

**Glide Runner: Laugavegur Trail Running Outfit Designed  
to finish the race fast and safely**

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SPD 689: Capstone

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June 14, 2024

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## **Laugavegur Trail Running Outfit**

### **Introduction**

“A Decade of Fitness”, is the title of an article posted on The New York Times website in December 2019. It outlines the major increase that has occurred in the physical activity of the public for the past decade and even longer. Every year, an abundance of studies are published listing the benefits of physical activity for health and longevity. People have caught on and have started to spend more time walking, jogging, weight training, swimming, biking, hiking et cetera in the hope of increasing their health and being able to spend more time with their grandchildren and great-grandchildren in their old age (Reynolds, 2019). This trend can be seen in the expansion of trail running. And with more people frequently training and competing in trail running, the need for specialized trail running garments and equipment has increased. Every trail is unique and comes with its own set of challenges while all trail running products on the market are generic. The purpose of this paper is to research how that might be changed with the design of a specific trail running outfit for the Laugavegur Ultra Marathon, one of the most popular trail running competition in Iceland (IBR, n.d.).

The scope of this project has been summarized into one problem statement. How could a competition outfit help elite male trail runners finish the Laugavegur Ultra Marathon in a shorter time by improving running economy, carry necessary equipment and keep them safe in case of sudden change in weather?

### **History of trail running**

One can safely assume that running has been a part of human history since the beginning. For our ancestors who lived as hunter-gatherers, running was essential for survival and was likely the driving force leading to the evolution of certain human characteristics

(Hunter-Gatherer, 2022). And as humans evolved, running evolved with them. In ancient Greek society, beginning around 700 BCE, running had started to turn into a competition. But continued to serve a purpose with messengers delivering news and in the military. The terrain was certainly not a flat tarmac road so this type of running was trail running.

Trail running as a sport has been credited to a group of friends in San Francisco in the summer of 1904. It started out as a bet where a few friends challenged each other to a race over the foothills of the Californian coast to be the first to reach the newly opened Dipsea Inn, just outside of San Francisco. The following year, on November 19, the group returned to stage the event, this time having formed a formal club. The Dipsea Trail Race was therefore the first organized trail-running event and is still held annually (Robinson, 2022). During the 20th century, trail running started to grow and since the mid-1990s, the popularity of trail running has grown at a rate of 15% each year (*Trail Running*, n.d.). Despite its popularity, it wasn't until 2013 that The World Trail Running Association was founded, with the aim to promote trail running around the world and give voice to all parties involved in the sport. Today more than 25,000 trail running races are held worldwide each year and World Athletics has recognized trail running as an official discipline (*126 Running Statistics You Need to Know in 2022*, 2022).

### **History of Laugavegur Ultra Marathon**

The Laugavegur Ultra Marathon, which is the main subject of this paper, is a trail race located in the southern highlands of Iceland. It is organized by Reykjavik Sports Association and took place for the first time in 1997 with 49 participants. The race has increased in popularity over the years and has reached the maximum possible participants of 550 runners. Thousands of runners, from all over the world, apply for the race each year. The participants are chosen by the organizers based on the ITRA general performance index and a lottery. The next race will take place for the 28th time on Saturday, July 13th, 2024.

## Users

Trail running is one of the fastest-growing sports in the world with a current estimate of 20 million trail runners worldwide (*Trail Running*, n.d.). However, the targeted users for this project are men competing in the Laugavegur Ultra Marathon. In that particular race, the conditions can be harsh and the course challenging. It is therefore only for experienced runners. The requirements for participation are strict and require an ITRA performance index of 370 or higher. Furthermore, participants need to have reached 18 years of age, know their limitations and be mentally able to help themselves when needed in difficult circumstances. This decreases the population of the targeted demographic and is estimated to be about 600,000 (ITRA, n.d.)

For the majority of sports, athletes are generally expected to peak at the age of 24 to 32 years old. However, for extreme endurance sports, like trail running and ultra marathons, the fastest times are generally achieved at the age of 35 to 45 years or older. And the age of peak performance increases with increasing race distance or duration due to the increasing importance of mental strength over physical fitness (Knechtle & Nikolaidis, 2018). The age range of the targeted users is therefore quite broad, men from the age of 18 to 60 years old.

The Laugavegur Ultra Marathon is not only marketed for trail runners in Iceland, it's equally as much meant to attract trail runners worldwide. Trail running can be considered a part of sports tourism, which is one of the branches of tourism that is expanding the most rapidly. Increasingly more places are using sporting events to attract participants and spectators in the hopes of boosting media publicity and creating a positive image of the place among inhabitants and guests. This not only increases the population of the targeted demographic but also shifts it. People who seek to travel across the globe to participate in

trail races could be considered more adventurous and have higher income levels. This makes them more likely to be willing to invest in a premium and innovative race outfit.

To summarise, the targeted users are 18 to 60 years old men. They are experienced trail runners, thus both physically fit and mentally strong with a mid to high level of income.

### **Jobs to Be Done**

In order to successfully create products for the participants of the Laugavegur Ultra Marathon it's crucial to know what is required of the runners to be able to complete the race. To understand that better, the Jobs-to-be-Done Theory can provide a framework for defining, categorizing, capturing, and organizing all the runners' needs (Ulwick, 2017). We can look at the products the runners wear during the race as if they were "hired" by the runners to help them do a certain job. Five of these jobs have been identified and are as follows: Run great distances alone in the wilderness, descend steep hills, take on and off garments with ease, carry mandatory equipment, and run on multi-terrain surfaces. These five jobs to be done are only an overview of some of the things the runners face during the race and with detailed analysis, the number of jobs to be done would increase greatly. Each and every job could also be further analyzed into a job tree to fully understand every element of the race.

### **Environment**

As stated above, the course of the trail race is called Laugavegur and is located in the southern highlands of Iceland. It is 35 miles long with a total ascend of 5,000 feet and a total descent of 6,300 feet. The course connects the two nature reserves, Landamannalaugar and Thorsmork. It is one of the most popular hiking trails in Iceland and in 2012, National Geographic chose it as one of the twenty most beautiful trails in the world (*Laugavegur*, n.d.).

The trail can be broken up into a few different legs. Each with its unique scenery and challenges but together they form a magnificent untouched and diverse wilderness. The first

leg of the race goes from Landmannalaugar to Hrafninnusker and is about 6 miles apart from each other in a straight line. Right at the beginning, the ascend is very steep so hiking, to begin with, is recommended so the runners don't exhaust themselves too early on. The next leg is from Hrafninnusker to Aftavatn, about 7 miles apart in a straight line. It starts with gulleys filled with snow and ice and moves on to muddy and slippery trails through a series of hot springs. The runners have to navigate through the slippery slopes carefully since losing their footing could end up horribly wrong. The second leg ends with a steep descent and at the bottom of the hillside is the first river the athletes need to cross. The third leg goes from Aftavatn to Emstrur. The trail is for the most part level but over sand which can be soft and the run-through is therefore often slow. That part of the course also includes the deepest river of the race that can reach the runners up to the mid-thigh. The last leg is from Emstur to Thorsmork and features yet another new type of nature and scenery. It includes steep inclines and starts with the runners navigating through a narrow trail in a canyon. The last river is then crossed before finishing the race off with a three-mile-long path in the woods (IBR, n.d.).

**Figure 1**

*Map of the trail Laugavegur*



Running in the wilderness of Iceland's highlands always includes a certain amount of risk. One of these risk factors is the weather which can be diverse and have a large impact on the runners' performance. If the preceding winter was cold there could be quite an amount of snow and ice on the way, slowing the runners down. At the highest altitudes, the conditions can be very harsh with winds reaching up to 45 miles per hour, pouring rain, and even hailstorms. Sunshine and heat can also make it more difficult for athletes where there have been instances of people needing intravenous fluids to treat dehydration.

The weather can also change rapidly and even if the race starts in good conditions there is no guarantee it stays that way the whole race. Therefore the runners need to be prepared for various conditions and equipped with safety equipment since the distance they are running is long and the members of the staff are often far between.

### **Product Range**

The product range for the proposed project is a full apparel competition outfit for elite male runners at the Laugavegur Ultra Marathon. That includes a waterproof and windproof running jacket, a top, shorts, leg sleeves and arm sleeves. The outfit will be designed to help the runners finish the race in the shortest time possible by being adaptive to the environment, increasing their running economy and carrying the necessary equipment. The colors and graphics of the products should emphasize the innovations and performance-enhancing features in the garments. As well as be relevant to the athlete's psychographic profiles.

### **Rules and Regulations**

There are no rules when it comes to the design of the products the runners can wear during the race, but there are several rules for the race itself. These rules need to be considered when designing the outfit to increase the chances of the runners' success. All participants need to be 18 years old and have an ITRA performance index of 370 or higher.

For added safety, all participants are required to bring a whistle, a jacket, a space blanket, and a mobile phone with them to the race. The space blanket is to be used to keep the runner warm in case of an accident or for other reasons if the runner needs to stop on the way to wait for assistance. The whistle is required in case participants get lost on their way due to bad weather or fog or are in need of assistance. And if a runner gets injured he should call emergency services.

All participants need to bring their own drinking cups or bottles and carry them throughout the course since no cups are provided at the drinking stations. There is also a strict prohibition against throwing any kind of litter along the way and human waste or anything else. Finally, participants must finish the race in under 9 hours and 15 minutes. (*Laugavegur Ultra Marathon Race Rules - Laugavegur Ultra Marathon, n.d.*)

### **Product Anatomy**

The competition outfit consists of three garments. Each garment can be dissected into different components where each part has a different function and a job to be done.

A running jacket features five different components; a hood, a zipper, a body, sleeves, and air vents. The hood protects the wearer from harsh conditions, and the zipper makes donning and doffing easier. Both the body and sleeves provide wind and rain protection while the air vents increase ventilation (*Bonatti Waterproof, 2022*).



**Figure 2***Running jacket anatomy*

A hydration vest consists of five components; front, back, and side panels, storage compartments, and adjustment bands. The front, back, and side panels work together to optimize the fit while allowing freedom of movement. The pockets and compartments are for storage of flasks and other essential items. And the adjustment bands limit bouncing by stabilizing the vest (*ADV SKIN 5*, 2022).

**Figure 3***Hydration vest anatomy*

Pants are made out of five components; waistband, pant legs, gusset, cuffs and pockets. The function of the waistband is to hold the pants up and in place, the pant legs protect the legs from the environment, the gusset is extra fabric in the crotch for increased mobility, the cuffs keep the pant legs in place and the pockets are to store items (Luna, 2019).

**Figure 4**

*Trail running pants anatomy*



## Key Competitors

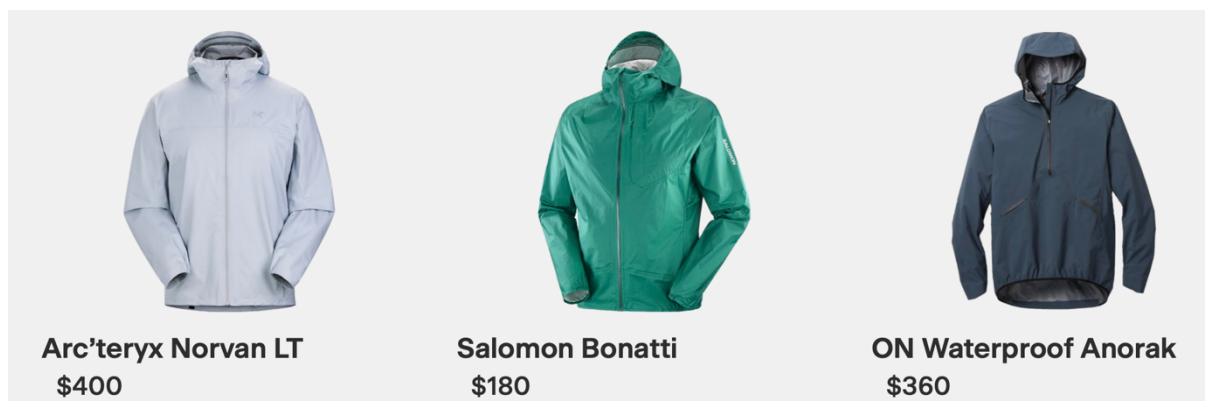
There are multiple options for runners to choose from when buying garments for trail running. With the recent increase in trail-running popularity, more brands have started to offer specialized trail-running product lines. This section will outline a few of those products to investigate what features and benefits are common among state-of-the-art garments.

Three of the most popular and best-performing waterproof running jackets are Arc'teryx Norvan LT, Salomon Bonatti, and ON Waterproof Anorak (Alastair, 2022). The Arc'teryx Norvan LT retails for \$400. It features GORE-TEX fabric for windproof and waterproof protection while providing breathability, it has articulated sleeves for mobility

and comfort and an adjustable hood for full weather protection (*Norvan LT Hoody Men's*, n.d.). The Salomon Bonatti retails for \$180. It features AdvancedSkinDry technology that protects from rain and wind while providing breathability, a chest pocket to secure light items close to you, and extra volume in the back to make room for hydration vests (*Bonatti Waterproof*, 2022). The ON Waterproof Anorak retails for \$360. It features vents in front and back to increase airflow and breathability, it packs into its own inner pocket to be stashed into the hydration vest and a three-layer membrane for waterproofing and breathability (*The Waterproof & Breathable Anorak*, n.d.).

