The Nome Collection: Technical Apparel Design Solutions for the Wild Winter Women of the Iditarod Trail Invitational

Chloe Burchard
Sports Product Design Thesis / University of Oregon
06/11/25

Table of Contents

Table of Contents 1

About the Race 3

History of the Iditarod 3

User 4

Proposed Product Classifications 5

General Problem Area 6

How can we? 9

Market Potential 9

Athlete Jobs to Be Done 10

Environment 11

Rules 12

State of the Art Product 13

Product Anatomy 16

Materials 18

Jobs to be Done 20

Manufacturing 22

Intellectual Property Landscape 23

Trend Research 25

Current Color Trends 25

Future Color Trends 26

Current Graphic / Material Trends 28

Future Graphic / Material Trends 29

Current Branding Trends 30

Future Branding Trends 30

Physiological Research 31

Biomechanical Research 33

Psychological Research 34

Shell Jacket Competitor SWOT Analysis 35

Shell Pants Competitor SWOT Analysis 37

Hybrid Mid-Layer Competitor SWOT Analysis 41

Softshell Pant Competitor SWOT Analysis 42

SWOT Findings 43

User Insights 44

Performance Testing Plans 53

Final Garment Construction 59

References 67

About the Race

The Iditarod Trail Invitational is a daunting feat, widely known as the "pinnacle of all winter ultra marathons" (*ITI*, n.d.). More than a race, this ultramarathon is a testament to human resilience and strength. Athletes are forced to dig deep and rely on more than their athleticism and skill set, but rather who they are at the core of their being. This race is self-supported meaning that athletes pack all their supplies for the race, including food (Gmrunner, 2023). The Iditarod Trail Invitational states that they "…draw the true adventurers who don't want to be cheated out of a profound experience by excess support from the race staff" (*ITI 1000 — ITI*, n.d).

Athletes can opt for the 350-mile or 1000-mile invitational course, navigating their way through the unmarked and treacherous Alaskan wilderness. Athletes competing in the 1000-mile race will have three supply drops along the way but must face the final 500 miles with no outside support, carrying all their survival items or shipping them to post offices along the way. The three categories of participants are on-foot athletes, cross-country skiers, and fat tire bike riders. (*ITI*, n.d.)

History of the Iditarod

Before diving into the history of the race it is important to first consider the history of the land itself. The Iditarod Trail is a part of the Indigenous lands belonging to the Athabascan, Iñupiaq, and Yup'ik/Cup'ik people (Julianne, 2022). The land was historically used for hunting and inter-village travel. Indigenous people of this region utilized dog mushing as a means of travel and transport for a long time before settlers came in during the gold rush (Julianne, 2022).

Dog mushing, stemming from the French word "Marche" or "to run" is a sport and traditional method of transport where dogs are used to pull a sled (1ST Alaska Tours, 2016). In

1973 Joe Redington Sr, otherwise known as the *Father of the Iditarod*, started the Iditarod Sled Dog Race. The first travelers of the formidable Iditarod trail utilized dog mushing as their primary means of transport, but Joe Redington Sr. looked to the future, optimistic about "human-powered" races (*Race History*, n.d.).

By the 1980s Alaska saw its first snowshoe and cross-country ski races on the trail and in 1987 Joe Redington Sr. encouraged members of the Arctic Bicycle Club of Anchorage to forge a new path from Knik to Skwenta for the first time on bike. Two years later in 1989 athlete Dan Bull took three other riders on a 21-day trek across the Iditarod Trail on a mountain bike from Knik to Nome (*Race History*, n.d.). By 1991, snowshoers, cross-country skiers, and bikers were testing their limits on the Iditarod Trail, coming together under a new multi-sport challenge known as 'Iditasport'. Just one year later in 1992 a new division was born for runners / on foot athletes. Shorter versions of the race ensued with 100-mile and 350-mile efforts. In 2000, for the first time, athletes set out against the length of the Iditarod, 1000 miles trailing from Knik to Nome. "Iditasport" technically ended in 2001 but was revamped in 2002 by Bill Merchant and officially named The Iditarod Trail Invitational (*Race History*, n.d.). Thus beginning a challenge that transcends time and terrain, drawing only the most intrepid athletes to measure their spirit on the storied Iditarod trail.

