded to fit the last. For the harder components such as the shell, extrinsic rear foot posts, fore foot post, and fore foot extensions are usually made of plastics, polypropylene, or carbon fiber, which may use other manufacturing techniques such as 3D printing or injection molding (Tsoules, 2023). Once the parts of an insole are complete, they are adhered to one another with adhesive if they are not already molded to one another. See Figure 5 for a flowchart of the process.

Figure 5
General Flowchart of Manufacturing Process for Insole



Overall, the designs of insoles and materials used may vary, but the manufacturing methods are transferable due to the general goal of insoles: provide additional comfort and stability for a user's foot within a shoe.

State-of-the-Art Compression Socks

In addition to the insoles and footwear, compression socks will be the third product included in the maternity aerobic kit. The goal of the sock is to provide adequate compression and support to the user's foot, especially considering arch and ankle support as well as reducing swelling due to lower limb edema. Other goals of the compression sock include designing for ease of donning & doffing, as well as incorporate focused regions of relief based on reflexology. There are various companies that provide adequate compression socks for pregnant and postpartum women. A few companies to consider while designing a compression sock for the maternity aerobic kit are detailed as follows, although there are more that may be considered throughout the design process.

The first company worth noting is Apolla, specifically its Performance compression sock as seen in Figure 6 (Apolla, n.d.).

Figure 6
Apolla Performance Compression Sock



The Performance sock offered by Apolla is $39.99 and can be ordered from their website or Amazon. The design of this compression sock differs compared to competitors in that it is designed at mid-height and made with REPREVE. Similar to other compression socks, this product offers 20-30 mmHg compression in the ankle and arch regions of the foot, as well as knit in padding in the heel and toe region of the foot for comfort (Apolla, n.d.). This product stands out because of its use for activities rather than lounging.

Another company worth noting as a competitor is Kindred Bravely, as shown in Figure 7 below (Kindred Bravely, n.d.). Their compression socks are sold as pairs on their website for $30.00.

Figure 7
Kindred Bravely Compression Socks



The features of the Kindred Bravely compression socks are similar to Apolla in that they offer 20-30 mmHg compression in the arch and ankle region but differ in design as they are knee high height (Kindred Bravely, n.d.). This product offers benefits related to their material, which is a viscose from Bamboo blend that offers moisture-wicking and odor-reducing capabilities (Kindred Bravely, n.d.). These compression socks differ from Apolla because they are specifically recommended for pregnancy, and not necessarily for performance activities.

Lastly, a recommended company which offers competitor products to that of the maternity aerobic kit compression sock is COMRAD with their Knee-High compression socks as shown in Figure 8 (COMRAD, 2025). These compression socks are $32.00 on the COMRAD website.

Figure 8
COMRAD Knee-High Compression Socks



These compression socks are important to include with the others because this product is recommended for both pregnancy and performance activities such as running, jogging, and walking. COMRAD claims that these socks reduce swelling from edema, are comfortable for all day activities, and increase circulatory health (COMRAD, 2025).

Competitors in this space have offered great solutions via compression and materials, which provide a strong foundation for the compression sock to continue to build from in the maternity aerobic kit. Nonetheless, there are other areas of improvement which could be addressed to better provide the intended demographic with socks that aid in relief, support, and encouragement when participating in aerobic activities.

Purpose of Compression Socks

Compression socks have been proven to be beneficial for various applications such as lounging, exercise, pregnancy, and alleviating other health concerns. Through construction of the knit material, varies levels of compression are zoned into the design of the silhouette to “apply gentle pressure” on lower limb extremities that helps to “decrease swelling and pain,” as well as “reduce inflammation” and improve circulation (Riverside Health, n.d.). There are abundant options on the market that offer different levels of compression, materials, sock height, performance benefits, and other features for intended use. The figure and table below detail generic anatomy that is common to see regarding compression socks and the “Jobs-to-be-Done” of these parts.

Figure 9

Anatomy of a Compression Sock



Table 2

Jobs-to-Be-Done: Compression Socks

Part of Compression Sock	**Jobs-to-Be-Done**
Cuff	No slip rib knit, provide comfort and stability
Sock Height	Graduated compression up the leg
Ankle	Compression for ankle support and stability
Heel	Knit-in padding for blister protection
Arch	Compression for arch support
Toe Box	Knit-in padding for comfort

Materials & Manufacturing: Compression Socks

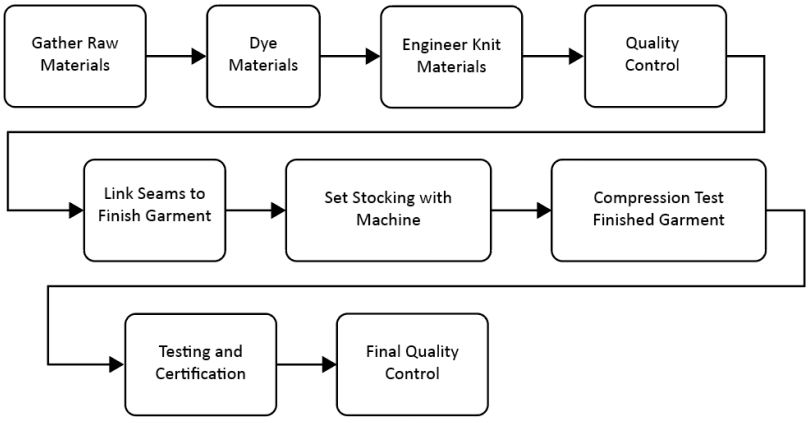
Compression socks are considered apparel and rely on knitting machines to achieve seamless engineered knits with medical grade compression for specific regions. There are various reasons consumers wear compression socks, which result in a multitude of designs, materials, and features seen in the market today. Regardless of the applications, the materials and manufacturing of compression socks are consistent. The compression levels categorize

compression socks for intended use, with 15-20 mmHg and 20-30 mmHg among the options that are recommended and common for the intended demographic to use during and after pregnancy, and for activities such as running, jogging, or walking. These values are important to consider because compression socks are categorized and recommended "based on their compression pressure…at the ankle level" (Lim et al., 2014).

The start of the manufacturing process begins with selecting the desired material for the compression garment and gathering the raw materials. The raw materials are washed and spun into yarn cleaning. Once the yarn is made, it is wrapped in elastic to achieve a stretch knit using core spinning methods. In some cases, the yarn is dyed with color using a dyeing machine after core spinning (TXG, n.d.). Once the material is ready to be knit, a knitting machine meticulously weaves the material into the desired pattern. Quality control will check the process at this point to ensure the pattern is standard, and then the sock is finished with link and sew methods to sew the toe box region. Some companies further the process by using a stock setting machine to achieve desired shape (TXG, n.d.). If needed, further testing is done to achieve certifications for medical grade compression levels and a final quality control check. This process requires more steps, expensive machines, and regular checks to achieve desired result for intended use. Shown in Figure 10 is a general flowchart to visualize this process.

Figure 10

General Flowchart of Manufacturing Process for Compression Socks



State-of-the-Art Recommended Running Shoes

In addition to innovating insole designs for pregnancy and/or postpartum, another focus of this maternity aerobic kit includes a running shoe. Three companies worth considering for reference products are highlighted below.

An inspiration for this project is the company founded by Allyson Felix called "Saysh." Specifically, a bestseller shoe that has been recommended for women is known as the "Saysh One," shown in Figure 11.

Figure 11
Saysh One Shoe



The price point of this shoe is listed on their website as $150.00. The benefits of this shoe are consistent with most running shoes in that the upper is made of a Jacquard knit for breathability, with additional breathable materials for the liner and a flexible lacing system for added comfort (Saysh, n.d.). Although these shoes are not specifically made for the terms of pregnancy and/or postpartum, Saysh has a pregnancy policy that allows customers to return shoes if their foot anatomy changes and receive a replacement (Saysh, n.d.).

The second company to consider for reference of a running shoe is called "APL." A recommended shoe on their website is the "Women's TechLoom Breeze" shoe shown in Figure 12 (APL, n.d.).

Figure 12
APL Women's TechLoom Breeze



This product is priced at $220.00 on their website. The benefits of this product are associated with APL technology such as their TechLoom upper which is seamless known for its "high elastic stretch rebound" material (APL, n.d.). This shoe utilizes a traditional lacing system with lace loop eyelets for smooth lacing. APL also claims to have made their lightest running shoe and emphasizes the benefits of their Propelium material for the midsole for superior energy generation and comfort compared to traditional EVA foam.

The third company to consider when assessing footwear designs intended for aerobic exercise during pregnancy and/or postpartum is known as "Kizik." A recommended shoe from this brand is known as the "Women's Athens" shown in Figure 13 (Kizik, n.d.).

Figure 13
Kizik Women's Athens



This product is comparable in price to the others, listed at $129.00 on their website. Benefits of this design relate to the technologies that are implemented in areas of the shoe which are trademarked by this. For example, HandsFree Labs technology for the heel counter allows for ease of donning and doffing and Extra Rabbit Foam is placed on the outsole for slight heel lift (Kizik, n.d.). This product also has a wider toe box which

allows for anatomy to expand as needed during use.

These companies add depth to the design process when innovating on a specific running shoe made for pregnancy and/or postpartum and will further influence the design of the running shoe as part of the maternity aerobic kit.

Purpose of Recommended Running Shoes

The purpose of running shoes varies and is dependent on the desired activity, but for the sport of running, the intent is to protect a runner's foot and provide support, energy, and comfort to aid in performance efforts. The anatomy of a running shoe and therefore the jobs-to-be done of its components are generally similar from brand to brand, which are detailed below. For example, the Saysh One running shoe shown in Figure 14 highlights the components of their running shoe. The jobs-to-be-done related to each part are referred to in Table 3 (Anatomy of a Running Shoe, 2022).

Figure 14

Anatomy of a Running Shoe



Note: Not all shoes have the same anatomy, parts may vary.

Table 3
Jobs-to-Be-Done: Running Shoe

Part of Insole	Jobs-to-Be-Done
Heel Tab	Placed for ease of donning and doffing, prevents friction against upper to avoid blisters
Heel Counter	Gives rear foot stability while training
Crash Pad	Improves cushioning for heel-toe running
Midsole	Works as a shock absorber to reduce impact and prevent injuries
Insole	Accommodates biomechanics by providing arch support and cushion
Outsole	Provides traction against surfaces
Toe Box	Allows room for anatomical comfort
Upper	Protecting the foot against environment and provides structure for the body of the shoe
Tongue	Provides barrier between laces and foot for secure fit
Heel Collar	Provides comfort and stability for the ankle

Materials & Manufacturing: Running Shoes

Since most running shoes utilize similar materials and technologies, the manufacturing processes are similar from company to company.

The components of the "upper" part of the shoe consist of engineered knits and additional cushioning, typically EVA foam material. For example, the upper part of the shoe is typically made from 100% nylon or polyester that is engineer knitted (i.e., Jacquard knitted). To get the shape of the upper, it is typically fitted around a "last," which is often a 3D printed foot model in a generic size (i.e., US size 7 for women). The heel collar, heel tab, and tongue may have additional EVA foam adhered and/or sewn between upper fabric. The separate parts of the components of the upper are sewn and/or adhered to their respective places. The eyestays of the shoe are typically laser cut or punched out of the upper material, sometimes the holes are finished off with an adhesive for a clean finish or left as is. The laces themselves are made of materials such as cotton, nylon, and

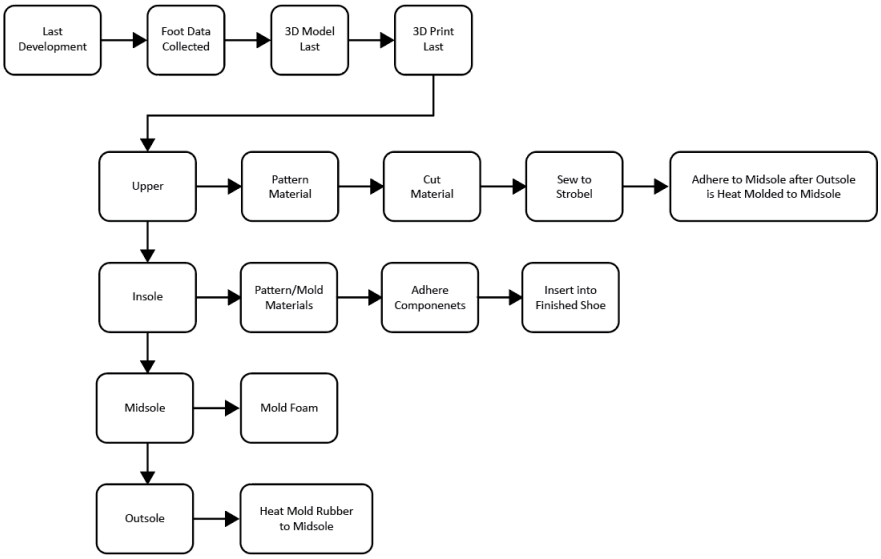
polyester, typically 100% or a blend thereof, and are machine braided material. For running shoes that utilize laces, the laces are laced throughout the upper pattern according to the eyestays pattern. Once the components of the upper are cut and sewn or adhered together, the entire upper is sewn to a hard material known as a strobel board, which is patterned to be slightly smaller than the midsole of the shoe. This is so that the upper can be directly adhered to the midsole surface and set in place to complete the process.

The midsole of the shoe is typically made from EVA foam or another foam specific technology that the company may have created. The material is injection molded into a shape that was made specifically for the shoe. Similarly, the outsole of a running shoe is usually made from a rubber material or a variation thereof, and heat molded to the exterior of the midsole of the shoe.

The methods of manufacturing each part of a running shoe, including the upper, midsole, and outsole, are based on traditional methods of shoe making and are transferable from company to company and between applications. Although there has been innovation in efficiency regarding how shoes are made, the overall process remains standard, and the shoe developed for the maternity aerobic kit will rely on these methods. Refer to Figure 15 for a general visual flowchart of process.

Figure 15

General Flowchart of Manufacturing Process for Running Shoe



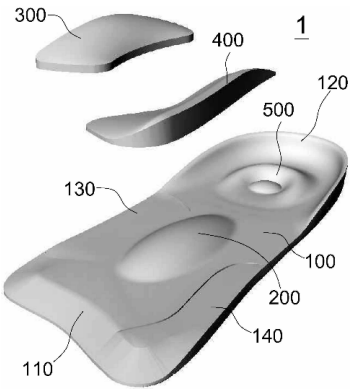
Intellectual Property: Insoles

The products within the maternity aerobic kit will be unique in its design and application, but it is important to note the existing products that are patented. Within the focus of insoles, there are three patents to note.

The first patent worth noting is titled “Functional insole for pregnant women” and is assigned number KR102227064B1. This patent was published in 2021, with intention to provide a “functional insole for pregnant woman” and is show in Figure 16 (Google, 2021).

Figure 16

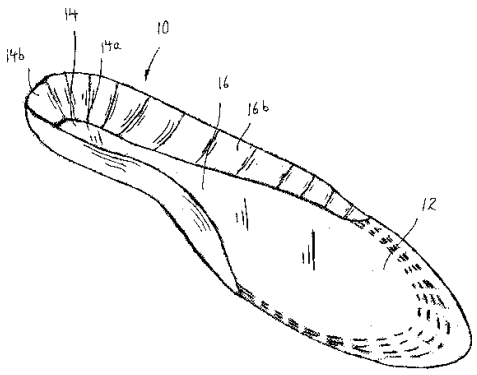
Functional Insole for Pregnant Women Patent Visual



The main body of the insole has “a first arch reinforcement bar, a second arch reinforcement bar, an outer metatarsal reinforcement bar, and a heel reinforcement bar” for purposes of redistributing the frontal weight of carrying a child and the general weight gain that women experience during and after pregnancy (Google, 2021). It is interesting to consider the makeup of this insole, with various components that intend to redistribute weight to alleviate lower body joints of additional stress from weight gain during pregnancy.

The second patent worth noting is titled “Pregnancy/maternity insoles” and is assigned number US6286232B1. This patent was published in 2001 and expired in 2020. A feature of this insole is that it “includes a forefoot portion for extending at least to metatarsals of a foot” and has a “cupped heel portion” with additional arch support (Snyder & Crane, 2021). Visuals of this patent idea are shown in Figure 17.

Figure 17
Pregnancy/Maternity Insoles Patent Visual



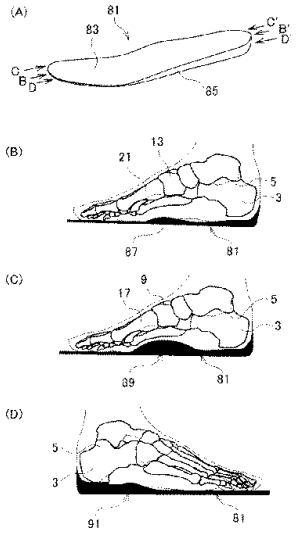
The intent here is to support the “midfoot portion of the insole to prevent abduction of a foot” (Snyder & Crane, 2021). This insole design is specific to the degrees at which the parts of the insole are designed for the intended user since “eighty percent of pregnant women suffer from lower back pain” (Snyder & Crane, 2021). This patent highlights the physiological changes that occur during pregnancy and focuses on how to maintain posture and gait to relieve women of pain they may experience.