## Figure 5

*State-of-the-art trail running jackets*

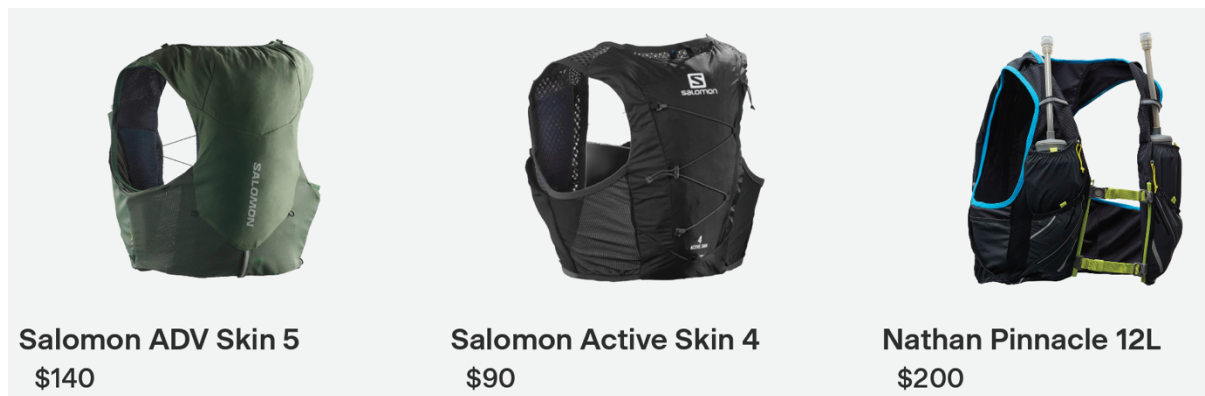


The three most popular and highest-performing hydration vests are the Salomon ADV Skin 5, Salomon Active Skin 4, and Nathan Pinnacle 12L. The Salomon ADV Skin 5 retails for \$140. It features SenseFit construction for a snug fit with optimal comfort, expandable pockets to store essential items, and an elastic sternum strap to adjust the pack quickly on the fly. The Salomon Active Skin 4 retails for \$90. It features SenseFit construction for optimized fit and stability, pockets and compartments to store flasks and other objects and elastic straps which makes it easier to breathe on the fly. The Nathan Pinnacle 12L retails for

\$200. It features tapered back panels to keep the moisture out, a long back for efficient dispersed capacity and thoughtful storage which are always within reach to store important items. (Abegg, 2022).

## Figure 6

*State-of-the-art hydration vests*



Three popular running pants among trail runners are the Salomon Cross Run Tights, Nike Dri-Fit Phenom Elite Pants and Nike Dri-Fit Trail ½ Length Running Tights. The Salomon Cross Run Tights retail for \$80. They feature a 4-way stretch for light muscle support, two strategic stretch pockets to keep gels, keys or smartphones close and secure on the move and an adjustable waistband for a perfect fit (*Cross Run Tights*, n.d.). The Nike Dri-Fit Phenom Elite Pants retail for \$105. They feature multiple pockets for storage, Dri-Fit technology that moves sweat away from the skin and zippers at the ankles for making it easier to take the pants on and off (*Nike Dri-FIT Phenom Elite*, n.d.). The Nike Dri-Fit Trail retails for \$80. They feature a tight fit for a body-hugging feel, multiple pockets to keep essential items secure and Dri-Fit technology that moves sweat away from the skin (*Nike Dri-FIT Trail*, n.d.).

## Figure 7

### *State-of-the-art trail running pants*



Further analysis of the anatomy of the products with SWOT analyses which investigates the strengths, weaknesses, opportunities and threats of every anatomical part of the main competitor garments can be found in Appendix B.

### **State-of-the-Art Materials and Manufacturing**

This section will overview the state-of-the-art materials and manufacturing methods used in the products listed above; a waterproof running jacket, a hydration vest and running pants.

The main material of the running jacket is 100% woven nylon or Gore-Tex with a DWR finish. The zipper is 100% stainless steel with nylon teeth. The first step in the manufacturing process is waterproofing the fabric followed by cut-and-sew methods. The fabric passes through a series of rollers and into a tank containing a bath of waterproofing materials and the chemicals are allowed to soak into the fabric. The fabric is removed from the bath and heated so the chemicals soak evenly into the fabric. The fabric passes through another series of rollers and is allowed to cool. This allows the chemicals to harden and stay in place in the fabric (*Raincoat*, n.d.). The fabric is then cut into patterning pieces which are

then sewn together. The seams are water-sealed and lastly, trims are sewn to the jacket (Miller, 2022).

The hydration vest features several different parts, each with a slightly different material. The body is 84% nylon and 16% elastane mesh, the back insert is 89% nylon and 11% elastane knit, the back body is 100% polyester mesh, the body insert is 88% nylon and 12% elastane knit, the foam is 100% polyethylene and the lining is 100% nylon spacer mesh (*Salomon ADV 5*, n.d.). It's manufactured using cut-and-sew methods. Materials are sourced and cut into patterning pieces. The different panels are then sewn together and trims added.

For the trail running pants, the pant legs and gusset are 90% polyester and 10% elastane knit, the pockets are 80% polyester and 20% elastane mesh, the waistband is elastic rubber band and 90% polyester and 10% elastane knit and the cuffs are is 90% polyester and 10% elastane rib knit (*Nike Dri-Fit Trail*, n.d.). The pants are made by conventional cut-and-sew methods.

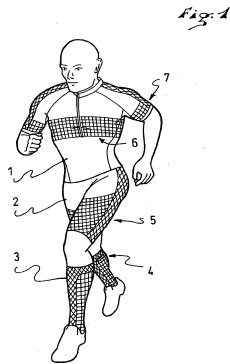
### **Intellectual Property Landscape**

Relevant patents in the trail running product space include patents on compression for baselayers, upper and outsole bonding in footwear, and ventilation for jackets.

*Close-fitting sports garment* – European Patent No. EP2449901B1 presents an invention related to fitted sportswear and in particular clothing intended for activities requiring postural support. Postural support is particularly important for endurance sports, such as running in the mountains or on rough terrain. The object of the invention is a garment with compression zones to provide postural support. It helps keep the joints stable to decrease energy expenditure during trail running (Chapuis, 2010).

**Figure 8**

*Close-fitting sports garment*

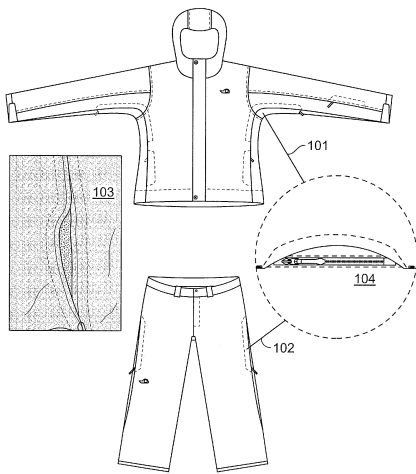


*Venting apparatus with no-catch mechanism* – U.S. Patent No. US8713712B2

describes a venting apparatus with a no-catch mechanism and a method of manufacture of the apparatus are described. More particularly, embodiments of the present invention may comprise: a fastening device, a venting mechanism wherein the venting mechanism further comprises an opening, a mesh arrangement, and a no-catch mechanism (Maurer, 2014).

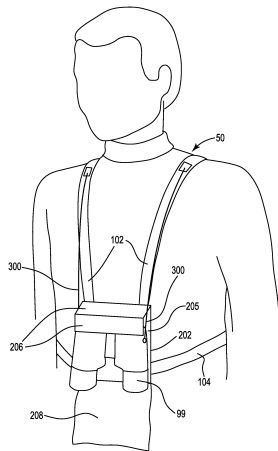
**Figure 9**

*Venting apparatus with a no-catch mechanism*

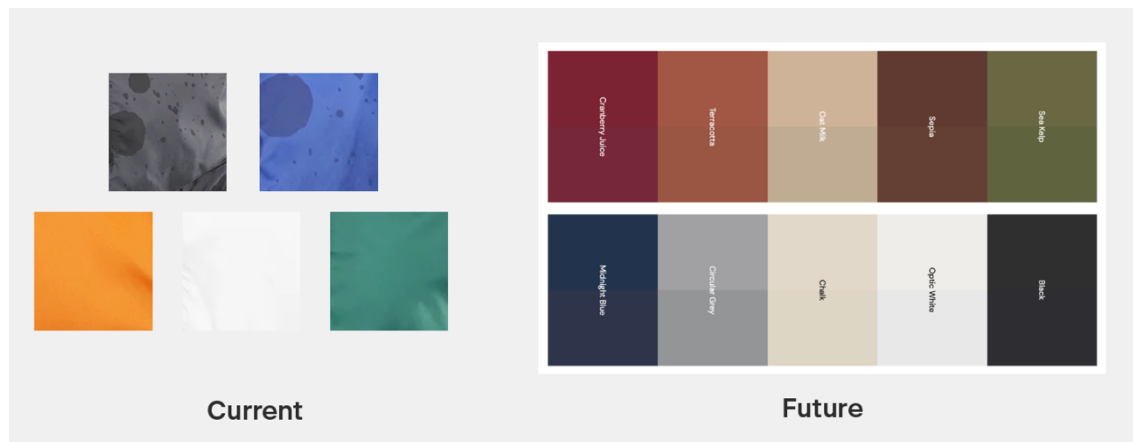


*Equipment Carrier with Tensioned Tether for Retaining Equipment in an Equipment Holder* – U.S. Patent No. US20200022484A1 describes an equipment carrier configured to secure at least one piece of equipment to a user, and corresponding method. The equipment carrier includes at least one equipment holder configured to be secured to the user. The equipment holder includes an engaging portion configured to receive the equipment. At least one tether includes a first portion attached to the equipment and a second portion attached to the user at a second location offset from the engaging portion (Hunt et al, 2013).

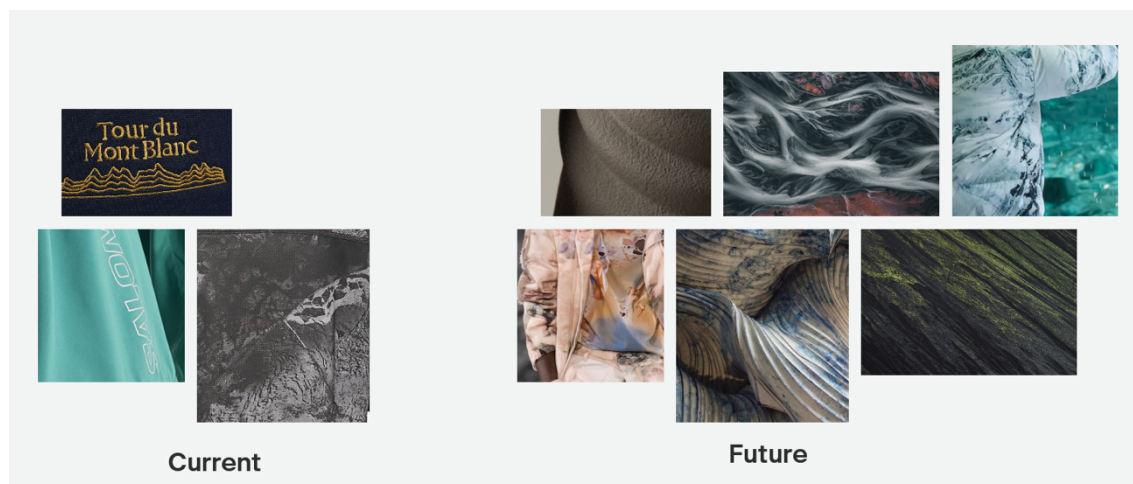


**Figure 10***Equipment Carrier with Tensioned Tether***Trends – Color, graphic and branding**

A relevant WGSN global color forecast says that as consumers gain a broader understanding of environmental issues, caring for the planet will become just as important as caring for ourselves. They see a continued focus on the climate, seasons, and locality. Colors will increasingly align with long-term and sustainable shades, as seen in the rise of foundational mid-tones and neutrals (Smith, 2022). The color palette chosen is a balanced palette of warm and cool tones, which are chosen with longevity in mind.

**Figure 11***Current and future color trends*

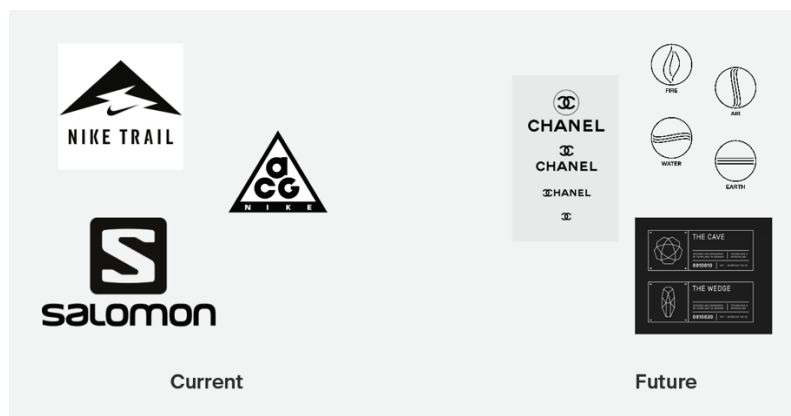
The diverse nature and landscape of Iceland have been the source of inspiration for the graphics in many Icelandic garments. Humans are deeply rooted in the strong connection of nature in the world around them, so the organic and flowing graphics are all about using natural and tactile elements to evoke the feeling, sight and sound of being immersed in nature (Rimmer, 2022).

**Figure 12***Current and future graphic trends*

The current trends for logo and branding are minimalistic and focus on three elements; infographics, adaptability, and purpose. Infographics are used on products to deliver a message and provide information about the product. The logo of many products are incorporated into the infographics. Nowadays companies have to be everywhere if they want to be noticed. It is not enough to only have a physical store or an advertisement in print. To thrive in the digital age, companies will have to have an online presence as well. Because of that, it's important to have a logo that can change in size, complexity, or color depending on what they are used for (Chang, 2022). That is logo adaptability. And lastly, the logo should be a manifestation of everything that the brand stands for. That's how the logo gets its purpose.

### Figure 13

*Current and future logo trends*



## **Physiology**

Performance in trail running can be predicted by the physiological characteristics of the runners. For a 35-mile-long trail race, there are four key physiological determinants, which can predict the runners' performance. Previous to the race, each runner was evaluated with lab tests to determine their physiological parameters. Correlations and multiple linear regressions were then used to find the determinants of performance in the race. The correlation is given with an  $r$  value which is always a number between -1 and 1 where  $r$  bigger than zero indicates a positive association.

The most important determinant is maximal oxygen uptake ( $VO_2$  max), which is the maximum rate of oxygen consumption attainable during physical exertion. The second most important factor is the max velocity at 12% grade, tested on a treadmill. The correlation for these two factors were  $r=0.86$  and  $r=0.85$  respectively. The third and fourth most important determinants are fat/carbohydrate oxidation at 6.2 mph with a correlation of  $r=0.59$  and knee extensor strength with an  $r$  value of 0.58 (Pastor et al., 2022).

