Designing Footwear for Adventure Travel Photographers in Diverse Warm Weather Environments

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Origins of Contemporary Adventure Travel and Travel Photography

Figure 1 The first photograph of Niagara Falls from 1840 (National Gallery of Art, n.d.)

The spirit of adventure has been alive for millennia, an innate desire to explore beyond the horizon that has pushed people to cross the Bering land bridge, canoe to unknown islands, and brave the seas of the Atlantic. The advent of the industrial revolution and its subsequent influences and inventions that have shaped the modern world has directly played a role in making adventure a more definable activity. More specifically, the invention of powered transportation, photography, and a surplus of labor in part due to the same technological progress has created the perfect environment for recreational adventure to be accessible and desirable for more than the wealthy elite or those working out of bold necessity.

Looking at a brief timeline, it becomes clear how these events gave adventure travel the identity it has today. Practical permanent photography was invented in 1839 in France (Gernsheim et al., 2024), and shortly thereafter, the Niagara Falls were photographed in the

spring of 1840 (National Gallery of Art, n.d.), becoming the first example of landscape photography. The Grand Canyon and the Matterhorn were later photographed in the 1860's, marking some of the earliest examples of adventure travel photography. As adventure travel and the photo documentation of their journeys continued to become more popular, National Geographic and the Explorers Club were founded, officially establishing contemporary adventure travel as we know it today. National Geographic was founded in 1888 in Washington D.C. (National Geographic, 2023), and the Explorers Club was founded in 1904 in New York, New York (The Explorer's Club, 2023). After World War II, adventure travel became even more accessible to the masses as the world stabilized, personal photographic equipment became more affordable, and fast, affordable travel options grew at a rapid pace (Wikipedia, 2023).

Today, there are millions of people who travel every year to explore the world around them and document their journey, with there being 969 million international travelers globally in 2022 alone (Statista, 2023). The most extreme and yet arguably underserved of those users are the independent photographers, journalists, scientists, conservationists, professors, and students that must venture by themselves deep into jungles, deserts, and forests, fueled by their own spirit of adventure, in search of more.

Figure 2 Scorpions fighting for territory in the Ecuadorian Chocó

Such memorable expeditions require proper documentation to seal these events in both personal and public history. For this reason, it is essential to put specific focus on the adventurers that bring with them professional data and image documenting equipment, especially cameras. For every extreme individual exploring the world, doing good when it is most difficult, and generally striving to better our rich natural environments, there must always be a photographer there to share that story with the world. So many great adventures have been long forgotten or underrepresented because there were no photographers present to document these stories. Designing gear for those not just deep in the most challenging environments, but deep in those challenging environments with hunks of metal and glass strapped to their bodies, that is necessary and powerful. While the saying is not as old as time, it may as well be… pictures or it did not happen.

Adventurer Profile

Figure 3 National Geographic photographer Javier Aznar and his bags during a jungle hike

An independent adventure photographer must be able to persevere in extreme circumstances. The goal of outfitting these users with superior equipment is to aid their already respectable abilities in the face of challenging environmental conditions, tough timelines, and restless nights. The focus user is typically between the age of 18 and 55, male or female, able bodied, and in good health. It is important to note that there is no ranked or peer to peer competition, and that independent adventure is always a battle between the user, their environment, and themselves. There can be users that are more advanced in age, not as broadly athletic, or have some physical disadvantage, but the overarching commonality is that they are gritty, determined, passionate, and able to take care of themselves without the immediate help of others.

Financially, it is important to recognize that although several users within the occupation of photographer, journalist, scientist, conservationist, professor, and student may have external funding to travel, they are not always without financial concern, and must adhere to strict timelines to meet their goals. They often have back-to-back schedules, limited time, limited freedom in the modes of transport they have to travel, and the pressure of adapting to unfamiliar cultures and terrains. Performance is as much about their ability to travel, hike, and brave the elements as it is to depend upon their gear as an investment in their career, not just a money-is-no object enhancement to their experience. It is also important to note that personal effects such as footwear and bags may not be sponsored in the same way that photography equipment or field research equipment may be, but they must rely on these products to protect themselves and their livelihood. They need to use the best equipment for their job, but only because it is required for them to survive and execute their work- there is a limit to their spending and access to general equipment.

Product Spaces Explored

Figure 4 Lowa Fusion Lo and Bogs Snake Boot

Success as an adventure travel photographer often hinges around compromise- the compromise between what equipment someone can pack, and their performance in the field. Performance in this case is the optimization between comfort and focus in pursuing a photographic goal and the ability to properly photograph the intended subject with all desired equipment. In an ideal world, all necessary equipment for both comfort and photography can be packed, but this is not the case for all adventures. Therefore, success in adventure photography is the optimal compromise of packed equipment that allows the photography maximum comfort and safety in the field in addition to all of their desired photo equipment. Focusing on the products necessary for independent adventure travel, footwear is most consistently the biggest pain point and influencer over packing volume and field comfort. While clothing can vary between individuals based on preference, physiological factors, and environmental conditions, as well as be more easily repaired or replaced while in the field, it is much more difficult to drastically change the footwear and storage requirements necessary for independent adventurers. Focusing more specifically on independent adventure photographers, it is essential for their photography gear to be transported safely both enroute to their destination and in the field, and the photography gear they bring is always the primary focus of the bags and equipment they use to carry their belongings. Likewise, certain destinations often require specific kinds of footwear. Travel in airplanes necessitates comfort and versatility, while rugged deserts and jungles may require sturdy boots or in some cases full rubber boots for protective purposes. Some destinations even mandate rubber boots for safety concerns, such as Reserva Canandé in Ecuador

(Fundación Jocotoco, n.d.), which is famously home to a variety of cryptic but deadly vipers that could be life-threatening if the proper footwear were not used. Regardless of the clothes one chooses to wear on their next adventure, the biggest consideration for every packing list, and the ones with the most influence over how they perform in warm, rugged environments, will always be their footwear and their carrying equipment. For these reasons it will be the focus of this thesis to develop the most space efficient and adaptable modular boot and travel shoe to best aid adventure photographers and others in their quests by preserving space in their packs and maximizing the places they wish to explore.

Current Issues to Resolve

Due to stringent carry-on travel regulations, the nature of independent photographic pursuits, and issues with personal capabilities to carry more gear, the biggest pain point for any independent adventurer is the balance between how much gear one can bring with them and the tradeoff between gear specialization and storage space. This is especially important for adventure photographers who must also balance their photography equipment with their trip essentials. Even for professionals that carry equipment in large, armored cases and have unlimited budget, their excursions into the field unaccompanied by those resources pose a threat to their comfort and safety. Bringing multiple pairs of footwear for a diverse set of circumstances can be advantageous when in the field, but when it comes time to travel between locales, or internationally, space and packing limitations can make so much footwear a burden throughout the entire journey.

It is worth noting the relative importance between apparel choices and footwear choices in strenuous adventure situations. While there are always improvements to be made for apparel, those products have a unique packability in odd spaces and crevices, as well as the ability to be worn or wrapped around an individual that makes their travelability high when carrying a diverse set of pieces. The lack of insulation required for warm weather places further reinforces the ability for most apparel pieces to be relatively packable and a non-factor during travel. For instance, although a wet locale like the Ecuadorian cloud forest may require both a rain jacket and rubber boots, the rubber boots are incredibly more burdensome to travel with, and nearly impossible to comfortably wear through airport security or an urban travel environment. This is

because traditional rubber boots take up a larger volume than smaller boots, are made of stiff materials that do not pack well into small, organic spaces, and are not well suited for airport security and travel comfort. The rain jacket can be packed away, wrapped around the waist, or simply worn with minimal difficulty or change in comfort. There is always a question of fit, performance in the field, and individual preference for which style of apparel to use- but with a greater diversity of current market solutions to solve these issues, and easier access to replacement equipment of similar performance value in the field, it makes the most sense to focus on footwear to resolve the largest issues with independent adventure travel.

Sustainability is also a factor when it comes to the footwear used on grand excursions and adventures. For example, it is often common practice for individuals required to wear rubber boots to purchase cheap pairs upon arrival to a location, use them while they are there, and discard or leave them behind when they are done. Additionally, bringing them home does not guarantee reuse or quality end of life, as these boots often are poor fitting and not performance oriented, making reuse uninspiring at best. Likewise, extreme specialization in footwear in environments where an individual may need to change footwear constantly throughout a single day or extended travel period means more gear for one adventure. While this approach makes sense in someone's home with easy storage access and travelability, it is not so easy when someone is on their own. Cutting down on the amount of footwear required saves material use, lowers gear weight and volume, and can improve the overall experience of an independent adventurer, versus changing between multiple pieces of gear for minimal performance gain. Some products cannot crossover, there will always be a need to have something lighter and more comfortable for travel, basecamp, or urban use- but this thesis will go on to prove that with two highly adaptable designs, perhaps up to five different pieces of footwear can be reduced to two. Looking at reducing and consolidating, keeping sensitive gear in carry-on compartments when traveling by air is essential and keeping that gear with you at all times when in the field and urban settings is equally as important. It is for these reasons that independent adventurers avoid checking bags if possible, and sometimes cannot afford the luxury of checking bags on flights or carrying traditional suitcases if they must be able to explore on foot by themselves. Maximizing the space available to a traveler both in their bags and where their bags are able to be stored at the bottleneck, airline cabins, can ensure all of their gear can be packaged, and no additional bags need to be checked. This reduces weight, bags used, and improves user walkability,

decreasing the overall carbon footprint of an independent traveler on their adventure. While designing a new bag would aid in this tremendously, reducing the bulk of footwear can help provide more space to travelers regardless of their bag setup.

Golden Circle

This thesis aims to bring unlimited freedom and maximum performance to those that seek to capture the spirit of adventure through photography in warm weather environments while minimizing their environmental footprint. It will accomplish this by designing a collection of products that let adventurers do more with less and go anywhere their feet can take them. A range of versatile footwear that can seamlessly transition between the airplane cabin, jungle floor, desert dunes, and urban promenade made with sustainable, performance driven materials will accomplish these goals.

Thesis Mission Statement

How could we maximize freedom of exploration for adventure photographers during travel to and within rugged warm weather environments while minimizing gear and environmental impact? This thesis aims to find a balance between efficient travel and ample gear, high performance and high protection, as well as maximized environmental adaptability and minimum environmental impact. There are always sacrifices to be made when seeking adventure, and it is the goal of this thesis to optimize and even eliminate some of those sacrifices to best prepare the most ambitious adventure travel photographers. A cohesive system of modular footwear focusing on two soles and three uppers should adapt to the needs of the most demanding travelers.

Market Context

The focus users for this collection are primarily independent photographers, followed by journalists, scientists, conservationists, professors, and students. They will be an individual of any sex, aged 18-65, in good health and able to travel and hike. They will be able to carry heavy gear and equipment with them through rugged warm weather terrain, city streets, and airports/bus stations. The average user could be described as an adult male or female aged 25-35 with the ability to self-sustain and move at their own pace in a foreign environment with adverse urban and environmental conditions. They are financially independent, but spendthrift.

The market is global, with most consumers coming from developed countries that have the finances or occupational context to use and purchase the necessary gear for adventure travel. Those who travel in this manner unprofessionally must have more free time, financial independence, and personal motivation, while those that travel for their job will purchase such gear out of necessity and may be in a greater variety of countries. The main takeaway is that creating products for global travel means these products need to be available to a global audience.

While global travel is slowly restoring to pre-pandemic levels, if not surpassing it, as evidenced by the forty million Americans traveling outside of the US in 2023 (Skipworth, 2023), discerning between travel purposes is less clear. That being said, photo tourism overall is on the rise due to social media influences such as Instagram (Miller, 2021). Looking more specifically at National Geographic, 132 photographers were sent on assignment by National Geographic in 2022 (Janean, 2022). While the total number of American tourists in comparison to National Geographic photographers is quite drastic, in between those numbers the gap is bridged by those inspired by National Geographic, adjacent companies that sponsor photographers, universities, and environmental initiatives that all form a substantial mobilization of independent adventure photographers. The rise of protected lands being established and studied in rugged warm weather environments in the face of ecological destruction is a trend that also necessitates more of these users to either enter the workforce or be inspired to travel (Nico, 2021). With photo-tourism trending to align with eco-tourism, it is more important than ever to tap into a global market of serious independent adventure photographers that need high performing and more sustainable gear.

Adventure Photographer's Skillset and Needs

Figure 5 Adventure Photographer's Skillset and Needs

Adaptability, perseverance, and maintenance are the three pillars of an adventure photographer's skillset. It is necessary to build and nurture these skills throughout an adventure, as there are minimal if any support systems for an independent traveler in a foreign and rugged environment.

Likewise, it is important to look at where these skillsets need to be applied for the specific adventure photographers being considered for this design thesis. Colder climates have a different set of necessary skills and a shift in needs for adventure travel photographers. Considering the follow climate chart in figure 6, the tropical, dry, and temperate regions are the relevant regions considered for both the project overall and the specific needs and skills of the adventure travel photographers.

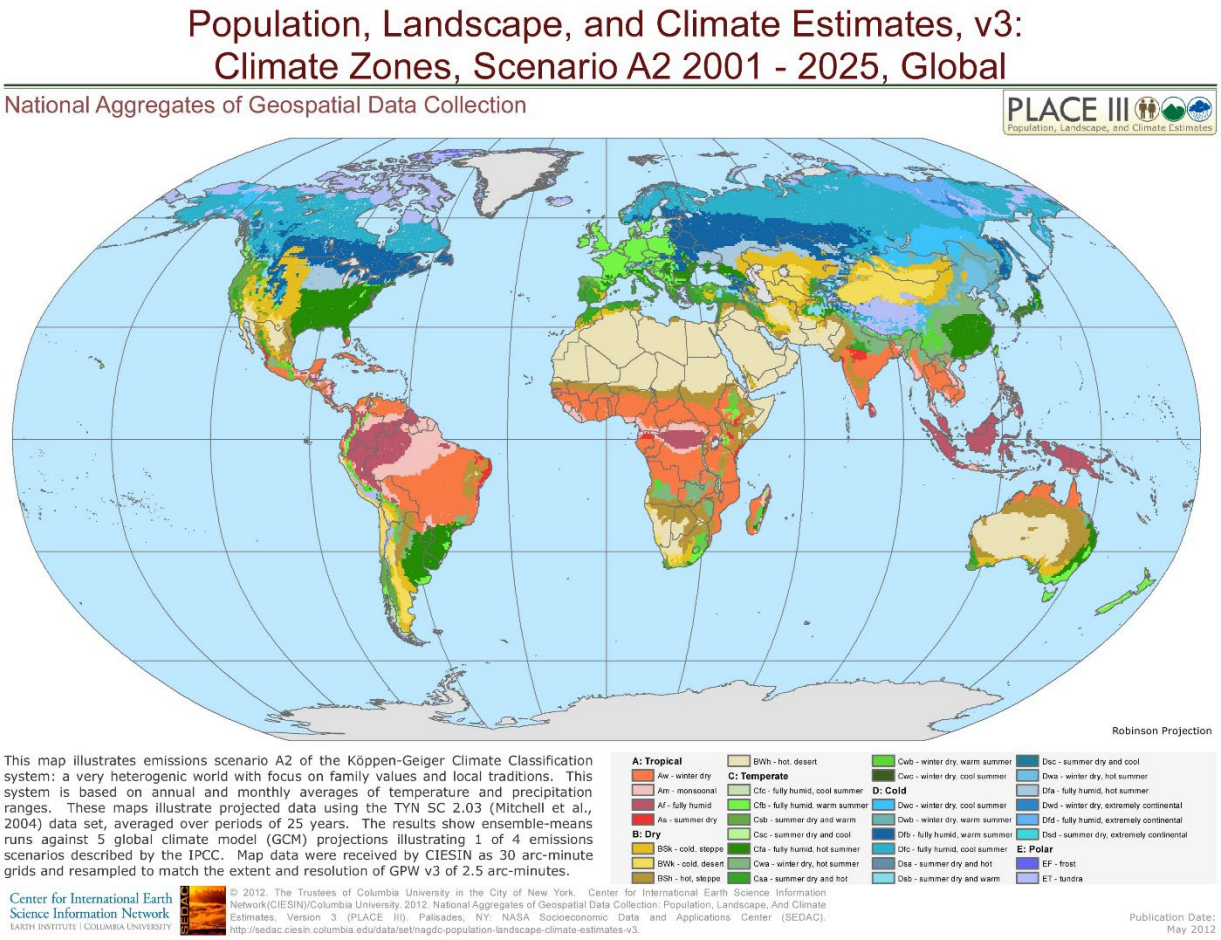


Figure 6 Climate Zones (SEDACMaps, 2024)

Adaptability is above all other skill sets and needs. When traveling, especially abroad, the athlete will be in a foreign environment both culturally and with regards to the geography and terrain. They must be able to have gear and equipment that can adapt with them, blend in, and be appropriate in the largest variety of situations. Looking more specifically at warm weather environments, the athlete will need to endure high temperatures, dry and wet conditions, and a variety of fauna and flora that are far more variable than those of colder environments. More specific challenges include adapting to extreme wet conditions like deep mud, standing water, beaches, rivers, and bogs while still being able to perform in dry environments while traveling and/or in other locales. An independent travel photographer cannot rely on taking their rain boots out of their garage when it gets muddy. Likewise, they have no real place to put their rain boots, should they have them, when it stops being muddy and wearing such boots becomes a detriment to adventure.

This is why adaptability is key- both in skillset and equipment. Another example is in the transition between urban travel and field work. To get to a field site or area of interest, beyond the airplane there are still several obstacles. Busses, cars, pick-up trucks, mules, and even travel on foot can all be necessary to get to where one needs to go. To get to Casa Del Medio in Reserva Canandé (Fundación Jocotoco, n.d.), a small bungalow in the middle of protected cloud forest, the trip must be done with mules if an athlete is not able to traverse the extremely muddy conditions. This is only after flying into Quito, Ecuador, taking a cab to a nearby village, moving to a truck, crossing a river via ferry, and then hiking into the reserve lab.

It is the same for arid environments as well- if an athlete cannot keep cool, and endure travel without air conditioning, even if they arrive at a well-maintained basecamp or hotel, they will not be able to continue their adventure. Even in these arid environments there can be sudden shifts in weather or environmental context (stream crossings, lakes, floods, etc.) that necessitate gear that can adapt and withstand these changes. The athlete must be like a high-performance shapeshifter, taking on the best traits needed to withstand any environment, culture, or situation.

Perseverance is closely related to adaptability. To get through the situations outlined in the previous paragraph, the athlete must have an unbreakable will and focus on their objective. Extremely long hours during the logistical part of their adventure means that independent adventure travel photographers are often not operating anywhere close to peak physical condition when in the field. Unless afforded the luxury of a relaxed timeline and delayed events, timelines for most adventurers can be extremely hectic.

Gear that does not give out during these times is essential, as that can break the morale of an adventurer, and limit their ability to complete their objectives on any given trip. The goal upon arrival at any destination is to spend as much time exploring that destination as possible, not to shop for replacement or additional equipment to continue exploring. The more rugged and dependable an adventurer's gear can be, the more an adventurer can persevere against delayed flights, freak weather conditions, navigational errors, animal encounters, injuries, or any other setbacks that may jeopardize their mission.

Maintenance is the third and final core skill adventurers must have. After adapting to a foreign land, and persevering through inevitable difficulties, some things are bound to go wrong. It is simply the nature of such stressful and ambitious excursions - products and people can and

will fail, no matter how good they are. Being able to troubleshoot issues, come up with quick solutions, and resolve serious issues is essential, especially for those traveling independently.

Products that synergize well with an adventurer's ability to maintain themselves and their adventure utilize features, parts, or design philosophies that ensure they can be fixed, reconditioned, or still used in the event of failure. Much like the famous Toyota Landcruiser (Duffy, 2023), they must be dependable because despite their flawless performance, they are dead simple to fix when they do fail. While innovation, tightly aligned with adaptability, is the primary focus and skillset, maintenance must not be sacrificed or forgotten by both the adventurer and the products they bring with them.

Environment of Focus

Figure 7 The Ecuadorian Chocó

Figure 8 Patagonia Lake Semi-desert Grassland and Surrounding Santa Rita Mountains

Figure 9 Shanghai Pudong International Airport

Figure 10 The open road...

The environment of focus will be warm weather rugged environments, especially those in the most natural and unexplored locales, without ignoring urban and travel contexts. Splitting the environments into urban and outdoor allows for a better understanding of the specific places this collection of gear will be designed for.

Understanding surfaces is key to designing footwear solutions. For outdoor surfaces, there will be rocky substrates, especially talus, riverbeds, boulders, and bedrock. There will not be a focus on any icy rocky terrain, and the most extreme rocky surfaces will be those of warm mountain tops without consideration of snow. Additionally, transitions between wet and dry substrates will be a primary focus, especially with regards to slick mud, wet wood, grass, leaves, and underwater surfaces. All surfaces will be considered for on and off trail context, meaning that it is assumed harsh vegetation, unmaintained and improvised paths, as well as unusually

steep or unstable terrain will be considered. Sand will be a tertiary consideration, with special focus given to dealing with sand ingress, and the inefficiencies of walking in sandy substrates.

For urban surfaces, travel seating situations will be heavily considered. Airplane and bus seats, cramped cab seats, and situations where the adventurer must sit with their bag are of high importance. Additionally, comfort and performance on concrete, around a base camp or hotel, and on dirty or poorly maintained urban surfaces will all be considered.

For outdoor locations, the places that will be studied are warm weather locations with special ecological interest, typically deserts and rainforests. Places with low relative biodiversity and no special ecological interest will not be considered, as most of these places can be traversed with little consideration of special equipment and are not traveled to by adventure photographers and similar users. Cold places will not be considered, as the amount of gear needed to properly explore those places necessitates checked bags, if not special teams, and is not as feasible for an independent adventure travel photographer to explore with one bag and two kinds of footwear.

Urban locations include airports, buses, cabs, and ferry stations during the traveling portions of an adventure. In between travels, cities, villages, and lounges may be explored, and it is important to consider how all the equipment brought with an adventurer will work in those contexts. There may not be a safe place or way to be without their gear, and so the design must reflect its adaptability to these environments.