The third patent worth noting is titled “Insole for footwear and footwear” and is

assigned number JP2004181202A. This patent was published in 2004 and expired in 2023. The interesting ideas within this patent relate to the three arches of the foot skeleton: “the horizontal arch, the inner vertical arch, and the outer vertical arch,” shown in Figure 18 (Yajima, 2016).

Figure 18

Insole for Footwear and Footwear Patent Visual



As women experience ligamental laxity due to the release of the hormone relaxin during pregnancy, ligaments loosen, and bones splay out to accommodate the fetus growing. As part of the effects of ligamental laxity, the arch of a woman’s foot may flatten, and it is worth noting the anatomy of the foot, particularly the arch, so that the insoles of the maternity aerobic kit are adequate to accommodate such changes. This patent is worth considering due to its focus on arch support and to be a “preventative effect on an orthopedic problem after childbirth” (Yajima, 2016).

Overall, these patents discuss interesting claims when designing insoles specifically for women who become pregnant or are postpartum. It is important to become aware of how others have tried to solve similar problems in the field, while also developing ideas on how to create unique and original insoles for maternity sports products. What would be within scope of this project while challenging past and current insole designs is to

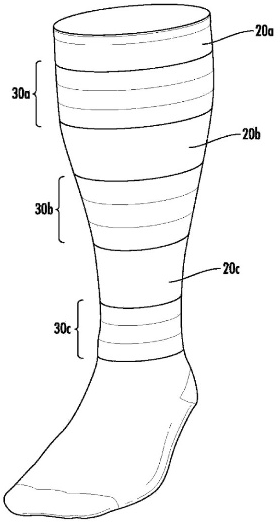
focus on changing the overall shape of the insole, working with more recent and advanced materials, and orienting the functionality to a sport such as running. With these initiatives, the maternity aerobic kit insoles will provide innovation for the intended demographic.

Intellectual Property: Compression Socks

Compression socks have various applications and benefits for a variety of users. There are multiple patents to be aware of, but three relevant ones are detailed below for relevance when designing the compression sock product in the maternity aerobic kit.

A patent worth discussing is titled “Compression fabrics with tailored comfort” and details a product that “provide[s] compression articles suitable for a wide variety of uses” including compression socks (Rock, et al., 2023). Illustration of compression areas in a compression sock example from this patent is shown in Figure 19 (Rock, et al., 2023).

Figure 19
Compression fabrics with tailored comfort



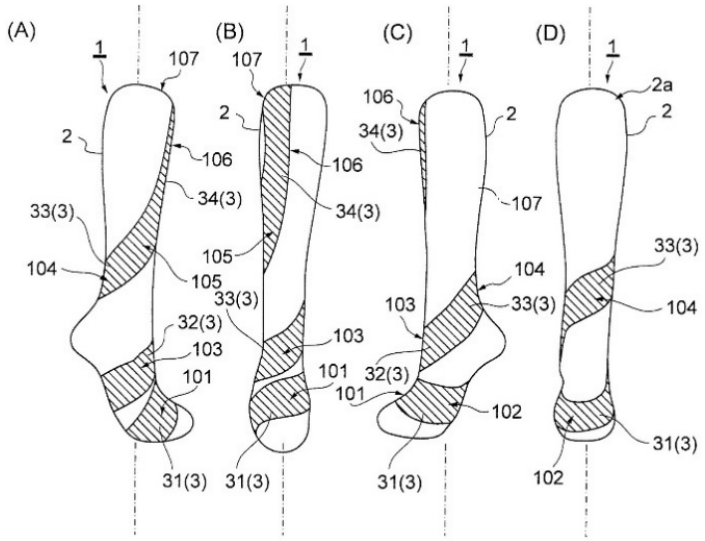
This patent explains that the “compression article includes at least two uniform compression regions” which vary in the amount of compression it provides and includes a transition zone (Rock, et al., 2023). The functionality behind this patent describes how most

compression socks are constructed regarding regions of higher compression that transition to lower compression. These construction details are good to be aware of because of how the compression sock in the maternity aerobic kit will utilize compression in specific regions of its own design.

Another patent that is relevant to this project is titled “Functional socks” and explains how compression socks “provide or assist in the removal of excess venous blood in feet and calves” (Mazourik et al., 2021). This patent has no illustrations associated with it and focuses on functionality of how compression stockings are designed to “prevent development of venous diseases such as edema, phlebitis and thrombosis and protect against further progression” (Mazourik et al., 2021). Knee high applications are also discussed in this patent, specifically how these products “increase circulation and prevent thrombus formation in the lower extremities” which is relevant to the intended demographic of this project and important to note when designing compression socks (Mazourik et al., 2021). This patent also discusses features such as gradual compression, material elasticity, and the effects on lower limb extremities. Overall, the “Functional socks” patent goes in depth about the construction, application, and effectiveness of compression socks for various uses. The information is important to be aware of for the purposes of the maternity aerobic kit.

The third patent that provides context and is beneficial to be aware of during the design process is titled “Leg garment” and describes a compression sock design that utilizes compression in specific regions of the lower limbs via an “inwardly-wound helix” compression zone that extends “from the instep to the ankle through the sole” as illustrated in Figure 20 (Mitsuno et al., 2017). The helix design emphasizes compression around the arch, lateral and medial sides of the foot, and the ventral ankle for support.

Figure 20
Leg garment Illustration



Although the design of the compression sock for the maternity aerobic kit will be different from the patents detailed here, the use of compression and the region of the body will remain similar to what currently exists. Understanding context of what is patented and designs that provide function for a broader demographic provide viable paths forward to creating novelty for a more specific demographic such as the one this project supports.

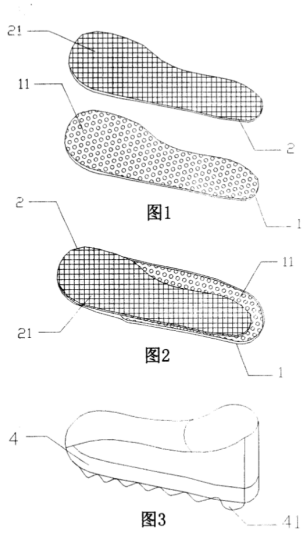
Intellectual Property: Running Shoes

Similar to recognizing the intellectual property of patents that have been filed regarding insoles, it is important to note existing patents related to running shoes made for women who are pregnant and/or postpartum. These patents will provide insight into concepts that have been attempted regarding maternity running shoes and the problems to solve within this space.

The first patent worth noting is titled “Health-care pregnant women’s shoes” and is assigned number CN2894333Y. This application was published in 2007 and has since expired in 2016. The basis of this patent is to provide pregnant women a shoe which has a “slide-prevented, massaging, vibration-insulating healthcare shoe and insole,” further visualized in Figure 21 (Google, 2007).

Figure 21

Health-care Pregnant Women's Shoes Patent Visuals



This design is for daily and not for athletic use. The abstract notes that benefits of this shoe design relate to the edema of the foot. Highlighted are also the shortcomings of how current products on the market fail to address the changes a woman's body endures while pregnant and thereafter. Areas to be aware of not infringing on are the layering of the components within this shoe, as well as how the shoe prevents slide and provides support for the foot of the intended user.

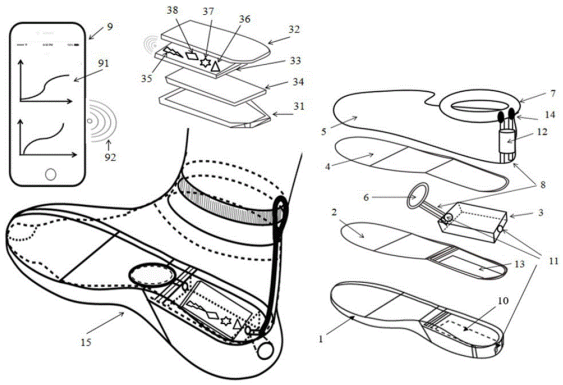
The second patent worth noting is titled "Shoes for pregnant women" and is assigned number JPH01135301A. The purpose of this patent and the design disclosed is to "allow a pregnant woman to walk comfortably by laying a flat insole on a midsole of a lady's shoe whose arch part is widened" (Kawabata, 1989). The justification for this design is that a shoe "with a low heel and a wide arch at the insole, combined with a thin, flat insole and an insole with a wide and thick arch" is appropriate for pregnancy due to the additional arch support. There are no images of this patent available to visualize the features of the shoe. What is worth noting here is that this patent was made in the 20th century but still holds relevant and useful information in the 21st century. One such problem that this patent is trying to solve, which is still relevant today, is the swelling of lower body joints and the flattening of a woman's arch during pregnancy. These will be

important considerations in the design of the running shoe for the maternity aerobic kit.

The third patent worth noting is titled “Pregnant women foot nursing and monitoring intelligent shoes” and is assigned number CN111838864A. This patent was published in 2020 with the status pending. This invention is for women who are pregnant and helps monitor their health through the footwear design. The shoe is considered “intelligent” and is made of “a sole, a shoe insole, an upper surface, a circuit packaging box arranged in a groove at the heel of the sole, an arch pressure sensor and a swelling monitoring sensor,” refer to Figure 22 for visuals (Google, 2020).

Figure 22

Pregnant Women Foot Nursing and Monitoring Intelligent Shoes Patent Visuals



This shoe has the goal of monitoring the changes of a pregnant woman’s foot in “real time” specifically related to “foot shape” and “foot pressure” to provide users suggestions on how to improve foot health throughout pregnancy (Google, 2020). Although there will not be technology implemented in the running shoe for the maternity aerobic kit, the problems to be aware of which this patent aims to solve are transferable. The structure of this shoe is interesting to consider with this patent as it relates to the Alchemy kit.

Overall, there are patents related to footwear designed for pregnancy, and although there are similar problems to solve across the patents, the approach solving these problems varies. A point to highlight here is that footwear made for athletic applications for pregnant and/or postpartum women are limited, which leaves opportunities for innovation within the scope of this thesis project. The athletic focus of the maternity

aerobic kit will challenge the existing patents due to the expanded problems to solve regarding the changes in foot anatomy as a woman experiences pregnancy. It will be a great focus to innovate on the upper portion of a running shoe, the midsole technology and design, as well as the toe box and lacing mechanisms for comfort and security. These ideas are within the scope of this project as they target expectant mothers who stay active through aerobic exercise.

State-of-the-Art & Future Color Trend Inspiration

The state-of-the-art color trends associated with active wear in 2024 were predicted to focus on "emotional support, product longevity, and bridging digital and physical worlds" (Kostiak, 2022). These predicted color trends provide a good foundation for why certain colors may be referenced in the future, and why certain products in the market use combinations of these colors. For example, a combination of colors that was predicted to trend in 2024 is shown in Figure 23 (Kostiak, 2022). Examples of how these colors are used in competitor sports products today are shown in Figure 24 and Figure 25.

Figure 23
2024 Color Trend Inspiration



Coloro:
A: 117-47-13, B: 072-45-06, C: 000-64-00, D: 031-77-03, E: 105-27-15
Pantone:
A: 18-3922 TCX, B: 18-5611 TCX, C: 17-5104 TCX, D: 14-4501 TCX, E: 19-4324 TCX

Figure 24
Saysh One use of Current Color Trends



Figure 25
Kizik use of Current Color Trends



The future color trends that are predicted to be influential in 2026 are centered around the color of the year, “Transformative Teal” (Samba, 2024). The year 2026 has a theme of being the year of “redirection” (Kostiak, 2024). An example of color schemes that stem from the “transformative teal” color, which could be applied to the Alchemy kit, are shown in Figure 26 (Clark & Barnscher, 2024). This image demonstrates six colors that have potential for a variety of combinations for product color ways. The pops of blues and greens will be offset by more subtle accent colors. For this project, the vision is to use shades of grays as part of the color palette. In addition to the neutral colors, pops of colors such as the “transformative teal,” and analogous colors of this color will be used as core colors. These colors are inspired by the colors that are currently trending, although not the same.

Figure 26
2026 Color Trend Inspiration



Color schemes for maternity sports products, specifically for apparel and footwear, tend to apply neutral tones, as well as pinks and pastels. The focus on innovation in the maternity sports product space identifies areas of exploration for color and the need for change in this space. Further insight from the survey which is discussed in the "Survey Questions & Results Asked of the Intended Demographic" section proved that the intended demographic prefers neutral tones of grays with cool tones for color. These results support the color schemes that are currently trending and predicted to trend soon.

State-of-the-Art & Future Graphic Trend Inspiration

Current and future graphic trends also influence the characterization of the Alchemy kit. The state-of-the-art graphic trends for activewear in 2024 focused on "mental health and socializing" influenced by endurance sports, healthy foods, and recovery activities (Browning, 2022). Graphics and trends related to these focuses emphasize simplicity but also boldness for consumers who wear innovative sports products. Emulating a balance of boldness and stability for the Alchemy kit is crucial to connect with the intended demographic. Visuals of graphics that are relevant and

inspirational to this project are shown in Figure 27 (*Pin by Shelley Grace on blackwhite in 2025: Moon Goddess, illustration, goddess,* 2023*; Samba,* 2024*; "circles" art print - INCADO: Art.com: Circle Graphic Design, Circle Art, art prints*. Pinterest, 2024; Bardsley, 2025; Palmer, 2025; *Pin by Taynara Carvalho on Moldura: Geometric shapes art, logo design, line tattoos*, 2025). These visuals capitalize on geometric shapes and nature to portray a sense of structure and fluidity, which each of the products in the kit will parallel.

Figures 27
Visual Inspiration Current Graphics



To further support thesis graphics and visuals in relation to this project, it is predicted that harmonizing with nature and focusing on replenishment will continue to be important for women's active wear in 2026 (Watkins, 2024). With this, the concept of "soft utility" is of importance, as it emphasizes natural imperfections through subtle patterns for lifestyle and activewear duality (Bardsley, 2024). The use of colors and subtle branding that help portray this messaging will be beneficial and in theme for the Alchemy kit. The graphics are not meant to be overpowering and use analogous color palettes to evoke emotion and connection to the products, which are concepts worth incorporating in the maternity aerobic kit.

State-of-the-Art & Future Logo and Branding Inspiration

Logo and branding designs have changed over the decades, not only due to the emergence of technology, but also based on manufacturing ease and customer preferences. While brands once focused on differentiating themselves with 3-dimensional logos and unique topography, recent trends that are predicted to continue in the future emphasize simplicity. An example of what is meant by this is shown in Figure 28 (Zeller, 2024). Another example of how companies have decided to adjust their logos to a simpler design is to stick with 2- dimensional imagery rather than 3-dimensional, shown in Figure 29 (Designer brand logos: Designer Brand Logos: Sports Brands: Sports Brands, Sports Brand Logos, logo design, 2018).

Figure 28
Changes in Branding Examples



Figure 29
Current Sports Company Logos



Although companies use simplicity for overall logos and typeface, websites and campaigns are more creative when trying to reach and influence consumers. For example, when looking at Saysh's websites, the "Maternity Returns" page uses a vintage aesthetic shown in Figure 30 and Figure 31 (*Maternity Returns*, n.d.). These methods of branding and graphics invoke emotion and nostalgia, which is interesting to consider when developing potential campaign methods to build awareness for the Alchemy kit.

Figure 30 and 31
Examples of Saysh's Website Branding & Campaigns



For branding and developing a logo for the Alchemy kit, it would be wise to follow the simplicity of current and future trends. For this reason, a simple typeface will be used for topography, and a 2-dimensional design will be illustrated for the logo. It would be unique to also add a personal touch that companies do on occasion, which is to create tags that are labeled directly to the consumer rather than the size or number that fits the consumer. For example, a personal touch would be to have the product label say "For [insert name of consumer]" rather than "Size 7" for their shoe size. Refer to Figure 32 and Figure 33 for an example of customized labels used in apparel products (n.a., 2021; see also n.a., 2024). To this extent, the hope is to go beyond the simple trends of logo and branding by reaching consumers in a way that feels more personal.

Figure 32 and 33
Examples of Personalized Tag



An interesting method to adhere to label fabric, which could be beneficial for the maternity aerobic kit, is to utilize heat to transfer care labels to fabric. Rather than sewing labels to fabric, which can cause irritation on the skin, using materials and methods that are better for skin sensitivity ensures comfort of consumers. An example of what this may look like is in Figure 34 (Tutton, 2024).

Figure 34
Example of Heat Transferred Label



The goal of this project is to provide women who experience pregnancy and postpartum the ability to connect with themselves physically and mentally as they prioritize their health. A brand identity that invokes this connection to the intended demographic is crucial and can be done through the right color, graphics, and branding.