## **Biomechanics**

Running biomechanics is the study of how the body moves and the relationship between those movements and the forces that cause them. In trail running, proper biomechanics is important to minimize the risk of injuries and to improve running economy, which increases performance (Jyoti, 2020).

The study of running biomechanics usually begins by looking at the gait cycle. This cycle starts when one foot makes contact with the ground and ends when that same foot makes contact with the ground again. It can be divided up into two phases; the stance phase and the swing phase. The stance phase is defined as the duration the foot is in contact with the ground, while the swing phase is the duration the foot is airborne. In between these two

phases are two periods where neither foot is in contact with the ground, which is referred to as float (Phillips, 2020).

The stance phase can be divided into four stages; initial contact, absorption, midstance, and propulsion. The initial contact marks the beginning of the stance phase and is the moment the runner lands. Runners can have slightly different gait cycles and therefore the runners can either land on their heel, midfoot, or forefoot. Forefoot running is more energy efficient than heel striking and the majority of elite runners use that style of running (Kasmer et al., 2013). Following the initial contact is absorption where tendons and connective tissue within the muscles store elastic energy for later use in the propulsion stage. The midstance is when the leg is directly under the hips taking the maximum load. The last stage is propulsion when the hip, knee, and ankle extend to push the body up and forward. The swing phase can be divided into two stages. The initial swing, where the quads and hip flexors contract concentrically to swing the leg forwards, and the terminal swing, where almost all the muscles of the lower limb activate in this phase to straighten the hip, knee, and ankle for the next initial contact. (Phillips, 2020).

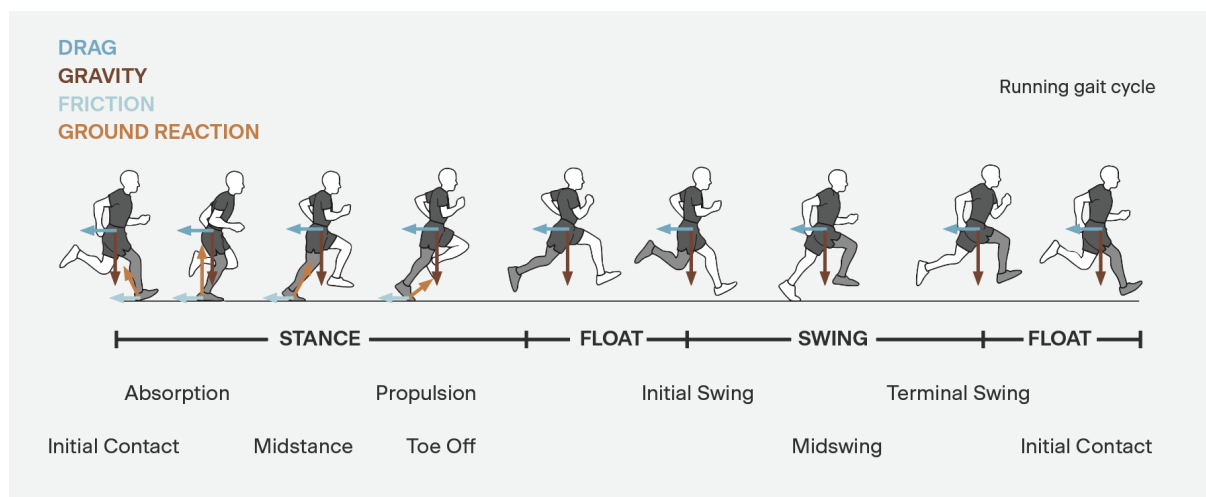
As gait velocity increases from slow to fast walking and then to running, the duration of the stance phase decreases, while the duration of the swing phase changes little. With increases in speed, the stance–swing ratio changes from 60:40 in normal walking to 20:80 in sprinting at 20 mph. Running speed is calculated as the product of stride length and stride rate (cadence). Initial increases in speed are made primarily by lengthening the stride while velocity increases at higher speeds are achieved by quickening the cadence, largely because there is an anatomical limit to stride length (HEHNE, 1990).

Out of the two phases of the gait cycle, the stance phase is more important because that's when the foot lands on the ground. If not done properly, the impact of the ground reaction forces can lead to injuries and impact running performance (Jyoti, 2020). The

external forces acting upon the body when running are following. The ground reaction force is the impact of the body with the ground. Drag force is the air resistance that occurs between the air and the runner and slows him down. Gravity is the force between the runner and the earth pulling straight down on the body when running upright. And lastly, the frictional force allows the runner's shoe to grip the ground.

**Figure 14**

*The gait cycle*



## Psychology

Psychology plays a major role in distance and trail running performance. The psychological effects on performance can be explained through what the runners think, how they feel, and subsequently the way they behave (Bandura, 1997). There are a wide array of these psychological factors that can play a role in distance running. Runners may have self-doubts in their ability, lack motivation, and have negative emotions when the race gets tough and things don't go as expected. To help manage these factors, the runners can use psychological strategies such as self-talk, imagery, and goal setting (Blagrove & Hayes, 2021).

Self-belief or confidence is one of the most important psychological factors that plays a role in distance running. Confidence is dynamic and can change based upon how well training sessions have gone, performances in races, and injuries. Motivation can be of two types; self-determined and non-self-determined. Non-self-determined motivation relates to external regulation like an external reward so the runner does not have full control over it. While self-determined motivation is internal, meaning the runner has more control over it and is therefore associated with more positive outcomes (Ryan & Deci, 1999). Ultra-marathon can be a rollercoaster of emotions where a runner may experience nerves just before the start, excitement during the first couple of miles, and towards the later stages. Emotions are a response to what is happening in the athlete's environment, or a response arising from thoughts in an athlete's mind. They need to understand what influences these emotions so they are less likely to impair the runner's performance (Lazarus, 2000).

Internal dialogue or self-talk can be used strategically to have positive outcomes and increase confidence. Runners can use statements to focus their attention on their technique like '*Keep good rhythm*' or motivational statements like '*I can do this*'. Imagery is used to re-create or create a new experience in the mind using multiple senses. That way, athletes can imagine an upcoming race or use imagery to reflect on a previous successful race or training session. When faced with adversity in the middle of a race, chances are they have envisioned it beforehand and are therefore better prepared in coping with it. The last psychological strategy is goal-setting. Goal-setting has consistently been demonstrated as one of the most effective human behavior techniques. Goals can fuel motivation, by encouraging persistence in the pursuit of the runner's aims and helping to direct their attention (Tenenbaum et al, 1999).

### **Athlete Insights**

Additional information was collected by sending out questionnaires and interviewing runners that have competed in the Laugavegur Ultra Marathon. The goal was to get a better understanding of the trail itself, where and what are the most challenging parts of the race, and how they dealt with it. As well as what are the types of equipment and garments they wear during the race and how they feel about them. The questions in the questionnaire can be found in Appendix A.

One of the interviews conducted was with Arnar Petursson, the winner Laugavegur Ultra Marathon for the last two years and 53 times Icelandic Champion in distance running. Below are some of the key takeaways from the interview.

“Having the vest full of items bouncing around can be very distracting. I did not store any liquid in the vest, I started out with one flask with 500ml of liquid and had it in my hand all the time.”

“Moving the weight of the items stored in the vest from the chest area towards the hips where the center of mass of the body makes you feel the weight of it a lot less.”

“Being able to quickly change outfits on the go is essential. During the point of highest elevation, I had a jacket on, gloves and a buff covering up to my eyes but I was still freezing. But at the finish line, I had taken all of it off and finished the race shirtless.”

### **Performance Testing Plans**

To determine a baseline of how the proposed products should perform, competitor products will be purchased, tested and analyzed. The three products tested are the Salomon Bonatti running jacket, Salomon ADV Skin 5 hydration vest and Nike Dri-Fit Trail running tights. These products will be tested for running economy, donning and doffing, and fit and comfort.



The first test will test the running jacket by measuring the effort needed when running downhill. It will take place at the skiing slope Artunsbrekka in Iceland. A video and muscle activity of the quadriceps and soleus muscles will be captured while an athlete runs downhill wearing the Salomon Bonatti jacket. A detailed testing plan can be found in table 1.

**Table 1**

*Downhill running economy testing plan*

Step	Details	Documentation	Time
Paperwork and background information	Consent form Name, age, weight and background in the sport	Form and questionnaire	5 min
EMG sensors calibration	Normal jogging at easy pace on level ground to get base level data from the EMG sensors	EMG sensor data	10 min
Product performance	Downhill running wearing the Salomon Bonatti running jacket	Video Photos EMG sensor data	15 min
Post-test questions	The athlete completes a post-test questionnaire to rate his perceived effort	Questionnaire	5 min

The second test will test the running jacket and hydration vest together to determine the ease of taking off the jacket, storing it in the vest and putting it on again while running. The test will take place on a level ground trail in Ellidaardalur in Iceland. Video will be taken of an athlete performing the task described above. Time will be measured with a stopwatch and effort determined through a questionnaire. A detailed testing plan can be found in table 2.

**Table 2***Jacket donning and doffing testing plan*

Step	Details	Documentation	Time
Paperwork and background information	Consent form Name, age, weight and background in the sport	Form and questionnaire	5 min
Practice	Athlete practices taking off the jacket and storing it in the vest while standing still	Video	10 min
Product performance	Athlete jogs at easy pace and takes off the jacket and stores it in the hydration vest.	Video Time	15 min
Post-test questions	The athlete completes a post-test questionnaire to rate how easy the process was	Questionnaire	5 min

The third test will test the hydration vest and pants for bounce when pockets are full of water and nutrition gels. The test will take place on the treadmill in the Nucleus Lab at the Portland Campus of the University of Oregon. A video will be captured of an athlete running on a treadmill with pockets full of water and nutrition gels. The vertical displacement of each garment during each step will be calculated using computer software. A detailed testing plan can be found in table 3.

**Table 3***Vest and pants bouncing test*

Step	Details	Documentation	Time
Paperwork and background information	Consent form Name, age, weight and background in the sport	Form and questionnaire	5 min
Preparing	Dots placed on pants and vest and pockets filled with waterbottles and nutrition gels.	Video	5 min
Bounce test	Athlete runs on treadmill and video recorded from the front view	Video	5 min
Post-test questions	The athlete completes a post-test questionnaire to rate the comfort of pants and if they hinder his movements	Questionnaire	5 min
Video analysis	Displacement of dots on hydration vest and pants measured in DartFish video analysis software	Data from Dartfish	20 min

**Professional Interests**

This section outlines my top strength according to the strengths finder test and how these strengths can be utilized for this project.

**Personal Strengths**

1. Competition
2. Achiever
3. Learner
4. Focus
5. Futuristic

**Golden Circle Statement**

Why? To inspire athletes to reach their full potential no matter at what level they compete.

How? By creating innovative and high-performing sports products

What? Running apparel and footwear

### **Project Alignment**

My top strength according to the strength finders test is competition. The outfit I will be designing is for competitive runners and therefore I feel like I can very well relate to them. Being a competitive runner myself I can understand their passion and drive to be successful and the faith they have to have in the products they use in their sport. A lot of products already exist in the trail running space so I am also eager to look at my thesis project as a competition to the existing products and do everything in my power to make mine better. I am also ambitious in my product line-up and have everything designed and made by the end of May 2023. I will need to have an extreme focus to get everything done by that time and prepare for when things don't go as planned and remind myself that achiever is one of my top strengths so I can get through it. I will also be doing a lot of things for the first time so I will have to learn new things along the way.

After graduation, I want to design running apparel. After this project, I will have a range of running garments that I can showcase in my portfolio to future employers. At large companies, the role of each person within each design team is often very specific. By doing all of the steps of the design process myself I will get a better understanding of what area of the design process I want to work at. And getting experience doing every step helps to expand my opportunities of getting a job within a design team. Choosing trail running as a topic also keeps my options open to getting a job in the outdoor industry. One of the most exciting opportunities for apparel designers in Iceland is at a company called 66 North, which is an outdoor brand.

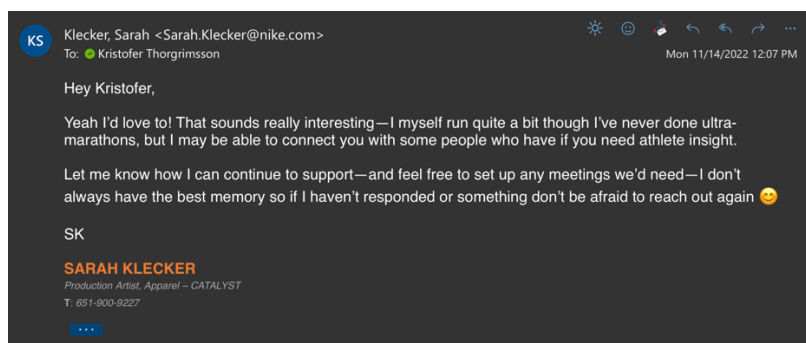
## Mentors

My first mentor is Sarah Klecker. She is an SPD alumnus and currently works as a Design Apprentice in Catalyst Apparel at Nike. Being an alumnus of the SPD program she has experience doing this project and could therefore provide valuable insights into what made her project successful.

My second mentor who came into the project at later stages is Rhys Mckenna. He is a senior designer for athlete concepts at adidas Terrex. Rhys gave meaningful feedback during the aesthetic phase of the project. He studies fashion at Edinburgh University and has experience designing for Burberry, Stella McCartney and adidas amongst others.

## Figure 15

### *Confirmation from Sarah*



## **Functional Design Process**

The main objective of the designed outfit is to allow the athlete to finish the Laugavegur Ultra Marathon fast and safely. Focusing on improving running economy, creating storage for the items the athlete needs to carry and making sure the outfit is adaptable to various weather conditions.

For simplicity and making it easier to follow the design process along. The race and the design process have been broken up into five segments. Each segment focusing on one of the challenges the athletes have to face during the race. They are the start of the race, mountain ascent, mountain descent, weather conditions, and the finish line.

### **Start**

Before the start of the race, the athletes need to find a way to store every item they need during the race. According to the rules, carrying a space blanket, a mobile phone, a whistle, and a jacket is mandatory. And based on athlete interviews, the majority of athletes competing in the Laugavegur Ultra also carry energy gels, a water flask and extra garments. Some of these items need to be easily reachable at all times, like the energy gels, the water flask and the extra garments. While the space blanket and the phone are only needed in emergencies.