User

The key users are part of a small and mighty group who call themselves "The Wild Winter Women". These are elite athletes and adventurers who already have several completed winter ultra races / pursuits under their belts. The Iditarod Trail Invitational is an invite-only race, drawing in only qualified athletes. To qualify for the 350-mile discipline athletes are required to have two finishes in specific qualifying events such as ITI winter camp, Arrowhead, Fat Pursuit,

Susitna, Tuscobia, The Drift etc. To earn a coveted spot in the 1,000-mile at least one 350-mile ITI race finish is required and from there a lottery system determines placement (*ITI*, n.d.). They range in ages from around 25-65 with the average age range of women who finish the 1,000-mile race being 43 years old (Gibbons, 2024).

These women possess a rare blend of observable traits. They are driven, resilient, and relentless in every aspect of life. It's not uncommon to find the Wild Winter Women biking year-round, ice climbing, lifting heavy, or crushing marathons in their spare time. For them, being outside and pushing limits isn't a pastime, it's a way of life. Yet, in striking contrast to their grit, they are also some of the most welcoming, silliest, easygoing and supportive individuals you'll ever meet. As Kendall Park put it, the women who thrive in this race are the ones who can face a perilous situation on the trail and still walk into the next checkpoint smiling, ready to do it all again. Adaptability isn't a choice for these women; it is a requirement. This sport demands more than toughness; it requires flexibility, optimism, and the ability to navigate hardship with humor and heart. These women go the distance, and they know how to make it fun.

Proposed Product Classifications

To go the distance, each athlete has a highly personalized layering system with several pieces of apparel harmonizing together to keep them safe from the elements. After interviewing athletes, the data was used to create a 'general' system of dress which informed the product classifications for this project. For the scope of this project the areas with the most opportunity were identified. Based on fit, feature and materiality challenges currently faced by athletes it was determined that two systems of dress would be developed for this project. One intervening at the soft-shell / mid-layer level and one intervening at the hardshell / parka level as shown in the figure below.

Figure 1.



Note. From Burchard – System of Dress

From this information the 'Vigor' and 'Gust' systems were born. The 'Vigor' system consists of a hybrid mid-layer jacket and a softshell pant. This system functions as everyday working layers that are intended to be worn over base layers and are engineered for optimal moisture management, light insulation and everyday wear. The 'Gust' system was developed out of a need for wind protective layers that are sized to fit over all other layers and engineered for optimal wind protection to breathability ratio. The 'Gust' system consists of a parka and a wind pant, designed to act as a shelter to the athlete, protecting against the harsh Alaskan wind.

General Problem Area

Athletes participating in the ITI face countless challenges along the trail several of which stem from the way their apparel interfaces with their environment and bodies. Through working closely with the Wild Winter Women and surveying current apparel problems, several commonalities were identified. First and foremost is moisture management. A quote from

Kendall Park, a repeat Iditarod Trail 350-mile bike finisher, highlights this issue "Our apparel is made for skiing and mountaineering which protect against wetness - when you're in a polar tundra climate like us the wetness you need to protect from is your own. There is so little gear that is meant for dry snow and high exertional activity and when you wear a traditional shell out here you might as well be wearing rubber". Athletes report constantly adjusting layers and ventilation to maintain body temperature. If an athlete gets slightly too warm or too cold the energy expenditure required to return to homeostasis can be critical, as the athletes need to utilize every calorie efficiently to finish this race. Kendall Park also relayed how in 2023 several athletes faced race ending frostbite and even digit-loss between Butterfly Lake and Yentna Station due to moisture build up from a fast-paced and unseasonably warm race start. For scale, a map of the race is provided below showing how quickly sweat buildup can become life-threatening.