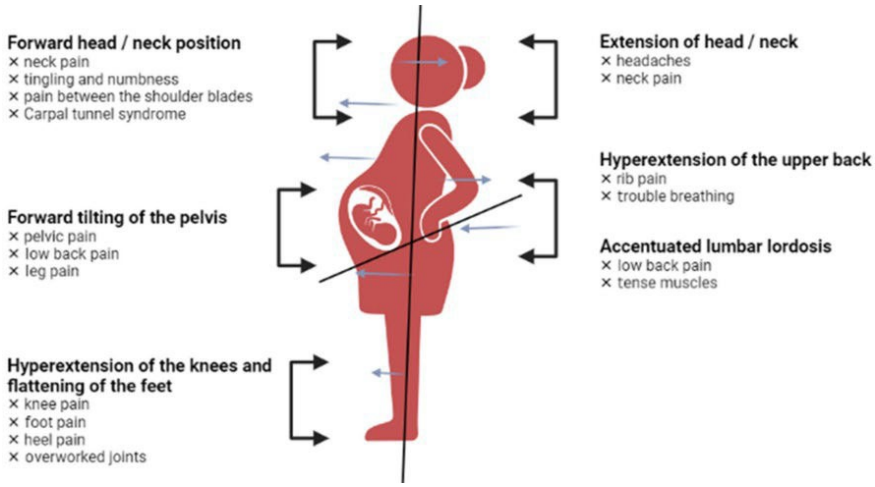
Physiological Research

Analyzing the research that currently exists in the maternity space is a priority when designing the Alchemy kit. This maternity aerobic kit is composed of footwear, insoles, and a compression sock. The purpose of these products is to provide comfort and stability by adapting to the intended user's anatomy as they experience the inevitable changes during pregnancy and thereafter. With these products in mind, research focused on the changes in foot anatomy during and after pregnancy are relevant when designing the products in the kit.

To address the needs of a maternity aerobic kit, the research discussed in this section focuses on the foot and lower body joints. This research is important because 27% of women experience a fall during pregnancy and 57% experience lower back pain, along with other risks due to physiological changes (Conder et al., 2019). During pregnancy, changes in the anatomy of a woman's body also occur due to the release of hormones such as relaxin. This hormone causes ligamental laxity, which results in the loosening of ligaments as it allows the body to adapt to the fetus growing throughout pregnancy. These anatomical changes affect women differently during and after pregnancy. More specifically, lasting changes in foot structure such as arch height, foot length, and foot width may occur as ligaments loosen and increase in mass add pressure to the lower body (Segal et al., 2013). The increase in mass changes the center of gravity and therefore increases pressure on the foot anatomy which forces the foot to adapt as ligaments loosen and bones in the foot accommodate what is occurring in other areas of the body (Conder et al., 2019). Refer to Figure 35 for visuals on how pregnancy may affect areas of the body (Conder et al., 2019).

Figure 35

Risk of Pain Associated with Physiological Changes of a Woman's Body During Pregnancy



Note: These are generalizations based on common occurrences women may experience during pregnancy.

In general, changes to the foot anatomy influence muscular fatigue, musculoskeletal disorders, and pathological alterations (Fiat, 2022). Risk of back pain, hip pain, loss of stability, lower body joint pain and inflammation, as well as altered posture are all symptoms that may arise due to physiological changes of the foot (Fiat, 2022). For these reasons, based on research from past studies, the need for better maternity specific footwear, including insoles, is imperative.

In addition to the footwear components, the compression socks included in this kit are equally as important due to lower leg swelling and discomfort that occurs especially in the third trimester and postpartum. According to research, "the frequency of leg edema was 65.9% and higher in the third trimester" and "could lead to several other symptoms like pain and cramps" (Rafique, 2023). Images of the effect of edema, focused on the foot and ankle are shown in Figure 36 (Shobowale, 2024).

Figure 36

Normal Foot vs. Pregnant Swollen Foot



It is estimated that about 70-80% of women suffer from edema in lower limb extremities during pregnancy, which is a staggering number to consider and highlights the importance of providing comfort and relief to women who experience edema (Davison, 1997). The research summarized in this section highlight the physiological changes that women experience during pregnancy and postpartum, which are common among the demographic.

With these considerations, the Alchemy kit includes products that are specifically designed to support women through the common physiological shifts they experience regarding lower limb extremities.

Biomechanical Research

In addition to the physiological research that supports the purposes of this project, biomechanical research is important to consider when designing each component of the maternity aerobic kit. The focus of the research discussed in this section will be on how changes in the foot affect the biomechanics of a woman's body as it relates to movement.

Paralleling the physiological changes previously discussed, the effects pregnancy has

on how the body moves throughout pregnancy and/or postpartum further justifies the need for a specific aerobic kit made for women during these periods. For example, physiological changes such as the release of relaxin contributes to ligamental laxity. Changes in the joints due to ligamental laxity causes joints to become more flexible, leading to misalignment and higher strain on lower body joints (Wei et al., 2024). Overall, changes in the foot and lower body joints increase risks to health as they affect balance, stability, center of gravity/pressure, gait patterns, and more (Condor et al., 2019). These changes become more obvious in the second and third trimesters of pregnancy, and prevalent in postpartum.

The importance of biomechanical research and how the body changes during pregnancy justifies the need to provide the intended demographic with adequate sports products to combat these changes and reduce health risks as they maintain an active lifestyle during and after pregnancy. There is more research to consider, but this section summarizes an adequate foundation as it relates to the potential biomechanical benefits that the maternity aerobic kit could offer.

Psychological Research

Another area of research that is crucial to acknowledge is the psychological research that exists regarding activity and pregnancy and/or postpartum. This category of research will further support the need for a maternity aerobic kit due to the immense need to prioritize a woman's mental health during and after pregnancy. There are many studies to source from which have evaluated the psychological effects of pregnancy during and after.

A study which conducted a scientific literature review of 17 articles related to depression during pregnancy concluded that on average significant levels of depression occurred during the second and third trimesters. The conclusions found that an average of 7.4% of women experience levels of depression during the first trimester, 12.8% in the second trimester, and 12% in the third trimester (Kołomańska et al., 2019). Another significant finding in this study is that the levels of depression experienced during pregnancy contribute to the severity of depression after pregnancy. This study concluded that 10-15% of women experience depression up to 12 months after giving birth (Kołomańska et al., 2019). With

these results in mind, physical activity is highly recommended by medical professionals to protect the mental health of the expectant mother as it is linked to preventing depression during and after pregnancy (Birsner & Gyamfi-Bannerman, 2015).

Many studies have collected data and provided valid conclusions regarding levels of depression during and after pregnancy. Within these studies, a common theme is that depression improves if consistent physical activity occurs throughout pregnancy. These studies provide scientific data and conclusions for the importance of physical activity, such as aerobic exercise, and therefore the necessity of products which support individuals to participate. The maternity aerobic kit in its entirety intends to be a tool for expectant mothers to use in an effort to help them maintain their mental health as they experience pregnancy and/or postpartum.

Potential Data Collection Methods for Products

With the previous research in mind, there are a range of methods to collect potential data for the products included in the maternity aerobic kit. The testing involved with this kit prioritizes each product separately, as well as together.

Firstly, a method of data collection to consider relies on scientific literature reviews to better understand past foundational methods related to testing areas of interests. Whether successful or not, it is important to understand the context of past studies and if improvements could be made for future testing for this project. The scope of the studies reviewed include physiological, biomechanical, and psychological changes of a woman's body as they experience pregnancy and postpartum. More specifically, focusing on lower body anatomy as it relates to the foot will be especially important to assess. These reviews will contribute to potential test plans which will collect data of the maternity aerobic kit regarding functionality.

Secondly, collecting qualitative data such as initiating a Likert-Like survey would benefit the maternity aerobic kit. The purpose of this method is to collect quantitative insight

based on a user's experience and/or preferences regarding the maternity aerobic kit. These surveys include a variety of open-ended questions, which make it possible to reach audiences remotely without having to set up interviews. These surveys are efficient and reliable when measuring opinions, perceptions, motivations, attitudes, and more because a Likert-Like scale is effective in gaining insight based on ratings (SurveyMonkey, n.d.). For example, if asked a question, participants are required to provide an answer based on a scale that may range from "Very Unlikely" to "Very Likely." As this method relates to gathering data for the maternity aerobic kit, these surveys have potential to analyze functionality, aesthetics, performance, activity, design, comfort, and additional features and benefits. The main goal of sending out a Likert-Like survey to potential consumers is to gather valuable insight on initial designs and improve the prototypes of the maternity aerobic kit. This method will collect data that will contribute to the overall success of the final version of the maternity aerobic kit for the intended demographic.

Lastly, it would be wise to consider data collection methods that are ongoing but may not be published. To this extent, connecting with academic research would be beneficial to better understand what data collection methods use current technology and tactics that may improve upon past test methods. The focus here would be on quantitative data collections for the maternity aerobic kit as it relates to foot anatomy and biomechanical changes that may occur. This approach will increase familiarity with present methods and awareness of how academics are identifying similar problems to solve. With this context, the maternity aerobic kit would benefit from acknowledging what problems others are collecting data on and how these products could further contribute to those efforts in data and analysis for future reference.

Survey Questions & Results Asked of the Intended Demographic

When considering the design of the products within the maternity aerobic kit, it is important to ask specific questions of the intended demographic to gain clarity regarding the

design of the running shoe and the insoles dedicated to the 2nd, 3rd, and postpartum periods of pregnancy. For the maternity aerobic kit and as a reminder, the intended demographic includes women in their 20s – 40s who become pregnant or are postpartum and wish to maintain an active lifestyle through aerobic exercise during this time in their life. Aerobic exercise may include running, jogging, or walking. A list of questions that was sent out to online platforms as a survey is documented in Appendix A. This survey explored questions and feedback prior to the decision to include a compression sock in the maternity aerobic kit. More information was collected during 1:1 interviews about the compression socks later in the design process, which is noted in the "Testing & Results" section.

After its release, 70 responses were recorded. Of these 70 responses, 64 were determined to be the intended demographic based on the first two questions which asked if they were someone who has experienced pregnancy and was also a participant in aerobic exercise during and/or after pregnancy. For the remainder of the survey, 45 respondents chose to finish to completion.

From the 45 who chose to finish the survey, the third question determined that the results were within the age range that the Alchemy kit is designed for, since all responses indicated that they experienced pregnancy and postpartum between 20 - 40 years old. The majority, about 57.8% experienced pregnancy from 30 - 34 years old, with the second highest age range at 17.8% was 25 - 29 years old. In addition to the demographic information recorded, it is also important to consider how frequently aerobic exercise was performed because this helps determine how relevant a maternity aerobic kit could be for the intended demographic. With this consideration, 51.1% of the responses indicated that aerobic exercise occurred more than three times per week, while 20% did at least 3 times per week, and 17.8% did at least two times per week. From these results, there is a clear indication that aerobic exercise is a priority during pregnancy. The same question was asked but was directed towards postpartum aerobic exercise. Twelve of the respondents were currently pregnant, so this question was not relevant to them at the time of taking the survey. The results of this question conclude that aerobic exercise is just as important, if not more important, during the postpartum period since 71.1% participated at least three times a week.

To further understand the potential impact of designing a maternity aerobic kit, the question of familiarity regarding running shoes and insoles was asked because it is important to know how much influence certain designs and technologies have on the intended demographic. From this question, the majority responded that they are familiar with these products, 68.9% were familiar, while 24.4% were indifferent towards the technology of these products. Regardless of their familiarity, only 4.4% were familiar with maternity specific running shoes, while 0% were aware of maternity specific insoles. For those who had heard of maternity specific running shoes, Saysh was the only company noted. From these responses, it is encouraging to understand the potential impact that the maternity aerobic kit can make within the maternity sports product space, not only in providing more options for the intended demographic, but to also educate and bring awareness to products made specifically for pregnancy and or/postpartum.

Another insight that was valuable to consider was to understand what pain was experienced by the respondents to narrow down on key focuses the maternity aerobic kit could help provide more support for. From the responses, 86.7% experienced pain during and/or after pregnancy. Of these responses, about 30.8% experienced pain in the foot and/or ankles. It is important to note that other pain points that were recorded related to lower body areas such as the lower back, hip, and knees, but may not be correlated to anatomical and biomechanical changes in the foot, which is outside the scope of this project.

These responses provided context for the questions that followed which asked what is most important to them when choosing running shoes and insoles during and/or after pregnancy. From these questions, the main priorities in footwear were determined to be comfort, stability, shock absorption, and a wide toe box. Regarding insoles, arch support, stability, and comfort were the main influences. When asked what they would change about current options for running shoes and insoles, responses were consistent with improving comfort, stability, and providing better options for if/when the anatomy of the foot changes. Within the realm of the running shoe, widening of the toe box and eased of donning and doffing were common responses that would be a focus of improvement for the maternity running shoe design. Specific to the insole, responses that influence the design of the insole

options for the maternity aerobic kit include increased stability and arch support compared to what is currently available.

The remainder of the survey focused on the potential aesthetics that may be preferred by the intended demographic. From these questions, color, silhouettes, and lockdown mechanisms were considered. The results show that the majority prefer neutral tones of gray or beige, with cool tones for a pop of color. Silhouettes such as the Orthofeet Kita Knit shoe that has been previously referenced was the preferred choice, followed by the Sasyh One option. These shoe preferences are consistent with the lockdown mechanism that 88.9% chose when considering other methods. To further understand potential competitors that satisfy these preferences, responses indicated that Brooks, ASICs, and Saucony were top competitors to consider for running shoes. For insoles, majority responded that they do not use separate insoles, but those who did prefer Dr. Scholl's or Superfeet.

The results from the survey provide valuable insight into the context of the maternity aerobic kit and provide further clarity on potential focuses and design aspects that could be incorporated into the vision of the kit for the intended demographic.

SWOT: State-of-the-Art Competitors

In the industry, SWOT analyses have proven to benefit the understanding of how well products or businesses are doing in the industry and provide a good foundation of comparison on the strengths, weaknesses, opportunities, and threats. Examples of SWOT analyses are in the tables below which focus on different anatomical parts of the products. Specifically, these SWOT analyses consider the insoles of competitors previously mentioned as well as the recommended running shoes. From these analyses, further insight was gained considering manufacturing, materials, designs, user interface, comfort, performance, functionality, and more. These areas are important to prioritize within the design of Alchemy to innovate existing designs and address the problems to solve regarding the insoles designed for pregnancy and postpartum periods as well as the footwear.