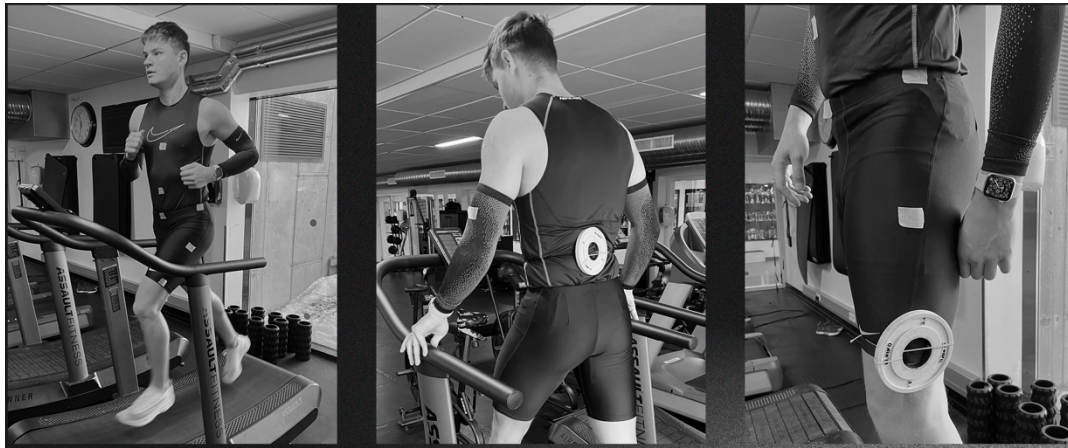
**Figure 16**

*The items carried by athletes in Laugavegur Ultra*

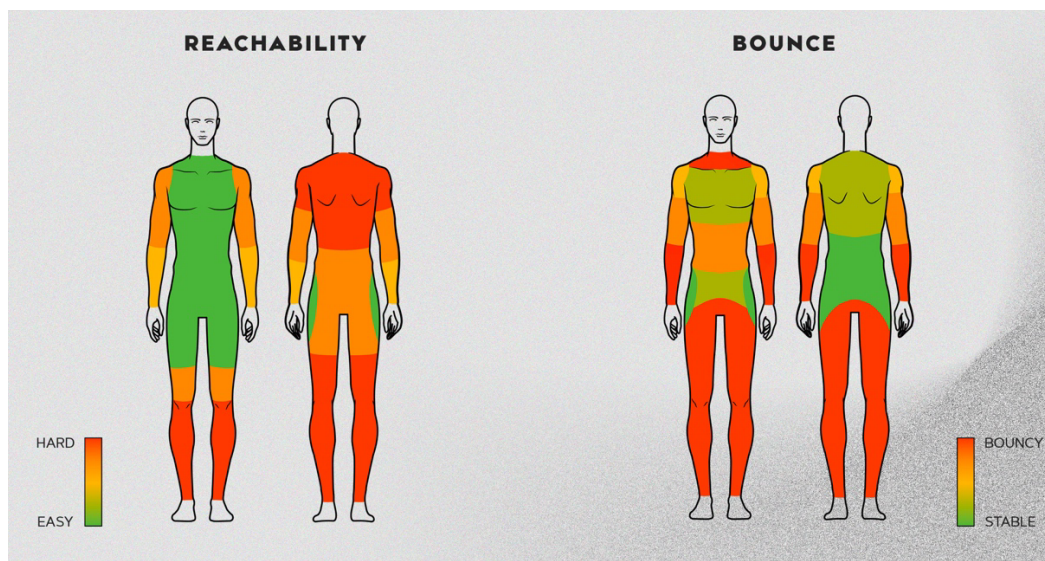


As previously mentioned, the two factors to consider when deciding where to store these items are reachability and bounce. During trail running there is quite a lot of vertical placement in each step, which means that the heavier items, like the water flask and the mobile phone, could bounce around if they aren't secured and placed properly. That is annoying and uncomfortable to the athletes and could slow them down.

To maximize reachability and minimize bounce, a test was performed. Stickers were placed on the athlete's body on potential pocket placements as can be seen in figure 17.

**Figure 17***Pocket placement testing*

The athlete was then asked to evaluate the reachability at each potential pocket placement. And how much bounce he could feel when a one-kilogram weight was placed in the same places. Based on these findings, two different body maps were created.

**Figure 18***Reachability and bounce body maps*

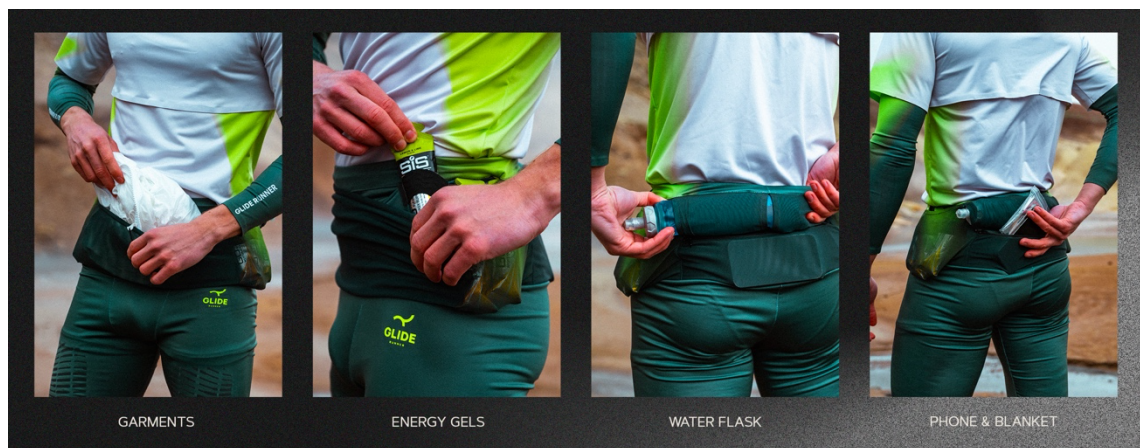


On the reachability body map, it's clear that everywhere on the front of the body and the sides of the hips are easily reachable. So that is where a pocket for the energy gels and extra garments will be placed. The bounce body map shows that heavy items, like the water flask and the phone, are best to be stored on the lower part of the back.

Every item that needed to be stored could be placed on the shorts. The shorts have a large kangaroo pocket in front to store extra garments. On each side of the kangaroo pocket, there are elastic silicone grippers for the energy gels. A pocket for the water flask on the lower part of the back. And beneath, a zippered pocket for the phone and space blanket. By fitting every item on the shorts, the use of a hydration vest was eliminated which is uncomfortable to many runners.

**Figure 19**

*Shorts storage*



A performance test was conducted to evaluate the reachability and perceived bouncing of the water flask and energy gels in the newly designed outfit. And compare it to the benchmark products. The results showed less received bounce for the water flask in the Glide outfit compared to a Salomon hydration vest. The reachability was however a bit less. The energy gels also bounced less in the Glide outfit and the reachability was similar.

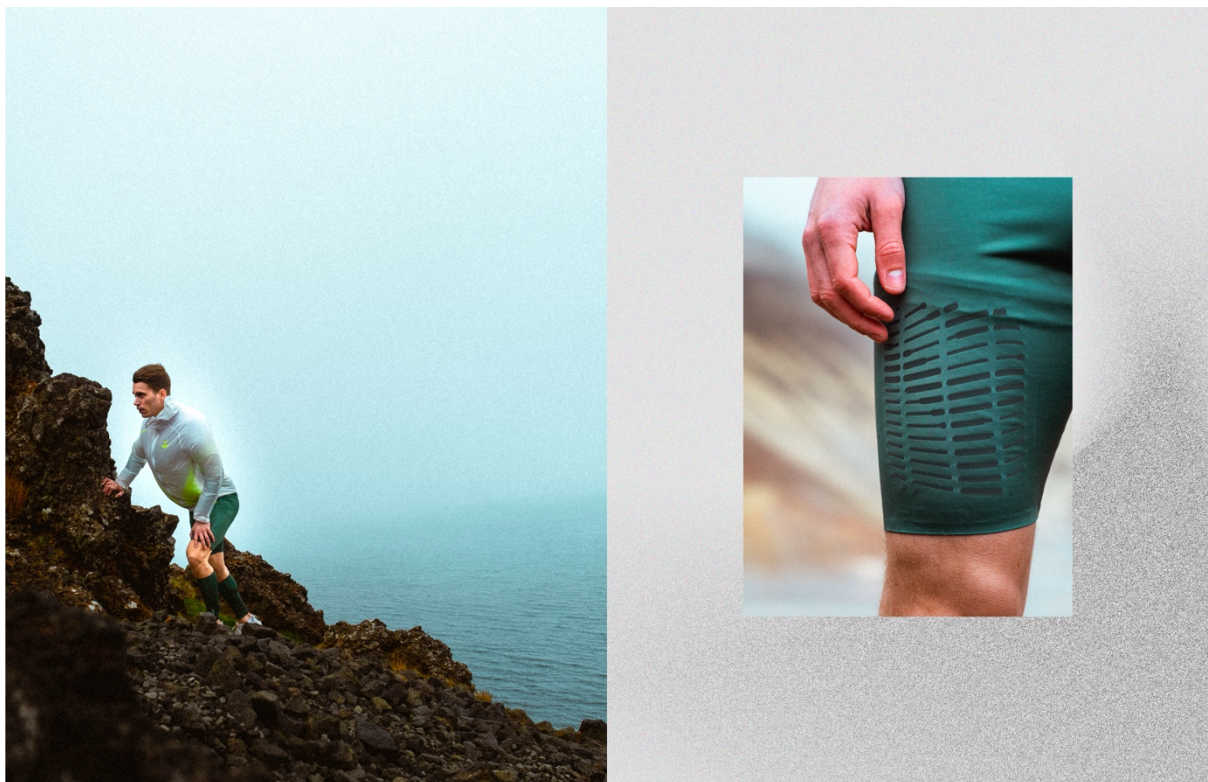
## Ascent

One of the many challenges the athletes encounter during the Laugavegur Ultra is mountain ascending. When trail runners climb steep hills they often use a technique called power hiking. In power hiking, the athletes use their hands to push their legs, decreasing the effort needed by the thigh muscles.

To minimize the slipping between the palms of the hand and the shorts. Grip panels were designed and placed on the front of the thighs of the shorts. The material used for the grip panels was silicone heat transfer vinyl.

### Figure 20

*Power hiking stance and the grip panel*



## **Descent**

Once the athletes have climbed a mountain they eventually have to descend as well. According to research, downhill sections are crucial for performance in trail running ultra marathons. Descending is very technical and those who are the fastest and can save the most amount of energy while descending are usually the ones who win the race (Genitrini et al., 2022). Therefore there is a lot to benefit from creating an innovation to help athletes descend hills faster.

The inspiration for the solution about how a garment can increase performance while running downhill came from growing up in Iceland. It was often very windy and while playing outside in the wind, the jackets were often used as sails to be able to catch the wind and be pushed around.

The innovation intended to have the athletes experience a similar feeling while running downhill. A jacket was designed with a sail on each side, stored inside a pocket while not in use. During descent, the athletes can engage the sails and use them to increase the silhouette of the jacket and therefore increase the wind resistance to help in brake. That way they can save a lot of energy, not needing to constantly use their legs to slow themselves down on the way down the hill. When running in a tailwind, the athlete can also use the sails to glide along.

**Figure 21**

*An athlete using sails to save energy while running downhill*



Lab testing was conducted measuring the drag force working on the jacket. To begin with, a benchmark jacket was put on a hanger and placed one meter from a fan. A force gauge was placed beneath the fan and attached with strings to the bottom part of the jacket. The fan was turned on to the highest setting and the force acting on the jacket was read from the force gauge and noted down. The fan was then turned off and the process repeated ten times. The results show an average of 1.2N working on the jacket. The raw data from the test can be seen below in table 4.

The drag force working on the new jacket increased from 1.2N, of the benchmark, to 1.7N. That is a 42% increase in drag force. One of the factors in the equation for drag force is area. The drag force is directly proportional to the area, meaning that if the area is doubled, the force will also double. The results of the testing are consistent with theoretical predictions, as the addition of the sails increases the area of the jacket by about 40%. The data from the test can be found in table 4.

**Table 4***Raw data from jacket wind resistance test*

<b>Benchmark</b>		<b>With sails</b>	
<b>Test</b>	<b>Results</b>	<b>Test</b>	<b>Results</b>
1	1.3 N	1	1.6 N
2	1.2 N	2	1.7 N
3	1.3 N	3	1.8 N
4	1.1 N	4	1.7 N
5	1.4 N	5	1.6 N
6	1.1 N	6	1.8 N
7	1.0 N	7	1.5 N
8	1.1 N	8	1.8 N
9	1.1 N	9	1.4 N
10	1.2 N	10	1.7 N
<b>Average</b>	<b>1.2N</b>	<b>Average</b>	<b>1.7N</b>

**Weather conditions**

During the race, the weather conditions can change very rapidly. The race could start in good conditions but as their altitude rises the temperature could drop, the wind start to pick up and rain start pouring down. Just as quickly, the sun could start to shine and the temperature increase. The athletes need to be prepared and equipped for all these conditions before the start of the race. The outfit they are wearing needs to be adaptable and every garment they want to use during the race, they need to carry from the start.



The jacket itself needs to be adaptable. The final design has a tight hood that stays put, even when running in headwind, thumbholes to cover the hands a little better when it's cold and a built-in whistle to call for help in case of an emergency and they need assistance.

## Figure 22

### *Jacket's features*



The layers underneath also need to be adaptable. Instead of the runners having to carry a sleeveless top, t-shirt, and sweater. The base layer was broken up into components to save weight. It consists of a sleeveless top, t-shirt crop top with a mock neck and arm sleeves. Each piece can be used individually or all together.

**Figure 23***The adaptable outfits*

It's not only important for the runners to have an adaptable outfit but also how quickly they are able to change outfits on the go. A jacket donning and doffing test was conducted to find out how long it takes to take off and put on a benchmark jacket to begin with. The runner was asked to take off the jacket while running on a treadmill at 5 km/hr and store it in the running vest. The runner was then asked to take the jacket from the vest and put it on again. The test was done five times and on average it took the runner 22 seconds to take the jacket off and store it in the vest and 29 seconds to take it out of the vest and put it on. The overall time was therefore 51 seconds. The raw data from the test can be seen below in table 5.