Figure 2.



Note. From Race details — ITI. (n.d.). ITI. (https://itialaska.com/race-details)

Butt warmth is another key problem area with 100% of surveyed athletes reporting a cold butt. Typically, athletes utilize down shorts and skirts to keep warm. In discourse on the Wild Winter Women Facebook page Alicia Hudelson stated “Gear companies need to figure this out. There is surely a better way if pants had extra strategically placed fabric on the butt.” And Jessica Roschlan stated “I think finding a way to keep the butt warm is key to success. As soon as my butt gets cold, I have a hard time regulating my body temperature.”

Zippers present extensive issues for athletes as well. One Likert-like survey that was handed out in person during the 2025 ITI kickoff stated “I get frustrated with my zippers” with ITI skier Laura Rushfeldt circling “strongly agree” several times to accentuate her frustration. Athletes repeatedly state that they need manual ventilation options and Kendall Park stated, “We love big zippers, #5 molded tooth is the best for us.” It is incredibly important that zippers properly function during the race to secure clothing, open ventilation or access pockets. Athletes frequently DIY their zipper pulls by adding large loops of paracord so that they are glove friendly.

Athletes also need layers that are adjustable and can adapt to a range of sizes. Some women report edema while partaking in this race, with athletes reporting that their body swells up to 2 sizes within the first few days of the race, meaning they must size way up in their apparel or risk it being too tight early on. Athletes are also constantly adjusting layers and may be putting on garments over several others, so they need extra space to ease donning and doffing and ensure apparel fits properly.

Lastly, women’s snow gear is traditionally slim fit for events like skiing or mountaineering and cause issues with comfortability and range of motion. This problem is exacerbated by layering and the fact that women partaking in the Iditarod Trail Invitational tend

to have muscular legs and buttocks. Not only does tight fit lead to discomfort but it can impact donning and doffing and breathability as well. Athletes are repeatedly wearing XL men's garments to counter the fit issues in their apparel.

How can we?

Following problem identification the overarching problem statement is as follows: How can we innovate a women's-specific ITI kit that delivers high performance moisture management and comfort over long durations in a dry polar climate, adapting to temperature fluctuations and repetitive aerobic activity? While these athletes face innumerous challenges on the trail this project will consider moisture management as a 'north star'. Solving all other problems through this lens will ensure athletes are getting the features they desire while still having their safety at top of mind.

Market Potential

The highly specialized products designed for the women embarking on the Iditarod Trail have the potential to trickle down into mainstream solutions. A large component of this project is the focus on extremity. When exposed to uncompromising winter conditions, apparel flaws have nowhere to hide, making a race like the Iditarod Trail Invitational the ultimate environment for designing winter apparel. If it works for women in the ITI, it will work for all cold-weather athletes alike. With this design philosophy in mind, it was determined that the target market for this line of products would be global.

In 2024, there were 65 starters for the 350-mile race and 38 for the 1,000 mile. 22% of these athletes were women. Overall, 66 athletes took off on bike, 27 on foot and 10 on skis. These statistics show about 23 female athletes partaking in the Iditarod Trail Invitational.

(Gibbons, 2024). This is a relatively small market if looking closely, but with the implications of this product line applying to all women in Snowsports, the target demographic is larger. About 41% of all Snowsport participants are female totaling around 10.4 million women globally partaking in Snowsport (Snowsports Industries America, 2020). Designing with the intention for the product to trickle down means around 10 million women globally fall into the target demographic for this project.

Athlete Jobs to Be Done

Competing in an ultramarathon is incredibly challenging. But competing in the world's longest winter ultramarathon entirely self-supported on an unmarked trail borders on unfathomable. Unfathomable, that is, to everyone except to the select few women who choose to set out on the journey which requires immense technical skill, endurance, strength, and knowledge. So, what does it take to face the challenge of the ITI and find success?