Figure 37
MommySteps Athletic Insole, $39.99 USD



Table 4
SWOT Analysis MommySteps Athletic Insole

Anatomical Part	SWOT Analysis	Description
Top Layer	Strengths	Designed to support foot for activity, memory foam for comfort
	Weaknesses	Material innovation
	Opportunities	Comfort for user's interaction
	Threats	Friction against the bottom foot causes blisters
Mid-Layer	Strengths	Ability to remold 3x if needed
	Weaknesses	Comparable design of structure to generic insoles
	Opportunities	Design innovation with additional features & benefits
	Threats	Products that have more support in regions of user’s foot
Bottom Layer	Strengths	Interface with shoe is stable and secure
	Weaknesses	Lack of innovation in features
	Opportunities	Additional features to support anatomy
	Threats	Cost of manufacturing

Figure 38

FootLevelers Mother Nurture Insoles, price not listed



Table 5

SWOT Analysis FootLevelers Mother Nurture Insoles

Anatomical Part	SWOT Analysis	Description
Top Layer	Strengths	Unique suede materials for each insole based on trimester
	Weaknesses	Friction interface with user
	Opportunities	Experiment with technologies/finishes to reduce friction between user and layer
	Threats	Cost of material innovation and manufacturing
Mid-Layer	Strengths	Additional comfort in designated areas for foot anatomy and changes in COG during pregnancy
	Weaknesses	Flimsy structure, bulky design reduces variability in shoes
	Opportunities	Design for athletic applications
	Threats	Support users during activities
Bottom Layer	Strengths	Maintains structure, adequate security in shoe
	Weaknesses	Material innovation
	Opportunities	Additional features/materials could be added
	Threats	Insoles that interact in shoes better

Figure 39

DirectFootClub 2nd & 3rd Trimester Insoles, $240.00 USD



Table 6

SWOT Analysis DirectFootClub 2nd & 3rd Trimester Insoles

Anatomical Part	SWOT Analysis	Description
Top Layer	Strengths	Comfortable microfiber EVA top liner
	Weaknesses	Synthetic material choice
	Opportunities	Natural material choice
	Threats	Performance based insoles
Mid-Layer	Strengths	Specific to trimester
	Weaknesses	Generic EVA foam choice
	Opportunities	Design of insole material to provide better support
	Threats	Cost of other options
Bottom Layer	Strengths	Provides some structure to arch
	Weaknesses	Material choice of suede
	Opportunities	Better material choice for support and shoe interface
	Threats	Better options for performance activities

Figure 40
Saysh One, $150.00 USD



Table 7
SWOT Analysis Saysh One

Anatomical Part	SWOT Analysis	Description
Upper	Strengths	Jacquard creel knit upper for breathability, custom fit technology for women's anatomy
	Weaknesses	No tabs for additional support donning & doffing, toe box
	Opportunities	Design of silhouette, additional features
	Threats	Better heel counter designs in competitors
Midsole	Strengths	Uses foam for comfort
	Weaknesses	Generic design and material used
	Opportunities	Innovate material and design to further support women's anatomical needs
	Threats	Competitors with better technologies and designs
Outsole	Strengths	Rubber materials used for adequate grip with surfaces
	Weaknesses	Generic design
	Opportunities	Material and design innovation
	Threats	Competitors, molding costs
Liner/Insole	Strengths	Breathable materials
	Weaknesses	Generic insole design
	Opportunities	Customization with fit
	Threats	Insoles that are more advance in orthopedic benefits
Tongue	Strengths	Unique design for greater surface area interaction with user
	Weaknesses	User interface for donning
	Opportunities	Additional tab/design of tongue for ease of donning & doffing
	Threats	Additional costs to design
Locking Mechanism	Strengths	V-Shaped flexible lacing design system
	Weaknesses	Adjustability for snug fit
	Opportunities	Innovation in the design of a lacing system for snug fit
	Threats	Competitors and cost of changes

Figure 41
Women's TechLoom Breeze, $220.00 USD



Table 8
SWOT Analysis Women's TechLoom Breeze

Anatomical Part	SWOT Analysis	Description
Upper	Strengths	Seamless high elastic upper material for comfort
	Weaknesses	Durability of upper
	Opportunities	Zoning areas of more stretch and stability in upper
	Threats	Cost of engineered knit construction
Midsole	Strengths	Lower heel drop than other running shoes (8 mm)
	Weaknesses	Stability on lateral/medial sides of foot
	Opportunities	Increase support in regions that need it
	Threats	Cost of design changes
Outsole	Strengths	Slip resistant design
	Weaknesses	Generic design for grip
	Opportunities	Design of outsole
	Threats	Competitor's designs, molding costs
Liner/Insole	Strengths	Comfortable top layer fabric
	Weaknesses	Support in regions that need it
	Opportunities	Design for anatomy
	Threats	Manufacturing costs of more innovative designs
Tongue	Strengths	Part of upper design for comfort and stability
	Weaknesses	Cannot be adjusted
	Opportunities	Adjustability to user's foot
	Threats	Competitor's solutions
Locking Mechanism	Strengths	Customizable fit
	Weaknesses	Traditional lacing system
	Opportunities	Design for ease of donning & doffing
	Threats	Competitors who have better options

Figure 42
Kizik Women's Athens Shoe, $129.00 USD



Table 9
SWOT Analysis Kizik Women's Athens Shoe

Anatomical Part	SWOT Analysis	Description
Upper	Strengths	Roomy toe box, HandsFree Technology, 4-way stretch material
	Weaknesses	Aesthetic
	Opportunities	Upper materials/construction
	Threats	Manufacturing costs
Midsole	Strengths	Rabbit Sole technology
	Weaknesses	Design of midsole
	Opportunities	Shape and design of midsole
	Threats	Competitor's technology, additional costs
Outsole	Strengths	Rubber traction
	Weaknesses	Grip performance
	Opportunities	Design innovation
	Threats	Better grip on surface in other designs
Liner/Insole	Strengths	Removable and washable
	Weaknesses	Functionality
	Opportunities	Design specific for performance
	Threats	Manufacturing costs and added focus on design innovation
Tongue	Strengths	Stays securely in place
	Weaknesses	Adjustability
	Opportunities	Shape and fit
	Threats	Additional costs and materials
Locking Mechanism	Strengths	Heel counter and lace system ensures security
	Weaknesses	Adjustability for snug fit
	Opportunities	Design for customization
	Threats	More secure methods

Considering the SWOT analyses of state-of-the-art competitor products, it is crucial in building a strong foundation for the concepts that will be implemented in the maternity aerobic kit. The strengths and opportunities with each product highlight areas that the maternity aerobic kit could address in its own designs. Equally important is building awareness of the potential weaknesses and threats to mitigate within the design. There are pros and cons of each product that has been assessed thus far, and the SWOT analyses summarize the important findings that the maternity aerobic kit takes into consideration.

For example, regarding the insoles, it is important to use material that is supportive and comfortable for each layer. These materials and the structure of the insole should interface with the consumer and the running shoe well. Threats to be aware of include the cost of materials as well as the manufacturing process of insoles due to the molding of the overall shape. Regarding the running shoe, strengths to consider are breathable upper materials, ease of donning and doffing, wider toe boxes, material innovation for the midsole to provide energy return and shock absorption, as well as adequate rubber grip for the outsole. Although there are various strengths, weaknesses, opportunities, and threats for insoles and running shoes, the SWOTs of the competitor products highlight key focuses to incorporate and build awareness while designing the maternity aerobic kit products.

Definitions of Success

Prior to ideation and prototyping the product line of the Alchemy kit, it is important to reflect on the research accumulated thus far to further define what success means for each of the products. Defining success combines scientific research, user insights, competitor analysis, and areas innovation. These definitions create an achievable scope for each product for the intended demographic. The definitions of success for the footwear, insoles, and compression socks of the Alchemy kit are detailed in Table 10.

Table 10

Product Definition of Success

Product	Definition of Success	Key Focuses
Footwear	The maternity aerobic shoe is designed for superior comfort, adaptability, and ease of use compared to competitors on the market. These focuses are important for the intended demographic due to the anatomical and therefore biomechanical changes they may experience during pregnancy. The footwear will be successful if the upper and midsole can expand together, donning & doffing effort improves by 25%, and the engineered knit materials provide 10% more comfort to user.	1. Comfort 2. Adaptability 3. Ease of Use
Insole	The insole of the maternity aerobic kit will provide superior comfort, stability, and support compared to competitors on the market. The key design features - including the structure, proprioception, moldability, and foot coverage - will contribute to the overall success of the insole as part of the maternity aerobic kit. The insoles will be successful if they provide 10% more support in the heel, arch, lateral, medial, and forefoot regions of the foot, 5% more adaptability and therefore comfort under the foot, and provide haptic feedback to help improve posture and balance.	1. Comfort 2. Stability 3. Support
Compression Sock	The compression sock of the maternity aerobic kit will provide intentional fit, relief, and support compared to competitors on the market. The key design features - including compression, cushion, material, and design - will contribute to the overall success of the compression sock as part of the maternity aerobic kit. The compression socks will be successful if they provide 5% more relief based on foot reflexology knit-in padding zones, intentional support via compression in the arch and ankle, and 25% improved donning & doffing effort provided by pull tabs knit into the sock.	1. Fit 2. Relief 3. Support

Functional Prototyping Process

After initial research and ideation, the process of rapid prototyping began. The intention behind this process was to exert as much energy in creating rough prototypes of concepts to flush out possible solutions. Below is a table that describes the key focuses and reasons for the prototypes that were attempted. Reference photos for these rapid prototypes are documented in Appendix B. These prototypes contributed to the final functional prototypes that were tested against competitor products.

Table 11

Rapid Functional Prototypes

Product	Focus	Description
Footwear	Heel Counters	Various heel counters were designed in Rhino and 3D printed to test effectiveness and necessity in final functional design to aid in donning & doffing hands free.
	Pull Tabs	Pull tab placement (tongue and heel) were placed for aid in donning & doffing, as well as fit and comfort to adjust tongue if needed.
	Upper Material/Construction	Upper construction was explored to develop areas of stretch and stability to be able to adapt to foot swelling and/or growth.
	Lockdown Mechanism	Types of lockdown like lacing, BOA, and cinching were explored. Placement of lockdown system was debated for ease of access and adjustment throughout pregnancy.
	Midsole	Design and materials were explored to make a midsole that was comfortable, stable, and adaptable to foot growth for demographic. Dual foam, lattice structures, drop height, thickness, shape, and more were explored with these prototypes.
Insole	Proprioception textures	Various geometric textures were designed, printed, and molded to understand how to incorporate the concept of haptic feedback in
		the insole to help user with spatial awareness and therefore balance.

	Foot coverage	The overall design of the insole was created in Rhino, 3D printed and molded into a structure that supported regions of the foot that are not typically designed for in the industry. These regions include forefoot, lateral, medial, arch, and heel of the foot.
	Foam layer design	Exploring what foams to use and thickness was crucial to familiarize with for user interface, comfort, and shock absorption.
Compression Sock	Pull tabs	To aid with donning & doffing, pull tabs were sewn in to competitor socks at different points.
	Relief based on reflexology	Padding in regions that were based on reflexology specific to pain points of pregnancy were sewn or glued on to get anatomical fit correct.
	Sock height	Rather than knee length compression socks, shorter heights were debated during prototyping and the profile of the cut at the shorter heights were considered.

Functional Prototypes

Through rapid prototyping, certain ideas were decided against while others were pursued. The goal of the winter term was to develop fully functional prototypes of each of the products in the Alchemy kit. The development of these prototypes was iterative while considering user feedback and constant troubleshooting. This process helped prepare for final testing of the prototypes to prove the effectiveness of the concepts. The functional prototypes were broken down into parts which equal a whole, as described below, and are photographed in Appendix C:

Footwear:

1. Heel Counter Prototype
2. Lockdown Mechanism
3. Upper Jacquard Knit
4. Expandable Midsole Prototype

Insoles:

1. Proprioception Layer
2. Design of memory foam layer
3. Design of shell of insole

Compression Sock:

1. Tabs with lower & sock height
2. Reflexology padding & lower sock height

Tests & Analysis

Part of the design process required research and development, which includes testing and analysis. There were multiple tests conducted which included competitor products and functional prototypes. The results from this testing identified strengths and weaknesses of competitor products, as well as validated concepts of the Alchemy kit. The rapid prototypes and final functional prototypes were compared to competitor products which highlighted future improvements.

There are three categories of testing that were completed: gut check, bench top, and high fidelity. Each of these categories provided valuable insights. The “gut check” tests were quick and required little setup for the purposes of finding quick answers to simple questions. The “bench top” tests required more time and equipment to setup. The goal of bench top testing was to gather data that validates the “gut check” tests and was more rigorous. The “high fidelity” tests were built upon the previous two categories and differentiated itself due to the involvement of people and specialty equipment. As a reminder, the problem statement that the Alchemy kit was addressed included:

> How can we design an effective aerobic kit that adapts to a woman’s changing body during pregnancy, offering the support necessary to maintain an active and comfortable lifestyle during this time?

The focus of testing for the athletic shoes was stability, adaptability related to the upper, and ease of donning and doffing. As it relates to insoles, tests were focused on stability, arch support, forefoot support, heel lift, comfort, and fit. Related to the compression socks, tests assessed compression at the arch and ankle, the support the socks provide to the user, as

well as ease of donning and doffing. The following tables summarize the “gut check” tests and the “bench top” tests that were performed with a description and summary of results of learnings, especially as related to competitor products.

Table 12
Gut Check Tests, s*ee Appendix D for data sheets.*

Product Focus	Test	Description	Summary of Results
Footwear	Upper donning features	Rating scale determining which footwear has features that help with ease of donning footwear.	Kizik and APL outperformed the lead competitors with a rating 8.
	Heel counter hardness	Measuring shore hardness of heel counters with a durometer and recording observations of construction for effectiveness when donning footwear.	Kizik was the only shoe to fit the lasts into the shoe with little residue on the pressure sensing paper compared to competitors.
	Upper material stretch	Manually stretching the upper material and recording observations specific to regions of the upper which are affected by physiological changes of the foot anatomy during pregnancy/postpartum.	Kizik had the most stretch in its upper material compared to competitors on the market. The stretch knit upper and stretch material as a liner provided more stretch than other performance shoes.
	Midsole flexibility	Manually twist and bend midsole, record observations and how it relates to support.	Kizik outperformed competitor midsoles based on how easily it was to twist and bend material of midsole.
Insole	Flexibility observations	Manually twist and bend insole, record observations and how it relates to support.	MommySteps Active & Athletic insole had the most support in its design compared to competitor products.
	Materials comparisons	Manually feel and materials of insole and observations of first impressions.	MommySteps Active & Athletic had the most moldable, supportive, and comfortable materials incorporated in their

			designs compared to competitors.
Compression Sock	Identification of compression	Record level of compression and where the compression is constructed in the body of the sock.	The Apolla Performance sock has higher values of compression at the arch and ankle region (20-30 mmHg).
	Identification of padding	Identify areas of padding in sock and how the material feels at those regions.	Padding in the Kindred Bravely sock is along the entire bottom of the foot, adding in the most comfort to its competitors.
	Height of sock placement	Measure height of sock and observations to where sock height goes to on user.	Apolla Performance sock has a lower sock height than its competitors, reducing its interaction with the user's calf and apparel if worn together.
	Material stretch test	Manually stretch compression sock and record how far material can stretch, specifically to arch and ankle support.	Kindred Bravely had greater stretch than its competitors, which could indicate greater adaptability to user's anatomy if swelling occurs.

From the "gut check" tests, there were learnings regarding the materials and design of competitor products as it relates to the features and benefits of each product and proving or disproving their claims. Thesis initial tests with current products provided initial data on which product may be a lead competitor. These results provided a solid baseline, which was verified by "bench top" tests.

Table 13

Bench Top Tests, see Appendix E for data sheets

Product Focus	Test	Description	Results
Footwear	Timed donning test	Time how long it takes to don footwear with two hands, one hand, and hands-free. Record observations.	Kizik outperformed competitors in all three categories.
	Instron test	Measure the stretch of waist region of upper of footwear with an Instron machine, record observations.	Kizik had the most stretch in its upper material compared to competitors on the market.
	Force midsole test	Use force gage to measure force it takes to bend midsole at the toe box.	Kizik outperformed competitor midsoles based on force gage testing, which validates the 'gut check' test results.
	Heel drop height difference	Measuring heel drop height (difference of height of midsole at heel and toe) with a caliper.	APL and Saysh had the lowest heel drop value compared to other competitors, with a value of about 0.3 in.
	Ball drop test (midsole)	Drop a metal ball and specified height and record the bounce height of ball, record observations and collect data.	Brooks had the least amount of energy return compared to other competitors.
	Midsole Hardness Test	Measuring shore hardness of midsoles with a durometer and recording observations.	Kizik had the hardest heel counter compared to competitors. The two-part system had a hard plastic embedded in the heel collar and a cage made of TPU around the heel region of the shoe for further stability.
Insole	Force insole test	Use force gage to measure force it takes to bend insole at forefoot, arch, and heel region to identify	MommySteps Active & Athletic insole had required the most

		areas of structure/support.	force at the toe, arch and heel region of its design compared to competitors, seen through the high forces collected.
	Ball drop test	Drop a metal ball and specified height and record the bounce height of ball, record observations and collect data.	MommySteps Active & Athletic insole had the least amount of average energy return throughout insole, including the forefoot, arch, and heel regions.
Compression Sock	Instron test	Measure the stretch of sock compression regions (arch and ankle) with an Instron machine, record observations.	Apolla had less stretch and greater recovery than competitors, specific to the arch and ankle region of the design which indicates greater compression and therefore support.
	Sock thickness test	Measure thickness of knit-in padded regions each sock has and observations.	Kindred Bravely has more support in its design than its competitors and is therefore thicker. Its main body is also thicker than Apolla Performance sock.

The “bench top’” tests verified the “gut check” tests that were performed. The “gut check” tests were quick and identified the pros and cons of competitors on the market. Following more rigorous protocols and lab equipment, more quantitative data on the competitor products were gathered. Considering this data, the top competitors were identified, later to be compared to the products in the Alchemy kit. From these findings, Kizik is the main competitor for footwear, MommySteps Active & Athletic is the main competitor for insoles, and Apolla is the main competitor for compression socks.

These conclusions were a result of which features contributed to the definition of success for each of the products in the Alchemy kit. For footwear, lockdown mechanisms, upper material, midsole design, and heel counter inclusion is crucial for success. For the insole, materials and overall full foot coverage design are important. For compression sock, comfort, fit, and relief are high priorities. Ultimately, the testing that was completed provided a great foundation to begin rapid prototyping prior to the final functional prototypes. The final functional prototypes that resulted from flushing out ideas from rapid prototyping were tested using "high fidelity" test methods, which involved subjects from the intended demographic.

For the "high fidelity" tests, the functional prototypes of the Alchemy kit received qualitative and quantitative data from n=4 subjects, two of which were in the second trimester and two of which were in the third trimester. From the previous test methods, the lead competitors of footwear, insoles, and compression socks were compared against the functional prototypes. The Kizik Women's Athens shoe, the MommySteps Active & Athletic insole, and the Kindred Bravely sock were used. Below is a table that summarizes results from these "high fidelity" tests, including the subjects' insight.