**Table 5***Data from jacket donning and doffing benchmark test*

	Take off	Put on	Overall
Test 1	18-sec	38-sec	56-sec
Test 2	25 sec	30 sec	55 sec
Test 3	22 sec	28 sec	50 sec
Test 4	21 sec	29 sec	50 sec
Test 5	21 sec	29 sec	50 sec
Average	<b>22 sec</b>	<b>29 sec</b>	<b>51 sec</b>

The same method as the benchmark test was copied to test the speed of the Glide Runner outfit's adaptability. The jacket donning and doffing for the new design took 49% less time in total. To take off the new jacket and store it in the shorts, took 11 seconds compared to 22 seconds for the benchmark jacket and the new jacket took 14 seconds to put on compared to 29 seconds for the benchmark. The data can be seen in table 6.

**Table 6***New jacket donning and doffing data and results*

	Take off	Put on	Overall
Test 1	13 sec	14 sec	27 sec
Test 2	11 sec	16 sec	27 sec
Test 3	10 sec	13 sec	23 sec
Test 4	11 sec	14 sec	25 sec
Test 5	11 sec	13 sec	24 sec
Average	<b>11 sec</b>	<b>14 sec</b>	<b>25 sec</b>



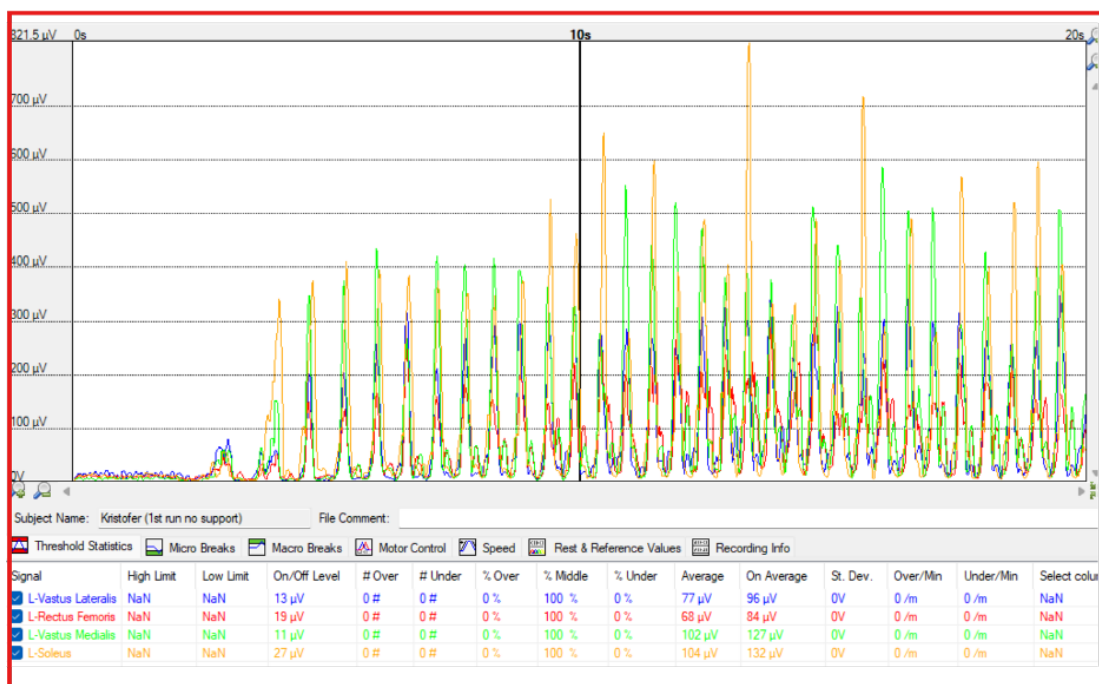
The main difference between the benchmark products and the new Glide Runner outfit is the placement of the pockets. The new and improved design features a kangaroo pocket in the front which is easier to reach than the storage at the upper back on the benchmark products. This change decreases the time it takes to stow the jacket and take it back out.

### Finish Line

Eventually, the athlete will finish the race and cross the finish line. To validate the design and measure the performance benefits of the outfit, EMG muscle activation measurements were conducted. A test subject ran downhill for 20 seconds in the newly designed running jacket, with and without using the sails. EMG signal was collected from the three quadriceps muscles; Vastus Lateralis, Rectus Femoris and Vastus Medialis, and Soleus which have the biggest action in downhill run. EMG area under the curve will give an estimate of the energy spent.

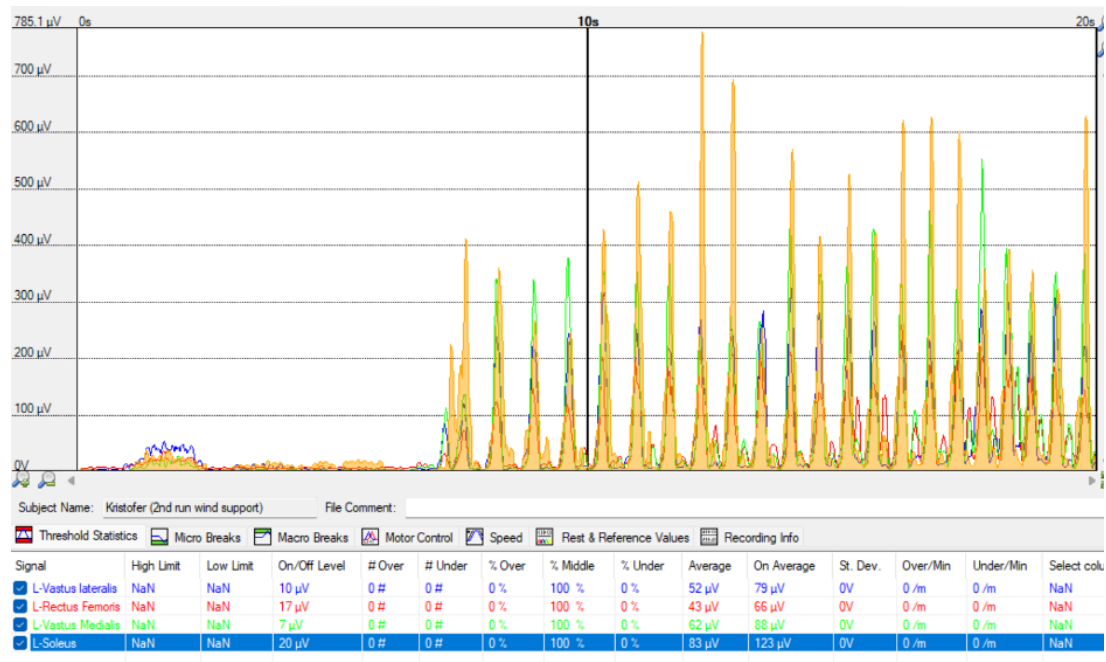
### Figure 24

*EMG data from benchmark test without sails*



**Figure 25**

*EMG data from test with sails*



There is a clear reduction in activity in all muscles no matter if looking at average or on average (area under EMG traces). The average of the “On Average” values show a 19% decrease in energy while running downhill with the sails engaged.

**Table 7***Data from EMG signals from the downhill running test*

	On Average	
	Benchmark	With Sails
Vastus Lateralis	96 $\mu$ V	79 $\mu$ V
Rectus Femoris	84 $\mu$ V	66 $\mu$ V
Vastus Medialis	127 $\mu$ V	88 $\mu$ V
Soleus	132 $\mu$ V	123 $\mu$ V
<b>Average</b>	109.8 $\mu$ V	89 $\mu$ V
Percentage difference	19 %	

### Aesthetic Design Process

This chapter will explain the aesthetic design process that followed the functional design process.

#### Moodboard

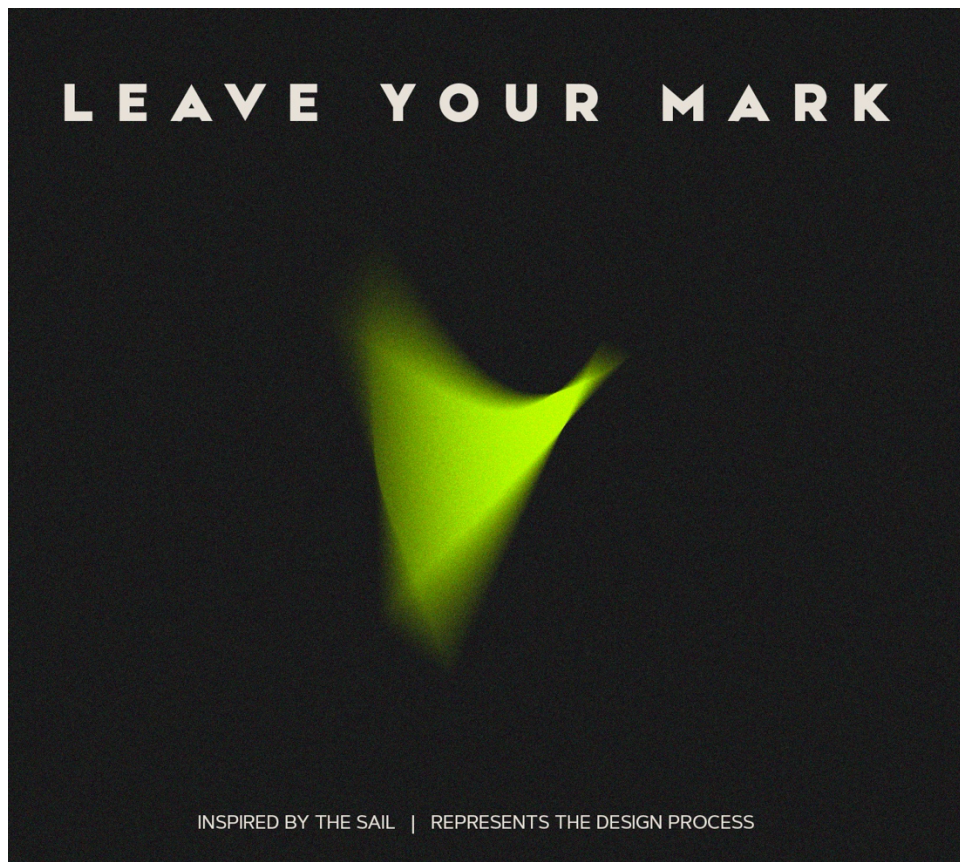
The color story for the final design is subtle anti-camo. The athletes are outdoor enthusiasts and care for the nature. That is reflected in the green and the light sand color inspired by the environment where the race takes place. The contrast between these two colors is then used to highlight the layering system in the outfit. One of the main objectives is safety, so the highly visible neon green is so the athletes can be more easily seen in case they get lost and need assistance. That same color is also used to highlight the main innovations in the outfit. The lightweight and semi-transparent fabrics reflect the liberating feelings the runners experience while running outside in nature.

**Figure 26***Moodboard for the aesthetics of the Glide Runner outfit***Graphics**

The title of the graphics created is “Leave your mark”. It is inspired by the silhouette of the sails in the jacket and is placed on the garments underneath the sails. So when the athletes take their jacket off, the sails have left their mark on the garments underneath. And the slogan, leave your mark, also encourages the runners to push themselves, set new personal records, and leave their mark on the community. Finally, this graphic represents the whole design process abstractly, starting with the blurriness of confusion, research, and ideation. Everything then comes together into a single point of focus and innovation. Making the functional design process leave its mark on the aesthetics.

**Figure 27**

*The graphic placed on the Glide Runner outfit*

**Final Outfit**

The final outfit consists of shorts, a sleeveless top, a crop top with mock neck, leg sleeves, and arm sleeves. For the final design, the focal point of the whole outfit was one of the main considerations. The intention was for that to be the main innovation, the sail in the jacket. That's why the jacket is in a neutral white color but the sails are colored in bright neon green so it will catch people's attention. It also helps in case the athletes get lost and need to make themselves more visible. And since the jacket is made from lightweight fabric, it's semi-transparent. So when the sails are inside the pockets, they are slightly visible through the fabric. Invoking curiosity about what's inside of the jacket. The sail-inspired graphics are placed on each side, directly underneath the sails. So it's like the color of the sails bleed onto



the garments below, leaving their mark. Reminding the athletes of the performance benefits in their outfit even though they aren't wearing the jacket.