Starting with physical requirements, athletes must display incredible physical endurance. Cardiovascular health, muscular strength, and the ability to physically perform in sub-zero temperatures are a must. It is important to look at this 'problem' through a total body lens and to also consider the mental aspects of this journey. Athletes must display mental fortitude, resilience, and grit. Knowing when to push ahead and when to break is key and requires immense self-awareness. The ITI is a survival race, and the risks of frostbite and death are ever-present on this journey. While a finished race is a successful one, making it off the Iditarod trail alive and unharmed is of utmost priority.

In addition to mental and physical requirements, the ITI requires loads of specific knowledge. Survival skills are a must. Given that the race is self-supported and unmarked environmental awareness is important, especially regarding navigation. First aid and shelter

setup are also key skills needed. Caloric maintenance is huge as well. In a race like this, every calorie counts when it comes to fueling the body for high mileage days and keeping the body warm. Athletes must be mindful of calorie intake and usage to maintain homeostasis.

Product knowledge in terms of apparel is important. Proper layering and educated material choices can make or break an athlete's performance. Equipment knowledge is also key for athletes facing the trail on skis or bikes to properly maintain equipment on the trail.

Environment

The ITI takes place in Alaska on the historic Iditarod trail. The 350-mile race goes from Knik to the secluded village of McGrath and the 1000-mile race continues for a brutal 650 miles to Nome. The race typically swaps routes in even and odd years, with even-numbered years taking the northern route and odd years taking the southern route (*Race Details — ITI*, n.d.). It may seem strange that the route oscillates between years, but the reasoning lies within the history of the Iditarod trail. Early on, only the northern route was followed but it was hard on small villages that lie along the route. The southern route was then developed to give smaller villages a break and to allow excitement and participation from other remote Alaskan villages (Gypsy, 2018).

Temperatures along the Iditarod trail are varied and unforgiving. In 1973 a record was set on the trail when temperatures dipped below -130 degrees Fahrenheit. Generally, temperatures will drop below -50 degrees Fahrenheit and can warm up to around 20 degrees Fahrenheit at the time of the race (Gmrunner, 2023). Weather patterns vary as well with frequent high winds. Ground conditions change from year to year and even throughout the race depending on snowfall. Ice, exposed rock and roots, tussocks, water and deep snow are not uncommon underfoot conditions on the trail.

Rules

The Iditarod Trail Invitational is exceptionally straightforward in its approach to determining rules for athletes. Typically, ultramarathons will publish a required equipment list for participating athletes including apparel, equipment, footwear, food, etc. The official race statement from ITI is as follows: “Unlike most winter races, the ITI does not require a laundry list of equipment. Only experienced winter athletes qualify for the race, so you are presumed to know how to take care of yourself in extreme winter conditions. The obligation is on you to understand the conditions you may face, the risks you are willing to accept, and that you will be responsible for the consequences of your own decisions, including those related to equipment” (Iditarod Trail Invitational, 2019). With the lawlessness of the race, athletes are not only encouraged but required to highly personalize their race apparel and equipment solutions.

The only official rules for the race are that you carry the race provided tracker at all times so that people can “dot watch” and see you move along the trail. The next is that this is a 100% human powered race, meaning that no outside assistance may be provided. Outside assistance includes riding on snow machines, cars, dog sleds etc. or having non-participating members follow you on trail providing “emotional support”. With this being said, athletes are allowed to accept food and housing from locals they meet along their journey. At the 2025 race start Kyle Durand, Race Director announced, “You only have yourself out there, if you call for help, it’s not coming.” The last rule is that athletes must check into each checkpoint in chronological order within the cutoff times or risk disqualification.

State of the Art Product

Before innovating new products, studying the strengths and weaknesses of benchmark products is incredibly insightful. State of the Art benchmark product was identified for each product area and evaluated based on all of its elements.