For weather, this is consistent in both outdoor and urban environments. Warm weather with extreme variability between wet and dry is the primary focus. Designing for extremes ensures maximum performance in all circumstances. Even desert locales can become inundated with water, and that is often a time when an adventurer would want to travel to that specific area, as it can indicate an event of ecological period of interest, such as a mating chorus of spadefoot toads. Because weather is often a catalyst of interesting observation, excellent photography, and general concern, the weather that will be designed for is expected to be the most difficult and dynamic of any adventure scenario.

Considerations and Restraints for Adventure Photography

Independent adventurers often need to adhere to specific project or assignment goals, corporate terms of conduct, and hectic schedules. It is not always a leisurely vacation and can be extremely demanding. Quick turnaround between assignments and/or meeting deadlines set by an employer also means that they may not have the luxury of returning home or stopping at places not immediately relevant to their work or goals. Even for those traveling on their own accord, having sources of income outside of what they are doing while traveling means that those users are likely not able to waste time or deviate from their travel plans. It is a lot easier to be flexible with a small road trip than it is with international travel, and that importance must be reflected in the dependability and adaptability of their gear.

Traveling to specific countries and places comes with its own rules and regulations. In addition to adhering to local customs, arriving at a field site may come with its own set of guidelines. For instance, the Jocotoco Foundation requires all visitors and employees at Reserva Canandé to wear rubber boots at all times when on their network of trail systems (Fundación Jocotoco, n.d.). This is for safety concerns relating to the variety of deadly vipers that call the Choco Forest their home, as well as the extreme levels of mud present at this reserve. It is important that adventure travelers can adhere to local rules such as these without being held back on other parts of their trip.

Specifically for air travel, there are size constraints for luggage. Looking closer at carry-on luggage, there are roughly 22-30 liters of volume available under the front seat, and between 40-50 liters of volume available in overhead bins on most international and domestic flights globally (Luggagepros.com, n.d.). Combined, these volumes make the perfect size for a backpacking bag, ideal for independent adventure with photographic equipment. However, the fact that these volumes are not combined means that it is not possible to take a typical fully filled backpacking bag as a carry-on for most flights. This is especially problematic as adventure travel photographers must avoid checking their camera equipment at all costs, and their bag may be damaged when checked, jeopardizing their adventure plans. These constraints make travel more logistically challenging, but they are not impossible to adapt to.

Product Line Plan

The product line plan to satisfy the most essential needs of discerning independent adventure travel photographers in warm weather environments will consist of a modular footwear system that has an urban and an outdoor sole as well as three interchangeable uppers to cover situations where a rubber boot, breathable hiking boot, urban shoe, outdoor sandal, and leisure slide are needed. The urban configurations will be light weight, comfortable, fast drying, excellent for air travel, compressible, anti-odor, and capable from the hotel room to a mild trail or aquatic situation. The outdoor configurations will be able to transform from a rubber boot to a heavy-duty breathable hiking boot, pack down in a bag during storage for easy packing and additional protection, as well as function better than current rubber boots. These core modular footwear items are the most essential products for warm weather travel, as it is easier to get away with less technical apparel, such as t-shirts, in warmer environments than it is to get away with less technical footwear. While there are several benefits to well-designed technical apparel for warm weather environments, the wrong footwear can turn any warm weather adventure into a misadventure.

Competitor Research

Looking at the competitive landscape, rubber boots and low hiking shoes will be compared. These products represent either one of the most common choices for general outdoor adventure consumers looking for products in each respective space, or the pinnacle of current design within each product space. Given the diversity of footwear used specifically by adventure travel photographers, it made sense to look at a broad range of approaches that cover the spectrum of what adventure travel photographers may use. It is also important to consider that each travel situation will prioritize products differently. For instance, a cheap rubber boot purchased during a trip may be of greater use and interest for someone who does not have the room to pack superior rubber boots purchased before their trip has commenced. This means that although on paper these products may not directly compete, in real world use they have very similar overall benefits to the consumer, and thus compete against each other.

Lowa Fusion Shoe - $175 | Topo Athletic Trailventure 2 - $110 | Altra Lone Peak 6 - $140

Figure 11 Competitor products for travel footwear

The three products chosen for examination in the low-cut travel shoe space are the Lowa Fusion Lo, Topo Athletic Trailventure 2, and Altra Lone Peak 6. These three products represent the full spectrum of footwear options most closely aligned with the space of a quick drying, capable, and comfortable travel shoe. Important to note in the broader travel footwear space is the subdued nature of most styles, both in terms of their aesthetics and their performance. They are often just toned-down leather hiking shoes, casual shoes with some additional features, or repurposed trail running and hiking shoes. While there are dedicated travel shoes on the broader market, such as the offerings from Tropicfeel, these options have to be more generalist in their approach, splitting the difference between urban and trail needs, which compromises their rugged trail performance (Tropicfeel, n.d.). Using dedicated trail shoes and travel shoes separately will always be the highest performing and most comfortable approach, but this increases packed volume.

The Lowa Fusion Lo is the goldilocks of the group, being supremely comfortable and easy to use with its full knit upper with elastic closure while ensuring maximum trail performance and durability with a PU monowrap midsole and grippy lugged rubber outsole. However, it comes in at the steepest price of the bunch, a hefty 175 dollars (LOWA Boots, n.d.). The steep price point is somewhat justified by EU manufacturing and more expensive PU foams that do not degrade as quickly as EVA counterparts, and there are plenty of more expensive travel shoes that use leather and more premium outsoles. Almost the ideal travel shoe, this shoe lacks dedicated drainage ports, a more city-smart aesthetic style, and potentially stiffer lacing for more difficult trail situations.

Creeping down the price point to 110 dollars, but upping the weight and capability, Topo Athletic's Trailventure 2 seeks to blend the running and hiking shoe space (Topo Athletics, n.d.). This capable yet light and well-ventilated boot features a trail-specific midsole and outsole design that uses the same foams and comfortable features as their trail-running shoes, ensuring a stable and safe hike with a light and cushy feel. These benefits do come at the cost of durability, and while this boot is at home on most trails, its lighter materials and cheaper construction methods mean it will wear down faster. For travel, it features a wide toe box, great for comfort, but also bulkier in airline seats. The last shoe on the list has an equally wide toe box but a slimmer footprint and profile.

The Altra Lone peak, splitting the difference in price at 140 dollars original retail (Altra, n.d.), is easily the lightest and most comfortable shoe featured. However, it features a construction that prioritizes light weight over durability. The outsole rubber is softer, the upper materials will eventually fail under excessive wear and tear, and the stitching is not reinforced in the same way a more rugged hiking boot would be. That being said, the EVA midsole is plush, the upper materials are supple and forgiving, and it is the least heavy on foot of the three competitor products. A true trail-running shoe by design, this model is popular with thru-hikers for its supreme comfort, breathability, zero-drop design, wide toe box, and slipper-like feel. The shoes do however need regular replacing, which is the price the thru-hikers pay. However, at half the cost of most resoleable backpacking boots, this is not a major issue for those with enough income to purchase more pairs. A unique feature of this shoe that is not advertised by Altra is the substantially undersized and flexible heel counter relative to other trail running shoes. While this increases the comfort and pliability of the shoe, its most important, and likely unintentional benefit is its ability to compress without damaging the integrity of the shoe. These shoes are extremely easy to pack and take up a similar amount of space to a pair of robust sandals. The zero-drop design reinforces this by keeping the midsole flat and minimal. However, the lack of stiffness means that proper lacing and heel lockdown is required to get the right fit, and wearing the shoe without the laces tied tightly can lead to pain over time for some individuals. The ideal replacement for these competitors blends the durable versatility of the Lowa, comfortable capability of the Topo Athletic, and easy packability of the Altra into a single shoe.

Figure 12 Competitor products for rubber boots

The three boots selected for comparison are the Venus Llanera Classic, BOGS Snake Boot, and the XTRATUF Classic. These boots were chosen because they span the full spectrum of outdoor boots and each have specific trade-offs and contexts to their use that make them interesting to compare and insightful towards the research goals of this project.

The Venus Llanera Classic is arguably the most interesting option, costing a whopping 12 dollars (Venus, n.d.). The idea behind purchasing this boot or others like it is that a traveler may travel to their destination, and then at the destination purchase an inexpensive boot comparable to the Venus Llanera Classic, potentially returning without their boot. Its performance is subpar, though it does do the job of keeping feet dry and protected during a hike. That being said, the sizing of this specific boot is limited, it has virtually no arch support, zero cushioning, and uses a thin material that is more prone to cracking and damage over time. There is very little if any support for more rigorous hiking, and the traction pattern of this boot and others like it are typically geared towards more agricultural use rather than field hiking.

A boot that is geared towards hiking is the BOGS Snake Boot, which is a fully featured snake-proof hunting and hiking boot, with a price to match at 210 dollars (BOGS, n.d.). This boot has a thicker and more supple rubber with snake protection and a wicking liner fabric. Additionally, there is midsole cushioning, a nylon shank, an insole, and achilles/ankle padding on the inside for a better fit. The traction pattern is still designed for the effective release of mud but is more suited for long hiked and rugged terrain. This boot still suffers from the same issues as all other boots in that it is difficult to get a super secure lockdown in very dynamic or steep

terrain, and thus does not function with the same security and efficiency as a regular hiking boot. It is however one of the most comfortable and capable options on the market for a warm weather rubber hiking boot, and definitely makes up for its bulk during travel on the trail. Some travelers would not want to take such a large boot with them on the airplane, or simply do not have the space, but for those that can, the performance difference between this boot and the other boots is well worth the hassle.

Finally, the XTRATUF 15in Legacy boot is a reliable staple that lies somewhere in between the BOGS and Venus boots, priced appropriately at 150 dollars (Xtratuf, n.d.). Trusted by farmers and fishermen across the United States and beyond, this boot offers a significant upgrade from the Venus Llanera Classic boots in terms of overall comfort, build quality, and hiking performance. However, it still keeps with a lighter synthetic leather silhouette, and is not as fully featured, protective, and as good on difficult trails as the BOGS Snake Boot. The price at 150 dollars is also relatively steep, and a good portion of that price is likely related to the lasting reputation of XTRATUF boots, which have been a staple in the Pacific Northwest and Alaska since the 1960's (Karpowicz, 2022). Despite this, for most of the consumers that purchase these boots, the trust and security they have in the ability for these boots to perform better and longer than cheaper competitors keeps them dominant in the market. For the purposes of travel, while they do work well on hikes and take up less space than bulkier options, they are not suitable for steep, diverse, rugged off-trail use, and are not designed for those use-cases.

Product Anatomy

Figure 13 Product anatomy of Lowa Fusion Lo

The Lowa Fusion Lo will be used as an exemplary shoe for design analyzation. This shoe, like all others, consists of three main parts with accessory parts, which are the upper, midsole, and outsole.

Starting with the upper, the Lowa Fusion Lo uses a seamless knit sock construction with a gaiter style opening. The lacing system is an elastic pull cord attached via inserted woven loops. The elastic has a cord lock and clip ending to keep the cord from flopping around. At the tongue area and heel there are wider woven webbing finger pull tabs in the same materials and colors of the lace loops. The primary logo is on the rear side below the ankle, with a secondary logo on the front tongue pull tab. Inside of the shoe is a padded section and stiff reinforcement for the heel and ankle regions, but aside from these parts, there are no liners due to the sock-like construction of the knit upper. There are likely reinforcement panels on the interior of the knit upper in the toe region and following the woven lace loops, and some bolstering under the laces at the tongue. On the top of the top of the toe box the upper is knitted such that there are a greater number of ventilation holes in this region. The upper blends with the midsole, offering additional support and heel cupping in an otherwise flexible design.

Focusing on the midsole, it is important to reiterate the importance and uniqueness of the wrap around upper. Lowa boots uses a specific manufacturing technique that directly bonds the midsole to the knit upper during material injection. Inside of the upper above the midsole is the insole, which has a fabric liner for comfort on top of the foam. The midsole itself may have a stiff shank inside of it for stability and stiffness in the arch region while maintaining flexibility at the break of the foot.

The outsole is straightforward, consisting of one piece of glued rubber. The outsole has flex grooves for improved flexibility in the foot where needed. The outsole also has directional traction lugs for uphill and downhill. There is a cutout where the outsole is least needed for traction in order to save weight and provide a larger area for the heel to catch on the terrain during descents.

Figure 14 Product Anatomy of Bogs Snake Boot

Rubber boots are less easily defined in terms of upper, midsole, and outsole, but their anatomy still follows the general rules of most shoes.

The upper of a rubber boot covers the midsole and blends into the outsole. The BOGS Snake Boot specifically has molded rubber around the foot, transitioning into a more traditional upper material as it goes up the calf. Looking at the rubber portion, there are reinforcements in the heel and the toe box for protection and support. A protrusion on the heel allows for a user to more easily remove their boot. The rubber continues up until it is above the ankle, providing additional support for the ankle. Beyond this region the upper shifts to a composite snake-proof material that is lined with wicking fabric in the interior. There is woven fabric grosgrain covering the rear seam and the top edge of the boot opening. Looking inside of the upper, there is foam padding in the ankle and heel regions for a more secure fit.

The midsole for this boot is glued inside of the external rubber shell, and then supplemented with a hefty insole. The insole also has a secondary removable spacer that effectively changes the width of the boot by changing the volume and height. The midsole also features a stiff nylon shank under the arch for rigidity and support.

The outsole is integrated with the upper materials on this boot, but it is a different material to the upper rubber. The outsole has properly spaced lugs designed to shed mud and grip

in slippery conditions, although it is rounder and less aggressive for climbing and hiking steeper trails. The rounded profile of the outsole assists with promoting a fluid and natural gait, as this is a relatively stiff boot. There is a break in the traction pattern under the arch for a logo and for the purpose of increasing the breaking power of the rear heel.

Product Jobs to Be Done

SHOE	BOOT
URBAN JTBD	**URBAN JTBD**
Airplane/Vehicle Travel Easy on/off, fits under seat	**Backpack Stowage** Must take up minimum pack volume
Hotel Use Sheds dirt, stays clean, comfy	**Backpack Protection** Must protect bag contents
Urban Travel Resists grime, stays supportive	**Last Resort for Urban Messes** Can be used during heavy rain
OUTDOOR JTBD	**OUTDOOR JTBD**
Light Trail Use Supportive under load, comfortable	**Rugged Terrain (Dry)** Stripped down version, core boot
Basecamp Use Quick drying, comfortable, slipper	**Rugged Terrain (Wet)** Boot with water protection
Water Use Drains quickly, can be water shoe	**Protection/Health** Core boot helps prevent injury

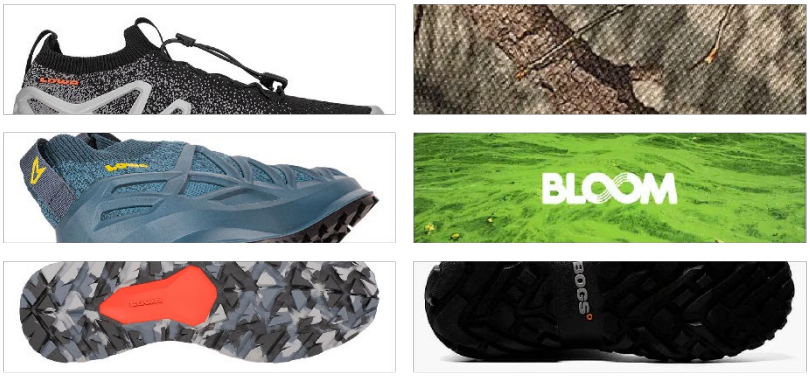
Figure 15 Product jobs to be done summary for shoes and boots

For the Lowa Fusion Lo, the upper is responsible for securing the foot such that it is well fitted, restrained but not constricted, able to breathe, and protected from moderate dirt and debris. It is also responsible for the primary ease of use in donning and doffing, as well as being the primary signifier of aesthetic style. The midsole is responsible for foot cushioning as well as lateral support. This shoe specifically uses the midsole more than other shoes to support the foot, which is a unique design trait. The outsole is responsible for providing maximum traction on a variety of surfaces.

Looking at the BOGS Snake Boot, the upper is the most important part of this boot. The primary job of the upper is to protect the foot from water, debris, dangerous animals, and anything else the outdoors can physically throw at this boot in a warm weather environment. It is

also responsible for the security and fit of the shoe, though in this model that is also done through the midsole, as there is no way for the upper to change shape to secure feet. The midsole is responsible for supporting and cushioning the foot. Due to the extra insole insert, it is also responsible for adjusting the fit of the boot. The outsole must provide the best traction in wet and dry environments, with a focus on shedding mud and performing best in the wet.

State of the Art Product Materials



Example: Lowa Fusion Shoe

Upper
Knitted Textile (Likely Nylon, Polyester, and/or Elastine)
Midsole
Polurethane blend (Lowa DynaPU) with Carbon Fiber shank
Outsole
Synthetic Rubber (Lowa GT)

Example: BOGS Snake Boot

Outer Shell
Natural 2mm rubber, Polyester Mesh
Interior Cushion + Insole
Rebound Bloom Algae based foam with Nylon shank
Outsole
BIOGRIP Rubber

Figure 16 Materials summary for shoes and boots

The Lowa Fusion Lo uses a knitted blend of synthetic materials, likely nylon with some elastane. Nylon woven webbing/grosgrain trims complete the lace loops and both pull tabs. Elastic shock cord with a fabric sheath work in conjunction with Nylon cord locks and hardware for the lacing system. EVA foam padding on the interior of the upper, as well as plastic reinforcement in the heel complete the upper materials. The midsole uses Lowa's proprietary PU blend called DynaPU. Inside of the midsole is a carbon fiber shank. The outsole uses Lowa's own synthetic rubber blend, Lowa GT.

The BOGS Snake Boot uses a proprietary composite snake-proof material on the top of the boot, likely a PU coated nylon fabric with snake-proof reinforcement and some integrated rubber. Lined throughout the entire interior is an anti-odor treated polyester mesh lining. The bottom rubber shell of the boot is 2mm thick natural rubber. The finishes on the boot are nylon grosgrain. The midsole is comprised of Rebound Bloom algae-based EVA foam with a nylon shank inside. The insole is also Bloom algae-based EVA, but a different blend from the Rebound foam used in the midsole, and is bonded to a polyester anti-odor treated fabric topper. The insole spacer is the same material as the regular insole. The outsole is made with BOGS' proprietary BIOGRIP rubber.

State of the Art Product Manufacturing

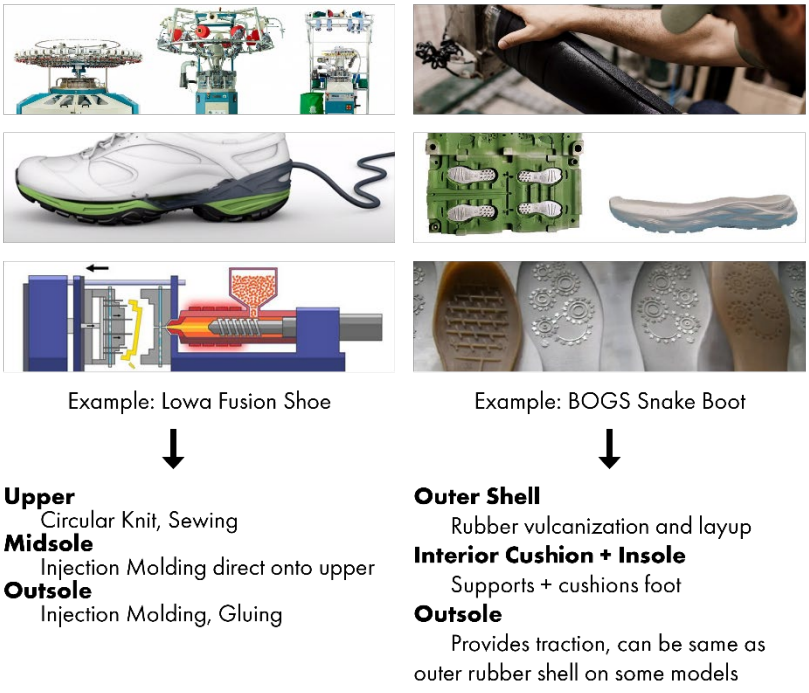


Figure 17 Manufacturing summary for shoes and boots

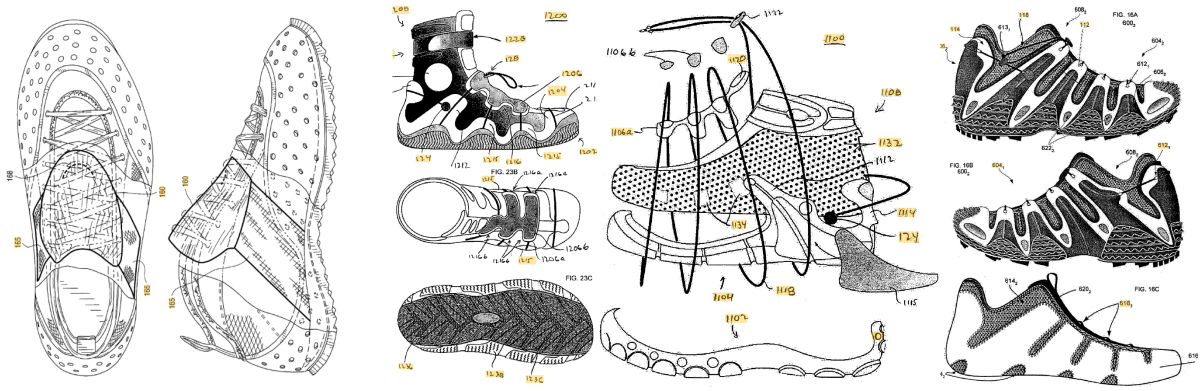
The Lowa Fusion Lo's upper is manufactured using a flatbed knitting machine. After knitting, reinforcement panels, padding, and any additional flat interior pieces are sewn or bonded to the upper. Additionally, trim pieces and logos are attached, such as the lace loops and tongue pull tabs. The upper is then sewn together and has the rear pull tab attached to hide the

seam before being sewn to a Strobel board and inserted into a last. With any additional interior base reinforcements added, such as the carbon fiber shank, the whole upper is then brought to a special injection machine. It is placed inside a foam injection molding machine where PU foam is injected and expanded directly onto the upper and bottom of the shoe, bonding it permanently. This is a unique process typical of Lowa shoes and is especially prominent on the Lowa Fusion Lo. After the foam cools the shoe is removed, and the outsole is prepared. The outsole is typically heat pressed using a rubber blend placed into a mold that functions similarly to a waffle iron. After the outsole is produced, it is then glued to the midsole of the shoe. Finally, die cut foam insoles with glued fabric toppers that have printed graphics are inserted into the shoe. The shoe is then laced. The cord locks for the lacing system are injection molded in a separate factory and delivered to the Lowa factory. After assembling and installing the lace system, the shoe is inspected for quality before being packaged in a cardboard box with paper separation.