Table 14

High Fidelity Tests, see Appendix D for data sheets.

Product Focus	Test	Description	Results
Footwear	Timed donning test	With participant of intended demographic, time how long it takes to don footwear and record observations.	The BOA prototype was 4x faster than the Kizik competitor.
	Likert-Like Survey	Ask participants of intended demographic a series of questions related to footwear that quantify opinions, preferences, feelings, thoughts, etc. based on a rating scale of 1-5.	The functional prototypes which assessed lockdown mechanism, heel counter, upper material, and midsole design received higher feedback than competitor products.
	Pressure Map	With participants of intended	Insole prototypes

Insole		demographic, record pressure map of users standing on various insoles and record observations.	had more consistent support in areas of the foot such as the lateral, medial, forefoot, and heel regions compared to competitors.
	Ball Drop Test	Drop a metal ball and specified height and record the bounce height of ball, record observations and collect data.	Prototype materials (foam + memory foam layer) had more shock absorption than leading competitors.
	Likert-Like Survey	Ask participants of the intended demographic a series of questions related to insoles that quantify opinions, preferences, feelings, thoughts, etc. based on a rating scale of 1-5.	The prototype was 15% more comfortable and stable standing in this prototype than competitors.
Compression Sock	Likert-Like Survey	Ask participants of intended demographic a series of questions related to compression socks that quantify opinions, preferences, feelings, thoughts, etc. based on a rating scale of 1-5.	Prototypes received higher average scores compared to competitor products.
	Timed donning test	With participant of intended demographic, time how long it takes to don compression socks and record observations.	Prototype with pull tabs was 47% faster donning and 80% fast doffing than competitors.

The conclusions from testing, especially the “high fidelity” tests involving the athletes, were encouraging. The results further validated that the functional concepts of the Alchemy kit products exceeded the definitions of success. The footwear prototypes proved to be significantly faster in donning and doffing times, more adaptable with a stretch knit upper and expandable midsole system, as well as more comfortable in overall design and better aesthetics compared to market competitors. The insoles proved to have more support, especially in the lateral and medial sections of the foot, were more comfortable for the user to wear, and

incorporated more benefits into the design regarding the use of proprioception textures. The compression socks proved to be faster in donning and doffing, 33% more comfortable than existing products, and designed more intentionally for the demographic to maintain comfort while exercising.

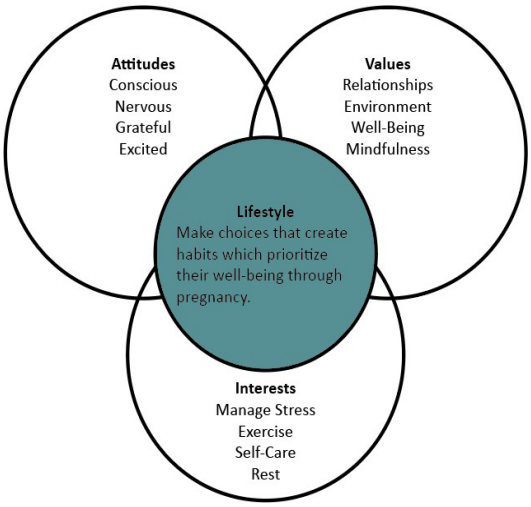
Overall, the prototyping process incorporated research, testing, and athlete insights to guide design decisions and innovation in areas that are relevant to the intended demographic. These conclusions proceeded to guide future design decisions, and created a solid foundation to build upon as “looks like” prototypes and branding became pertinent.

Psychographics of Demographic

Through research and outreach, learning about the intended demographics psychographics highlighted that through each trimester there are various changes in habits, attitudes, interests, and values that contribute to the overall lifestyle women prioritize as they transition into motherhood. Although there may be slight modifications through each trimester, the main concern of women is to take care of their well-being as it relates to mental and physical health. The attentiveness expectant mothers have during pregnancy is a result of how their health impacts their newborn’s health. Social support, environment, physical activity, emotional changes, and more can impact women during pregnancy. It is important to build awareness and educate people on the psychographics of this demographic because it better equips people to support women during pregnancy beyond their own bias. Below in Figure 43 lists a few considerations of the psychographics that relate to pregnancy, although these may vary and there are more to consider. These learnings guide the purpose of the Alchemy kit, which in its entirety supports expectant mothers in maintaining an active lifestyle through pregnancy by curating a system of maternity sports products – including footwear, insoles, and compression socks made for aerobic activity such as running, jogging, and walking.

Figure 43

Venn Diagram of Psychographics to Consider for Pregnancy



Mood Board & Ideation

To guide the sketching process and curate cohesive designs for each product which contribute to the overall theme of the Alchemy kit, the mood board shown in Figure 44 demonstrates the inspiration that guided the final designs. The word “alchemy” has multiple definitions and applications, but regarding this project, alchemy refers to the transformational process of creation. Pregnancy, in this context, is synonymous with alchemy in that it is a transformational process that women experience as they create life and transition into motherhood. In the mood board, the color scheme of the Alchemy kit as well as specific imagery is used to portray how the final designs were inspired by the powerful women that these designs are intended for, as well as product inspiration which was useful to keep in mind when developing each product. The goal of each product in the kit is to promote comfort, stability, adaptability, and ease of use. The purpose of the kit is to encourage women to challenge the controversy that is associated with movement during pregnancy and embrace the challenges that arise. Pregnancy is a beautiful moment in a woman’s life, and it is also one of the most challenging. The mood board which inspired the theme of the Alchemy kit touches on these points through imagery and colors, creating a dynamic balance between the beauty and challenge of movement and pregnancy. The color palette for this project consists of shades of

gray, as well as analogous shades of “transformative teal.” For further details, refer to Table 15 for the hex codes of the color palette.

Figure 44
Alchemy Kit Mood Board



Table 15
Alchemy Kit Color Palette and Codes

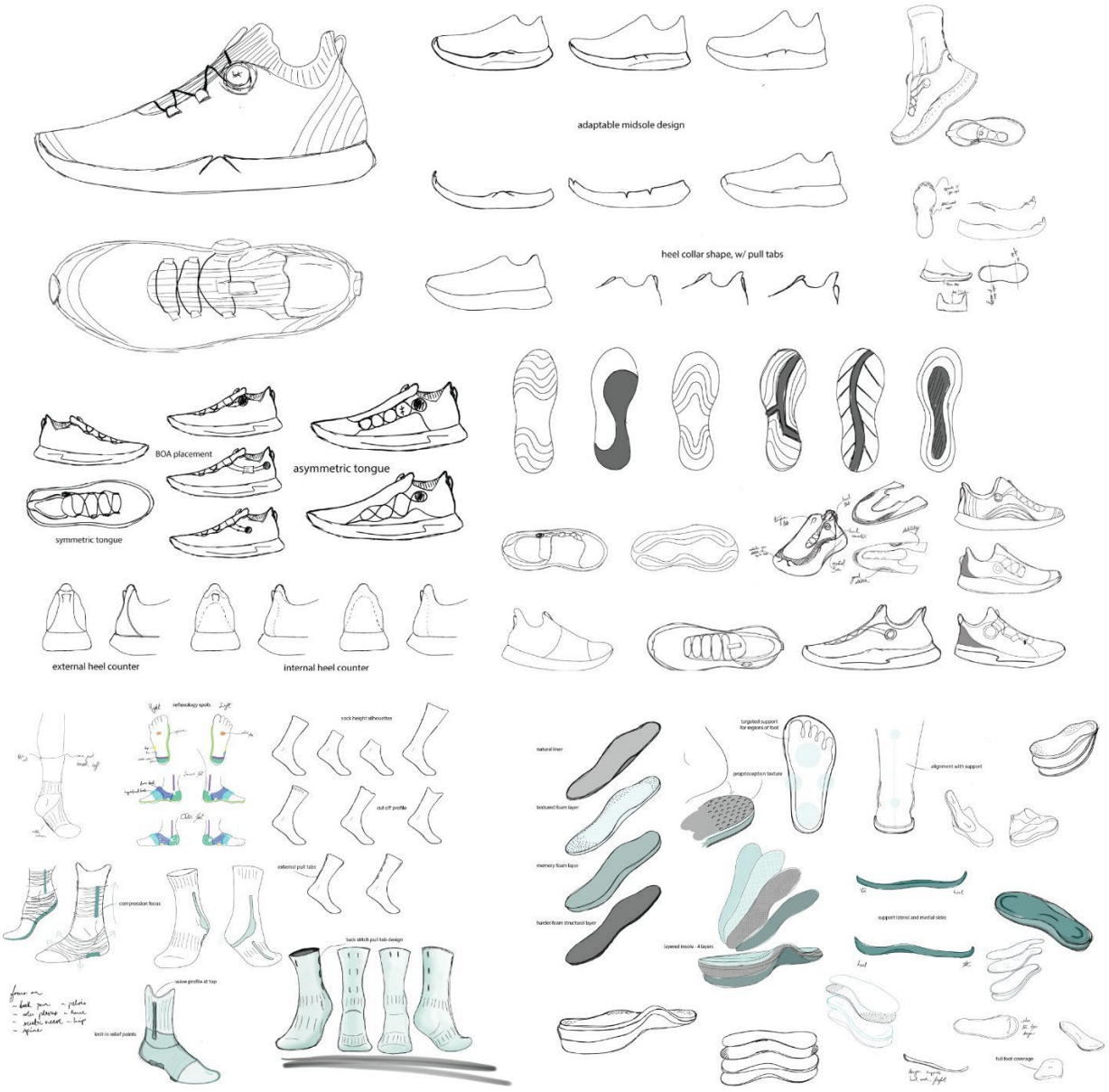
Color Swatch	Color Name	Hex Code
	Transformative Teal	#1B4D54
	Mist Gray	#B0BEBD
	Twilight Slate	#47565A
	Ivory Dream	#FFFFFF
	Shadephase Gray	#333333

The mood board, as well as previous research considering the demographic and current market competitors, inspired the ideation for each product and contributed to ideas that were sketched and prototyped. Figure 45 shows the sketches that considered a range of ideas for

each product before deciding on the final design of each product in the Alchemy kit.

Figure 45

Alchemy Kit Product Sketches



Project Branding

Deciding on the branding of the Alchemy kit was an iterative process which considered the theme of this project and the influence of existing competitor brands. Branding is important to connect with the consumer based on certain visuals and styles that convey the overall identity of the company, or in this scenario, the project. While the color themes, graphics, and mood board contribute to brand identity, logos and watermarks are just as important. Figure 46 shows the Alchemy Kit logo and watermark.

Important callouts for the logo include the simplicity of the design and the meaning behind the color, font, and shapes of these key branding items. The color chosen for the shapes and text is the “transformative teal” color that is consistent in each of the products in the kit. This color is central to the Alchemy kit due to its boldness, symbolic representation of transformation, recognition as the Color of the Year for 2026, and alignment with the theme of this project. The font of the watermark is Nessyn Sentry, which is an artistic serif font that portrays elegance, femininity, and class. The fluidity of the letters emphasizes the idea that pregnancy and the change that women experience is a continuous, evolving process that occurs in phases – much like the way the letters seem to flow from one to the next to form a word that has a meaning. This adds further depth to the meaning of “Alchemy” in this context – a transformative process that leads to creation. Lastly, the logo that contributes to the project identity is a series of three circles that are offset from one another to create the illusion of crescent moons. There are a few reasons that three circles were chosen for the logo. Firstly, the number three is associated with symbolism such as creativity, balance, harmony, completeness, and connection. There are also three trimesters during pregnancy, and three products in the Alchemy kit. The illusion that the three circles make of the phases of the moon also adds an element of depth due to the lunar connection women have with the moon, and how the phases of the moon can correlate to the phases of pregnancy. While simple in its design and execution, the logo and watermark contribute to the depth and complexity that this kit embodies, similar to the experience of a woman’s transition into motherhood.

Figure 46
Alchemy Kit Logo & Watermark



The placement of branding on each of the products is strategic and based on the influence that exists among competitor brands. The footwear industry is consistent in the branding locations of products such as footwear, insoles, and compression socks. Refer to Figure 47 for relevant industry examples.

Figure 47
Branding Placement Examples



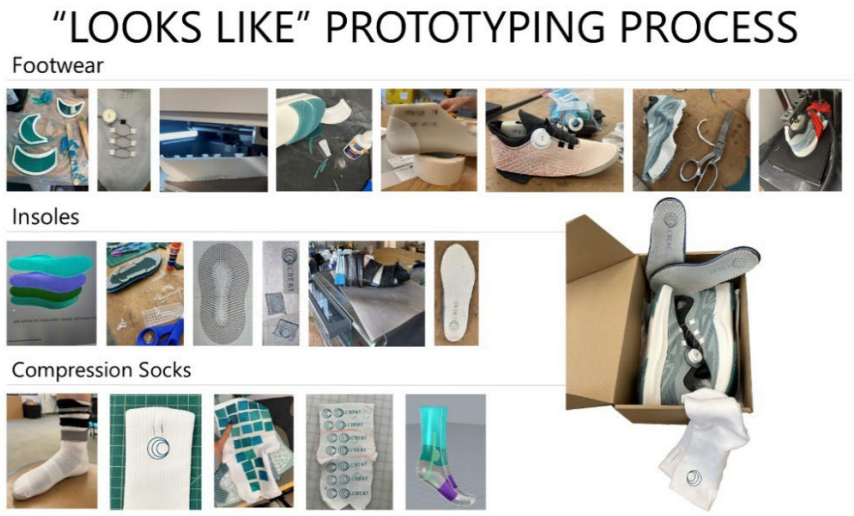
Regarding the Alchemy kit products, the branding of products will follow what is standard in the sportwear industry. This includes placement of the logo and a combination of

the logo with the watermark. Areas on the footwear such as the outsole and design of the upper align with the design language of the project. The insoles will have the Alchemy watermark and logo placed in the center heel. The compression sock will have the logo visible on the exterior (lateral) sides of the left and right sock. Visuals of this branding are showcased in the "Looks Like Prototypes" section that follows.

"Looks Like" Prototypes

To expand upon the research, testing, outreach, and functional prototyping that was previously done, prototyping continued. The focus of the final round of prototyping was to develop beautiful "looks like" prototypes of each of the products in the Alchemy kit. These "looks like" models incorporated athlete insights and the functional concepts that were previously validated through testing. Iterating cleaner versions of the products while also combining the themes of the project brings to life the vision of the Alchemy kit as if these products were to be sold to the intended demographic and compete with competitors that have achieved current success. Figure 48 depicts some of the prototyping process that resulted in the final beautiful prototypes. Details of the final design and materials, including features and benefits of each product, are described in the following sections.

Figure 48
Snapshot of "Looks Like" Prototyping Process



Final Design & Materials: Footwear

The iterative process of prototyping contributed to the success of the “looks like” prototypes, which effectively bring the vision of the Alchemy kit to life. The final design of the footwear is shown in Figure 49 below, with callouts of the features and benefits for the intended demographic. Table 16 details the materials and manufacturing of the final design of the footwear.

These features prioritize comfort, adaptability, and ease of use for women during each stage of pregnancy and can be applicable in postpartum. The upper features such as the heel and tongue pull tabs aid in donning & doffing, as well as securing the shoe in comfortable positioning. Additionally, the upper houses a TPU heel counter that provides stability in the heel which improves donning & doffing. The padding in the heel that surrounds the heel counter further supports the heel while ensuring comfort for the user.

The majority of the upper is made of Tencel™ Lyocell and blended with performance fibers and Lycra for variability in stretch and stability in the upper design. Specifically, there are regions with increased stretching in the waist and in the toe region to allow the foot to grow in width and length if needed. The regions of less stretch are targeted in the heel to ensure stability for the user, with medium stretch in the remaining zones. The zones of stretch and stability are manufactured using flat knit engineering, creating a seamless design. The intention of a seamless upper is to reduce discomfort in regions of the foot that may experience growth by minimizing seams which have the potential to cause pressure or irritation.

Furthermore, BOA® technology is intentionally placed on the medial side of the foot to allow ease of access to the user throughout pregnancy. One of the advantages of using BOA® technology, specifically the Li2 model, is the ease of adjustment with the dual tightening dial. Associated with the BOA®, textile covered cables and strengthened eyestays are used to create a lockdown mechanism that works efficiently and effectively together. Although placed on the medial side, the BOA® is placed towards the top of the foot to minimize the risk of interaction between the right and left foot during aerobic activity, especially during the first trimester when a woman’s gait is not as wide as it may be in later trimesters.

With a stretch knit upper, the midsole implements Adaptisole technology that is a unique feature which creates an expandable midsole in width and in length to accommodate up to a full size. This feature works well with the stretch knit upper as it allows the foot to grow if needed, while minimizing potential pressure against the foot. Although these features adapt to possible anatomical changes in the foot, if the user's foot does not change the design of the footwear maintains stability and comfort.