### Figure 28

*3D render of the full product lineup*

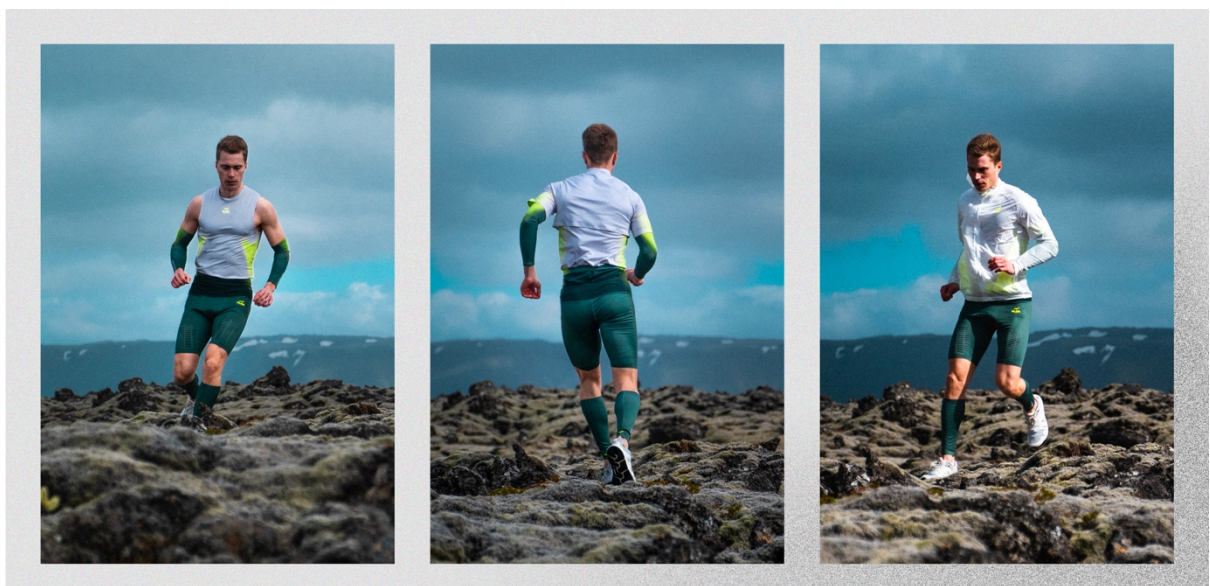


**Figure 29**

*The Glide Runner outfit on person*

**Figure 30**

*Athlete running in the Glide Runner outfit*



## References

- 126 Running Statistics You Need to Know in 2022*. (2022, March 29).  
 Livestrong. <https://www.livestrong.com/article/13730338-running-statistics/>
- Abegg, J. (2022, November 19). *Best Running Hydration Vests and Packs of 2022*.  
 Switchback Travel. <https://www.switchbacktravel.com/best-running-hydration-vests-packs>
- ADV SKIN 5*. (2022, June 1). Salomon. <https://www.salomon.com/en-int/shop-int/product/adv-skin-5-lc11659.html>
- Alastair. (2022, December 3). *The Best Waterproof Running Jackets For Trail Running [2022]*. Trail & Kale. <https://www.trailandkale.com/gear/best-waterproof-running-jackets-for-trail-running-ultrarunning/>
- Norvan LT Hoody Men's*. (n.d.). Arc'teryx Equipment.  
<https://arcteryx.com/us/en/shop/mens/norvan-lt-hoody>
- Bandura, A. (1997). *Self-Efficacy: The Exercise of Control* (1st ed.). Worth Publishers.
- Bonatti Waterproof*. (2022, July 8). Salomon. <https://www.salomon.com/en-int/shop-int/product/bonatti-waterproof-lc11935.html>
- Blagrove, R., & Hayes, P. (2021). *The Science and Practice of Middle and Long Distance Running* (1st ed.). Routledge.
- C. Smith. (2022, September 28). *Global Colour Forecast A/W 24/25*.  
<https://www.wgsn.com/fashion/article/631f257077022e777143353a>
- Chang, J. (2022, January 14). *17 Branding Trends for 2022/2023*. Financesonline.com.  
<https://financesonline.com/branding-trends/>
- Chapuis, S. (2010). *Close-fitting sports garment* (Patent No. EP2449901B1). European Patent Office. <https://patents.google.com/patent/EP2449901B1/en?q=trail+running&oq=trail+running>



## References

*Cross Run Tights*. (n.d.). Salomon.

<https://www.salomon.com/en-us/shop/product/cross-run-lc11667.html>

Genitrini, M., Fritz, J., Zimmermann, G., & Schwameder, H. (2022). Downhill sections are crucial for performance in trail running Ultramarathons—A pacing Strategy

analysis. *Journal of Functional Morphology and Kinesiology*, 7(4),

103. <https://doi.org/10.3390/jfmk7040103>

HEHNE, H. J. (1990). Biomechanics of the Patellofemoral Joint and Its Clinical Relevance.

*Clinical Orthopaedics and Related Research*, 258(NA;), 73??85.

<https://doi.org/10.1097/00003086-199009000-00011>

Hunt, F., Engstrom, J., & Pellet, A. (2013). *Equipment Carrier with Tensioned Tether for*

*Retaining Equipment in an Equipment Holder* (Patent No. US20200022484A1). FL

ARCHERY HOLDINGS

LLC. [https://patents.google.com/patent/US20200022484A1/en?q=hydration+vest&oq](https://patents.google.com/patent/US20200022484A1/en?q=hydration+vest&oq=hydration+vest)

[=hydration+vest](https://patents.google.com/patent/US20200022484A1/en?q=hydration+vest&oq=hydration+vest)

Hunter-Gatherer. (2022, October 12). In *Wikipedia*.

<https://en.wikipedia.org/wiki/Hunter-gatherer>

IBR. (n.d.). *Laugavegshlaupid*.

Laugavegshlaupid. <https://www.laugavegshlaup.is/laugavegshlaupid>

IBR. (n.d.). *Route Description*. Laugavegshlaupid. [https://www.laugavegshlaup.is/en/route-](https://www.laugavegshlaup.is/en/route-description)

[description](https://www.laugavegshlaup.is/en/route-description)

ITRA. (n.d.). *ITRA Database*. International Trail Running Association. <https://itra.run>

Jyoti. (2020, December 22). Biomechanics Of Running: All You Need To Know.

Finisher Magazine. [https://finishermag.com/running/biomechanics-of-running-all-](https://finishermag.com/running/biomechanics-of-running-all-you-need-to-know/)

[you-need-to-know/](https://finishermag.com/running/biomechanics-of-running-all-you-need-to-know/)

Kasmer, M. E., Liu, X. C., Roberts, K. G., & Valadao, J. M. (2013). Foot-Strike Pattern and Performance in a Marathon. *International Journal of Sports Physiology and Performance*, 8(3), 286–292. <https://doi.org/10.1123/ijsp.8.3.286>

### References

Knechtle, B., & Nikolaidis, P.T. (2018, June 1). Physiology and Pathophysiology in Ultra Marathon Running. *Frontier in Physiology*, 9.  
<https://doi.org/10.3389/fphys.2018.00634>

*Laugavegur Ultra Marathon Race Rules - Laugavegur Ultra Marathon*. (n.d.).

Laugavegshlaupid. <https://www.laugavegshlaup.is/en/race-rules>

*Laugavegur*. (n.d.). Ferðafelag Islands.

<https://www.fi.is/en/hiking-trails/trails/laugavegur>

Lazarus, R. S. (2000). Toward better research on stress and coping. *American Psychologist*, 55(6), 665–673. <https://doi.org/10.1037/0003-066x.55.6.665>

Luna, N. (2019, March 28). *The Anatomy of Pants*. Mood Fabrics.

<https://www.moodfabrics.com/blog/the-anatomy-of-pants/>

Maurer, K. (2014). *Venting apparatus with no-catch mechanism* (Patent No. US8713712B2).

U.S. Patent. <https://patents.google.com/?q=trail+running&oq=trail+running&page=1>

Miller, S. (2022, July 17). *How to Sew a Blazer*. wikiHow.

<https://www.wikihow.com/Sew-a-Blazer>

*Nike Dri-FIT Phenom Elite*. (n.d.). Nike. <https://www.nike.com/nl/t/dri-fit-phenom-elite-mens-knit-trail-running-pants-1RtbJG/DM4654-451>

*Nike Dri-FIT Trail*. (n.d.). Nike.

<https://www.nike.com/t/dri-fit-trail-mens-1-2-length-trail-running-tights-7szLxS>

Pastor, F. S., Besson, T., Varesco, G., Parent, A., Fanget, M., Koral, J., Foschia, C., Rupp, T.,

Rimaud, D., Féasson, L., & Millet, G. Y. (2022). Performance Determinants in Trail-Running Races of Different Distances. *International Journal of Sports Physiology and Performance*, 17(6), 844–851. <https://doi.org/10.1123/ijsp.2021-0362>

### References

Phillips, M. (2020, August 12). Introduction to Running Biomechanics. Runners Connect.

<https://runnersconnect.net/running-biomechanics/>

*Raincoat*. (n.d.). How Products Are Made. <http://www.madehow.com/Volume-6/Raincoat.html>

Rimmer, K. (2022, June 15). Back to Basics: Organic Graphic Design Trends. Envato.

<https://www.envato.com/blog/back-to-basics-organic-graphic-design-trends/>

Robinson, R. (2022, March 2). *The Birth of Trail Running*. Runner's World.

<https://www.runnersworld.com/advanced/a20811911/the-birth-of-trail-running/>

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, 55(1), 68–78. <https://doi.org/10.1037/0003-066x.55.1.68>

Tenenbaum, G., Spence, R., & Christensen, S. (1999). The effect of goal difficulty and goal orientation on running performance in young female athletes. *Australian Journal of Psychology*, 51(1), 6–11. <https://doi.org/10.1080/00049539908255328>

*The Waterproof & Breathable Anorak*. (n.d.). ON Running.

<https://www.on-running.com/en-us/products/waterproof-anorak>

*Trail Running*. (n.d.). worldathletics.org. <https://www.worldathletics.org/disciplines/trail-running/trail-running>

Smiley, K. (2021, July 28). *ANATOMY OF A SWEATER*. Local

Laundry. <https://locallaundry.ca/blogs/local-laundry-weekly-blog/anatomy-of-a-sweater>

Ulwick, T. (2017, January 6). *Jobs-to-be-Done: A Framework for Customer Needs*. Medium;

Jobs-to-be-Done + Outcome-Driven Innovation. <https://jobs-to-be-done.com/jobs-to-be-done-a-framework-for-customer-needs-c883cbf61c90>

## Appendix A

### Questionnaire for Laugavegur Ultra Marathon Competitors

What's your gender?

What's your age?

How long have you been training for trail running?

What garments and equipment do you currently wear during a race in windy and wet conditions?

How many ultra-marathon trail races do you compete in per year on average?

How often have you competed at the Laugavegur Ultra?

What was the most difficult part of the Laugavegur Ultra Race?

What do you like about the current trail running outfits

What do you dislike about current trail running outfits?

What do you like about the current hydration vests?

What do you dislike about current hydration vests?

What do you like about the current trail running shoes?

What do you dislike about current trail running shoes?


If there were no physical constraints, what would an ideal trail running outfit look like?


What is the number one thing you want the competition outfit to provide you with?

## Appendix B

### SWOT Analysis

SWOT analysis of state-of-the-art trail running jackets

SALOMON BONATTI JACKET \$180					
	STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS	
SLEEVES	<ul style="list-style-type: none"> <li>Waterproof and windproof</li> <li>Elasticated hems to prevent cold air to from getting inside the garment</li> <li>Articulated sleeves</li> </ul>	<ul style="list-style-type: none"> <li>Hems are not adjustable</li> <li>No pocket on sleeves</li> <li>No ventilation underarms</li> <li>Does not provide any insulation</li> </ul>	<ul style="list-style-type: none"> <li>Keep it water- and windproof but make them elastic as well</li> <li>Increase ventilation</li> <li>Make hems adjustable</li> </ul>	<ul style="list-style-type: none"> <li>Loosing windproofing qualities when making them elastic</li> <li>More water will enter garment when increasing ventilation</li> <li>Adding features will make the jacket heavier</li> </ul>	
BODY	<ul style="list-style-type: none"> <li>Made from waterproof and windproof materials</li> <li>Added volume to make room for hydration vest underneath</li> <li>Dropped back hem and waist adjustment</li> <li>Smart vent button in front</li> </ul>	<ul style="list-style-type: none"> <li>No ventilation system at back</li> <li>Added volume makes it not fit as well when not wearing hydration vest</li> <li>Does not provide assistance to running biomechanics</li> </ul>	<ul style="list-style-type: none"> <li>Increase ventilation at places where the body sweats the most</li> <li>Make it storable in the hydration vest if you want to take it off in the middle of the race</li> <li>Jacket could positively impact your running biomechanics</li> </ul>	<ul style="list-style-type: none"> <li>Making garment more elastic could affect the windproofing</li> <li>Adding ventilation might make it easier for water to enter</li> <li>Adding features will make the jacket heavier</li> </ul>	
HOOD	<ul style="list-style-type: none"> <li>Minimalistic construction</li> <li>Made from waterproof and windproof materials</li> <li>Protective hood that stays put</li> <li>Fits close to your head</li> </ul>	<ul style="list-style-type: none"> <li>No draw cords or pullers</li> <li>Not adjustable</li> <li>Not removable</li> </ul>	<ul style="list-style-type: none"> <li>Make it adjustable to fit to the hed better</li> <li>Make the hood removable to use when weather conditions are better</li> </ul>	<ul style="list-style-type: none"> <li>Adding draw cords and pullers makes it more complex</li> <li>Making the hood removable might make it less durable</li> </ul>	

ARC'TERYX NORVAN LT JACKET \$400					
	STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS	
SLEEVES	<ul style="list-style-type: none"> <li>Made from Gore-Tex material so it's waterproof and windproof</li> <li>Adjustable hems to prevent cold air to enter</li> <li>Articulated sleeves for mobility and comfort</li> <li>Gusseted underarms</li> </ul>	<ul style="list-style-type: none"> <li>Not made from flexible and elastic material</li> <li>Gore-Tex material is usually stiff</li> <li>No pocket on sleeves</li> <li>Does not provide any insulation</li> <li>No underarm vents</li> </ul>	<ul style="list-style-type: none"> <li>Make the material softer and more flexible</li> <li>Increase ventilation, specially underarms</li> <li>Add pockets for storage</li> </ul>	<ul style="list-style-type: none"> <li>Loosing windproofing qualities when choosing softer fabric</li> <li>More water will enter garment when increasing ventilation</li> <li>Adding features will make the jacket heavier</li> </ul>	
BODY	<ul style="list-style-type: none"> <li>Made from Gore-Tex material so it's waterproof and windproof</li> <li>Elasticized bottom hem for secure fit</li> <li>Drawcord on bottom hem to seal out drafts</li> <li>Single hip pocket to store small items</li> </ul>	<ul style="list-style-type: none"> <li>No ventilation system at the back</li> <li>Does not provide assistance to running biomechanics</li> <li>No integration with hydration vests</li> <li>Heavier than many other jacket</li> <li>Not easily packable</li> </ul>	<ul style="list-style-type: none"> <li>Increase ventilation at places where the body sweats the most</li> <li>Jacket could positively impact your running biomechanics</li> <li>Think about donning and doffing mid race</li> <li>Make it lighter</li> </ul>	<ul style="list-style-type: none"> <li>Making garment more elastic could affect the windproofing</li> <li>Adding ventilation might make it easier for water to enter</li> <li>Adding features will make the jacket heavier</li> </ul>	
HOOD	<ul style="list-style-type: none"> <li>Built in hood adjustment cord</li> <li>Easily adjustable to protect from the elements</li> <li>Fits very well in general</li> </ul>	<ul style="list-style-type: none"> <li>Draw cords and pulleys add weight and complexity</li> <li>Adjustability decreases durability</li> <li>Hood is not removable</li> </ul>	<ul style="list-style-type: none"> <li>Make the hood removable to use when weather conditions are better</li> <li>Simplify the design to save weight</li> </ul>	<ul style="list-style-type: none"> <li>Removing draw cords and pulleys takes away adjustability</li> <li>Making the hood removable might make it less durable</li> </ul>	