The BOGS Snake Boot starts with the production, cutting, and sewing of the primary upper composite material. The upper material is produced by bonding layers of different material together, including a camo-printed face fabric. Next, the bottom rubber section is lapped together by hand and vulcanized such that the placed pieces of rubber bonds together. The midsole, which is produced via injection molding of EVA foam is then inserted into the rubber shell and glued in place. A nylon shank is cut and glued into the EVA foam, unless it is included in the injection molding process. The polyester inner bootie and lining is then sewn. This includes the stitching of embedded EVA foam panels on the interior of the bootie. The bootie is sewn to a base piece of stiff fabric before being attached to the aforementioned composite upper material. Nylon grosgrain is sewn along the edge seem and sewn along the top of the bootie and outer composite upper material to protect the raw edges. This entire assembly is likely placed inside of the rubber shell and glued into place. The rubber outsole is then heat pressed using BOGS' Biogrip compound before it is bonded to the rubber outer shell with glue. During heat pressing the BOGS logo is placed in the rubber mold so that it becomes one with the outsole. Once all pieces are glued together, the boot is tested for quality and then packaged into a large cardboard box with paper and cardboard spacers.

Intellectual Property Landscape

The intellectual property modular rubber boots, and multi-use travel shoes is relatively sparse, but does feature both inspiring designs and some patents to avoid infringing upon. There are also some expired patents that could have potentially been inhibiting, but are now further sources for inspiration towards designing effective solutions to the problems independent adventure travel photographers face on their journey and in the field.



Footwear for water sports - EXPIRED

Shoe with anatomical protection

PATENT 4 - US5771610A **PATENT 5 - US7631440B2**

Figure 18 Footwear patents surrounding drainage and modular anatomical protection

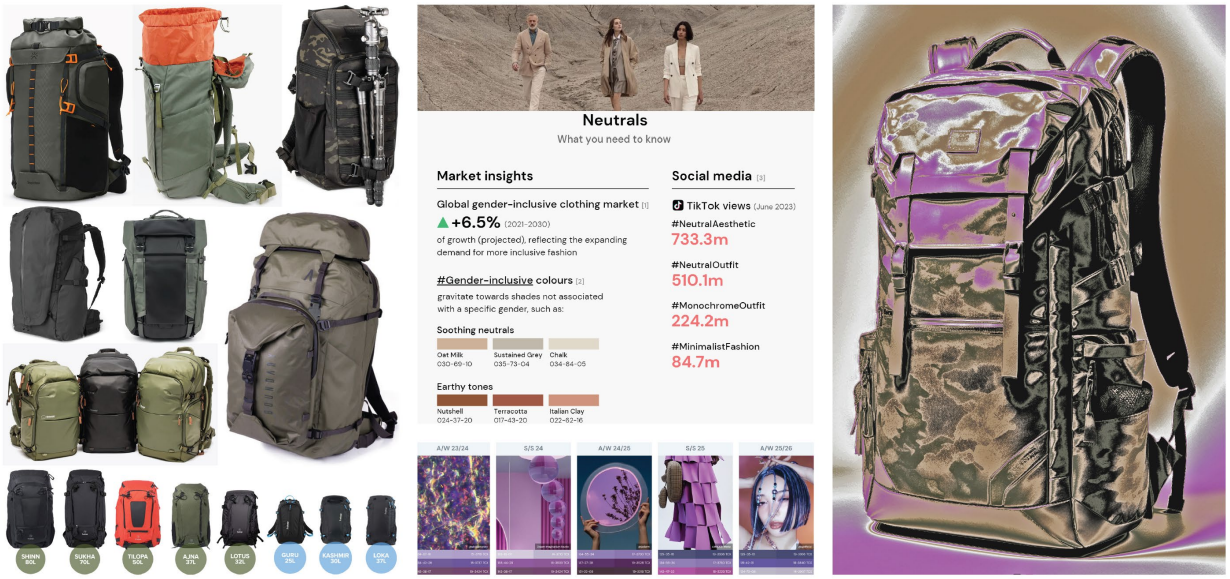
Moving on to footwear, there are two patents worth looking at in the modular and wet/dry hiking space. The first patent is expired but details an extremely versatile shoe that is durable and protective while still providing excellent drainage and mobility. The second patent is still active and goes in depth to explain complete modular designs that could be concerningly similar to some potential innovations but ultimately are too specific.

The first patent is by Patagonia and details a rubber-randed trail shoe with a neoprene gaiter/bootie that is perforated around the entire shoe (McDonald, 1998). The perforated rubber rand protects the foot and ensures 360 degrees of traction surface, while the perforations let water drain through what would otherwise not be a porous material. The neoprene gaiter/bootie protects the foot and ankle with some padding while also sealing the interior of the shoe from debris that could come in during full submersion in water. While not exactly the perfect travel

shoe that can work in a variety of conditions, this patent has a lot of great ideas that mean its status as expired is especially helpful.

The second patent is by Timberland and goes in depth to feature multiple footwear designs that all broadly use the same patented method of construction (Keen & Opie, 2009). In each design there is always an inner fabric bootie and a midsole which is then surrounded by what the designers call a superstructure, a semi-rigid cage that houses the lacing system and integrates with all parts of the shoe. Protective pieces are also able to interact with the superstructure, sandwiching between the superstructure and the inner fabric bootie. These protective pieces are sometimes removable. It is an interesting albeit specific method for creating a modular outdoor shoe that can function in a variety of circumstances. It will be important to avoid this direct method for any modular attachment and integration of protective pieces on a modular rubber boot/hiking boot design.

State of the Art and Future Color Trends



TRENDS TODAY
Earthy colors and blacks with orange or warm accents, or white/bright solid color

TRENDS TOMORROW
Inspired by the AW 24/25 Future Terrains Forecast, Colour Trends: The Next Neutrals, a past AW 17/18 London Catwalk, and Colour Evolution A/W 25/26

Figure 19 Color trends in the outdoor travel space

State-of-the-art color trends in today's market for outdoor equipment is mostly earthy colors or blacks with bright accents, typically an orange, white, or other bright solid color associated with visibility and clarity. There are also quite a big of monochromatic options, with brown and tan footwear dominating, as well as black. These colors represent the ideal palette for those moving through urban and outdoor environments. However, the lack of variety in color in these spaces that still respects the limitations of adventure travel means there is still room for exciting new opportunities.

Looking at the trends of tomorrow, WGSN was used as the primary trend forecaster. By parsing through future trends and identifying trends that aligned with the existing use-cases and functions of the primary and secondary colors of state-of-the-art products, a cohesive future trend was defined. The AW 24/25 Future Terrains Forecast displayed the best variety of emerging trends surrounding the intersection of urban and natural landscapes and the kinds of colors and textures these environments would have in the future (Casey & Bulmer, 2023). Focusing in on specifically which colors would work best with the environments outlined by this design research and referencing WGSN color trends, WGSN's article *Colour Trends: The Next Neutrals* was explored for the primary colors to be used. These colors are trending now and will continue to trend in the future due to their gender-neutral properties and alignment with natural and sustainable undyed fibers (Smith, 2023). They are also highly adaptable for both urban and outdoor spaces and can fit in with both wet and dry environments. For the secondary or accent color, WGSN's Colour Evolution A/W 25/26 was referenced for selection of an alternative accent color the yellows and oranges now in the market (McCarthy, 2023). Typical outdoor boots and trail running shoes use bright colors for contrasting features and interiors or exterior panels that need a high level of visibility. Purple is a color that has not been well explored in this space and resonates well with yellowish neutrals and earth tones. While not as visible as orange, it can still provide significant contrast and is less likely to be visually alarming to wildlife and insects, attracting far less insect attention than orange, yellow, or red (Lawrence, 2023). It is clear that with all things considered, the future of colors in the outdoor adventure photography space is neutral earth tones with bright purple accents.

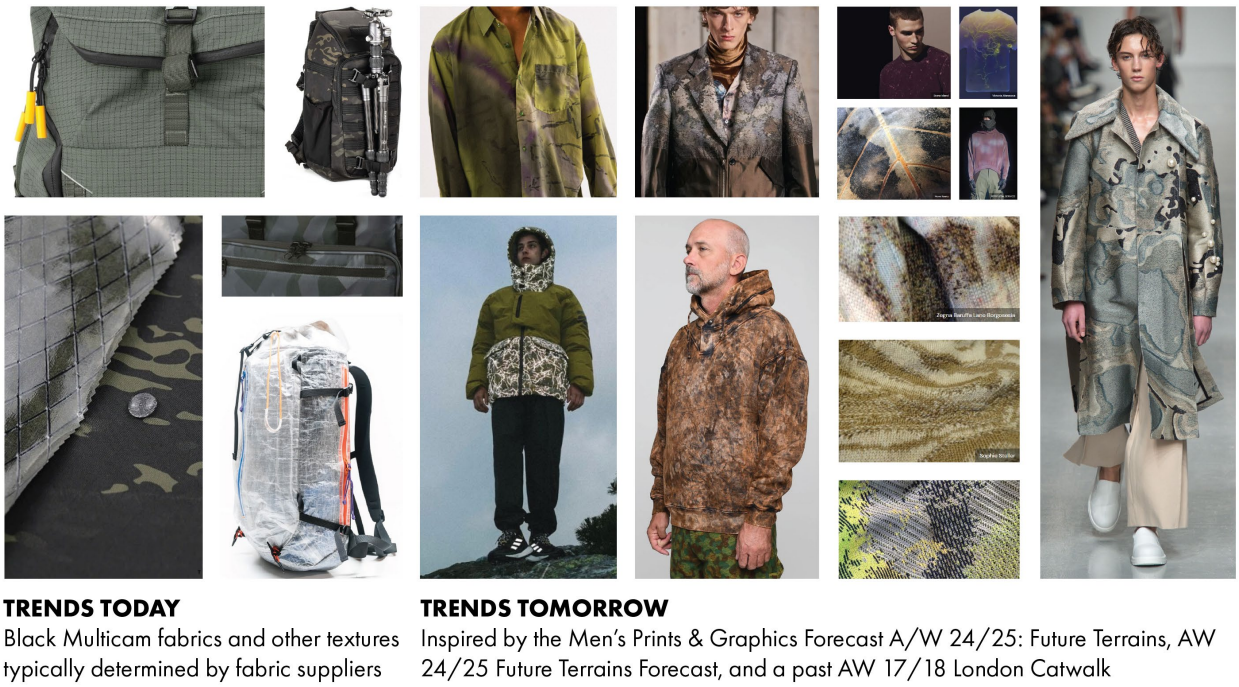


Figure 20 Graphic trends in the outdoor travel space and adjacent fashion spaces

Today's state-of-the-art outdoor footwear use a very limited number of graphics, primarily reserved for textures and logos. Some textures are entirely dependent on the material itself, relying on contrasting threads, unique construction methods, and composite materials to create texture on the fabric. Some boots will also use a print on the fabric itself, which is typically related to the intended field use, and trail/urban shoes may use a sublimation print for a different stylistic approach.

Tomorrow's trends were developed from a combination of referencing WGSN's future trends, the needs of outdoor travel adventure photographers, and the state-of-the-art bags acting as adjacent products in this space. The graphics and prints from WGSN's A/W 24/25 Future Terrains articles were particularly inspiring, as it is clear that incorporating a graphic element can both elevate urban style and hide dirt and grime from outdoor adventures (Casey & Bulmer, 2023). Incorporating effective camouflage can also reduce visual noise in the field and ensure stealth while photographing wildlife. However, this must be balanced with the ability for a user to identify features on their footwear and be aware of their footing in dangerous circumstances, and so the use of non-traditional camo patterns can function while being appropriately visible to

the user. A striking piece discovered in the AW 17/18 London Catwalk report on WGSN showed a particularly effective example of a unique pattern that could function well to hide dirt and improve stealth while also elevating aesthetics and hiding blemishes and stains (WGSN, 2017). The general A/W 24/25 Future Terrains Forecast also included some powerful examples of materials and graphics that demonstrate this balance, albeit with a brighter color palette that would need to be subdued (Chow, 2023). These bright colors would need to be absent from the graphics, but subtle hues could be included in the graphics that help unify the pattern with brighter accent colors that can be used internally and/or sparingly to not be so bold and visible to the outside world.

State of the Art and Future Logo/Branding Applications

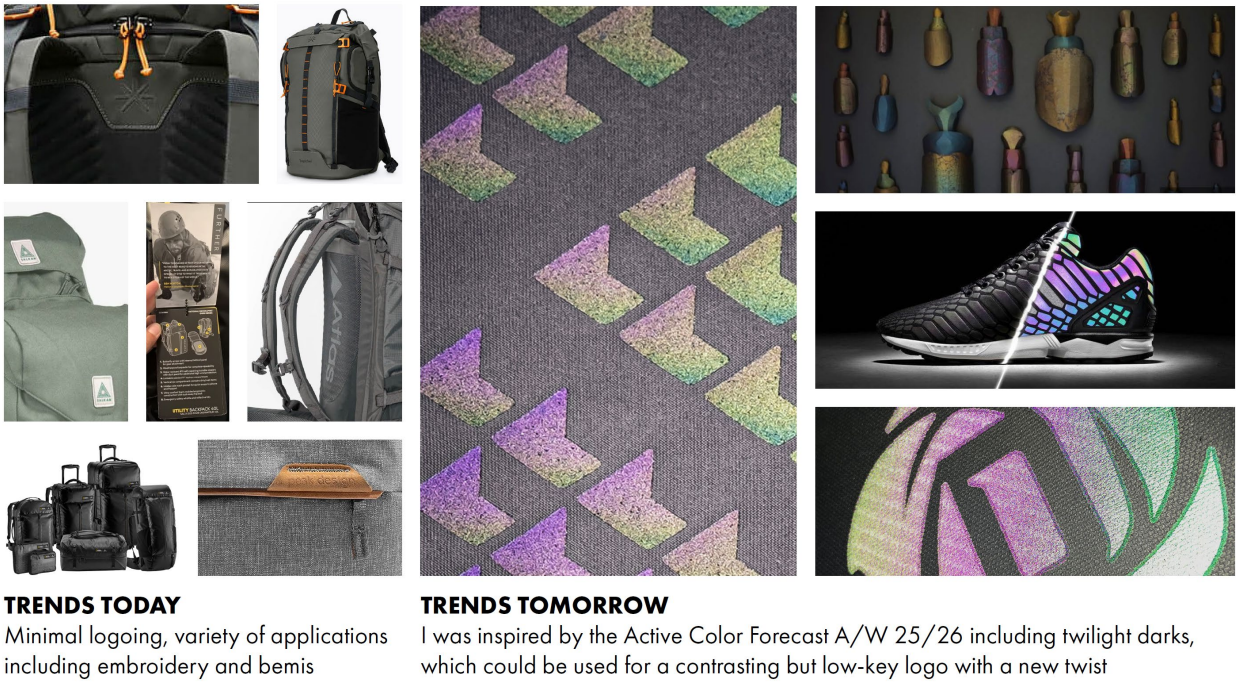


Figure 21 Logo/branding trends in the outdoor travel space and adjacent performance spaces

Current state-of-the-art trends for logo and branding applications are fairly minimal. For most products in this space branding is minimized for most extreme outdoor footwear and urban footwear, but relatively loud in the middle space with trail running shoes. Prominent logo application examples include same-color-application with contrasting depth or texture for subtle

visibility, small sewn in patches, embroidering, and embossing. Large logos and branding may appear across uppers, or other areas where they will only be visible to the owner of the footwear such as the insole. Most successful brands ensure that while their travel products remain stealthy in risky environments, the target user of these bags is well aware of which brand made which bag. A great example of this is Peak Design, which shares fabric materials, logo placements, distinguished patterning, and custom hardware across their entire lineup (Peak Design, n.d.). A particularly clever integration of traditionally bold branding in the adjacent bag space is the Eagle Creek x National Geographic collection of travel bags. These bags use bright yellow zippers with black PU covers and all black fabrics and trims to only gift a subtle hint to the branding while still being iconic and recognizable (Ranum, 2023).

Typically missing from the current space, and something that should be a part of the future of branding, is the use of reflectivity. While reflective logos are not new in the outdoor product world, they are not typically used in backpacking boots or muck boots, at least not to a drastic degree. Looking at IGSN's Active Color Forecast A/W 25/26, twilight darks were featured as an exciting option for a burst of color and visibility while still appearing muted (Clark & Kostiak, 2023). This color group combined with reflectivity yields an iridescent oil slick finish, which has been popular in active and outdoor spaces, especially cycling and running. While not a new color or finish, in combination with the future color palette and textures defined in the previous sections, using this kind of material for branding would be an excellent and cohesive combination that would still feel fresh in the markets of tomorrow. With regards to reflectivity, most contemporary footwear avoids reflectivity in order to remain stealthy and not draw attention in both urban and natural environments, with the exception of road running shoes and safety boots. However, in extreme field conditions at night, such as dense jungles, reflectivity can help adventurers remain visible to others while not drawing the attention of wildlife with bright colors during the day. Even in instances where one may be exploring alone, finding your footwear at camp can be helped by reflective elements. The future of logos and branding is the appropriate blend of unique subdued reflective elements that seamlessly integrate with the colors and graphics of the bag.

Physiological Research

Figure 1. Protective footwear and wool felt liner used during the tests.

New approach to assessing comfort of use of protective footwear with a textile liner and its impact on foot physiology

Energy cost of backpacking in heavy boots

BOOT MICROCLIMATE

"Impermeable footwear does not allow for heat dissipation, while sweat, which is produced profusely, evaporates only marginally and accumulates on the skin and the internal surface of footwear, without fulfilling its basic physiological function."

WEIGHT ON FEET VS ON BAG

"The results indicated a mean increase of 0·96% in [Vdot]O2 whilst backpacking for each 100thinsp;-g increase in boot weight. In contrast the oxygen cost of increasing the backpack load was only 0·15% indicating that it was 6·4 times more expensive to carry weight on the feet as compared to the back."

Figure 22 Physiological research summaries for boot microclimate and weight

To better understand the physiological strains on independent adventure travel photographers, it was important to identify key studies that examined common pain points within the current product landscape for these users. Rubber boot microclimate, the effects of prioritizing more robust footwear, and how to best configure a bag for optimal weight distribution are all topics that must be properly understood before new products can address these concerns.

The first topic, rubber boot microclimate, is particularly tricky to solve but easy to understand. The article examined, which set out to find new ways to assess the comfort of textile lined rubber boots, aptly described the reason typical rubber boots cause increased physiological stress on their users. It stated that impermeable footwear does not allow heat to escape because the natural cooling method of the body, sweat, is unable to evaporate at a sufficient rate, causing incredible moisture buildup with minimal heat loss (Irzmańska et al., 2013). Current rubber boot designs do a great job of keeping moisture out, which in turn makes it difficult to remove moisture inside of the boot. Rubber boots likewise do not use a waterproof breathable membrane, and while some natural rubbers are more porous than other synthetic alternatives, they do not

function at the same level as membranes. Membranes, however, are fragile, which defeats the purpose of a sturdy rubber boot. Future designs must make heat and moisture management the number one innovation focus, either through the protection of effective but fragile membranes, or the improved regulation of heat and moisture within non-permeable designs.

Another issue with bulky, heavy boots such as rubber boots and robust hiking boots is the weight they add to the foot. A study was identified that compared weight added to a hiker's foot versus the same weight added to their bag to determine how much the placement of that weight affected their performance. The study indicated that it was 6.4 times more expensive in terms of energy output/oxygen consumption to carry the same weight on the foot versus on the back (Legg & Mahanty, 1985). This is important to note because of the need for robust, protective footwear in the field contrasting with performance deficiencies when these boots are donned. It is often when travelers most need the extra energy that they are forced to wear more robust footwear. For example, when traversing rainforests in Ecuador, even if it is not required by the reserve, rubber boots are absolutely needed to get through the thick mud, vegetation, and for protection from venomous animals on the forest floor. However, hikes in these regions can be particularly steep and technical, the combination of which means hiking in these environments is extremely challenging, as one must hike uphill while slipping and sinking into mud. Wearing heavier boots is the exact opposite of what is best in this situation. The only way to address this conflict is to develop new ways to maximize protection while reducing weight. Likewise, only equipping what you need can be advantageous as well. A modular boot that can have its extra protective pieces stored on the bag, which will reduce energy expense of carrying that weight by 6.4 times, means that a traveler can benefit from effectively having both light and heavy boots without carrying two boots or being affected by the burden of always wearing the heavier boots' weight on their feet. Where to carry this extra weight to effectively take advantage of the maximum increased efficiency of proper carrying on the body is the natural next step in optimizing the essential adventure travel equipment for physiological performance.

Biomechanical Research

The influence of shaft stiffness on ankle joint kinematics and kinetics during walking in hiking boots

ANKLE PROTECTION VS ECON

"Results showed significant differences between low and high shaft all high-shaft boots with some of the latter also being different. Results indicate that the shaft construction may have substantial effects on walking economy in hiking boots."

The Effects of Shoe Type on Biomechanical and Physiological Responses to Stepping and Inclined Walking

SHAFT HEIGHT BIOMECHANICS

"When translated to a hiking scenario, it could be proposed that use of mid-shaft hiking boots may provide more ankle support during outdoor activities that involve stepping or inclined walking, without affecting the kinetic chain of the lower extremities."