Lastly, the outsole of the footwear is made for environments that are paved. Simple and effective prototypes were created to aesthetically demonstrate how natural rubber, and adequate tread would support the intended demographic in a safe and effective manner. The overall design of the outsole implements subtle tread that provides grip in the toe and heel regions of the foot, which are commonly seen in walking and running footwear. The crescent-like design ties into the theme and aesthetic of the Alchemy kit, further connecting the user to the project branding. The use of natural rubber is common in running shoes and is a great alternative to synthetic rubbers.

The design considerations that were accounted for when testing, ideating, prototyping, and iterating on this process were thoroughly thought out. Based on research, market competitors, user insights, and testing, the features and benefits of the Alchemy kit footwear emphasize the idea that innovation is possible for maternity sports products. It is not only possible, but necessary to accommodate a woman's changing body during pregnancy in order to provide sports products that support them on their journey into motherhood.

Figure 49
Final Footwear Design & Callouts



Table 16
Final Footwear Design & Materials Descriptions

Part	Material	Manufacturing	Description
Upper	Tencel™ Lyocell Performance Blend	Engineered Knit	Natural yarns blended with polyester for performance benefits. Majority natural yarn for user comfort.
Midsole	Algae Bloom EVA Foam	Molded	Use of sustainable EVA alternative foam with similar performance benefits.
Outsole	Natural Rubber	Injection Molded	Natural materials used for adequate traction for paved routes.
Padding	Ortholite PU Foam	Molded	Comfortable Ortholite foam in heal and tongue of shoe for user comfort.
Heel Counter	TPU	Molded	Durable material to provide effective heel counter for ease of

			donning & doffing.
Lockdown	BOA® Technology (Li2)	Sourced	Li2 BOA® used for multi-directional adjustment for ease of donning and customizable fit.
Eyestays	Rec. PET Webbing, Teflon enforced	Sourced	Low friction webbing is specifically made to interact with BOA® cables.
Pull Tabs	Rec. PET Webbing	Sourced	Durable pull tabs for ease of donning and doffing.
Adhesive	Barge Glue	Applied	Used to secure the outsole to midsole, and midsole to upper.

Final Design & Materials: Insoles

Through research, testing, athlete insight, and prototyping, the final design and materials of the insoles of the Alchemy kit are designed with key focuses in mind and further support the intended demographic through pregnancy. Figure 50 below shows the final design with materials and manufacturing detailed in Table 17.

The overall design of the insoles differs from what currently exists for the intended demographic, especially in support, materials, and technologies. There is more support in the lateral, medial, forefoot, and heel of the insole compared to what currently exists. Using high density 0.18D OrthoLite® X-Sorb™ foam for the bottom layer of the insole allows for a customized shape to be molded and maintain its integrity throughout each phase of pregnancy. The bottom layer is 3.18 mm thick. The second and third layers of the insole use lower density Ortholite® foams, which vary in purpose and features. The third layer is molded OrthoLite® Eco Impressions™ that is 0.15D and 6.35 mm thick. The purpose of memory foam is to respond to the foot's anatomical changes by conforming to the shape of the user's foot, offering adaptive support without requiring effort from the user. The second layer of the insole design uses a denser Ortholite® foam that is molded with strategically placed spherical proprioception textures. Specifically, this foam is the OrthoLite® X35™ that is 0.145D and 4.763 mm thick. The

LunarSense technology refers to the spherical textures that gradually fade from the edges toward the center of the insole. This design is manufactured into the second layer of the insole via heat molding. This gradient pattern delivers noticeable texture around the perimeter, offering haptic feedback that enhances the user's awareness of their body – especially if balance is affected during pregnancy due to changes in center of gravity and balance as women progress. The first layer of the insole, which directly interacts with the user, is made of a 1 mm thick Tencel™ Lyocell for breathable comfort under the foot. This liner is vacuumed onto the second layer to ensure secure attachment to the LunarSense technology. In its entirety, the insole is thicker than the average insole but fits nicely into the drop in midsole of the footwear to create a system that is adaptable, comfortable, and supportive for the intended demographic to wear during pregnancy and participate in aerobic activity.

The addition of the insoles to the Alchemy kit adds depth and functionality to high end maternity sports products which contribute to the success of this kit as it relates to the intended demographics needs and innovative possibilities.

Figure 50
Final Insole Design & Callouts

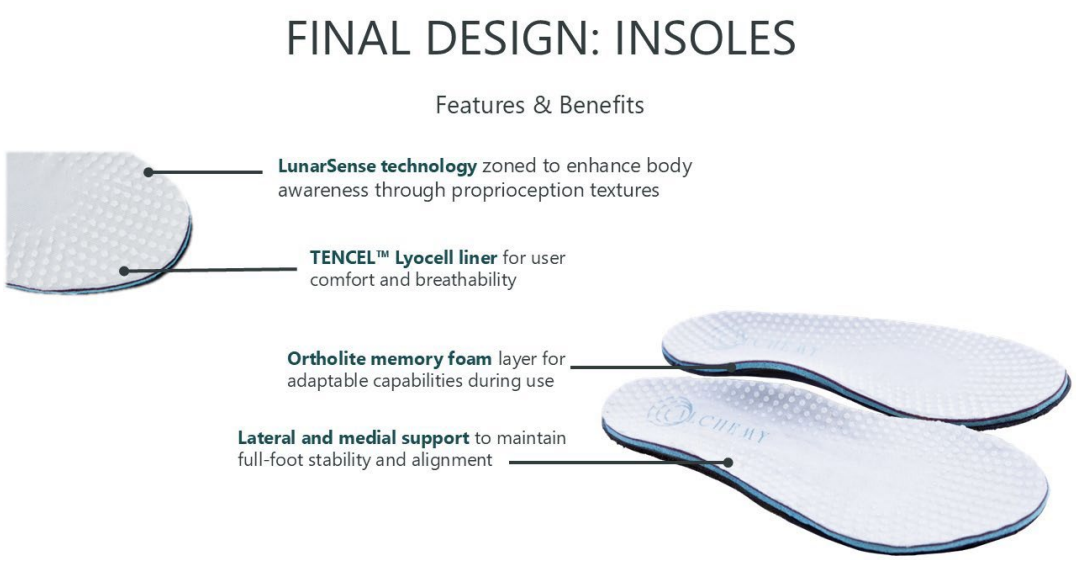


Table 17

Final Insole Design & Materials Descriptions

Part	Material	Manufacturing	Description
First Layer	Tencel™ Lyocell Performance Blend	Engineered Knit	Natural yarns blended with polyester for performance benefits. Majority natural yarn for user comfort. Thickness is 1 mm.
Second Layer	OrthoLite® X35™	Heat Molded	Proprioception layer uses higher density foam for noticeable texture molded into foam. Foam density measured at 0.145D, thickness is 4.76 mm.
Third Layer	OrthoLite® Eco Impressions™	Heat Molded	Comfort layer made of memory foam for adaptable benefits while wearing footwear with insoles. Foam density measured at 0.15D, thickness is 6.35 mm.
Fourth Layer	OrthoLite® X-Sorb™ foam	Heat Molded	Structural layer made with high density foam for full foot support, especially in forefoot, lateral, medial, arch, and heel regions of the foot. Foam density measured at 0.18D, thickness is 3.175 mm.

Final Design & Materials: Compression Socks

Lastly, the compression socks were prototyped with an athletic aesthetic in mind, combining the functional elements previously evaluated with a design that encourages movement during pregnancy – unlike what is typically seen in existing products. Below in Figure 51 is the final design of the compression socks, with callouts for features and benefits. Table 18 identifies the material composition and means of manufacturing of the compression socks.

The Knitab technology provides subtle efficiency to help put on and take off the socks during pregnancy, which is a task that becomes quite difficult. Santoni circular knit sock machines have the capabilities to knit in openings in the designated areas of the socks, providing users with opportunity to adjust in the front and back of the socks at their discretion. There are no changes to the medical grade compression that is typical when designing compression socks and is specked to maintain medium compression of 15-20 mmHg to provide comfortable support in the arch and ankle regions. The TENCEL™ Lyocell blend emphasizes use of natural yarn with performance yarn to provide the intended demographic with a more natural option that maintains performance benefits such as breathability, moisture wicking, and reliable stretch. The concept of thickening certain regions of the sock with knit-in padded zones based on foot reflexology further demonstrates how this product is made intentionally for pregnancy. Women may experience pain in the knees, hips, spine, lower back, and sciatic nerve as their bodies change during pregnancy. Based on foot reflexology and research, the compression socks of the Alchemy kit implement zones of knit-in padding for gentle pressure to targeted areas, aiming to provide relief for women – especially during aerobic activity.

The compression socks complete the Alchemy kit in its entirety, providing the intended demographic with intentionally designed products, empowering them to participate in aerobic activity throughout all phases of pregnancy and into postpartum.

Figure 51
Final Compression Sock Design & Callouts

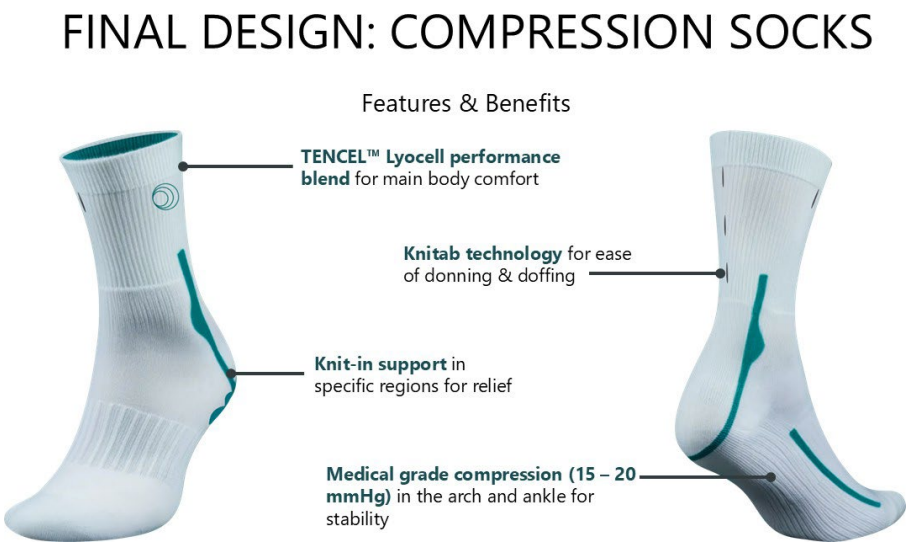


Table 18
Final Compression Sock Design & Material Descriptions

Part	Material	Manufacturing	Description
Main Body	70% Tencel™ Lyocell/15% Polyester/9% Lycra/6% Nylon	Santoni Circular Knit Sock Machine	A blend of natural and synthetic yarns to provide user with comfort and performance benefits.

In the Future

The Alchemy kit offers an innovative solution to intentionally designing sports products for expectant mothers who wish to maintain an active lifestyle through aerobic activity. Inspired by the complex and powerful experience pregnancy is for many women, the term "alchemy" emphasizes the natural process of creation. As a reminder, the initial problem statement that guided this project is:

How can we design an effective aerobic kit that adapts to a woman's changing body

during pregnancy, offering the support necessary to maintain an active and comfortable lifestyle during this time?

The solution is Alchemy – a maternity aerobic kit which includes products that prioritize comfort, adaptability, and ease of use for the intended demographic. More specifically, the product line of the Alchemy kit includes footwear, insoles, and compression socks made to last for the duration of pregnancy and support women in aerobic activity. Through research, testing, ideating, prototyping, and designing, the final products are shown in Figure 52 below.

Figure 52

The Alchemy Kit In-Situ Photos

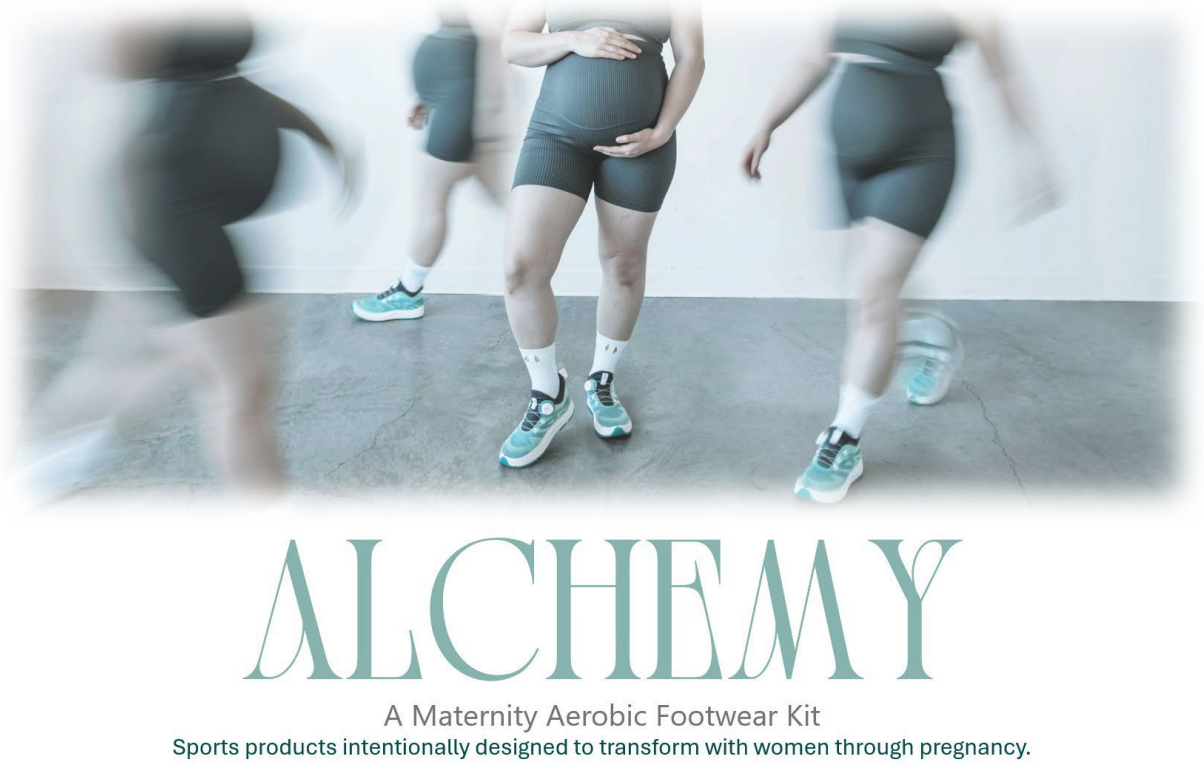


These visuals showcase the potential that maternity sports products have, demonstrating a stronger presence in the sports industry beyond what is currently offered today. This project has multiple educational moments to build upon, with transferrable concepts of innovation regarding sports products specifically designed for women. Identifying problems and developing solutions to fill design gaps that exist in the industry is a continuous effort.

The goal of the Alchemy kit is to expose and fill gaps in the sports industry for a very important demographic. Empowering women through high quality sports product designs is a necessary mission, and one that will no doubt have positive impact. Figure 53 demonstrates how the Alchemy kit incorporates the themes that have guided this project – combining pregnancy, movement, and innovation into a space that has potential beyond what is currently being explored.

Figure 53

The Alchemy Kit In-Situ Photos



For a summary of the design process, refer to Appendix F for the final presentation of the Alchmey kit.