SWOT analysis of state-of-the-art hydration vests

SALOMON ADV SKIN 5 HYDRATION VEST  
\$140



	STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
BODY	<ul style="list-style-type: none"> <li>• Snug fit with optimal comfort and friction-free wearability</li> <li>• Stretch and breathable fabric</li> </ul>	<ul style="list-style-type: none"> <li>• Can become too hot</li> <li>• Heavier than most hydration vests</li> <li>• Can cause chafing on longer runs</li> <li>• Makes you more sweaty</li> </ul>	<ul style="list-style-type: none"> <li>• Combine the hydration vest to the jacket</li> <li>• Jacket and hydration vests integrated better together</li> </ul>	<ul style="list-style-type: none"> <li>• Might become more expensive with more features</li> <li>• Jacket and hydration vest integrated together will not make them perform as well on their own</li> </ul>
STORAGE	<ul style="list-style-type: none"> <li>• Easy access to hydration</li> <li>• 12L capacity which is ideal for longer distances</li> <li>• Expandable front pockets with elastic loops to limit bouncing</li> <li>• Internal bladder compartment</li> </ul>	<ul style="list-style-type: none"> <li>• Bottles can't hold a lot of water</li> <li>• Reservoir are hard to refill on the go</li> <li>• No side pockets</li> </ul>	<ul style="list-style-type: none"> <li>• Storage for other things than just liquid</li> <li>• Jacket could be tucked away in the pockets</li> </ul>	<ul style="list-style-type: none"> <li>• Having pockets full of things makes the vest heavier</li> <li>• If jacket packs into the vest there is less room to pack other things such as liquid</li> </ul>
TRIMS	<ul style="list-style-type: none"> <li>• Makes the vest more versatile with adjustable fit</li> <li>• Durable and reliable YKK zippers</li> <li>• Sternum strap to adjust the pack quickly on the fly</li> </ul>	<ul style="list-style-type: none"> <li>• Difficult to adjust during the run</li> <li>• Not very durable</li> <li>• Not easy to fix if it breaks</li> </ul>	<ul style="list-style-type: none"> <li>• Make them easier to adjust during the race</li> <li>• Increase durability</li> <li>• Design the trims in a way they are fixable</li> </ul>	<ul style="list-style-type: none"> <li>• Adding trims and increasing adjustability makes the design more complex</li> <li>• Having fewer trims and more sizes might be better</li> </ul>


NATHAN PINNACLE 12L HYDRATION VEST  
\$200



	STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
BODY	<ul style="list-style-type: none"> <li>• Great comfort and fit</li> <li>• Made out of lightweight and highly stretchable fabric</li> <li>• Designed to keep you moving in comfort</li> <li>• Breathable</li> </ul>	<ul style="list-style-type: none"> <li>• Expensive</li> <li>• Heavier than most other hydration vests on the market</li> <li>• Should not be put in a washing machine</li> <li>• Stiff materials on the chest</li> </ul>	<ul style="list-style-type: none"> <li>• Jacket and hydration vests integrated better together</li> <li>• Make it out of softer fabrics</li> <li>• Have it durable enough to be put in the washing machine</li> </ul>	<ul style="list-style-type: none"> <li>• Adding features increase weight</li> <li>• Might become more expensive with more features</li> <li>• Jacket and hydration vest integrated together will not make them perform as well on their own</li> </ul>
STORAGE	<ul style="list-style-type: none"> <li>• Great access to pockets when running</li> <li>• Twelve pockets and a hydration sleeve for a bladder</li> <li>• Side access kangaroo pockets</li> </ul>	<ul style="list-style-type: none"> <li>• Hydration flask sold separately</li> <li>• Difficult to store trekking poles</li> </ul>	<ul style="list-style-type: none"> <li>• Create better storage for trekking poles</li> <li>• Create separate storage for the running jacket</li> </ul>	<ul style="list-style-type: none"> <li>• Having pockets full of things makes the vest heavier</li> <li>• If jacket packs into the vest there is less room to pack other things such as liquid</li> </ul>
TRIMS	<ul style="list-style-type: none"> <li>• Versatile</li> <li>• Large diagonal zipper for easy entry for necessities</li> <li>• Straps instead of elastic cords in the front</li> </ul>	<ul style="list-style-type: none"> <li>• Sternum trap is pretty stiff</li> <li>• Not very comfortable</li> <li>• Difficult to adjust when on the move</li> </ul>	<ul style="list-style-type: none"> <li>• Make the vest easier to adjust during the race</li> <li>• Keep the durability of the straps but make it more comfortable</li> </ul>	<ul style="list-style-type: none"> <li>• Making trims more comfortable might decrease durability</li> <li>• Having fewer trims and more sizes might be better</li> </ul>

SWOT analysis of state-of-the-art trail running pants

<p>SALOMON CROSS RUN TIGHTS \$80</p> 				
	<b>STRENGTHS</b>	<b>WEAKNESSES</b>	<b>OPPORTUNITIES</b>	<b>THREATS</b>
<b>LEGS</b>	<ul style="list-style-type: none"> <li>• 4 way stretch fabric</li> <li>• Fabric offers light muscle support</li> <li>• Technical fabric to improve body comfort by keeping you dry and warm</li> <li>• Woven panel on tibia to make them more resistant</li> </ul>	<ul style="list-style-type: none"> <li>• Fits tightly to the body which might hinder movement</li> <li>• Does not improve running economics</li> <li>• Does not assist with keeping proper running biomechanics</li> </ul>	<ul style="list-style-type: none"> <li>• Make them tight on some areas of the body and loose on others</li> <li>• Design pants to improve running economics and biomechanics</li> </ul>	<ul style="list-style-type: none"> <li>• People might not want to run in tights</li> <li>• Tights can be difficult to take off if runners want to change in mid race</li> </ul>
<b>POCKETS</b>	<ul style="list-style-type: none"> <li>• Two side pockets to store items</li> <li>• Minimalistic to add minimal weight and no bulk</li> <li>• Keeps gels, keys or smartphone close and secure on the move</li> </ul>	<ul style="list-style-type: none"> <li>• Only room for small items</li> <li>• Storing items in pocket add bulks and bounces around</li> </ul>	<ul style="list-style-type: none"> <li>• Add more pockets so more items can be stored</li> <li>• Design the pockets so items won't bounce around</li> <li>• Add zipper to pockets</li> </ul>	<ul style="list-style-type: none"> <li>• When running with hydration vests, pockets on bottoms might not be needed</li> <li>• Object might fall out of pockets when running because they are not closable</li> </ul>
<b>WAISTBAND</b>	<ul style="list-style-type: none"> <li>• Adjustable flat waist construction</li> <li>• Bak hook to stow a light tee</li> </ul>	<ul style="list-style-type: none"> <li>• Not very comfortable</li> <li>• Difficult to adjust when on the move</li> <li>• Band to adjust waistband might break</li> </ul>	<ul style="list-style-type: none"> <li>• Make more sizes so the waistband does not have to be adjusted as much</li> <li>• Create more durable adjustment system than only having cord</li> </ul>	<ul style="list-style-type: none"> <li>• If waistband cord brakes the waistband can't be adjusted any more</li> </ul>

<p>NIKE DRI-FIT PHENOM ELITE PANTS \$105</p> 				
	<b>STRENGTHS</b>	<b>WEAKNESSES</b>	<b>OPPORTUNITIES</b>	<b>THREATS</b>
<b>LEGS</b>	<ul style="list-style-type: none"> <li>• Windproof and breathable fabric in the front</li> <li>• Water-repellent and stretch-woven in back to help move in all directions</li> <li>• Moves sweat away from your skin</li> <li>• Zippers at ankles to help you take them off</li> </ul>	<ul style="list-style-type: none"> <li>• Loose fit which increase air resistance</li> <li>• Not stretchy enough</li> <li>• Not suitable when it's too hot nor too cold</li> <li>• Don't offer any insulation</li> <li>• Legs too short</li> </ul>	<ul style="list-style-type: none"> <li>• Combine loose fit and tight fit for optimum comfort and performance</li> <li>• Design the pants to improve running economics</li> <li>• Redesign the pants to improve running biomechanics</li> </ul>	<ul style="list-style-type: none"> <li>• Runners might only want to run in tights</li> <li>• Runners would like to change to shorts mid race</li> </ul>
<b>POCKETS</b>	<ul style="list-style-type: none"> <li>• Multiple pockets</li> <li>• Keeps your trail snack and phone close</li> <li>• Pockets closable with zippers</li> </ul>	<ul style="list-style-type: none"> <li>• Pockets have too much room</li> <li>• Multiple pockets adds complexity</li> </ul>	<ul style="list-style-type: none"> <li>• Design the pockets so items won't bounce around</li> </ul>	<ul style="list-style-type: none"> <li>• When running with hydration vests, pockets on bottoms might not be needed</li> <li>• Having zippers make it harder for runner to quickly grap items in pockets</li> </ul>
<b>WAISTBAND</b>	<ul style="list-style-type: none"> <li>• Adjustable waistband</li> <li>• Internal drop-in pocket at waistband</li> <li>• Elastic waistband with draw string</li> </ul>	<ul style="list-style-type: none"> <li>• Elastic waistband and drawcord too thin</li> <li>• Drawcord not very durable</li> </ul>	<ul style="list-style-type: none"> <li>• Make the waistband and drawcord more durable</li> <li>• Increase size range to limit the need of waistband adjustments</li> </ul>	<ul style="list-style-type: none"> <li>• If waistband cord brakes the waistband can't be adjusted any more</li> <li>• Pants might fall down when running if adjustability is removed</li> </ul>



## Appendix C

### Proof of concept slide deck







# TRAIL RUNNING

COMPETITION OUTFIT FOR LAUGAVEGUR ULTRA



LAUGAVEGUR TRAIL

**35 MILES** long hiking trail

**LOCATED** in the southern highlands of Iceland

**12,000** feet of total climb and drop

**WEATHER** changes rapidly & multi-terrain





THE ATHLETE

**MALE** trail runner, aged 25-55 year old

**HIGHLY** experienced and focused on performance

**VALUES** exploration and conquering difficult terrains

**GO-GETTER** wanting to reach his full potential



WHY TRAIL RUNNING

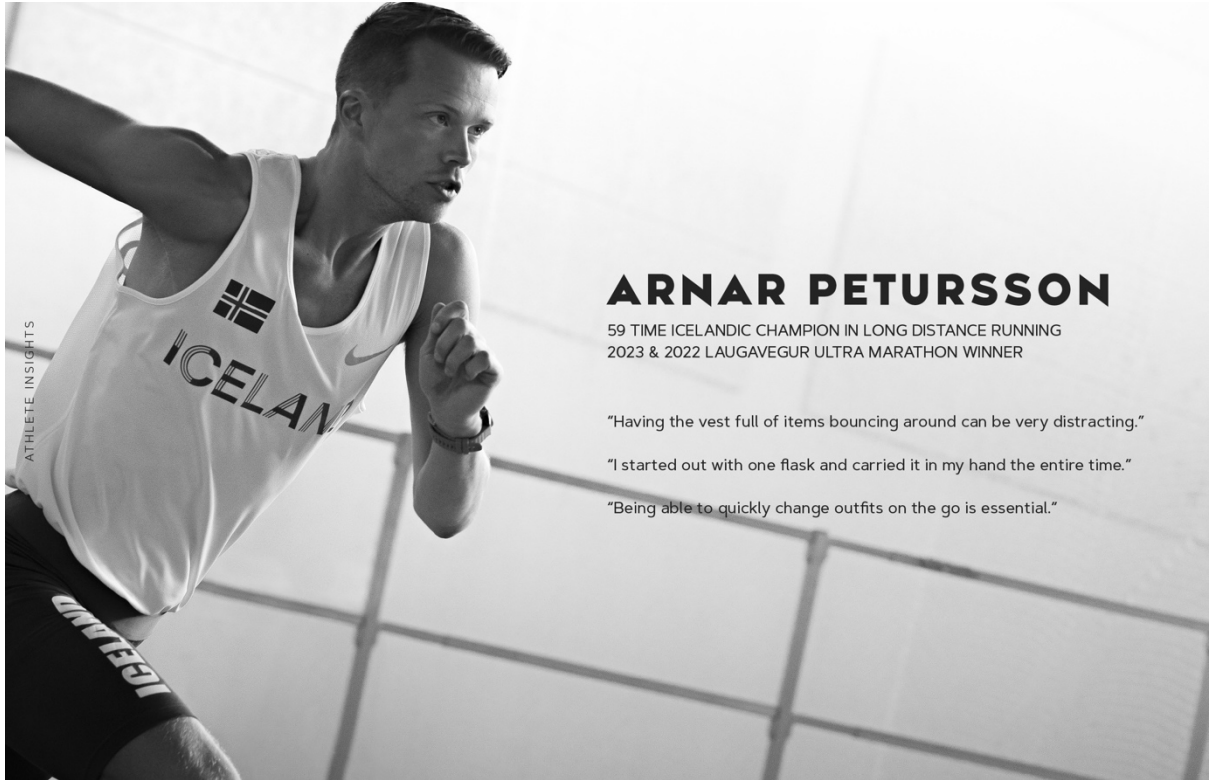
**350%** increase in participants last decade

**UNIQUE** trails come with unique challenges

**HIGHER** peak age for performance

**COMMUNITY** of adventure seeking individuals





ATHLETE INSIGHTS

## ARNAR PETURSSON

59 TIME ICELANDIC CHAMPION IN LONG DISTANCE RUNNING  
2023 & 2022 LAUGAVEGUR ULTRA MARATHON WINNER

"Having the vest full of items bouncing around can be very distracting."

"I started out with one flask and carried it in my hand the entire time."

"Being able to quickly change outfits on the go is essential."