Figure 23 Ankle protection and shaft height biomechanical research summaries

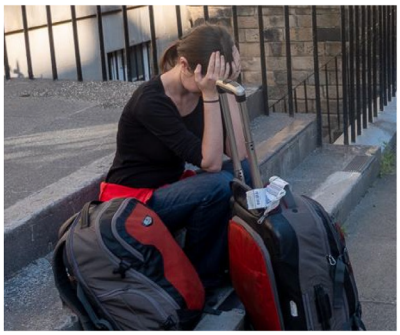
Following the theme of balancing footwear capability and pack configuration for peak physiological performance, research was compiled on the effects of ankle protection and walking biomechanics with regards to footwear shaft height, as well as ways to maximize carrying efficiency through proper load bearing and distribution.

The first paper looked at how the shaft stiffness of a hiking boot, as well as low and high shaft heights, could affect hiking economy. The goal was to understand the appropriate balance between ankle protection and hiking economy, and how the design of a boot influences each of these aspects. Results of the study stated that shaft construction of hiking boots may have significant effects on hiking/walking economy (Larsen et al., 2017). Additionally, a hiking boot with a stiffer shaft that was properly designed to be more pliable in bending with natural foot/leg flexes during the gait cycle can improve walking economy while maintaining ankle protection. Boots with low to no rise are obviously the best, as they do not restrict movement of the foot or leg, but they provide no additional protection of the ankle or any other sensitive areas in that region. From reading this article it is important to note that in instances where hiking boots must

have additional protection and stiffness, it must be designed in a way to maximize walking economy and gait fluidity without compromising its protective properties during accidental or unintended movements through rough terrain.

Again, looking at shaft height, a different paper hypothesized that boots with higher shaft height would disrupt the typical kinetic chain between the hips, legs, and feet during the gait cycle. However, this hypothesis was disproven, as properly designed footwear that provides superior ankle support through high shaft heights do not affect the kinetic chain of the lower extremities during outdoor activities that involve stepping or inclined walking (VanSumeren, 2019). This is a great finding that supports the continued relevance of hiking boots that support the ankle. With the rising popularity of trail running shoes, there is a movement of consumers to move towards lighter, less supportive boots and shoes. However, most situations where users may trend towards buying these shoes are on well-maintained trails. Likewise, adventure travel photographers are often not the typical day-hikers or through-hikers that stick to clear, predictable trails. They are individuals that travel through intense environments, sometimes completely off-trail, in order to gather photographs, research, or achieve goals not typically set out by purely recreational hikers. Therefore, it is important to understand how to minimize the negative physiological and biomechanical impacts of high-shaft-height boots while also understanding their unique benefits to those that need these types of footwear. Improving support and protection while reducing ankle muscle fatigue through overly restrictive footwear can achieve this goal.

Psychological Research



Risk factors for psychological stress among international business travellers

The Role of 'Peace of Mind' and 'Meaningfulness' as Psychological Concepts in Explaining Subjective Well-being

BUSINESS TRAVEL STRESS
"Correlations between predictors and travel stress showed that social and emotional concerns (such as impact of travel on family and sense of isolation) contributed the most to such stress, followed by health concerns, and workload upon return from travel."

PEACE OF MIND
"More specific, in the final models: basic needs, feelings of autonomy and relatedness, peace of mind and meaningfulness were significantly associated with the life satisfaction component. For the positive affect component: psychological needs, peace of mind, and meaningfulness were the significantly associated factors. Finally, the negative affect component was most significantly associated with basic needs, psychological needs, and peace of mind, while meaningfulness did not play a significant role in explaining negative affect."

Figure 24 Travel stress and peace of mind psychological research summaries

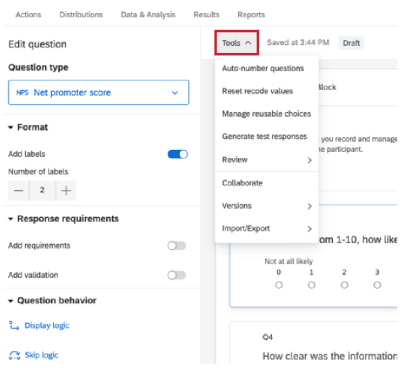
There is a broad range of psychological factors with regards to independent adventure travel. Being largely alone in a foreign environment with your livelihood on your back is often a stressful situation to be in, and so any way to alleviate that stress through effective product design is most welcome.

Looking at an article about psychological stress among international business travelers, it was clear that the stress of travel could have negative influences beyond one's mental state. The research stated that social and emotional concerns in conjunction with travel stress impacted health and snowballed into greater bouts of stress on individuals travelling internationally for business (Striker et al., 1999). Extrapolating on this information and expanding its application to independent adventure photographers, who will be traveling internationally, often for business purposes, it is easy to understand how sensitive stress factors in environments outside of those experienced by typical business travelers can have a compounded effect. It is already stressful enough to hike through a desert mountainside, or through a dense jungle, but to combine that situation with the enhanced stressors one experiences traveling internationally, there is real cause

for concern. That means it is essential to not only design products that have a low chance of failure, but to have humility and understand the need to design for eventual failure. A product may be admired for its entire useful life, but as soon as it proves useful, especially in a stressful situation, it will be admonished no matter how beneficial it was before failure. Planning ahead and incorporating secondary features that preserve functionality in the face of catastrophic part or material failure can help provide peace of mind in the most stressful of travel situations.

Peace of mind, the antidote to stress, is another equally important psychological concept. In the second article referenced for psychological research, peace of mind was consistently mentioned as a major psychological pillar with regards to life satisfaction, positive effects, and negative effects, in the case that peace of mind is not present (Sophie et al., 2022). That being said, peace of mind extends far beyond reducing failure on a piece of equipment. Peace of mind is about packaging the most useful tools, equipment, and items into the smallest common denominator of space available to someone travelling by themselves with their belongings at all times. In other words, peace of mind means you know that no matter where you go, you will have what you need to be safe, comfortable, and able to make the most of any opportunity or misfortune. This concept is difficult yet achievable in the context of an independent adventure travel photographer exploring warm weather environments. Achieving this goal means that an adventurer would have minimal concern for injury or lack of preparedness, as they will be able to travel with the gear they need to achieve their goals safely and comfortably.

Research Types



UO Qualtrics Survey

Virtual Interviews

SURVEYS
I will use online surveys to reach a broad audience to collect data pertaining to current products and specific known user situations. Surveying can also help to gather users I can interview later.

INTERVIEWS
Interviewing will happen after the survey process. Some users may be contacted before the survey is closed for an interview, and some may be interested in an interview after the survey.

Figure 25 Summary of the types of initial user research to be employed

Research types that will be used for initial data collection and information gathering will be surveys, interviews, and perception maps. Surveys are reliable and quick tools for gathering and comparing large amounts of data from the maximum number of users possible. This will help with initial impressions with regards to potential solution paths, predicted issues with current designs, and new opportunities yet to be discovered. Interviews represent an opportunity to utilize the connections made during the survey stage to go deeper into understanding the most important problems and miniscule details that could be easily misunderstood or not shared in a survey format. Actionable and significant quotes can be generated from these sessions, as well as meaningful connections to users that can be leveraged during the design validation process.

Strengths, Weaknesses, Opportunities, and Threats Analysis

Lowa Fusion Shoe - $175 BOGS Snake Boot - $210

Figure 26 Competitor products to be analyzed, Lowa Fusion Lo (left) and Bogs Snake Boot (right)

STRENGTHS

UPPER
Highly flexible for easy on/off and fit adaptability
PADDING + LINING
Minimal padding and unlined for breathability
FORM
Low cut with elastic cuff to keep debris out
LOCKDOWN
Elastic for easy use

OPPORTUNITIES

UPPER
Some overlays/reinforcements in high wear areas can work
PADDING + LINING
Add more padding in tongue + ankle areas
FORM
Extend the cuff to rise above the ankle
LOCKDOWN
Incorperate stronger lacing, less elastic

WEAKNESSES

UPPER
Potential lack of durability in rough conditions
PADDING + LINING
Can let some dirt and water in, may be too unpadded
FORM
Low cut exposes ankles
LOCKDOWN
Elastic does not perform well in strenuous conditions

THREATS

UPPER
Knit uppers with hot melt pieces may be more advanced
PADDING + LINING
Travelers seeking comfort may require more padding
FORM
Some users may need more ankle protection
LOCKDOWN
Poor lockdown due to elastic limits this shoes full usability

SHOES - UPPER

Figure 27 SWOT Analysis summary for Lowa Fusion Lo - upper

For the chosen comparison product, the Lowa Fusion Lo, the upper is comprised of a primary knit material with padding and some lining in a low-cut form with an elastic speed lace lockdown system. While this design is great for flexibility, adaptability to various feet, ease of use, and overall comfort, there are opportunities to include more durable overlays, more padding, and a hiring cuff for better protection. Additionally, while this shoe is robust enough to handle more technical terrain, the elastic lacing system may hold it back while trying to traverse challenging obstacles and terrains. This is threatening because it caps the limit of the shoe's capability even though the rest of its design allows for it to be more capable. Likewise, a shoe like this being used in rougher terrain could benefit from a slightly higher cuff to protect the ankle and to better prevent debris from getting into the shoe.

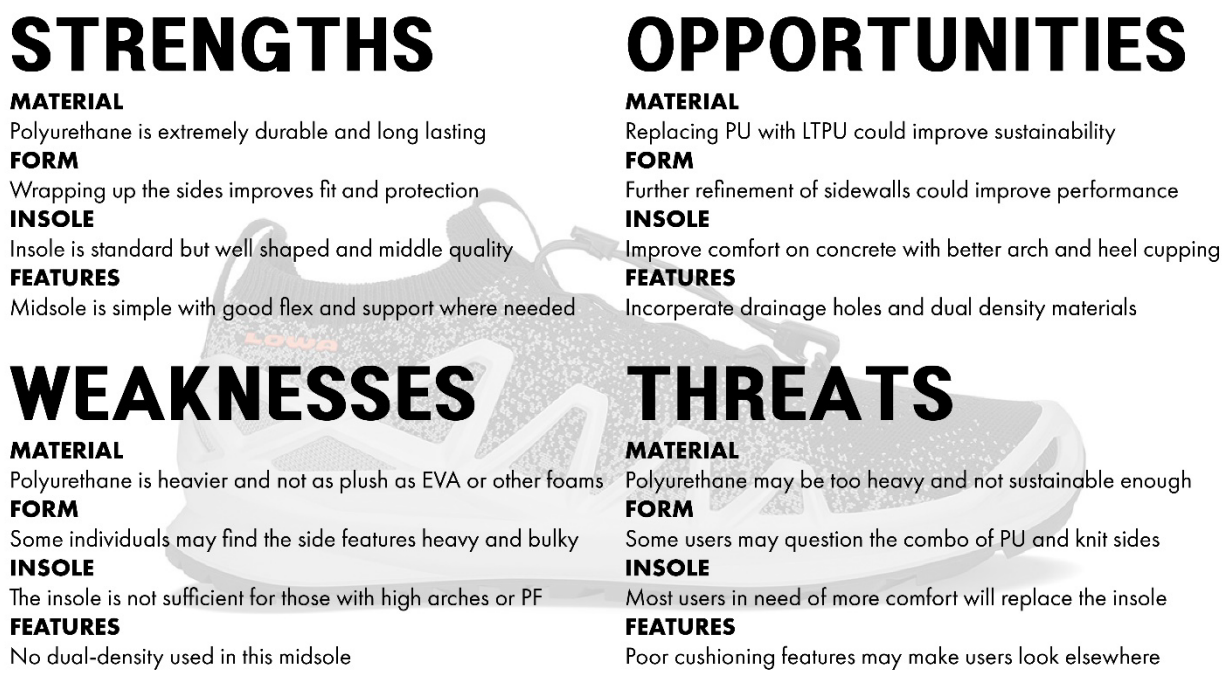


Figure 28 SWOT Analysis summary for Lowa Fusion Lo - midsole

Looking at the midsole of the Lowa Fusion Lo, there is a unique use of durable polyurethane (PU) foam for this type of shoe with an even more unusual side-wrapping form. The insole is unremarkable, as are the features of the midsole, aside from the side-wrapping and

some clever shaping to aid in flex and stability. The PU material is a great choice for longevity as well as support, but it is a heavy material with average to poor sustainability. With the midsole being such a dominant feature of this shoe, replacing the PU with something similarly durable yet lighter and more recyclable, such as new liquid thermos-polyurethane (LTPU) foams, the Fusion would be an even better shoe. Likewise, the average insole could use some improvement, as a more robust insole with proper heel cupping and arch support would vastly increase this shoe's comfort and performance on concrete, which is a troubling surface for low-profile, dense PU foams to deal with. For those looking at using this as a travel shoe, the lack of proper comfort off of the trail could be threatening, as long queues for airline security as well as extended days in cities could make this an uncomfortable choice for those with feet that need more support. Likewise, an improvement in sustainable materials would keep this shoe relevant moving forward.

Figure 29 SWOT Analysis summary for Lowa Fusion Lo - outsole

The outsole of the Lowa Fusion Lo is arguably the least innovative part of the shoe, with a basic proprietary rubber compound, minimal features, and hybrid lugs that work well in the city and trail. While the outsole material may be adequate, it would be more competitive to use a higher end rubber. The traction pattern also works well but does not have any particularly special features. What the outsole does well on this shoe is its ability to function well in the city and on the trail. City streets wear down raised, widely spaced lug patterns, and outsoles that have more surface area tend to last longer regardless of the thickness of the rubber. There is very little depth to the lugs and heel braking structures on this outsole, which could be problematic on rougher terrain and off-trail use. While throttling this shoe off-trail is not the ideal situation, the materials of this shoe suggest that it can survive in a pinch, and a lack of confidence in the outsole design in the most demanding of situations is a threat. Likewise, some more advanced design elements and features would better match the innovation in the rest of the shoe and make this more than a competitive shoe, but a superior shoe to other options on the marketplace.

Figure 30 SWOT Analysis summary for Bogs Snake Boot - upper

The Bogs Snake Boot is the chosen boot for analysis, and its upper is comprised of a dual material composition with a snake-proof material and natural rubber, which is then lined with a moisture-wicking and anti-odor fabric. The upper has excellent protective elements and some features designed to improve fit, but their effectiveness, while better than most rubber boots, is somewhat dubious. To alleviate fit and upper performance issues without reducing the protective qualities of the boot, it would be great to map flexibility in key areas through different material choices, as well as integrate some kind of lockdown or internal fitment system. The biggest threat to this boot is its fit, as it only comes in half sizes and has issues with proper lockdown and adaptability to various foot shapes. Likewise, the use of camo only does tend to make this shoe stand out in some environments, and makes it feel like the end user is not as broad as they really could be. Protection, however, is top notch, and while there can be improvements in ventilation, the materials used for this are very high quality. Introducing cutting edge phase-change materials in the liner would elevate this boot above the competition.

Figure 31 SWOT Analysis summary for Bogs Snake Boot - midsole

The Bogs Snake Boot's midsole is a plush and comfortable EVA foam internally integrated in a hidden form-factor that works in tandem with the insole to provide fitment, cushioning, and anti-odor features. While incredibly comfortable out of the box, the materials used for the midsole and insole are not going to last as long as the boot itself. Eventually they will compress after time has passed, or after some very hard hiking. This also poses more than a comfort issue, but a fit issue as well, as Bogs has included an extra insole riser to help provide a different fit for customers with narrower or wider feet. If the midsole and insoles do not last, the fit will eventually change as the midsole will compress, widening the boot. Likewise, the heel and instep lockdown will suffer because of this as well. Poor fit is the greatest threat to the Bogs snake boot, as well as poor longevity of the otherwise fantastic cushioning. A dual density midsole material using longer lasting materials, and a more robust set of insoles would largely alleviate these concerns.

Figure 32 SWOT Analysis summary for Bogs Snake Boot - midsole

The outsole of the Bogs Snake Boot is a sustainable, proprietary Biogrip rubber compound that features chunky lugs with a rounded side profile and heel brake to stay stable in wet substrates, shed mud, and grip during descents. While this is a great combination strictly soft and muddy conditions, the rubber fails to grip well on slick, hard materials, the rounded profiles provide zero confidence when edging rock or trying to ascend tricky terrain in the boots, and the lugs do not have effective siping. Using a grippier material in both wet and dry conditions would be great, and this could be aided by blending material into the rubber to give it some texture on slick surfaces. Likewise, adding sharper edges in key areas such as the heel and toe edges could help with more technical terrain. The rounded shape helps provide more surface area in mushy terrain, and so it can stay in some regions, but being rounded in all areas only serves to limit the boots hiking performance. Adding siping and some lug variability to deal with slick but not muddy surfaces like wet rocks and logs would also be a welcome addition. The inability for this outsole to perform in demanding hikes with great elevation and terrain variability is the biggest threat to this boot in terms of outsole performance, and may be a dealbreaker for someone looking for a boot they can hike in.

User Research

Qualtrics Survey:

The goal of this survey was to better understand how independent adventure photographers travel, gauge their excitement for future features, and identify current pain-points not immediately revealed by research.

Independent Adventurer Backpack and Footwear Survey - Initial Insights

Survey Completion Time:

7-15min

Summary:

The purpose of this survey is to gauge baseline interests and needs of independent

adventure travelers, with special focus on those carrying sensitive equipment such as cameras or scientific instruments. I will be designing two types of modular footwear and one two-part backpack for my sports product design master's thesis at the University of Oregon. Based off initial market research and my own personal choices in what I would like to design for I have determined these three products to be the biggest limiting factors in both carrying capacity and the ability to travel to further or more diverse environments. Your help in taking this survey will give me the insights needed to make sure I can equip adventurers like you with the best carrying system and the most versatile set of footwear needed for all warm-weather environments. Thank you for your participation!

Contact Information:
Email: dcarhuff@uoregon.edu
Phone: 520-661-4197
Instagram: @danielcarhuff
website/portfolio: danieljcarhuff.design (for both photography and product design)

Q1 What is your age range?

- ○ 18-25 (1)
- ○ 26-35 (2)
- ○ 36-45 (3)
- ○ 46-55 (4)
- ○ 56+ (5)

Q2 What is your occupation or interest that requires or motivates you to travel?
Please select all that apply, and add any additional occupations or interests in the Other... section.

- ☐ Photographer (Professional) (1)
- ☐ Photographer (Enthusiast) (2)
- ☐ Biologist (3)
- ☐ University Professor/Faculty/Researcher (4)
- ☐ Student (5)
- ☐ Journalist (6)
- ☐ Ranger (7)
- ☐ Volunteer (8)
- ☐ Tourist (9)
- ☐ Guide (10)
- ☐ Other... (11) _____

Q3 What kind of warm-weather environments do you typically travel to or have travelled to?
If you do not know the exact type of environment, you may list locations as well.

Example: Jungle, Cloud Forest, Desert, Savanna, Chaparral, etc...

_____

Q4 Please select all activities or travel attributes that are relevant to your past or expected adventures. Multiple answers may contradict - that is okay! Feel free to add other activities.

- ☐ Alone (1)
- ☐ With groups (2)
- ☐ For work/volunteer/study (3)
- ☐ For play/hobby (4)
- ☐ Backpacking/Remote access (5)
- ☐ Urban/Hotel/Lodging (6)
- ☐ Extended travel within/beyond a destination (7)
- ☐ Staying at destination for extended time (8)
- ☐ Rugged hiking/Outdoor exploration (9)
- ☐ Urban exploration (10)
- ☐ By plane (11)
- ☐ By car (12)
- ☐ By train (13)
- ☐ By bus (14)
- ☐ Other 1... (15) _____
- ☐ Other 2... (16) _____
- ☐ Other 3... (17) _____

Q5 When going on an adventure, do you typically travel with or without checked luggage?

- ○ With (1)
- ○ Without (2)
- ○ Depends on the trip (3)

Q6 If you do check luggage, do you avoid checking sensitive equipment such as photography gear, sensors, or other fragile electronics?

- ○ I do not check sensitive equipment (1)
- ○ I check sensitive equipment in a typical suitcase (duffle, roller, etc.) (2)
- ○ I check sensitive equipment in a dedicated hard case (Pelican, other hard cases with foam inserts, etc.) (3)
- ○ I do not travel with sensitive equipment (4)
- ○ Other... (5) _____

Q7 Please describe your current preferred bag, backpack, hardcase, and/or suitcase setup for travelling on an adventure. If you know brands or models, please share them. You may list either your go-to setup, or one you have used in the past.

For example: I have taken for carry-on a hard 40L roller suitcase with camera equipment and a Mammut 28L daypack, and checked an 80L Exped backpacking bag for a 9 day trip through the forests of Ecuador.

_____

Q8 Do you feel like you could fit all of your belongings, including camera/electronic equipment, without checking any additional bags, into a 70L bag for a week long adventure in a foreign country?
Example shown: Thule Landmark 70L (50L + 20L)

- ○ Definitely not (1)
- ○ Probably not (2)
- ○ Might or might not (3)
- ○ Probably yes (4)
- ○ Definitely yes (5)
- ○ Other... (6) _____

Q9 Would a 70L bag, split into a 25L and 45L bag for overhead and underseat airplane storage, with improved comfort and ergonomics for adventure/outdoor use and specific considerations for photography and sensitive equipment appeal to you as an adventure traveler?

- ○ Yes! (1)
- ○ Yes, but I would still additionally check luggage for most adventures (2)
- ○ No (3)
- ○ Other... (4) _____

Q10 Please provide any additional comments about your bag use during adventure travel, and if you have any additional thoughts or ideas to propose for a new design relevant to the split 25/45 70L bag concept.
(Optional)

_____

Q11 Please select all of the footwear you may take with you during your most extreme travel adventures.

- [ ] Airport/Urban/Everyday/Running Shoes (1)
- [ ] Slides/Camp Shoes (2)
- [ ] Light Hiking Boots/Trailrunning Shoes (3)
- [ ] Heavy Duty Hiking Boots/Backpacking Boots (4)
- [ ] Jungle Boots (5)
- [ ] Rubber Boots/Wellingtons (Select if you also purchase these mid-travel) (6)
- [ ] Wading Boots/Shoes (7)
- [ ] Water Shoes/Canyoneering Boots (8)
- [ ] Hiking Sandals (9)
- [ ] Other... (10) _____

Q12 What are the most difficult kinds of footwear for you to pack/carry? Do you have any exceptional difficulties, or prefer to buy certain footwear on-location?