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Appendix A

Initial Survey for Maternity Aerobic Kit

1. Are you someone who has experienced pregnancy and/or postpartum?
    a. Yes
    b. No (if no, survey will not be relevant and will close out)
2. Are you someone who participated in aerobic exercise (running, jogging, walking) while pregnant and/or postpartum?
    a. Yes
    b. No (if no, survey will not be relevant and will close out)
3. When did you experience pregnancy?
    a. Under 20
    b. 20 – 24
    c. 25 – 29
    d. 30 – 34
    e. 35 – 39
    f. 40 – 44
    g. 45 – 49
    h. 50+
4. How often do you or did you participate in aerobic exercise while pregnant (running, jogging, walking)?
    a. I do not/did not participate in aerobic exercise regularly
    b. 1x/week
    c. 2x/week
    d. 3x/week
    e. More than 3x/week
5. How often do you or did you participate in aerobic exercise while postpartum (running, jogging, walking)?
    a. N/A – currently pregnant
    b. I do not/did not participate in aerobic exercise regularly
    c. 1x/week
    d. 2x/week
    e. 3x/week
    f. More than 3x/week
6. How familiar are you with running shoes and insole technology?
    a. I am familiar with running shoes/insole technology
    b. I am indifferent towards running shoes/insole technology
    c. I am not familiar with running shoes/insole technology
7. Have you heard of maternity specific running shoes?
    a. Yes
        i. If yes provide a box to fill in and specify which products they have heard of
    b. No
8. Have you heard of maternity specific insoles?
    a. Yes

        i. If yes provide a box to fill in and specify which products they have heard of
    b. No
9. Have you experienced lower body pain while training during pregnancy and/or postpartum? Please expand on when you experience this during and/or after pregnancy. Examples: During the second trimester I experienced flattening of the arch in my foot, knee pain, ankle swelling/pain, hip pain, lower back pain, etc. If no pain occurred, please note.
    a. Open ended question
10. What is most important to you when choosing footwear for aerobic exercise while pregnant or postpartum? (check boxes to choose multiple)
    a. Comfort
    b. Stability
    c. Arch support
    d. Breathability
    e. Wide toe box
    f. Thick midsole
    g. Adequate traction
    h. Easy of donning & doffing
    i. Energy return
    j. Shock absorption
    k. Other (please specify)
11. What is most important to you when choosing insoles for aerobic exercise during pregnancy? (check boxes to choose multiple)
    a. Arch support
    b. Forefoot support
    c. Heel lift
    d. Stability
    e. Comfort
    f. Structure
    g. Moldability
    h. Washability
    i. Removability
    j. Other (please specify)
12. What is most important to you when choosing insoles for aerobic exercise during postpartum? (check boxes to choose multiple)
    a. N/A – currently pregnant
    b. Arch support
    c. Forefoot support
    d. Heel lift
    e. Stability
    f. Comfort
    g. Structure
    h. Moldability
    i. Washability
    j. Removability
    k. Other (please specify)
13. If you could change one thing about your running footwear to accommodate pregnancy what would it be and why? Examples: wider toe box, breathable upper material, lockdown mechanism, traction, midsole support, etc.

a. Open ended question

14. If you could change one thing about your running footwear to accommodate postpartum what would it be and why? If postpartum is not applicable, put N/A. Examples: wider toe box, breathable upper material, lockdown mechanism, traction, midsole support, etc.
    a. Open ended question
15. If you could change one thing about your insoles to accommodate pregnancy what would it be and why? Examples: arch support, forefoot support, rear foot support, shock absorption, stability, etc.
    a. Open ended question
16. If you could change one thing about your insoles to accommodate postpartum what would it be and why? If postpartum is not applicable, put N/A. Examples: arch support, forefoot support, rear foot support, shock absorption, stability, etc.
    a. Open ended question
17. What aesthetics in footwear do you prefer?
    a. 
    b. 
    c. 
    d. 
18. What range of colors offered in maternity sports products do you prefer?
    a. 

    b. 

    c. 

    d. 

    e. Other (please specify)
19. What method of lockdown do you prefer in a running shoe and why?
    a. Shoelaces
    b. Slip-On
    c. Velcro
    d. Cinching
    e. Other (please specify)
20. Is there a specific company you prefer for running footwear?
    a. Brooks
    b. Asics
    c. Hoka
    d. ON
    e. Nike
    f. New Balance

    g. Sketchers
    h. Kizik
    i. Saysh
    j. Other (please specify)
21. Is there a specific company you prefer for insoles?
    a. Dr. Scholl's
    b. Superfeet
    c. LightFeet
    d. Orthofeet
    e. FootLevelers
    f. MommySteps
    g. Other (please specify)
22. If there was a perfect solution for a maternity aerobic kit which includes a running shoe and insole technology dedicated to the 2nd, 3rd, and postpartum periods of pregnancy, what would you envision?
    a. Open ended question
23. Would it be okay to contact you to follow up on your answers?
    a. No
    b. Yes - Please leave your First Name, Last Name, and email

Appendix B

Rapid Functional Prototypes

PROTOTYPES | heel counter



PROTOTYPES | lockdown

9





10



11



12



PROTOTYPES | lockdown

13







14



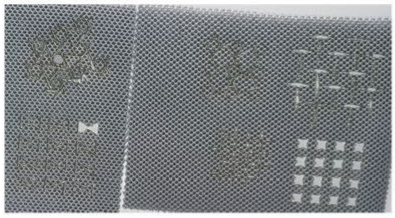






PROTOTYPES | upper

15 - 20



21 - 22





23



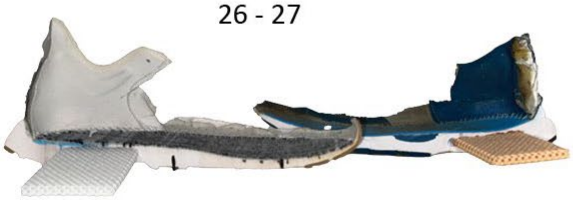
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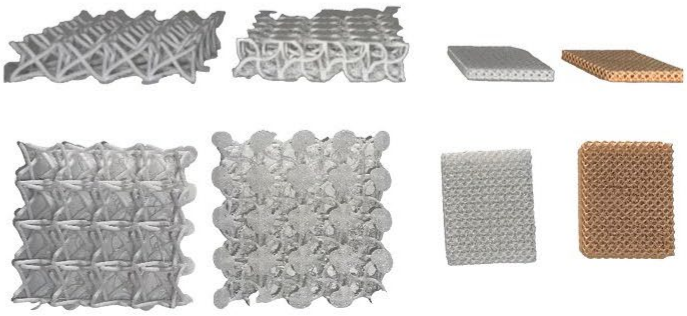
PROTOTYPES | midsole

26 - 27





28 - 31

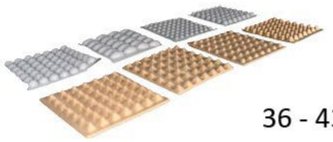


PROTOTYPES | insole



32 - 35





36 - 43

44





45 - 46



47



PROTOTYPES | insole

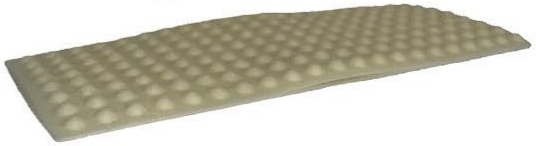
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49





PROTOTYPES | comp. sock

50



51



52

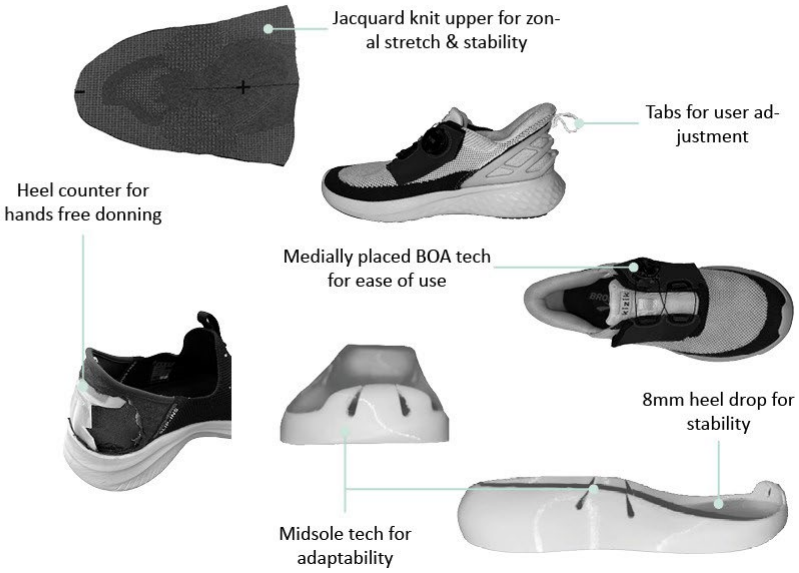


Appendix C
Final Functional Prototypes

P R O T O T Y P E S f o o t w e a r

Footwear Focus

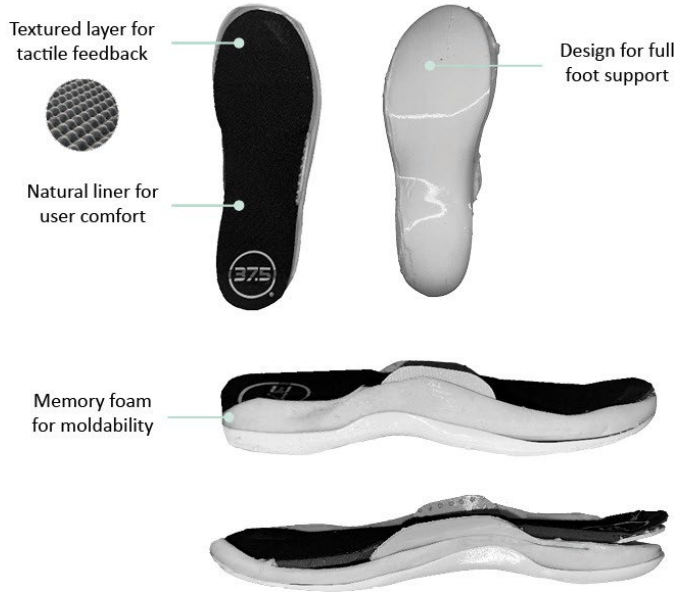
1. Comfort
2. Adaptability
3. Ease of Use



PROTOTYPES insole

Insole Focus

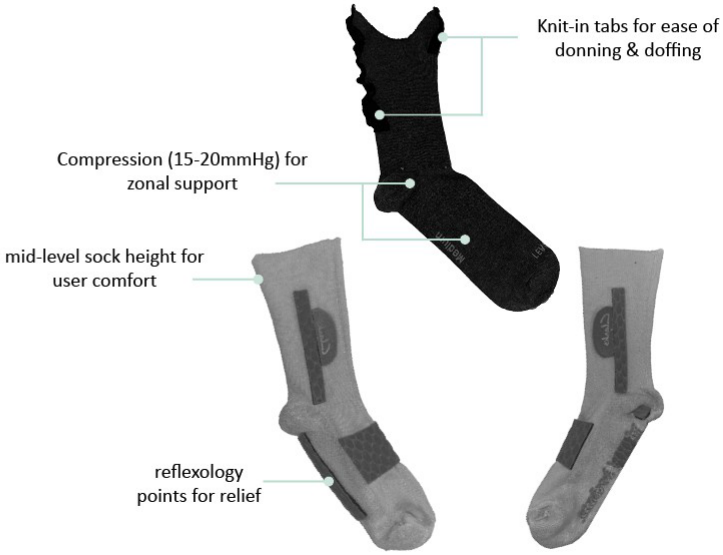
1. Comfort
2. Stability
3. Support



PROTOTYPES compression sock

Compression Sock Focus

1. Fit
2. Relief
3. Support



Appendix D

Gut Check Testing & Results

Test: Gut Check Testing Upper Donning Method Date: 1/15/2025

Focus: Upper Donning Methods

Rating:

0 = Not Present
1 = Not Functional
2 = Not Functional
3 = Some Functionality
4 = Functional
5 = Very Functional

Product	Ability to Adjust Lockdown Mechanism from Back of Shoe	Adjustable Tongue Design	Heel Tab	Heel Counter	Total
Kizik Women's Athens	0	2	1	5	8
Brook's Ghost Runner	0	3	0	3	6
APL Sneaker	0	1	4	3	8
Saysh One	0	3	0	4	7

Test: Gut Check Heel Counter Date: 1/17/2025

Focus: Heel Counter, Rating of Last Insertion

Rating:

1 = Min. Effort 2 = Some Effort 4 = Medium Effort

3 = Effort Noticeable 5 = Max. Effort

Product	Rating (Reg. Size Last) (1 – 5)	Rating (Maternity Last) (1 – 5)	Notes
Kizik Women's Athens	2	3	- Not that hard to insert regular last - Needed to fully untie laces and loosen to fit maternity last in
Brooks Ghost Runner	4	5	- Hard to fit both last in - Could get regular last in further, but not all the way - Narrower shoe in general
APL Sneaker	3	5	- Easy to fit reg last in - Maternity last required a bit more effort but still fit
Saysh One	3	4	- Was able to get both lasts in shoe - More effort required to fit maternity last in - Heel counter really helped

Test: Gut Check Insole Date: 1/13/2025

Focus: Insole Flexibility/Support

Rating:

1 = Min. Effort 2 = Some Effort 4 = Medium Effort

3 = Effort Noticeable 5 = Max. Effort

Product	Rating	Structure Notes	Dependent Variable: Experience Twisting Laterally and Medially	Dependent Variable: Experience Twisting Backwards
MommySteps Active & Athletic	4	- Top fabric layer interact with foot - Two layers of foam - Bottom layer provides structure - In total 4 layers	- Arch support is higher in medial side so harder to bend around here - More flexible in forefoot due to lack of material	- Easier to bend - Material in arch prevents further bend - Thicker material in heel so harder to bend here - Harder to bend - Material in arch prevents further bend - Thinnest part is forefoot
Valsole	3	- Top fabric layer interacts with foot - Mid rubber layer - Bottom hard structure with harder component at heel - Gel components under heel and under forefoot - In total 3 layers	- Not twistable at arch - More structure in heel than in forefoot - No structure in forefoot, twists very easily	- Very flimsy and thin front part of insole - Gel components very sticky and squishy - Arch support is very hard, not very malleable here - Can bent at heel backwards but not forwards

Generic Brooks Insole	1	- Top fabric layer interact with foot - Foam layer - In total 2 layers	- Very twistable in both directions - No support in any section of midsole	- Very bendable in both directions - No support in any section of midsole
Generic Kizik Insole	2	- Top fabric layer interact with foot - Foam second layer, denser than Brooks - In total 2 layers	- Very twistable in both directions - Most structure in heel, but still easy to bend - Mild structure in arch	- Very bendable in both directions - Thicker heel portion - Thin forefoot section
Generic Saysh Insole	1	- Top fabric - Foam bottom (recycled?) - Two layers	- Very twistable, not real structure in insole throughout design	- Very bendable, due to no structure or support in insole

Appendix E

Bench Top Testing & Results

Test: Bench Top Heel Counter Date: 1/17/2025

Focus: Heel Counter, Pressure Sensing Film

Color:

1 = Little to no color
2 = Some Pink
3 = Noticeable Pink
4 = Darker Pink
5 = Darkest Pink

Product	Dependent Variable: Color Gradient (Reg. Size Last) (1 – 5)	Dependent Variable: Color Gradient (Maternity Last) (1 – 5)	Notes
Kizik Women's Athens	3	4	- Had to push pressure down on heel counter but slid in after
Brooks Ghost Runner	3	-	- Had to push down on last hard - Couldn't get maternity last into shoe
APL Sneaker	2	2	- Could slide lasts in more easily with shoe
Saysh One	-	-	- Couldn't get maternity last into shoe



Test: Bench Top Testing Footwear Date: 1/14/2025

Focus: Flexibility/Support

Product	Dependent Variable: Force (N)	Observations/Image Uploads
Kizik Women's Athens	1. 30.3 2. 30.3 3. 29.8 4. 30.8 5. 28.9 6. 28.2 7. 29.5 8. 29.2 9. 27.7 10. 28.0 AVG: 29.27	- Harder to flex than others - Consistent results
Brooks Ghost Runner	1. 15.8 2. 17.5 3. 16.4 4. 17.8 5. 16.5 6. 17.3 7. 16.6 8. 16.7 9. 17.0 10. 16.7 AVG: 16.83	- Easy to bend - Consistent results
APL Sneaker	1. 8.3 2. 7.8 3. 8.1 4. 7.8 5. 8.0 6. 8.1 7. 8.3 8. 7.9 9. 8.2 10. 8.0 AVG: 9.64	- Easiest to bend
Saysh One	1. 19.8 2. 18.7 3. 18.3 4. 17.8 5. 19.5 6. 18.4 7. 18.6 8. 18.4 9. 18.8	- Consistent results - Some force required to move - Comes back to position - Midsole seems sturdy

	10. 18.7 AVG: 18.7	

Test: Bench Top Testing Insole Date: 1/14/2025

Focus: Insole Flexibility/Support

Product	Dependent Variable: Force (N)	Observations
MommySteps Active & Athletic	Forefoot: 1. 8.5 2. 7.8 3. 9.6 4. 7.4 5. 9.5 6. 7.6 7. 6.9 8. 7.8 9. 7.1 10. 6.9 AVG: 7.91 Arch: 1. 30.3 2. 29.1 3. 25.8 4. 23.5 5. 24.3 6. 20.2 7. 28.3 8. 27.4 9. 28.2 10. 26.8 11. 29.2 AVG: 26.39 Heel: 1. 18.8 2. 20.2 3. 17.8 4. 17.1 5. 23.4 6. 19.2	- Structure in forefoot compared to others - Arch support present - Heel harder to bend than forefoot

	7. 22.4 8. 19.8 9. 20.3 10. 19.2 AVG: 19.82	
Valsole	Forefoot: 0 AVG: 0 Arch: 1. 34.5 2. 35.8 3. 39.2 4. 42.3 5. 41.9 6. 43.2 7. 40.2 8. 43.3 9. 47.8 10. 41.5 AVG: 40.97 Heel: 1. 10.5 2. 10.3 3. 9.5 4. 8.6 5. 9.8 6. 10.3 7. 10.4 8. 8.6 9. 8.4 10. 9.5 AVG: 9.59	- No forefoot support - Arch support hardest to bend at - Heel cup has structure, hard component at edge
Generic Brooks Insole	Forefoot: 1. 0 AVG: 0 Arch: 1. 5.6 2. 5.4 3. 5.2 4. 6.1 5. 6.5	- No real structure in insole - More material in arch which may be why some force recorded here