OBJECTIVE

FINISH THE LAUGAVEGUR TRAIL ULTRA

# FAST & SAFELY

RUNNING ECONOMY | ITEM STORAGE | ADAPTABLE OUTFIT







### REACHABILITY & BOUNCE

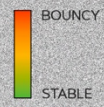
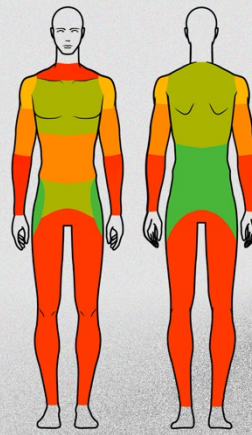
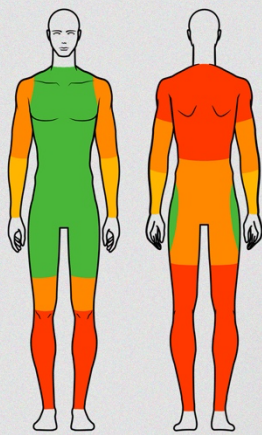
TESTING



### REACHABILITY

### BOUNCE

BODY MAPS





STORAGE IDEATION



SHORTS STORAGE



GARMENTS



ENERGY GELS



WATER FLASK



PHONE & BLANKET



### WATER FLASK

PERFORMANCE TESTING



**LESS**  
bounce in Glide compared to  
benchmark product

**HARDER**  
to reach in Glide compared to  
benchmark product

### ENERGY GELS

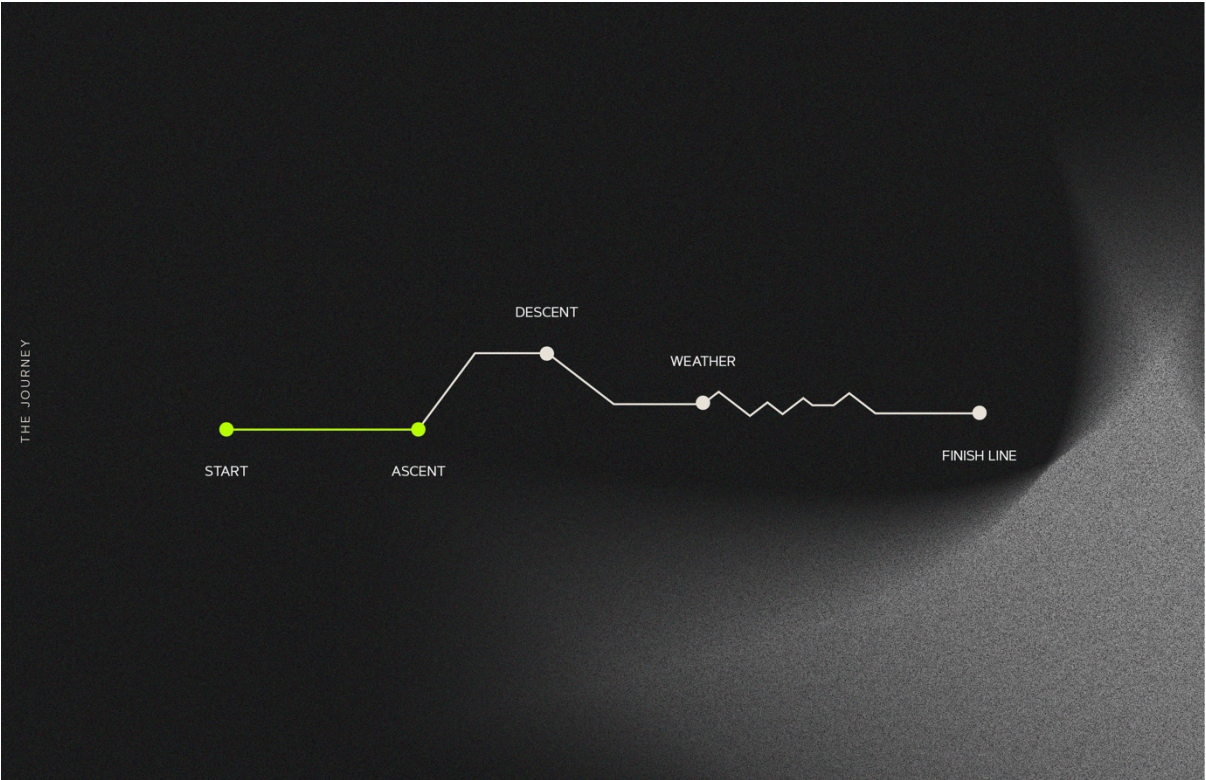
PERFORMANCE TESTING



**LESS**  
bounce in Glide compared to  
benchmark product

**SIMILAR**  
reachability in Glide compared to  
benchmark product



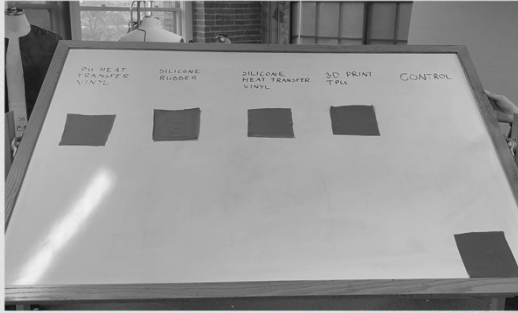
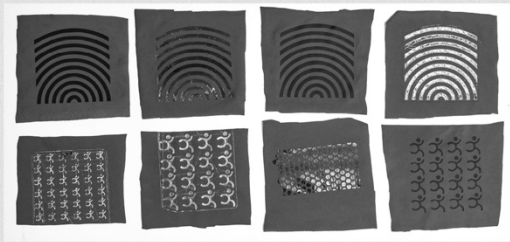


**A S C E N T**

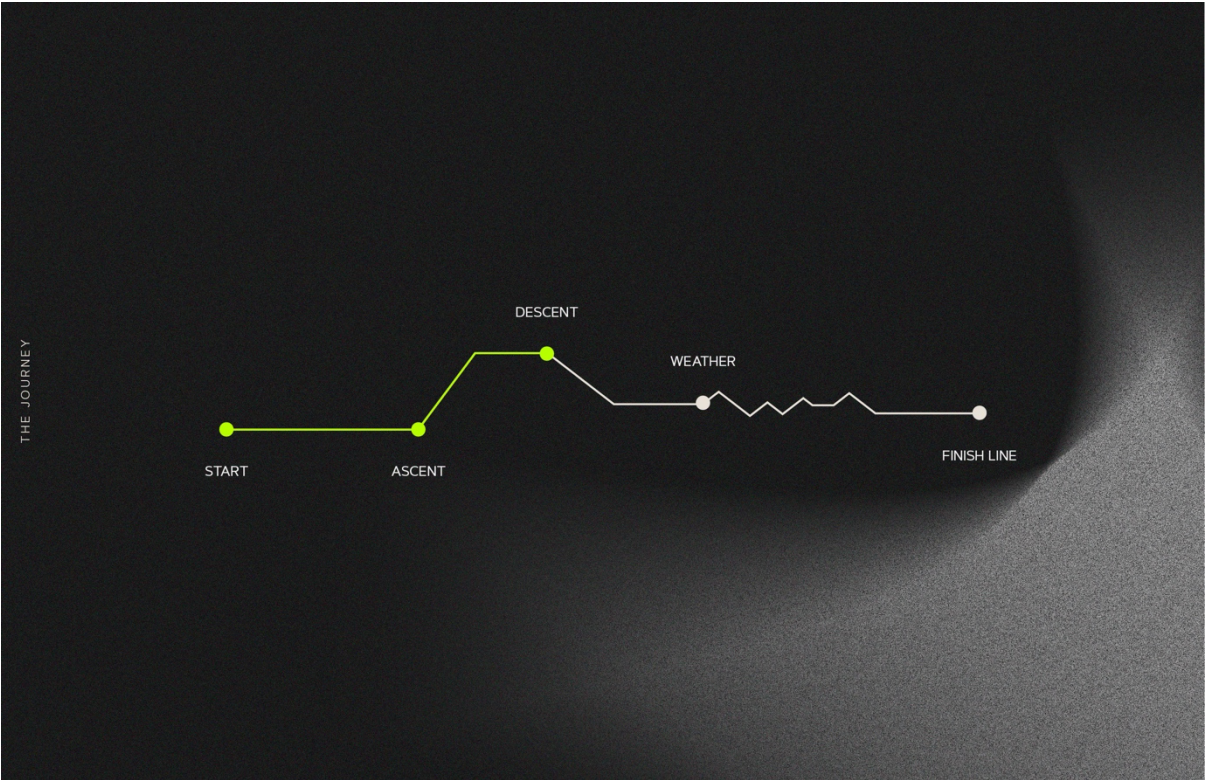




SHORTS GRIP PANEL









THE INSPIRATION



JACKET'S SAIL







### JACKET AIR DRAG

PERFORMANCE TESTING



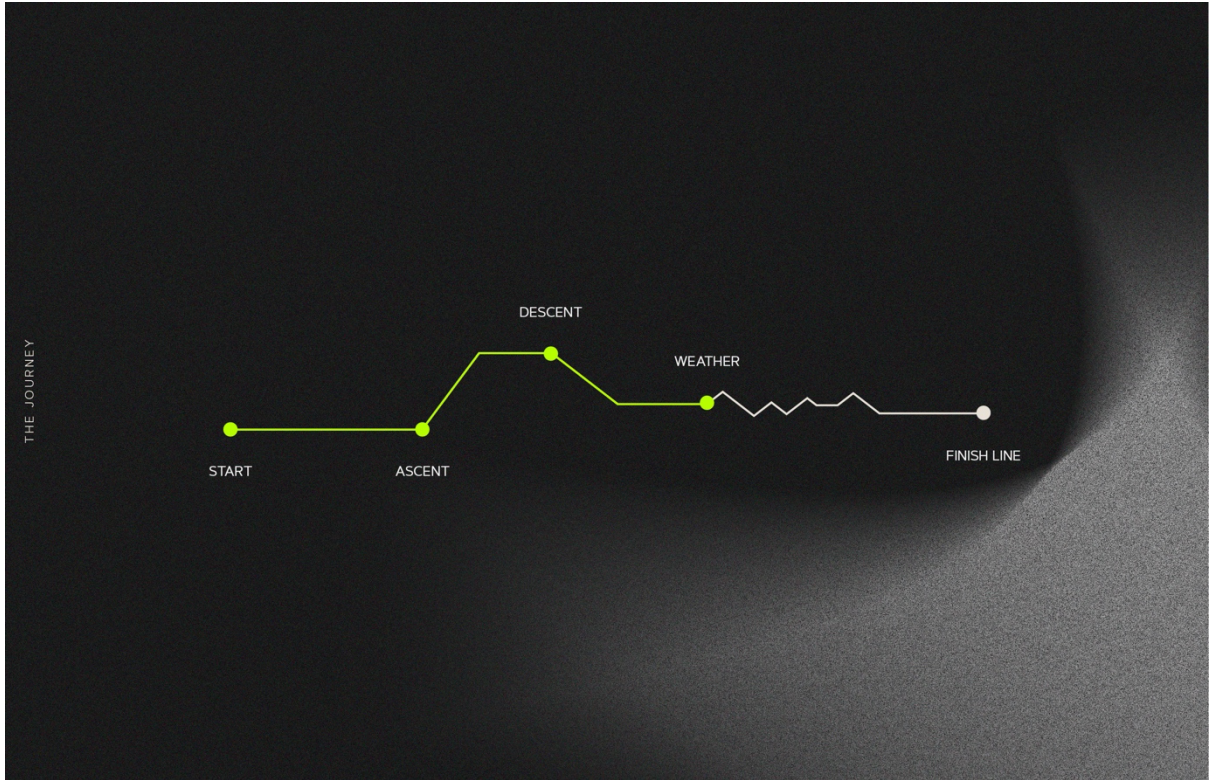
1.2N DRAG FORCE OF BENCHMARK JACKET



1.7N DRAG FORCE OF GLIDE JACKET

**42%** increase in drag force







ADAPTABLE OUTFIT







### JACKET DONNING & DOFFING

PERFORMANCE TESTING



51 SEC TOTAL TO TAKE OFF AND PUT ON



25 SEC TOTAL TO TAKE OFF AND PUT ON

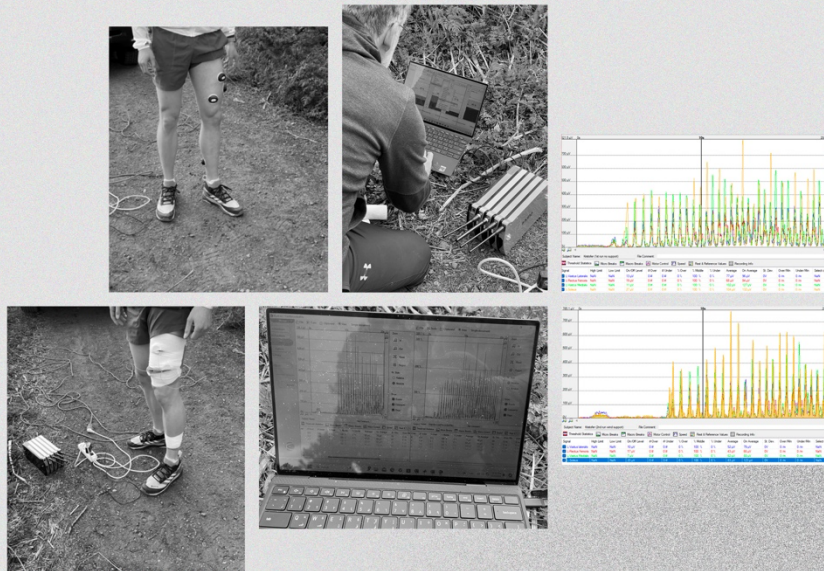
**51%** less time



THE JOURNEY



EMG MUSCLE SENSORS





### DOWNHILL RUNNING ECONOMY

PERFORMANCE TESTING



110 $\mu$ V MUSCLE ACTIVITY WITHOUT SAIL



89 $\mu$ V MUSCLE ACTIVITY WITH SAILS

**19%** less energy

RESULTS



**3%**

4:06:42<sup>4<sup>TH</sup></sup> → 3:58:07<sup>1<sup>ST</sup></sup>



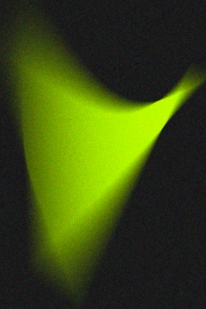
# SUBTLE ANTI-CAMO

MOODBOARD



# LEAVE YOUR MARK

GRAPHICS



INSPIRED BY THE SAIL | REPRESENTS THE DESIGN PROCESS













FRAMES FROM VIDEO