For example: Rubber boots are the most difficult for me to travel with, as they are bulky and only required for small sections of my trip.

_____

_____

Q13 Do you have a go-to airport/travel footwear choice that you bring on every trip? If so, what is the brand/model, and why do you choose to wear it?

For example: I wear the Altra Lone Peak 5 for its wide toebox, breathability, packability, easy on/off in airport security, rugged tread, and all day comfort in urban and outdoor environments.

_____

_____

Q14 Would you be interested in a modular rubber boot/hiking boot hybrid that could seamlessly integrate with your carry-on travel bag for space-saving storage?

- ○ Yes! (1)
- ○ No (2)
- ○ Other... (3) _____

Q15

Please select all features you would be excited about having in a travel shoe.

- [ ] Merino wool uppers and/or insoles (for anti-odor and moisture management) (1)
- [ ] Modularity - converts to a sandal/slide (2)
- [ ] Modularity - removable waterproof lining (3)
- [ ] Machine washable (4)
- [ ] Zero drop (no heel lift) (5)
- [ ] Natural drop (minimal heel lift, 2-3mm) (6)
- [ ] Typical heel lift (normal running shoe) (7)
- [ ] Wider toe box (8)
- [ ] Narrow toe area - easier to squeeze under airline seats (9)
- [ ] Long lasting but heavier foam midsole (think hiking shoe) (10)
- [ ] Less durable but plusher midsole (think max cushion running shoe) (11)
- [ ] Packable (less supportive but collapses flat for storage) (12)
- [ ] Tread optimized for urban/city use (13)
- [ ] Tread optimized for light trail use (14)
- [ ] Easy on/off (15)
- [ ] Laceless design (16)
- [ ] Knit upper (17)

- [ ] Leather upper (18)
- [ ] Arch-supporting insole (19)
- [ ] Neutral styling (blends in) (20)
- [ ] Vibrant styling (stands out) (21)
- [ ] Other... (22) _____

Q16
Please select all features you would be excited about having in a modular rubber boot/hiking boot.

- [ ] Modular - Flexible rubber boot interior sock (1)
- [ ] Modular - Flexible rubber boot overshoe (2)
- [ ] Ability for main hiking boot waterproofing without rubber boot insert (3)
- [ ] Fast-drying non-waterproof main hiking boot (4)
- [ ] Removable cladding for protection from vegetation and venomous animals (5)
- [ ] Integration into carry-on bag for easy storage and added bag protection (6)
- [ ] Merino wool knit lining in rubber boot piece for odor/moisture management (7)
- [ ] TPU rubber that can be melted with a lighter to heal cracks or holes (8)
- [ ] Modular traction patterns for wet and dry environments (9)
- [ ] A focus on lighter weight designs (10)
- [ ] A focus on heavier but more supportive designs (11)
- [ ] Traditional features that make the boot easier to repair while travelling (12)
- [ ] Innovative features that sacrifice repairability while travelling for greater performance (13)
- [ ] Leather upper materials (14)
- [ ] Synthetic upper materials (15)
- [ ] Toe protection, stiffness, and impact/penetration protection at the expense of weight and flexibility (16)

☐ Enhanced flexibility, weight, packability, and agility at the expensive of protection and durability (17)

☐ Other... (18) _____

Q17 Please share any additional thoughts you have about your current travel shoes/boots or future ideas for travel shoes/boots that you want to see! (Optional)

_____

_____

Q18 Thank you for your valuable time spent participating in my design research survey!

(Optional)
If you would like to stay in touch, you may add your contact information below, such as your name, email, phone number, instagram, or any other preferred method of contact. I would be happy to have anyone interested involved in follow-up interviews or even user testing of prototypes!

You may contact me at:
Email: dcarhuff@uoregon.edu
Phone/Text/Whatsapp: 520-661-4197
Instagram: @danielcarhuff
Website: danieljcarhuff.design

_____

Responses:

Participants: 8 Participants

Question 1: Age

4 participants 18-25, 1 participant 26-35, 36-45, and 46-55

These results indicate that most adventurers are young and ambitious, but that age is not a limiting factor for who can be an independent adventure photographer.

Question 2: Occupation

5 participants Biologist, 4 participants Photographer (Enthusiast), 2 participants University Professor/Faculty/Researcher and Volunteer, 1 participant Photographer (Professional), Student, Ranger, and Tourist

These results are skewed by the ability for respondents to indicate multiple choices, but it shows a strong focus on enthusiast photographers with professional ties to scientific focuses.

Question 3: Environment

Participants listed Desert, Montane Forests, Chaparral, Riparian, Wetlands, Jungle, Mountains, Thorn Scrub, Cloud Forest, Rainforest, Coastal Tropics, Mediterranean Scrub, Beach/Ocean, Madrean Oak Woodland, Tropical Dry Forest, and multiple instances of “Literally all warm weather climates”

These responses demonstrate the breadth of warm-weather climates these extreme users visit. This reinforces the importance to focus on adaptability to both wet and dry environments, as the ones listed range from the wettest environments on earth to the driest.

Question 4: Travel Attributes

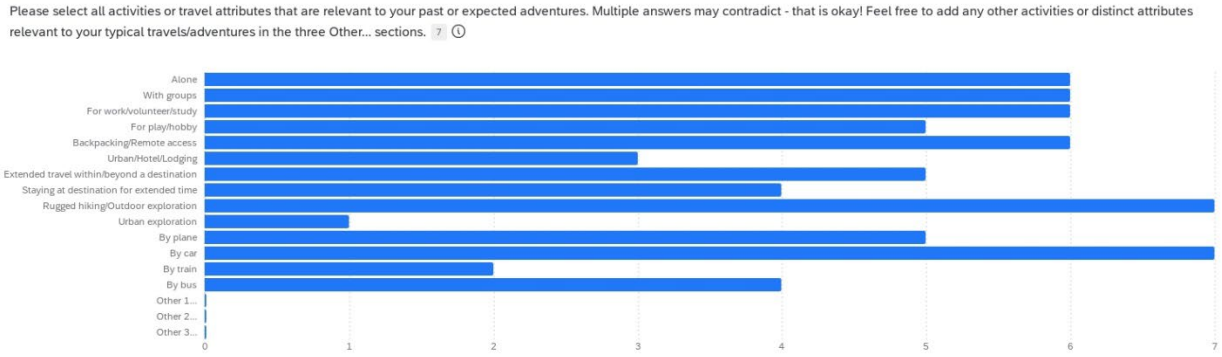


Figure 33 Travel attributes responses

It is clear that there is a healthy mix of travel from alone to in groups and professional to leisure. The only travel scenario not chosen as consistently as the others is urban exploration, though it is important to note that all remote travel will likely involve some form of urban travel no matter how brief. However, it is important to note that the purpose for travel for these users is rarely for urban exploration itself, which indicates that it is indeed necessary for these users to have a robust footwear option for outdoor exploration.

Question 5: Checked Luggage

2 respondents typically travel with checked luggage, 1 without, and 4 said that it depends on the trip.

This is a fairly standard response with the majority of users still needing to use checked luggage, however it appears that there is less of a prioritization of checking luggage and a greater focus on travelling without checked luggage if possible.

Question 6: Sensitive Equipment Luggage Check

6 respondents do not check sensitive equipment in their luggage, while 1 does in a typical duffle bag albeit with hard-case protected contents on the inside.

This is a huge affirmation that it is necessary to design for storage maximization in checked luggage as sensitive equipment such as cameras and other photography gear are almost always taken in carry-on and are only checked if it is possible to ensure no damage comes to that equipment. This, however, limits adventurer mobility with heavy hard-cases and is only necessary for the most extreme users with film crews, multiple camera traps, or other situations. It was indicated later in the survey that the one person who checks their gear still keeps their primary camera gear in a dedicated overhead 40L carry-on bag.

Question 7: Current Preferred Carry Equipment

These responses varied yet they also revealed important details about the user. As was said previously, those that check equipment still keep their most valuable equipment with them on their carry on. They did so in a 40L carry-on filled to the brim with equipment. The other respondents primarily used some kind of 25-40L day bag and will often pair that with a 55L-60L bag for extended trips. While these larger bags can be brought on the plane in a pinch, they are not ideal and technically too large per most international regulations.

Question 8: Is 70L enough for all belongings and equipment for a week long adventure?

Figure 34 Question 8 responses

There was a clear split between professional photographers and other users that relied upon checked luggage and those looking to travel light. Most participants said that their stuff would probably fit between two bags totaling 70L, but those that need more than that indicated

that it would not work for them. This is encouraging as there is always the ability to check a bag, but for most people to think they can be self-sufficient with a carry-on, that reinforces the value of a very space-efficient carry and footwear system.

Question 9: Do you want the bag?

Essentially this question directly validates whether or not these users are interested in the bag idea I am proposing. Following the same patterns as before, 5 respondents said Yes and 2 respondents said Yes, but I would still additionally check luggage for most adventures. This is great as no one said they were not interested!

Question 10: Additional Comments – Bag Use

Weight distribution was immediately mentioned – a primary goal of the intended novel design. Carrying capacity and strong frames are related and was mentioned multiple times. Others shared that their heavy and hard gear ruptures seams and pushes into their back when carrying. There was some skepticism for carry-on with domestic flights in foreign countries, which would have to be addressed with some kind of deployable protection should the bag need to be checked. However, this is likely an avoidable and highly specific circumstance that would present a challenge for any adventurer regardless of their carry situation. Wheels were also mentioned with a good backpack frame; however the added bulk of this feature would likely limit mobility ironically. A solid frame seems to be the way to go!

Question 11: Extreme Adventure Footwear Choices

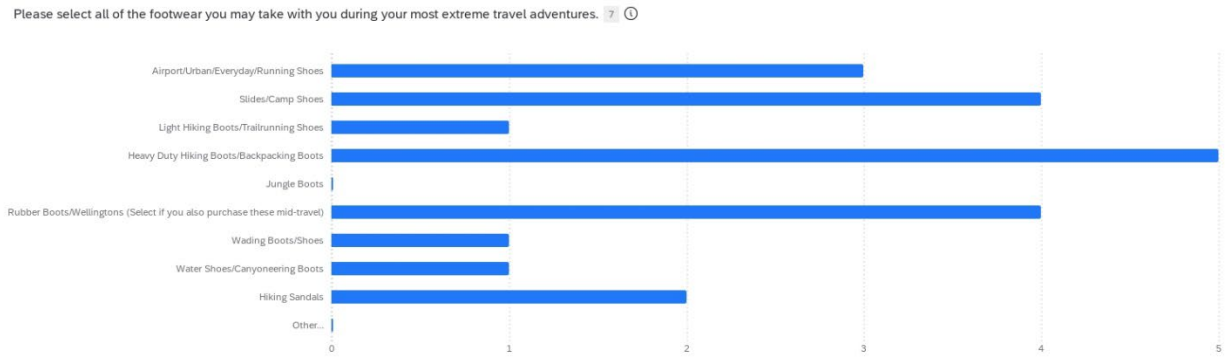


Figure 35 Footwear Choice Responses

The most popular piece of footwear taken on extreme adventures was the heavy-duty hiking boots/backpacking boots category. This was surprisingly followed immediately by rubber boots and slides/camp shoes. This is a huge validation as it was unexpected that rubber boots would be necessary for the majority of users, but this clearly shoes that they are needed for the most rugged of warm-weather adventures. Urban shoes were a close third, with all other categories mentioned at least once except for jungle boots. Jungle boots are not popular for civilian use, but there is a lot that can be gained from studying their design.

Question 12: Most Difficult Footwear to Pack

Unanimously boots of any kind, especially hiking boots and rubber boots were listed as the most difficult to pack. This was expected but also extremely validating. It would be a gamechanger to make this problem disappear.

Responses:

“Rubber boots. Usually I have to buy them in location each time, but depending on location. Sometimes I must bring them”

“Hiking boots are probably the bulkiest/most annoying thing to bring for me, especially since I only use them a couple times per trip (or not at all).”

“Hiking boots are large and heavy.”

“Rainboots -- too big and bulky”

“Hiking boots suck to travel with but I make it work. Usually will throw them in the bag with my other stuff.”

“I’m with you on the rubber boots. Take up a ton of space and are super heavy.”

“Boots of any kind suck since they're heavy and bulky”

“Rubber boots for the above reason”

Question 13: Go-to Airport/Travel Footwear

Slip-ons, sneakers, and trail runners were mentioned. Some put no preference. There seems to be less of an issue with travel shoes but those that have preferences for a type of footwear have a strong preference.

Responses:

“Whatever is comfortable to walk with in city, airport”

“I usually just wear my Brooks Adrenaline 21 sneakers.”

“Merrell slip-ons for ease at airport security.”

“No, whatever sneakers I have at the moment”

“Chacos, I wear them everywhere unless I’m wearing hiking boots.”

“Love my Topos for warm, dry environments. Danner hiking boots are solid for mountain hiking spring through fall but leather isn’t breathable.”

“Uggs if I have space and a bag to store them later, or Salomon trail runners with the wide toe and Goretex outside came in very handy when people next to me spill drinks on my shoes”

“No”

Question 14: Modular Rubber Boot Interest

100% said Yes or Other, and those that responded Other said “fairly interested” and “possibly but I am pretty maxed out on carryon bag dimensions.” It is important to consider exactly how much space integrating the boot with the bag would take up. Taking advantage of dead zones in current bag designs and minimizing bulk would be essential so as to not change internal volume.

Question 15: Travel Shoe Features

Figure 36 Travel shoe feature preferences

The features these users were most excited about for travel shoes were easy on/off, laceless design, and Merino wool uppers. These features were closely followed by modular waterproofing, machine washability, wider toe box, packability, tread optimized for light trail use, and neutral styling. Features no one cared about were zero drop, narrow toe area, tread optimized for urban/city use, and vibrant styling.

Question 16: Modular Rubber Boot Features

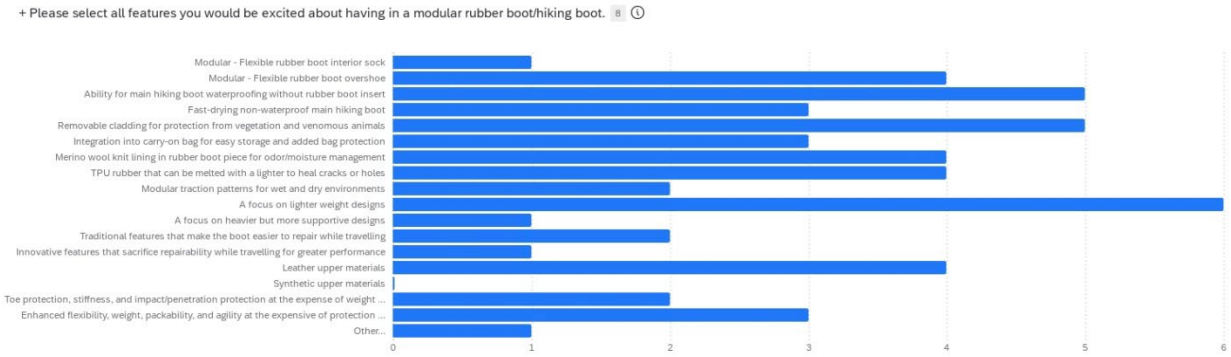


Figure 37 Modular rubber boot feature preferences

The feature users were most excited about was a focus on lighter weight designs, which was closely followed by main hiking boot waterproofing and removable cladding for punction protection. After that there was some enthusiasm for a flexible rubber overshoe design, a merino wool knit lining in the rubber boot, TPU rubber that can be melted with a lighter for repairs, and leather upper materials. Surprisingly, there was zero interest in synthetic upper materials. There was little enthusiasm for sacrificing repairability, heavier but more supportive designs, and interior rubber sock designs.

Question 17: Additional Footwear Thoughts

Lightweight and flexible with snake protection was mentioned, though some contrasted that with overall durability due to their boots failing them quickly. One user mentioned that the modularity adds flexibility but may add too much complexity as they like to make do with simple designs. They did however also add to the lightweight non-bulky camp.

Question 18: Email

One email was provided from a professional biologist and avid enthusiast photographer of the natural world. Others provided their names.

Personal Alignment with My Thesis Project

My Strength Finders Strengths:

Strategic

Command

Futuristic

Communication

Responsibility

I desire to inspire joy and reverence for exploring the natural world by designing innovative outdoor products with novel approaches to improved use and end of life through understanding the ways products impact human emotions and the wellbeing of the environment.

My thesis project is all about designing for the individual empowerment of users that respect nature and seek adventure within it. It considers a responsible future of commanding users that must strategize complex trips in order to communicate the importance of the natural world to fellow peers and the general populus. This includes but is not limited to professional adventure photographers, ecologists, biologists, students, and enthusiasts with such a powerful ambition that their endeavors must take them to the furthest corners of the globe in search of natural forces bigger than themselves. These are the scientists discovering new species, the photographers documenting endangered animals for conservations, the students putting in invaluable hours helping others in the field, and even those that just thirst to see far more than the typical tourist destination on their next vacation. All of these users and their journeys carry with them the same strengths that I do.

The users outlined by my thesis must be strategic in how they pack and organize their belongings and travel plans, just as I must be deliberate in designing for the maximum versatility, practicality, and space efficiency. A lack of proper planning could mean a direct impact on a trip's itinerary if a part of the trip is not possible due to a lack of sufficient or functional gear.

Likewise, if I do not strategize for the order of events the bag and footwear in my thesis may be used in, the user experience will suffer. There must always be a reason for how, why, and when each product is called upon and integrates with each other. My strength of strategy will help ensure this is delt with in full (Rath & Clifton, 2017).

My strength of command resonates with the sheer will of users that will benefit from my project. There are a thousand ways to do one thing, but designing a project with a clear vision and ambition that commands its proper usage without being inflexible or insensitive is the best way to design products that must be relied upon. If a product is too vague in how it is used, or who it is targeted for, the opportunities for it to be used in poor situations or in poor manners increase. Likewise, having a sense of command on a project will keep it feeling aligned and identifiable, which is important in such a flooded market. I must be able to rely on my sense of command to be confident in the system I design and instill that confidence in all that use my products.

Futurism is an essential strength to have for this project. Being able to look towards the future for innovations that are not currently available is the only path to creating measurable advancements in this product space. Likewise, taking into consideration environmental concerns, and how those concerns may benefit the project through more material and space efficiency is essential. Without a futuristic outlook, sustainability concerns and other difficult constraints such as storage space may seem like obstacles, met with pessimism and few viable solutions. Approaching with optimism and an eye towards the future, these constraints will turn into points of inspiration to develop new design features that have important impacts beyond the problems they were originally meant to solve.

Communication is twofold- it is about my user's and my own personal strength to use photography as a tool to communicate the significance of adventuring and the natural world, but it is also about effective branding and design of the project. Presently it is difficult to discern whether or not photographic bags are appropriate for outdoor hiking environments, if rubber boots can be used in alpine hikes with strenuous elevation changes, and whether urban footwear can be relied upon as much in the outdoors as it can be in the hotel room. Clearly communicating not just the intentions but the versatile performance of the products in my thesis collection will be something I must execute well, and I will rely on my strength as a communicator to do this.

Responsibility is central to designing a collection of products that must help individuals reach far flung environments while also being environmentally sensitive. These products must be robust and reliable without being so harmful as to make their existence a net negative for the passionate users that will don them. I must be responsible in my material sourcing and design to ensure that I only create reliable products with consideration of their lifecycle and initial production impact on the environment.

The body of work I am creating is directly related to my ambitions in the performance design industry. There is absolutely nothing else I would rather be designing right now than this collection of products- and that is by design. Why work on projects that do not matter for your career? As someone with a strong background in industrial design, but also with a keen interest in softgoods technologies, it is natural for me to seek innovations in spaces that blend the two passions, namely footwear and backpacks. Footwear allows me to use my 3D skills and focus my talents on two completely different approaches to footwear design within the same outdoor performance space, showcasing the breadth of my skills while still staying appropriately within the space that has the companies I wish to work for. Likewise, building an innovative bag shows I have the skills to work in product spaces outside of footwear while still demonstrating applicable abilities that would help me in either a softgoods or footwear space. Additionally, having a collection that spans two different product categories will show that I have a strong ability to understand a brand aesthetic and execute it anywhere in a brand's lineup, should they design more than one kind of product. It will be very exciting to work on this project and see where it can take me to kickstart my career.

Performance Testing Plans

HCW:

How could we maximize freedom of exploration for adventure photographers during travel to and within rugged warm weather environments while minimizing gear and environmental impact?

Metrics:

Efficiency (Time/Access/Ease/Energy Expenditure)
Storage Maximization (Gear Carried vs Space Available)
Adaptability (Number of Scenarios where Gear is Useful)
Traction (Footwear Only)

Boots:

Special consideration will be given to Adaptability, Traction, Storage Maximization. The boots must travel better than any boot on the market, seamlessly working with the bag to provide flat, space saving storage and travel. Traction and adaptability to various terrains and situations must be improved beyond current boots. Durability will be a key focus where necessary, but durability may be measured in the ability for parts to be replaced or repaired to extend the life of the boot, not just in terms of abrasion resistance or strength.

Shoes:

Special consideration will be given to Adaptability and Storage Maximization. The shoes need to function as both everyday and down-time specialists, tackling campsites just as well as security lines, so adaptability is key. Because of their frequent use, special attention must be paid to thermoregulation and by extension the ways that these shoes handle bacterial growth. These are comfort-first shoes, so quick drying materials and breathability are a must. They must also be efficient and comfortable, as frequent donning and doffing, as well as extended use in cramped areas and on hard surfaces means they must not be fussy and very inviting to wear. Likewise,

storage maximization is key because they will not be used much in field environments and will be packed away during more rugged travel.

Data Collection Plans:

Boots:

Boots will be tested primarily on the trail. There may be additional testing in a timed lab environment for storage or donning/doffing time trials, but it is important that the boots are tested in a real environment with a user. Materials can have certain lab-tested tractional/grips specifications, but these are not the most useful when the primary environment includes mud, wet rock, logs, moss, and so many other variables that cannot be consistently tested in a lab with the weight of a human foot. Foot security and confidence in the product is often a very personal thing and must be evaluated as such.