	6. 5.3 7. 5.5 8. 5.6 9. 5.4 10. 5.1 AVG: 5.07 Heel: 1. 0 AVG: 0	
Generic Kizik Insole	Forefoot: 1. 0 AVG: 0 Arch: 1. 7.5 2. 9.6 3. 8.3 4. 7.9 5. 6.8 6. 9.2 7. 9.8 8. 8.6 9. 7.4 10. 8.6 AVG: 8.37 Heel: 1. 10.2 2. 8.8 3. 8.5 4. 8.6 5. 7.4 6. 7.5 7. 8.9 8. 7.6 9. 7.9 10. 8.0 AVG: 8.34	- Thicker foam insole than Brooks - No real forefoot support - Some arch support - Some heel support
Generic Saysh Insole	Forefoot: 1. 0 AVG: 0 Arch: 1. 0 AVG: 0	- No resistance to bending - Consistent foam layer throughout insole - Minimal structure to insole

	Heel: 1. 0 AVG: 0	

Test: Bench Top Testing Insole Date: 1/14/2025

Focus: Ball Drop Test/Energy Return

Product	Dependent Variable: Height of Ball (in)	Observations
MommySteps Active & Athletic	Forefoot: 3 Arch: 2 Heel: 3	- Layers of foam and structured bottom throughout
Valsole	Forefoot: 4.5 Arch: 5 Heel: 6	- Layers of foam/gel and structured arch heel focus could have resulted in higher height
Generic Brooks Insole	Forefoot: 3 Arch: 4 Heel: 3	- Thin foam insole - Some more material in arch which could be why there was more return
Generic Kizik Insole	Forefoot: 3 Arch: 4 Heel: 4	- Foam layer throughout, thicker in arch/heel
Generic Saysh Insole	Forefoot: 3 Arch: 3 Heel: 3	- Height is consistent due to consistent thin layer of foam material - No real difference throughout insole design with height of foam material

Test: Bench Top Testing Midsole Date: 1/16/2025

Focus: Ball Drop Test/Energy Return

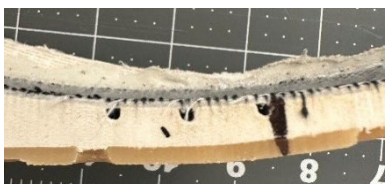
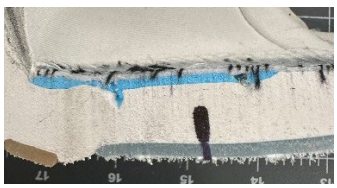
Product	Dependent Variable: Height of Ball (in)	Observations
Kizik Women's Athens	7 – 8	- Consistent bounce - Ball would roll forward into shoe after removing tube
Brooks Ghost Runner	6 – 7	- Least amount of bounce - Ball would sit in heel, not roll forward after removing tube
APL Sneaker	7 – 8	- Consistent bounce - Ball would roll forward into shoe after removing tube but not as fast as Kizik
Saysh One	7 – 8	- Bouncier than I expected - Ball would stay in heel cup

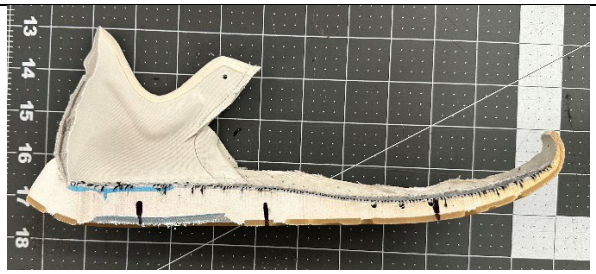
Test: Bench Top Midsole, Hardness & Features Date: 1/16/2025

Focus: Midsole Stability

Product	Dependent Variable: Hardness (HA)	Observations/Image Uploads
Kizik Women's Athens	Forefoot: 26 Arch: 24 Heel: 23	- Feels less dense - Same feel around midsole in different areas   
Brooks Ghost Runner	Forefoot: 23 Arch Blue Foam: 42 Arch White Foam: 24 Heel: 22 Guardrails: 48.5	- Feels denser - Guardrails on medial and lateral sides of shoe, disconnects at heel - Medial guardrail goes from back heel to arch - Lateral guardrail goes back heel and stops just before arch

		   
APL Sneaker	Forefoot: 26 Arch: 15 Heel: 21 Guardrails: 065	- Softer feel for majority of midsole - Guardrails around heel much harder, no squish to it, cups around heel of shoe - No texture

		   
Saysh One	Forefoot: 28 Arch: 23 White Foam at Heel: 14.5 Blue Foam at Heel: 16.5	- Blue foam at heel harder than white foam - Generic hardness throughout midsole - Very thin at forefoot  

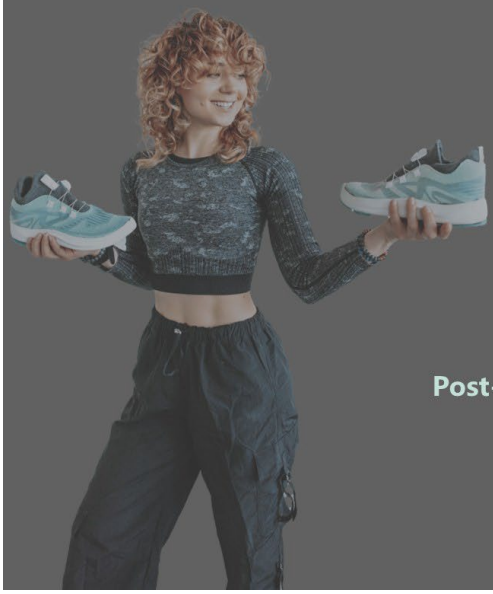
		

Appendix F

Final Project Presentation



MY WHY



Who I am — Engineer, Designer, Instructor

My Why — Advocate for niche demographics through high-quality sports product designs

Post-Graduation — PhD at Loughborough Sports Institute focused on pregnancy/postpartum and sports product design

PROBLEM STATEMENT

How can we **design an effective aerobic kit** that **adapts to a woman's changing body during pregnancy,** offering the support necessary to maintain an active and comfortable lifestyle during this time?

RESEARCH CONSIDERATIONS

"**...aerobic exercise...can significantly reduce the symptoms of depression** in pregnant women." (Kołomańska et al., 2019)

Psychological

1 in 5 women have increased anxiety & depression

~70% will hide or underplay severity

10 – 15% meet current activity recommendations

Physiological

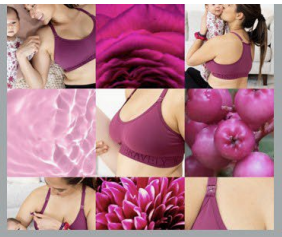
~50% experience **foot pain** during pregnancy

~80% experience **edema**

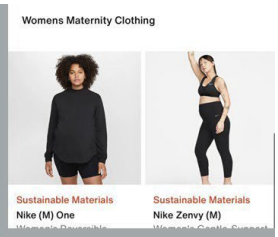
~70% experience **foot growth (w + l)**

"Pregnancy [is] associated with a persistent **loss of arch height, rigidity...and foot elongation...could contribute to an increased risk of subsequent musculoskeletal disorders..."** (Zangão et al., 2024)

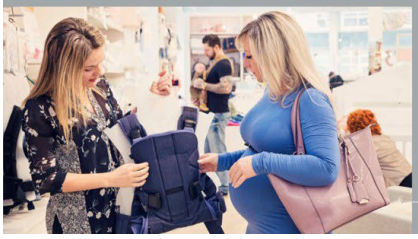












WHAT MATERNITY IS TODAY

Generic materials (polyester/nylon)

Boring and predictable color palettes

Temporary fit designs for entire pregnancy

Cautious marketing campaigns

Aesthetically **displeasing** for demographic

Lack of attention to changing biomechanics

Maternity products made for **lounging**

Focusing on what women **"should"** do or buy

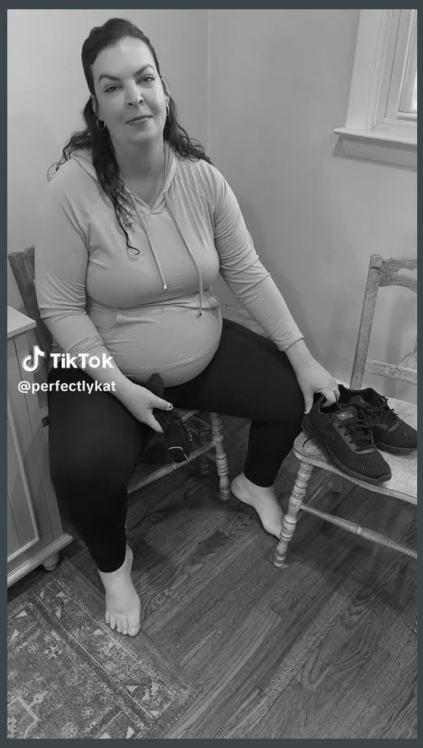
USER INSIGHTS

Comfort **Stability** **Ease of Use**

"If **the shoes could somehow expand** to accommodate growth and swelling…that would be perfect."

"Re-tying shoelaces to fit whatever size my foot is that day is a pain…"

"… a pregnancy recommended **compression sock that is easier to put on and take off** would be helpful."



SOLUTION: ALCHEMY KIT PRODUCT LINE

Empowering expecting athletes, this collection brings forward-thinking design to maternity sports products made for movement.



Footwear



Insoles



Compression Socks

*aerobic activity meaning running, jogging, walking

WHAT MATERNITY COULD BE



SKETCHES & IDEATION



TESTING GOALS

Focused on enhancing **comfort, stability, & ease of use** to support the intended demographic in aerobic activity.

Footwear	Insoles	Compression Socks
Upper features	Material choice	Compression zones
Midsole design	Consumer comfort	Targeted relief
User interface	Anatomical support	Donning & doffing

TOP COMPETITORS



Kizik Athens
$129



MommySteps Active & Athletic
$39.99



Apollo Performance
$37

Strengths		
Heel counter design	Heat moldable capabilities	Natural material comfort
Weaknesses		
Lacing lockdown system	Generic design	Fit around calf
Opportunities		
Insole design for support	Improved foot support	Design for versatility
Threats		
Company success	Ease of use	Socks made for exercise

"WORKS LIKE" PROTOTYPING



Footwear

Upper stretch knit zones

Lockdown mechanism

Heel counter design

Pull tab placement

Midsole expansion

"WORKS LIKE" PROTOTYPING



Insoles

Structural support

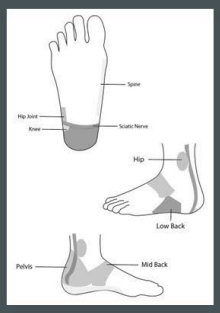
Proprioception textures

Adaptable materials

Thicker width

Overall comfort

"WORKS LIKE" PROTOTYPING







Compression Socks

Knit-in zones of relief

Discrete pull tabs

Lower height design

Biocompatible materials

Overall user comfort

FUNCTIONAL PROTOTYPES: FOOTWEAR



- ✓ **4X faster donning**
- ✓ **Grows & expands with foot**
- ✓ **20% more comfortable**

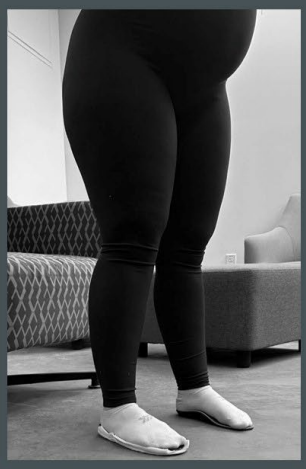


"I like the idea of the BOA and I think **placing it on the medial side of the foot makes a lot of sense.**"
~ Kara

FUNCTIONAL PROTOTYPES: INSOLES



- ✓ **Extra support under foot**
- ✓ **25% more shock absorbing**
- ✓ **15% more comfortable**
- ✓ **Improved body awareness**



"I appreciate that it gives support beyond just the heel, **the extra support feels like a full hug** rather than a 'push' like what the other insoles feel like."
~ Alex

FUNCTIONAL PROTOTYPES: COMP. SOCK





- ✓ **47% faster donning**
- ✓ **80% faster doffing**
- ✓ **Preferred design height**
- ✓ **33% more comfortable**



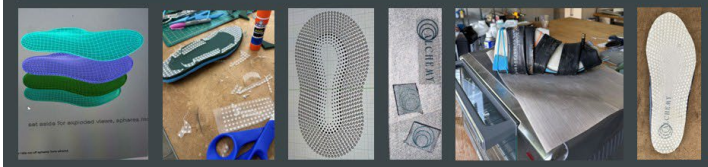
"I **love the idea of pull tabs and think it's a great idea** for putting the sock on and taking it off." ~ Kara

"LOOKS LIKE" PROTOTYPING

Footwear

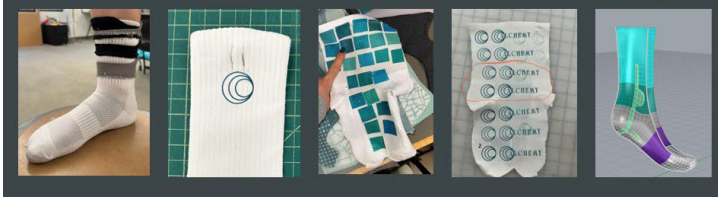


Insoles





Compression Socks





FINAL DESIGN: FOOTWEAR

Features & Benefits



Tongue and heel pull tabs for ease of use

TENCEL™ Lyocell performance blend upper for comfort

Medially placed BOA® technology for accessible security

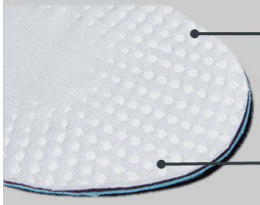


Adaptisole technology provides midsole expansion of up to one full shoe size

Stretch knit upper for seamless regions of stretch and stability

FINAL DESIGN: INSOLES

Features & Benefits



LunarSense technology uses strategically placed textures to support body awareness through enhanced proprioception

TENCEL™ Lyocell liner for user comfort and breathability

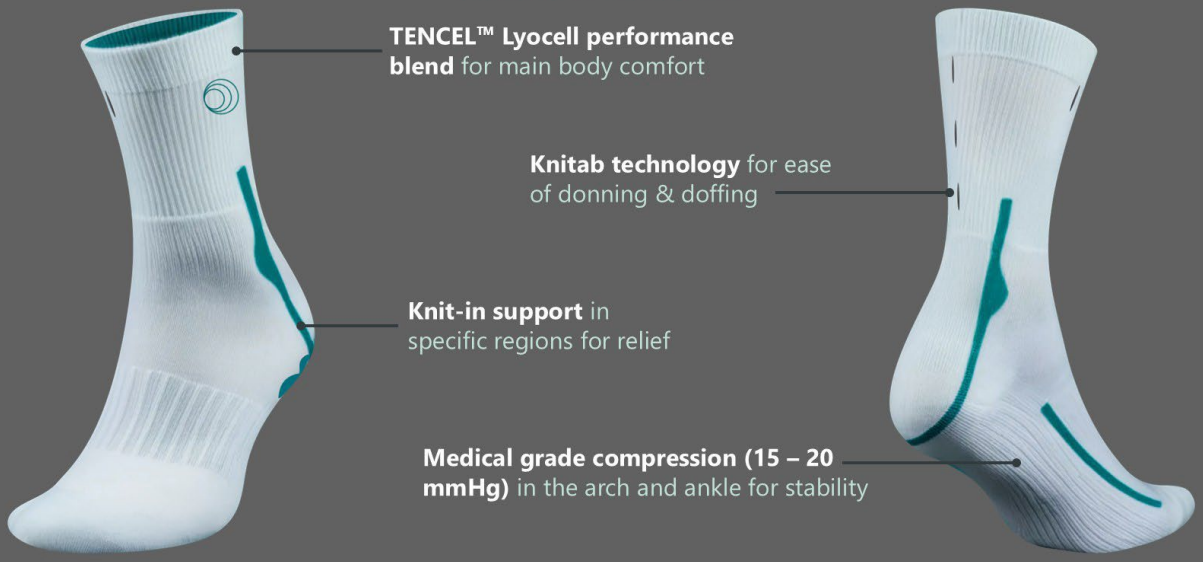
Ortholite memory foam layer for adaptable capabilities during use

Lateral and medial support to maintain full-foot stability and alignment



FINAL DESIGN: COMPRESSION SOCKS

Features & Benefits



TENCEL™ Lyocell performance blend for main body comfort

Knitab technology for ease of donning & doffing

Knit-in support in specific regions for relief

Medical grade compression (15 – 20 mmHg) in the arch and ankle for stability



ALCHEMY

A Maternity Aerobic Footwear Kit

Sports products intentionally designed to transform with women through pregnancy.


THANK
YOU!