- Ability for boots to function well in wet and dry conditions (May only be for prototypes and not competitive products) Adaptability
    - Evaluate the ability for the prototype boots to function in wet and dry conditions on a holistic level and compare that with the capabilities of the more specifically designed rubber boot. What does the rubber boot fail to do well that must be capitalized on in the prototype design?

- Traction independently evaluated in a trail setting on wet rocks, mud, dry rocks, dry dirt, leaves, logs, sand, and underwater Traction Adaptability
    - Hike with a user and compare their feedback on the traction in various substrates. Shadow them if possible and identify any changes in hiking style or confidence. If possible, on some materials that can be replicated in a lab environment, perform a lab test. This can be done by placing the boots on a surface with a standard weight inside of them. The surface is then tipped up at an angle, and stopped at the angle the boot starts to slide. The higher the angle, the better the traction. This testing

may also be replicated on a smaller scale with sample materials but additional research must be done to perform more scientific small-scale tests.

- Packability of boots in competitive product bags Storage Maximization
    - Pack the competitive boot in the competitive bags. Time the packing process and make notes of the overall change in volume of both the exterior of the bag and the bags storage capacity. Make notes on other important factors, such as the bag's ability to be packs in tight spaces with the boots stored.

- Dry weight (lab) Efficiency
    - Competitor products and prototypes of the same size will be weighed on a scale clean and dry to determine their base weights.

- Favorite features
- Worst features
- Desired but not present features
- General comments

Shoes:

Shoes will be tested around the city, in the lab, and on the trail. There may be multi-day trials where a user will have to wear the shoes in their daily life and report back their findings. There will also be simulated scenarios, such as sitting in a cramped seat, timing donning/doffing during airport security, and an evaluation of any modular or multi-use capability. There will also be lab tests for drying speed. Trail evaluation may happen in conjunction with the rubber boots but will not be as rigorous as these shoes are not meant to be primary trail shoes.

- Compressibility versus competing shoes during storage Storage Maximization

    - Shoes will be compressed and stored in both competitor and prototype bags and compared with each other based on the volume they take up as well as their ability to function and/or return to form after compression.

- Ability to function as a water shoe, beach shoe, or sandal (may not be tested) Traction Adaptability
    - If tested, the prototype and competitive models will be brought to river or beach situations for specific tests in these areas. Debris mitigation, ease of use/power swimming, and desirability for use in these settings vs barefoot or with socks will be determined.

- Favorite features
- Worst features
- Desired but not present features
- General comments

Data Analysis

Data will be analyzed based off the metrics provided, the product category, and whether or not it is qualitative or quantitative data. Photography will accompany most testing for analysis.

Quantitative:

Quantitative data will provide direct ranking between product features, materials, and use-case scenarios. It will be represented directly in the form of charts, rankings, or direct numerical comparisons.

Efficiency (Time/Access/Ease/Energy Expenditure)

- Weight of system
- Weight of individual footwear units

Storage Maximization (Gear Carried vs Space Available)

- Number of specific pockets/compartments directly correlated to space efficiency
- Number of ways a shoe/boot can compress/take up less space

Adaptability (Number of Scenarios where Gear is Useful)

- Number of applicable use-case scenarios
- Number of useful configurations

Traction (Footwear Only)

- Slip-angle-traction testing results
- Number of appropriate substrates where traction is optimal

Qualitative:

Qualitative data will form the backbone of featureset evaluation, as well as problem identification and mitigation analysis. Questions that are not posed in the form of 1-10 or other processable values or rankings will be displayed in the form of important, affirming quotes. However, the primary use of this data will be to inform the design of the products with regards to the specific metric being analyzed. While quantitative data can objectively prove a metric of one product to be superior, it has limited ability to inform design choices and provide unforeseen opportunities for innovation. That being said, most qualitative data will be recorded in ways that allow for consistent, measurable performance. 1-10 questions are great at this and will form the backbone of perception survey and interview questions. Feature rankings will be especially important early on and allow for users to provide feedback on what innovations are impacting them the most.

Efficiency (Time/Access/Ease/Energy Expenditure)

- Perceived energy expenditure
- Perceived ease of use
- Perceived accessibility

Storage Maximization (Gear Carried vs Space Available)

- Perception of maximized storage and the ability to overpack

Adaptability (Number of Scenarios where Gear is Useful)

- No hinderance in any activity due to perceived gear limitations

Traction

- Sense of security on multiple terrains while hiking
- Metric of surprises with regards to traction – when was there more or less grip than expected and on what surface
- Information about how bags and footwear feel and where on the body they feel that way
- Extended comfort or lack of comfort over longer periods of time
- Perceived comfort in specific situations either live or reenacted

Photography:

Photographs will be collected during most data collection trials or tests. These photographs will provide critical documentation of the testing that illustrates pain points, successes, and important features, activities, or situations to note. The most useful photographs will be selected and presented alongside qualitative feedback or quantitative datapoints to better illustrate the findings from user testing.

Test Results

Testing was separated into weight, packability, traction, and field performance. Competitor product testing was wrapped into weight, packability, and traction testing, with field testing being mostly exclusive to high fidelity in-situ travel testing with prototypes and alternative, but similar comp products. Prototype testing occurs in all categories and was completed with both works-like and looks-like prototypes. Both boots and shoes were tested for all categories, but most emphasis was on boot traction and field performance and overall system weight and packability.

Weight:

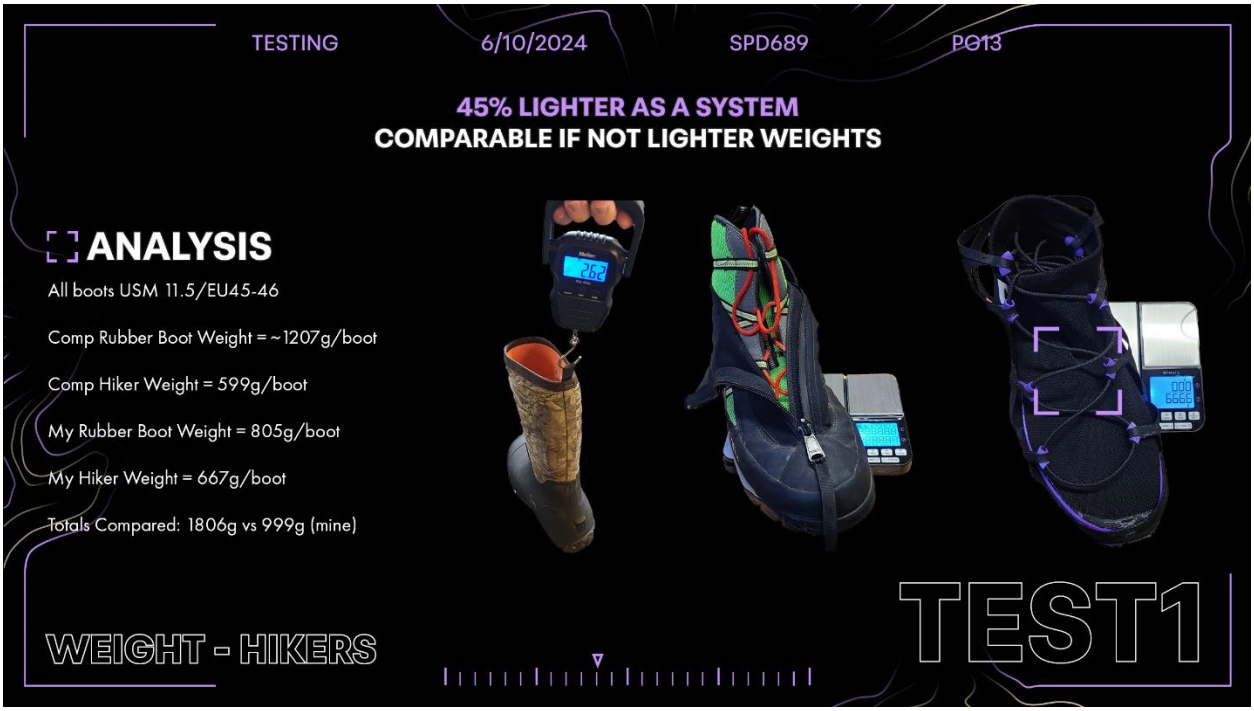


Figure 38 Weight testing summary

Weight testing proved that the prototype modular boot system was 45% lighter than the equivalent set of competitor footwear, which was the Bogs Snake Boot and Altra Lone Peak 6 highlighted in this paper in addition to a breathable hiking boot, hiking sandal, and slide/flipflop that were all of average weight and build for their class of product. Individually, paying special

attention to the rubber boot and hiking boot, the prototype rubber boot was significantly lighter at 402gs/boot lighter, while the hiking boot was marginally heavier by 68g/boot. A marginal increase in weight for regular hiking boots while significantly decreasing the weight of the least efficient competitor product (the rubber boots) in addition to almost half the total weight when comparing the entire system is successful. This means that at a minimum, even if a user were to skip bringing urban footwear and only brought boots for field use, the system would still be significantly lighter. Likewise, if there were a situation where one kind of terrain would be encountered but a large amount of travel was necessary, for little to no weight penalty a user could have access to urban shoes and slides versus traveling exclusively in their field boots.

Packability:

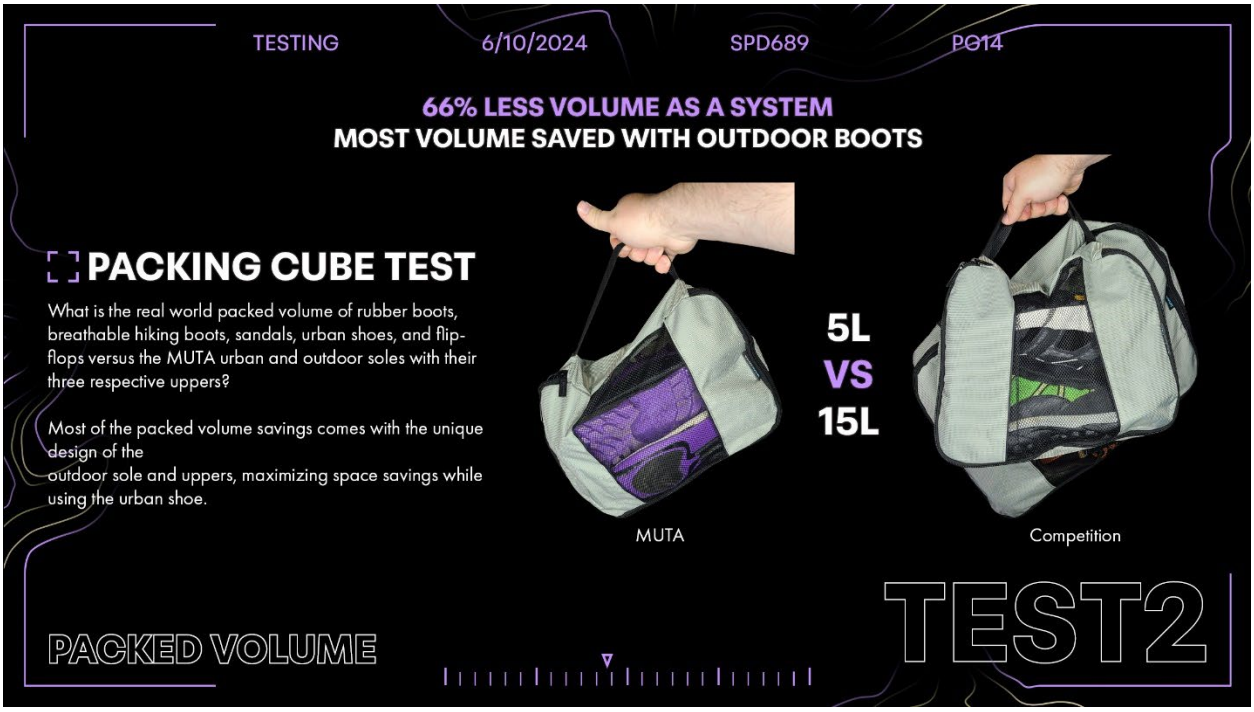


Figure 39 Packability testing summary

Packability testing was done with standard packing cubes to mimic real-world travel situations. Initial testing with works-like prototypes using volume measurements calculated with rulers while each product was compressed also supported the results of this test, but the visual

comparison of full packing cubes more effectively shows the practical gain of the prototype modular footwear system's design. Using generic 5L and 10L packing cubes with a half pair of each competitor product and each part of the prototype system, the same ones used in the weight testing, it was determined that for every 5L packing cube used to carry the prototype system, the equivalent amount of standard competitor footwear would take up both a 5L and 10L packing cube. This means that the prototype system uses 66% less volume. Doubling these numbers would get the true storage capacity comparison for full pairs. Similar to the weight testing, most volume reduction comes from the unique design of the rubber boot prototype combined with the versatility and collapsibility of the swappable uppers used between the urban sole and outdoor sole. Each piece individually takes up less volume, with one exception being the slides, as they take up roughly the same space as a normal pair of slides, if not slightly more depending on the model. However, this is the least voluminous item and the one footwear product that did not have any previous issues with packability. Packed volume reduction was a huge success!

Traction:

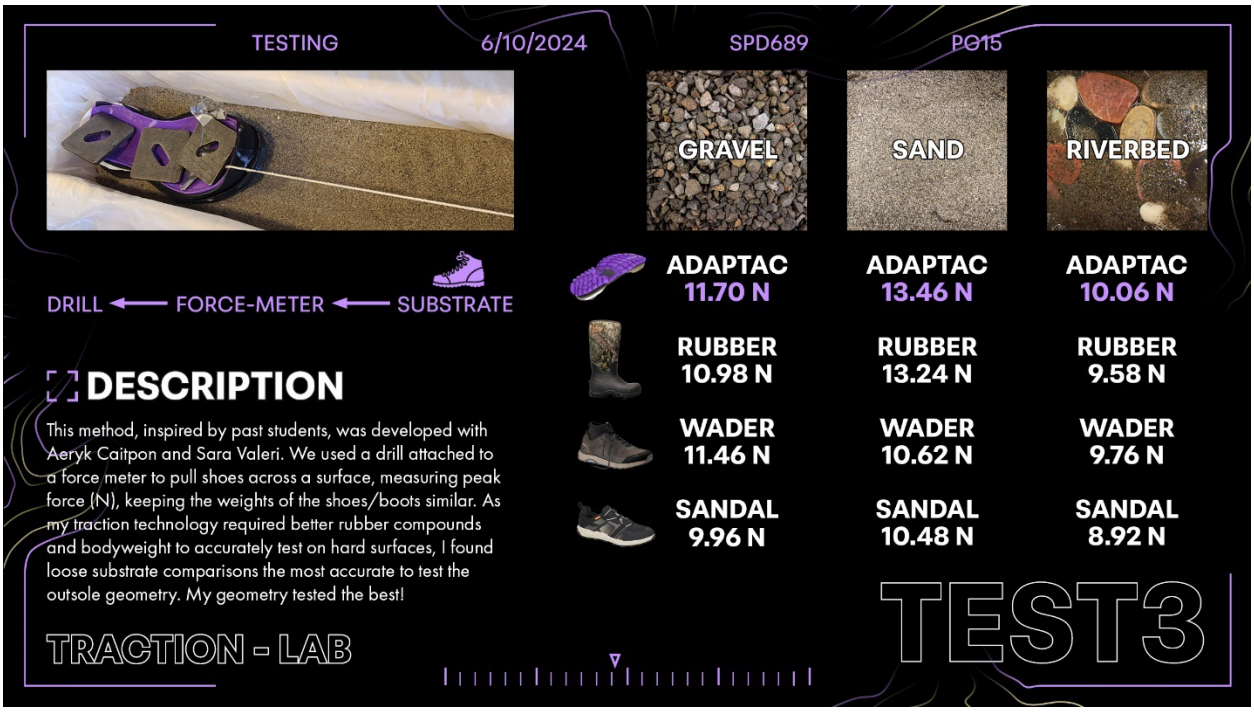


Figure 40 Traction testing summary

Traction testing in the lab was done using a trough that had multiple substrates loaded into it for the prototype and competitor products to rest on. Those products would then be attached to a cord, which was attached to a force meter, and finally a cordless drill. Weights were placed on each piece of footwear to roughly even their weights. After this, five trials each on every substrate would be conducted where the drill would be triggered at the same amount of power and would drag the footwear across the substrate. The force meter would rate the peak newtons experienced during the dragging. The five trials would then be averaged out to get the final testing number. Errors during each trial and extreme outliers were retested to ensure accuracy in the data. Soft substrates were reset after every trial to not dig holes into them and affect the performance.

Both loose, hard, and wet and dry substrates were tested. However, for the purposes of evaluating the prototype technology, hard substrate data was ignored. This was due to the lack of weight necessary to engage the outsole technology being used on the prototype outdoor sole, which relies on the weight of a human body to compress the foam above the outsole, conforming the outsole rubber onto the rocks. It was however used to compare competitor products, and the soft substrates such as Sand, Gravel, and Riverbed were used to evaluate the capabilities of the curved outsole design of the prototypes, as this curved geometry would not be deformed while on softer substrates that would move before the weight of a body could deform the outsole.

For the loose substrates taken into consideration, the prototype outsole beat out every competitor product. From these results it is clear that the increased surface area of a wavy outsole given the same footprint is able to outperform competitor outsoles that do not use a wavy underside profile, and thus have left surface area to generate traction. Outsole geometry is also shown to be optimized by this test.

For hard substrates, further testing was done in the field to verify the performance of the conforming outsole technology to validate the exclusion of the hard surface traction dragging data in the final results. No difference in traction was observed by the expert user during A/B testing, and excellent traction on hard granite rock was reported when testing the full pair of prototypes. Furthermore, excellent performance on sand and more efficient perceived walking performance supported the results of the loose substrate lab traction testing.

It is also important to note that rubber outsole compounds of the prototype were never optimized for comparable performance, and an inferior compound (95A TPU) was used, compared to the high-performance natural rubbers and softer synthetic blends on the competitor products. Testing results in all areas would likely increase provided a better rubber compound was used.

Raw Traction Testing Data:

SHOE	SUBSTRATE	T1	T2	T3	T4	T5	AVG (N)
CANYONEERING BOOT 1174g	GRAVEL	10.1	10.8	11.1	10.3	10	10.46
	SAND	11.6	11.6	11.1	10.5	11	11.16
	WOOD (WET)	11	14.6	13.5	13.5	14.3	13.38
	SLATE (DRY)	17.6	17.4	17.4	16.6	17.4	17.28
	SLATE (WET	15.7	14.9	16.9	18	18.2	16.74
	RIVER ROCKS (WET)	8	8.1	8.7	8.6	9	8.48
RUBBER BOOT 1219	GRAVEL	12.1	11	8.9	11.5	11.4	10.98
	SAND	13.3	13	12.6	13	14.3	13.24
	WOOD (WET)	12.8	12.5	12.3	13	13.3	12.78
	SLATE (DRY)	17.1	15.4	16.1	18.8	14.9	16.46
	SLATE (WET	12.1	12.2	15.5	14.5	14.9	13.84
	RIVER ROCKS (WET)	8.9	12.1	7.9	9.3	9.7	9.58
LIZARD WATER SHOES 1031	GRAVEL	10.2	7.7	11.1	10.7	10.1	9.96
	SAND	10.3	10.6	10.3	10.8	10.4	10.48
	WOOD (WET)	12.9	13.5	13.7	12.3	14.7	13.42
	SLATE (DRY)	13.7	15.7	14.1	15.5	13.2	14.44
	SLATE (WET	7.7	9.4	8.4	9	8.9	8.68
	RIVER ROCKS (WET)	8	10	9.9	8	8.7	8.92
ALTRA LONE PEAK 1043	GRAVEL	10.2	9.6	9.6	10.6	9.1	9.82
	SAND	11	10.9	11.2	10.2	10.2	10.7
	WOOD (WET)	12.2	10.8	11.8	10.1	11.7	11.32
	SLATE (DRY)	9.5	9.1	9.1	9.9	10.5	9.62
	SLATE (WET	8.7	10.5	8.8	7.9	9.6	9.1
	RIVER ROCKS (WET)	9.6	8.4	10	10.5	9.3	9.56
ORVIS WADE HIKERS 1095	GRAVEL	13.2	10.3	11.9	11.9	10	11.46
	SAND	11.6	10.4	10.3	10.4	10.4	10.62
	WOOD (WET)	12.8	13.2	13.8	12.9	13.2	13.18
	SLATE (DRY)	14.3	17.8	15.9	12.6	13.1	14.74
	SLATE (WET	12.2	11.1	12.8	10.3	11.9	11.66
	RIVER ROCKS (WET)	8.9	9.6	11.5	10.6	8.2	9.76
NIKE TRAIL 1016	GRAVEL	10.1	9.8	10	10.3	9.6	9.96
	SAND	10.5	10.7	9.7	9.9	10.5	10.26
	WOOD (WET)	11.1	9.8	11.6	11.5	11.4	11.08
	SLATE (DRY)	8.9	10.4	10.7	10.6	11.5	10.42
	SLATE (WET	9.3	8.1	9.4	8.3	8.8	8.78
	RIVER ROCKS (WET)	5.9	9.7	7.6	9.4	8.4	8.2
Dan Boot 1200	GRAVEL	12.6	11.8	10.2	11.9	12	11.7
	SAND	12.9	15.5	13.8	13.2	11.9	13.46
	WOOD (WET)	8.6	9.7	8.6	8.4	9.4	8.94
	SLATE (DRY)	7.7	6.6	7.5	6.7	8.6	7.42
	SLATE (WET	6.5	7.2	7	7.4	8.6	7.34
	RIVER ROCKS (WET)	12.1	9.2	9.5	10.1	9.4	10.06

Figure 41 All raw lab testing traction data

Field Performance:

Figure 42 Expert user in-situ high-fidelity field testing user profile and feedback summary

Jules Wyman is a wildlife biologist and photographer based in the bay area of California who frequently travels locally, country-wide, and globally for research and photography. He is a 2023 Stanford graduate in Ecology and Evolution with sights on returning for his graduate degree. Jules is also a published scientific research author, published photographer, and a semi-finalist in the Wildlife Photographer of the Year competition with dreams of winning the overall award, the most prestigious award in wildlife photography. He has experience using equivalent competitor products in all areas covered by the prototypes and often struggles with what he can pack, preferring to travel with as little bags as possible, often in situations where he must always travel with all his belongings on his body.

Jules Wyman was selected as an expert user for high fidelity in-situ field testing. His work gives him the benefit of a consistent local job along with being paid when traveling for research activities that help further ecological research as a whole, even without specific ties to his employment. This meant that Jules could agree to a real research/photographic expedition where he started in his local work environment, traveled to a remote destination, and continued

traveling throughout a variety of smaller destinations with varying field conditions and their own unique photographic and research objectives.

A trip outline was prepared, and the objectives were to start with tide-pooling research at his local nudibranch study in Pillar Point, CA, before travelling to Tucson, AZ. Over 16 different species were recorded, and the unique landscape of this region was documented. After travelling to Tucson, Jules would drive several hours to a remote corner of Southwestern Arizona called Cabeza Prieta National Wildlife Refuge to rendezvous with wildlife biologist Dale Turner. Dale and Jules would then survey Tule Tank, looking for introduced Spiny-tailed Iguanas. While they have not been reported for some time, it takes several visits to a locale where they have been previously documented to prove that they have been extirpated. Jules conducted A/B boot testing with his own Lowa Camino GTX boots and helped Dale in their search. Despite not finding any of the non-native iguanas, Jules spotted a native Chuckwalla, which is a large rock-dwelling lizard that is found in nearby mountain ranges. However, this was the first time a Chuckwalla had been documented in the Cabeza Prieta mountains, providing a significant datapoint to their range distribution. After Cabeza Prieta, the trip continued to the Tinajas Altas mountains for a primarily photographic pursuit of the Speckled Rattlesnake. This rattlesnake varies in its appearance based on the rocks found in each mountain range it is found. The Tinajas Altas are one of the most remote ranges where these snakes are found but contain brilliant white rattlesnakes that are highly sought after by photographers. This is because of the white granite rock that dominates the range, a landscape that would be a challenging but apt test for the breathable boots on rock. Jules used the full boot prototype pair during his photography of one of the speckled rattlesnakes he found, following it for over an hour. After a successful photography session and additional feedback about the boot's performance, it was time to pack them away for the next adventure, stopping a night in Yuma. Hiking around the sandy desert flats of Yuma, a rare flowering body of the underground and parasitic plant, Sand Food, was spotted and photographed. This proved to be another positive data point adding to a year of Sand Food discoveries in Arizona, a plant that had only been seen a handful of times in Arizona since the 1980's. Before heading back to Tucson, Jules stopped at the Mohawk Dunes, the only place in the world where the Mohawk Fringe-toed Lizard lives. The plant life of these Dunes was studied by Dale Turner years prior and was an excellent place to test the sand capabilities of the breathable boot. Jules reported excellent stability and efficiency in the sand and lauded their easy

donning/doffing before camping on the dunes. Returning back to Tucson, and then heading south to Tubac, AZ, Jules helped search with Dale one more time to verify a report of an introduced lizard near the Santa Cruz River. Jules was able to test the rubber boot in the water and give feedback on the works-like prototype's performance. Afterwards, all of the prototypes were packed away, and Jules returned home to California to continue surveying tidepools, construction sites, and special interest wildlife areas.

After this epic adventure, Jules had this to say about the prototypes and system he experienced firsthand:

"I could definitely see myself using a modular boot in my work–it felt like a very useful innovation for people in my field"

"I do normally carry multiple pairs of shoes on field expeditions or suffer when I don't"

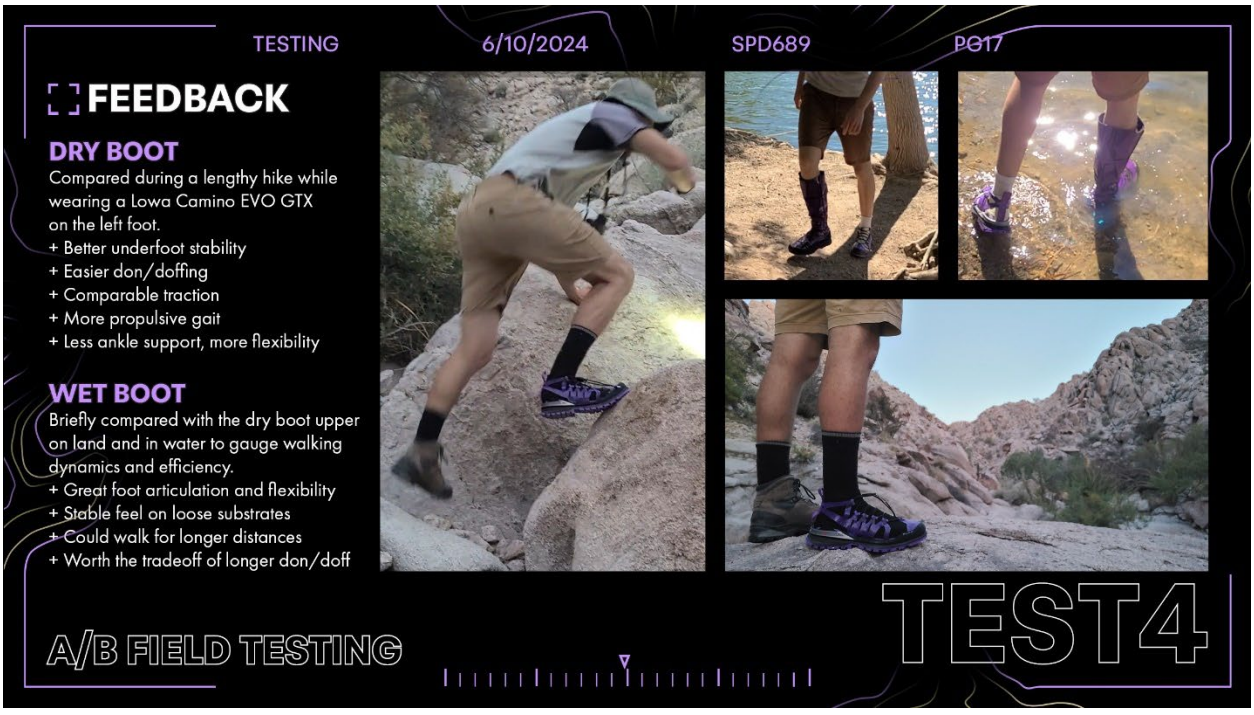


Figure 43 A/B field testing summary – Cabeza Prietas and Patagonia Lake

Looking more specifically at the A/B testing, Jules gave feedback while directly comparing his own Lowa Camino GTX boots and his past experiences with rubber boots

equivalent to the featured competitor products. For the dry/breathable boots he said that they had better underfoot stability, were far easier to don/doff with a superior lacing system for speed, had comparable traction on rock with no noticeable difference in performance, featured a more propulsive gait while walking, and had less ankle support but more flexibility in tight situations. Overall, he found the performance comparable and the only thing holding him back was the difference in upper stiffness, which is to be expected given that the Lowa Camino GTX is a full leather and waterproof shoe. He said that if there was a stiffer upper option offered that he would also purchase that, but that for all activities except the most unstable rock, he would prefer the more flexible and breathable upper on the prototype. That being said, he did say that despite being more challenging, the support was acceptable and hiking in extremely rough terrain was still safe and comfortable, just not superior to the Lowas.

The rubber boot prototype testing was less thorough than the breathable boot testing but led to key insights that helped inform an updated design. While there were some initial issues with the fit having to do with extra fabric needing to be added to aid in wrapping over to reach the attachment system on the sole, Jules was able to give general feedback on the rubber boot concept and performance. His performance comments were that there was great foot articulation and flexibility and a stable feel on loose substrates. Additionally, he said that he felt he could walk for longer distances compared to other rubber boots he has worn in the past, and that the performance benefits were well worth the tradeoff in donning/doffing time compared to typical rubber boots.

Figure 44 Full field testing summary – Tinajas Altas Mountains

Figure 45 Full field testing photography during Speckled Rattlesnake photoshoot, the snake (left), the process (right)

Wearing both prototypes on relatively similar terrain, Jules had high praise for the breathable boots. Jules relied on the boots to closely follow an inquisitive and determined Speckled Rattlesnake (likely out looking for a mate) around varied rocky slopes filled with granite rocks and boulders for well over an hour. This meant Jules had to focus entirely on the snake, leaving his footwear an afterthought. He was able to completely trust the boots and felt confident and safe navigating terrain with his hands full of camera equipment and eyes focused on the snake. Afterwards Jules reported great footbed comfort over the entire period of hiking,

outstanding upper fit and comfort, excellent perceived traction and control on rocky terrain, excellent perceived breathability, no issues with security of the upper on the sole, great perceived lockdown, a good balance of flexibility and support, and adequate rock protection. His one major criticism was the need for better lateral pinkie protection and a redesign of the toe protection in that area as his right foot experienced some rubbing on the edge of the toecap. This, however, is a relatively simple fixed and a planned update for the outdoor sole design.

Figure 46 Full field testing summary – Mohawk Dunes

Figure 47 Full field testing photographing the Mohawk Fringe-toed Lizard (left), and exploring the Mohawk Dunes (right)

On the dunes Jules tested the outdoor boots in both a hiking and camping situation. He wore them in the car driving in, hiking along the dunes at sunset, and at the campsite at night and before bed. His thoughts were that the breathable boots had noticeably better traction on sand, a perceived improvement in efficiency walking on sand with less sinking noted, great protection from sand ingress inside of the upper, and great ease when donning/doffing for camping and use outside of his tent. Further inspection after his use of the sand ingress in the modular system revealed some sand between the upper and lower layer, but Jules did not notice any difference in performance, or any issues caused by this.

Design Summary – MUTA Modular Adventure Footwear

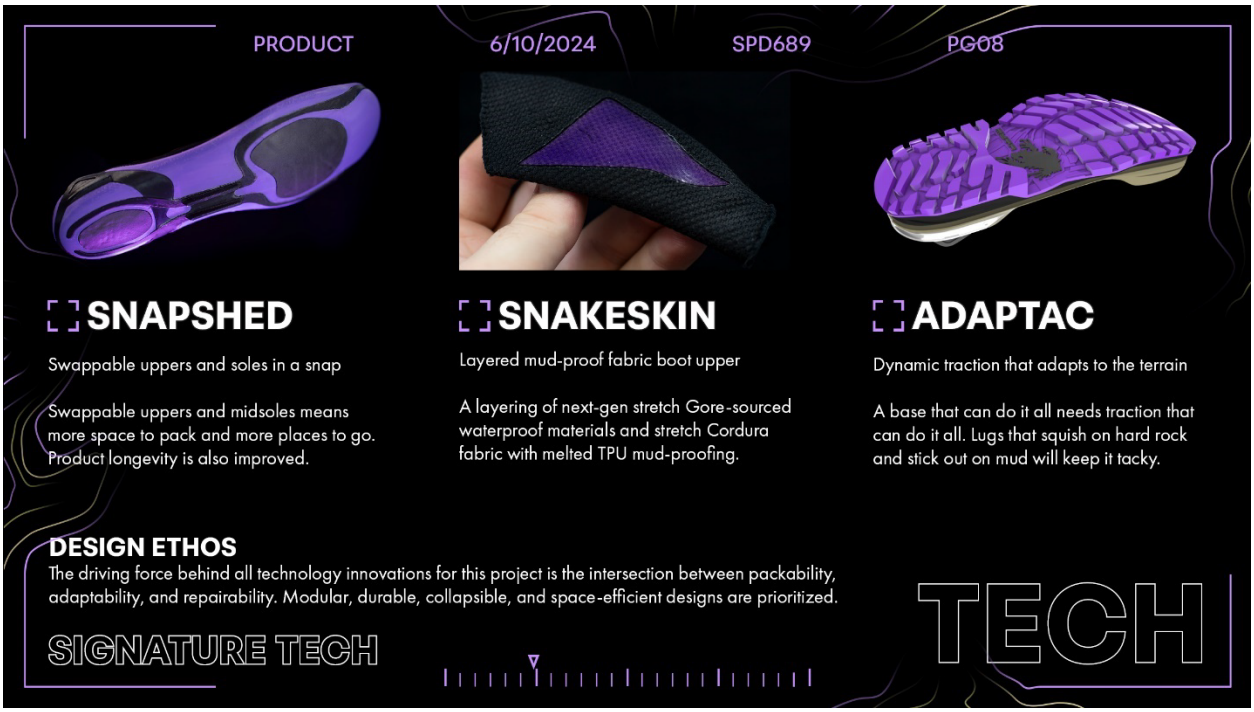


Figure 48 Technology overview

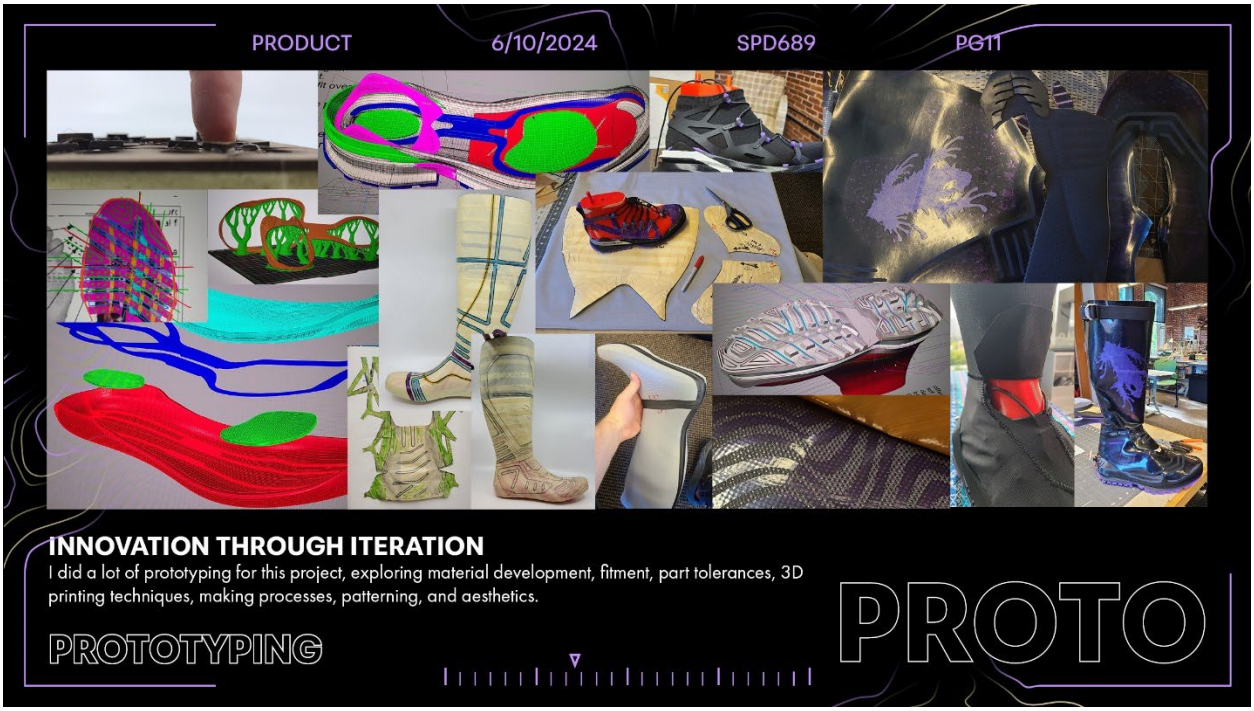


Figure 49 Prototyping snapshot

Figure 50 Mood board showcasing the psychographic user profile and intended aesthetic direction

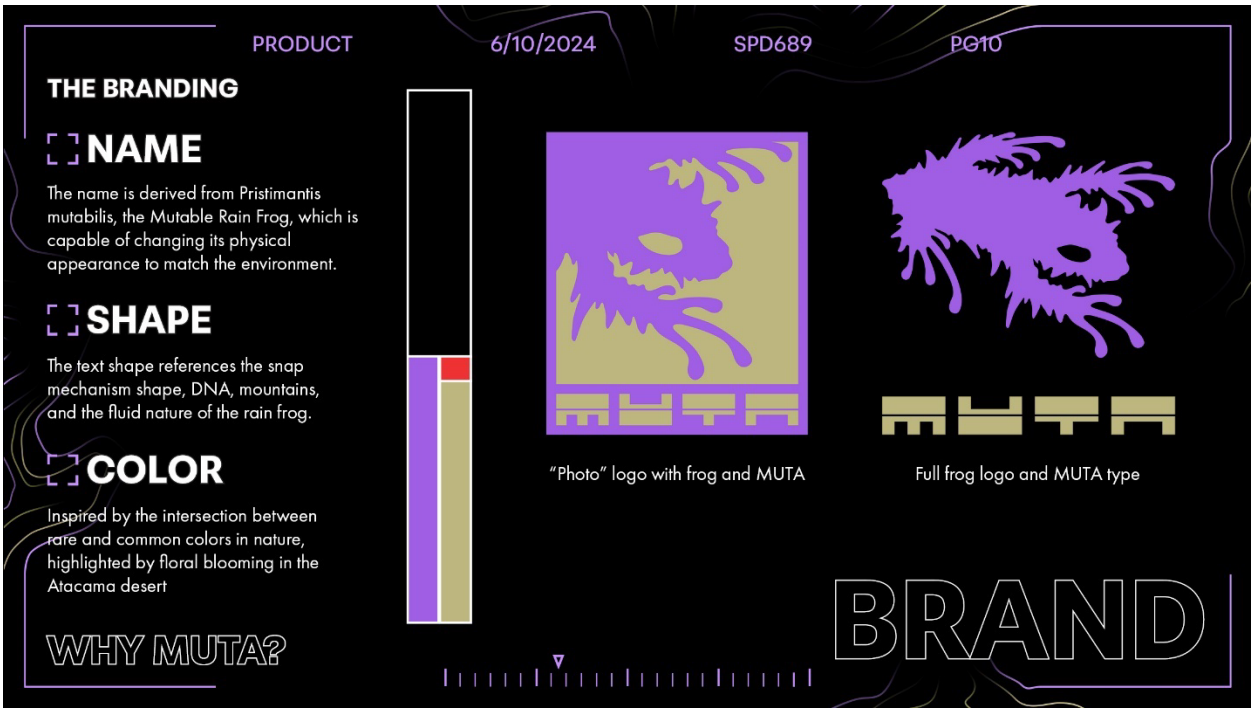


Figure 51 Naming, logo, and color palette summary

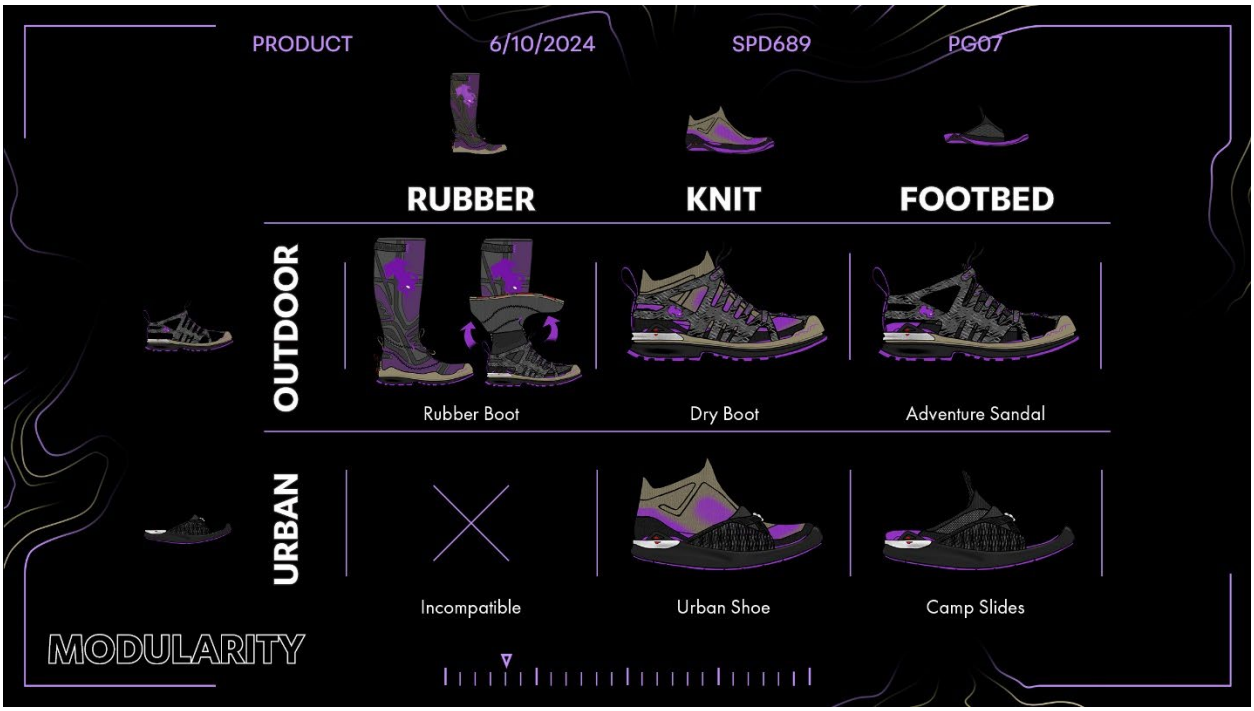


Figure 52 Modularity overview showing which uppers are compatible with which soles to make each piece of footwear

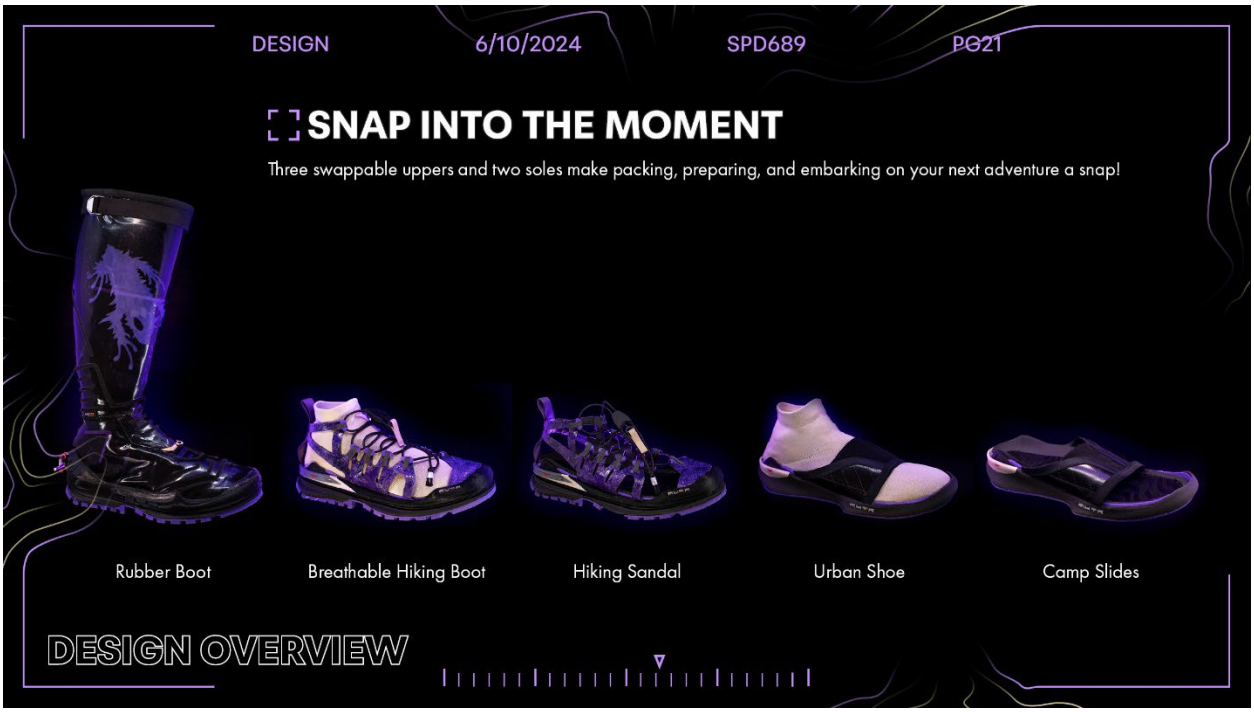


Figure 53 An overview of the complete MUTA modular footwear system with all combinations

Figure 54 Rubber boot feature overview

Figure 55 Extended Rubber Boot Features

Figure 56 Rubber boot action photography

Figure 57 Breathable boot feature overview

Figure 58 Breathable boot in action

Figure 59 Hiking sandal feature overview

Figure 60 Hiking sandal in action

Figure 61 Urban shoe feature overview

Figure 62 Urban shoe in action

Figure 63 Camp slide feature overview

Figure 64 Camp slide in action

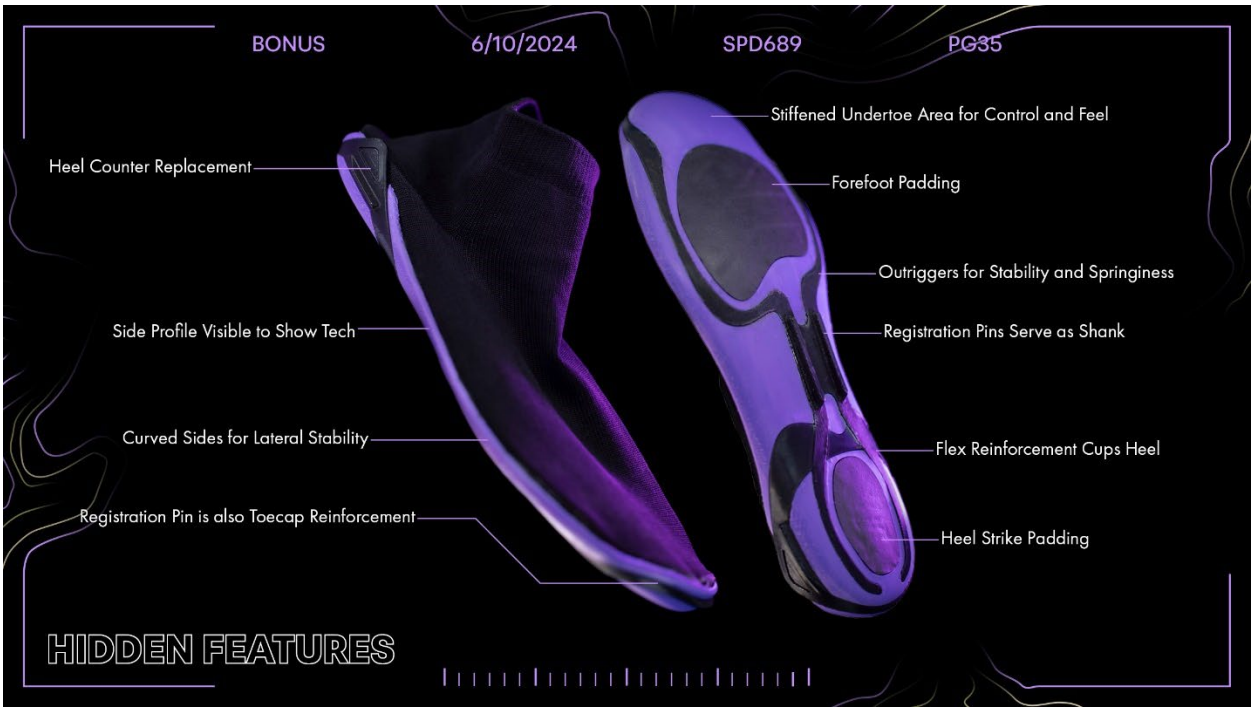


Figure 65 Hidden features of the SnapShed technology

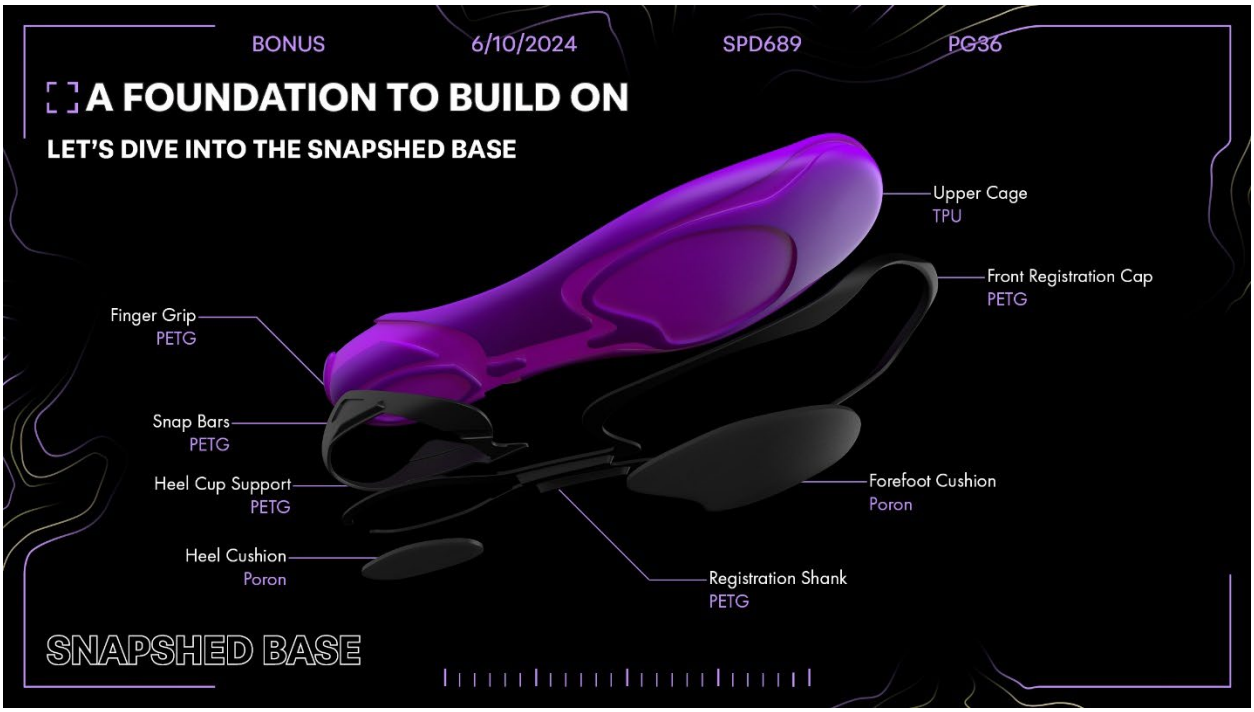


Figure 66 Overview of the SnapShed base used on all uppers to attach to the soles

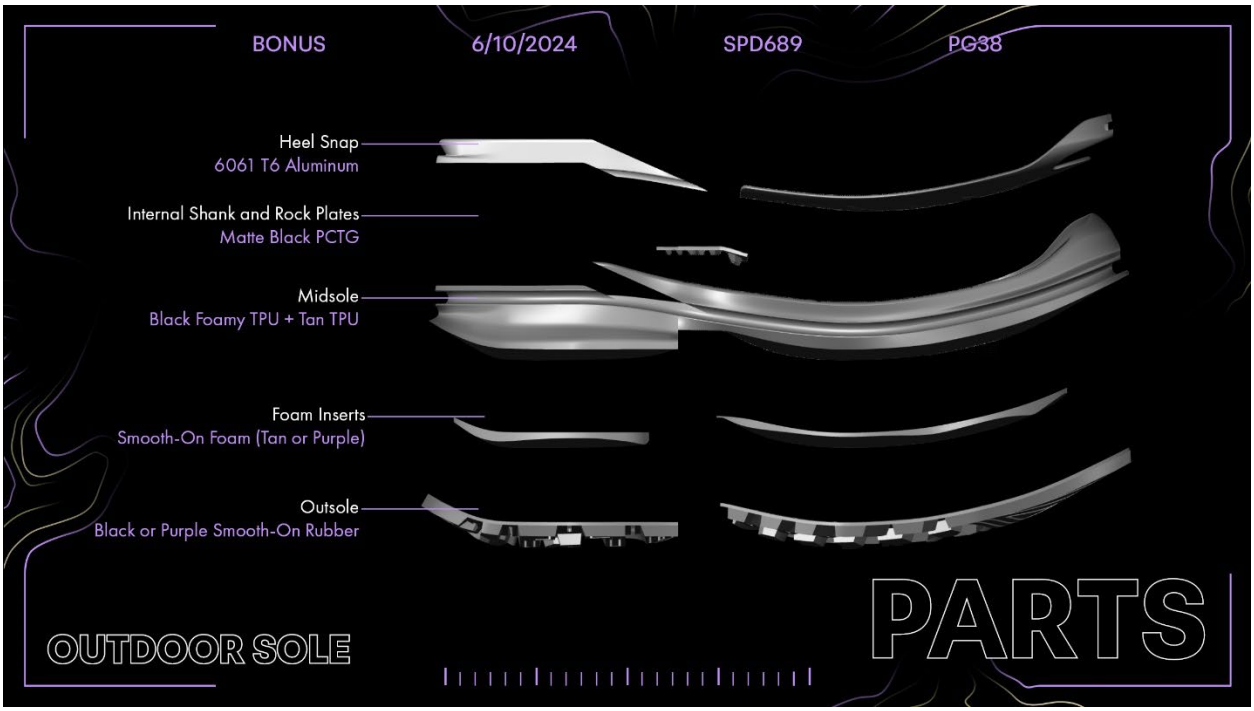


Figure 67 Material and parts overview of the outdoor sole

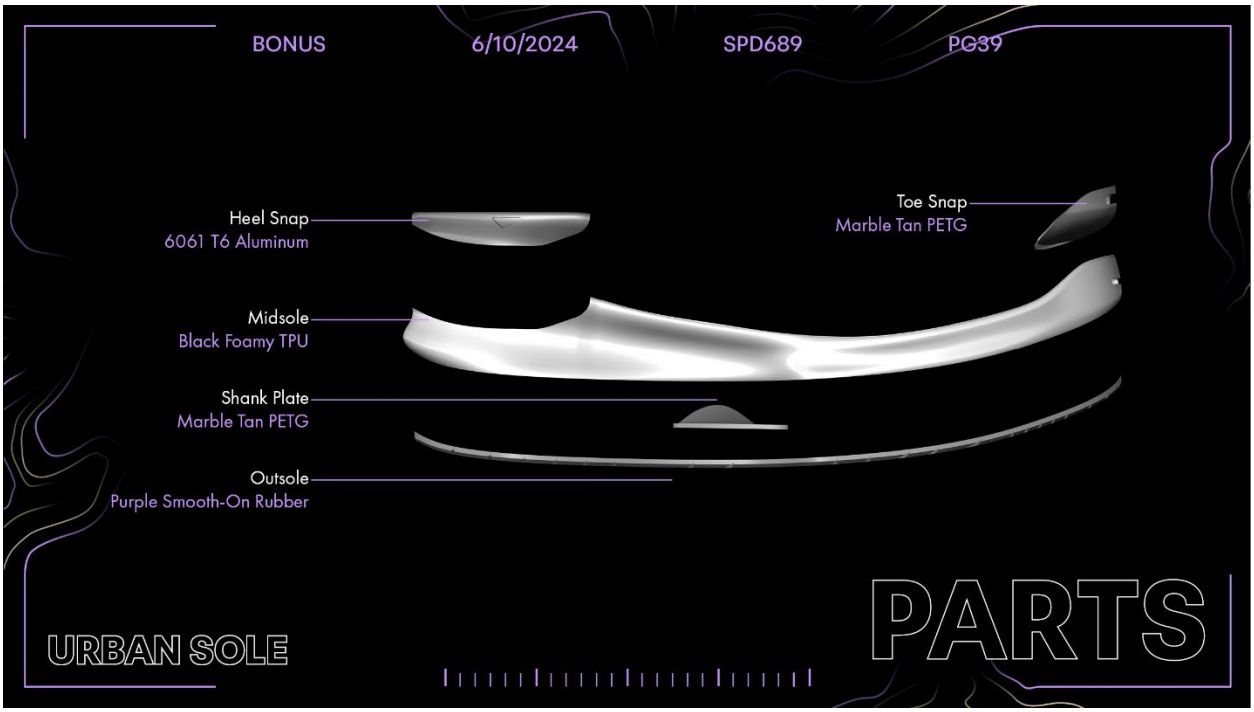


Figure 68 Material and parts overview of the urban sole

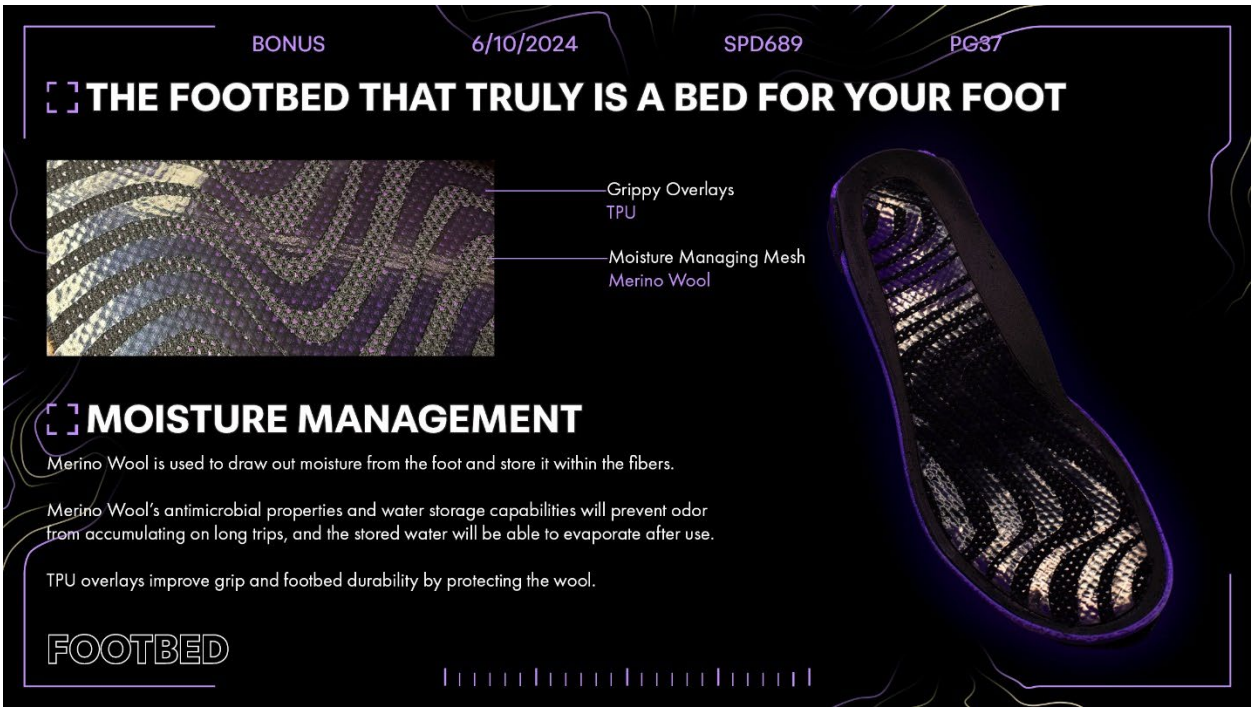


Figure 69 Additional information about the TPU merino footbed material technology

Figure 70 Overview of the upper pieces and their materials

Prototypes Today:

The current prototype system includes one outdoor sole, one urban sole, and three uppers, the rubber boot upper, the knit upper, and the footbed upper. The outdoor sole pairs with all three uppers, creating a rubber boot, breathable boot, and hiking sandal, while the urban sole pairs with the last two uppers, the knit upper and the footbed, to create an urban shoe and camp slide.

The rubber boot features a mudproof outer layer called Snakeskin that surrounds the cage of the outdoor base, which compresses the knit sheath that holds the waterproof liner. This layer is made of a laminate of multi-layered zoned TPU and stretch Cordura. It has external access to lacing for easier donning/doffing and flex grooves that double as areas where the boot can breathe and help the waterproof liner expel moisture. The exterior mud proof layer is cinched around a groove on the bottom of the outdoor sole, and has adjustability at the top of the boot at the calf. The curved outsole provides ample traction on softer terrain.

The breathable boot uses a TPU nylon knit laminated cage material to create a durable but comfortable and flexible support structure for the TPU upper that slides inside. This provides the lockdown, durability, and stability of a hiking boot to a soft, packable, breathable, and comfortable circular knit upper. Speed lacing at the top keeps things easy to use with one pull operation in and out, and Dyneema sheathed 3mm shock cord provides extra durability and less stretch than typical shock cord, ensuring reliable lockdown. The deformable outsole provides excellent traction on hard terrain.

The outdoor sandal builds off the same cage system but now uses it without an upper next to skin. Cooling fabric on the interior face of the cage provides good comfort. The footbed has 1.5mm of extra height compared to the insoles used inside of the knit upper to offset the space gained by removing the knit upper. The footbed also features merino wool netting covered in laminated TPU to provide the optimal balance of footbed traction, durability, odor resistance, and moisture regulation. The curved and deformable outsole provides dynamic traction on the soft and hard terrains commonly found on beaches and rivers.

The urban shoe pairs an urban sole with the knit upper. The urban sole has a curved bottom profile optimized for walking, but not so curved that standing in line at the airport

becomes painful. The outsole is flat and designed to grip to concrete and wear slowly over time. There is reinforcement under the shank to prevent plantar pain, and a mildly reinforced toecap that protects the toes from being stubbed but stays low profile for extra space in airplane cabins and car rides. The knit upper features no heel lockdown outside of the knit fabric itself, which makes it incredibly easy to don and doff in airports, but still provides enough stiffness for urban walking. The forefoot lockdown of the urban sole is comfortable and elastic, providing lateral support and keeping the foot secure. The midsole is kept as low profile as possible while still incorporating underfoot flex grooves that improve cushioning and flexibility.

The camp slides take the urban sole and add the footbed upper for a casual, comfortable, and clean experience. Merino wool in both the footbed and the elastic cuff of the urban sole cuts down on odor and provides a supremely comfortable next-to-skin feel. Forefoot lockdown uses the same material as the outdoor sole, providing next to skin cooling. Edges finished with elastic improve comfort and ease of use when sliding in feet. Extended sidewalls along the rear side snap-fit region eliminate chafing and provide more stability than typical slides. A mild toecap keeps toes visible and vented but prevents stubbing. Reduced material in the forefoot provides good flex when walking.

Prototypes Tomorrow:

The major updates that are needed to further improve the prototypes consist of improving the donning/doffing of the rubber boot, further lightweighting the urban sole with mild changes to the underfoot profile, modifying the pinkie toe region of the outdoor sole cage and toe cap, and providing additional padding in the heel of the urban sole lockdown cage to improve comfort and performance in sandal mode. A future leather waterproof hiker upper would also be a welcome inclusion to the MUTA adventure footwear system, as requested by my users.

Adding a slot into the achilles region of the rubber boot where the pull tab of the outdoor boot cage can be pulled through and used during donning/doffing will significantly improve the donning of the rubber boot, as this pull tab tends to get crushed when the foot is pushed into the boot. Fixing this would mean that the rubber boot upper will never need to be uncinched from its

base and can be donned/doffed like a traditional rubber boot, albeit with custom lacing adjustability.

Lightweighting and optimizing the urban sole will provide further weight and volume reductions will improve the usability as a slide. Making the bottom profile more of a rocker shape without getting rid of a true flat region for line standing will help the shoe flex less during the walking gait, reducing heel lift in the urban shoe and reducing flopping in the camp slide. Reducing material in the heel where this is a residual built-in 10mm drop from the hiking last it is based off will also make the urban options lighter and further improve the intended rocker gait motion.

User testing of the outdoor sandal was excellent in terms of the footbed, lockdown, and performance of the outdoor sole, but the upper chafed the user in the achilles area without socks and provided some mild irritation along the lacing region. While it is less important to pad the lacing area, the achilles region can have a soft pad attached that works better when the sandal is wet. Worn with socks or in a dry environment there are no issues, but on a sandy and wet beach where chafing is a concern, it is important to add some softer fabrics and light padding to regions that will experience the most friction.

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