Kari Anne Gibbons, ITI 1000 athlete, runs a blog where she discusses gear recommendations. She mentions that she wears the Men's Kangri Gore-Tex Jacket (Whenoutsideblog, 2020). This is an interesting benchmark product as it highlights women's need to wear men's gear to achieve proper utility or fit. This product sells for $425 and features 70 denier, 3-layer Gore-Tex fabric, 2-way full venting YKK Aqua Guard pit zips for ventilation, and a fleece-lined chin guard for comfort (Men's Kangri GORE-TEX Jacket, n.d.). It is important to mention that amongst all the features and benefits listed for each product, this paper will consider the top 3 features regarding the scope of this project.

The second benchmark jacket comes from Arc'teryx with their Beta AR style priced at $400. This jacket features 80 Denier face fabric and a Gore-Tex ePE membrane, a C-knit backer, and articulated arms for improved mobility (Beta Jacket Women's, n.d.). Thirdly, and on a different note is the small brand Empire Wool and Canvas Company's Arctic Anorak jacket. This product, though different than the others, is a strong example of a product that connects back to traditional roots and is a favorite of some athletes. This jacket is constructed of a tightly woven cotton canvas with a detachable fur ruff for warmth (Empire Wool and Canvas Company, 2024). All three jackets have an emphasis on wind proofing with the first two also having an emphasis on waterproofing and ventilation while the Empire Arctic Anorak focuses more so on warmth.

Research was additionally conducted on the comparable offerings for hard-shell pants. When looking at technical cold-weather apparel Arc'teryx is always a consideration. Arc'teryx

Sentinel Pant sells for $600 and offers athletes 80 Denier, 3-layer, ePE Gore-Tex face fabric and articulated patterning for unrestricted movement (Sentinel Pant Women's, n.d.). These pants are a solid competing product as they, unlike many other comparable styles, have an emphasis on mobility. The next comparable hard shell pant offering is the Outdoor Research Women's Headwall pant priced at $400. These pants offer 3-layer Gore-Tex face fabric and feature full-length YKK Aquaguard side zippers for easy don and doff (Outdoor Research, n.d.). This is an interesting product due to the full-length side zip feature. Not only does this allow the athlete to quickly add or shed this layer but it allows for more customizable breathability if the athlete needs to quickly dump heat. In addition, if the athlete is injured or experiencing frostbite the ability to quickly and efficiently remove layers is vital to first aid efforts.

Third on the list is the Women's Mammut Taiss Pro HS Pants, priced at $479. These pants differentiate themselves from others on the list as they do not utilize Gore-Tex technology for wind and waterproofing. These pants feature Mammut DRYtechnology ™ a proprietary technology designed to compete with Gore-Tex. Other features include pre-shaped knee panels for freedom of movement and an embedded RECCO reflector for emergencies (TAISS Pro HS Pants Women | Mammut, n.d.)

For the hybrid mid-layer jacket, the first comp product is the Mammut Women's Eiger Speed ML Hybrid Hooded Jacket. This jacket sells for $200 and is described as a "technical wind-repellent hybrid jacket". It utilizes body mapping to provide accurate moisture management with a polyester and spandex body material crafted for wicking sweat. Quick access front pockets for ease of storage and a fitted hood for windy conditions make this a strong option for high aerobic activities in cold windy conditions (*Eiger Speed ML Hybrid Hooded Jacket Women | Mammut*, n.d.-b).

Secondly, is the Norrona Women's Falketind Alpha120 Zip Hooded Jacket. This jacket retails for $219. It utilizes 120 GSM Alpha Direct material for a breathable yet warm body and Polartech Power Grid for side stretch panels. Additionally, this offers harness compatible pockets and a close fitted hood (*Norrona Falketind Alpha120 Zip Hooded Jacket - Women's - Clothing*, 2024). This is a piece designed for active layering and provides several features desired by women who partake in the Iditarod.

The first softshell pant competitor is the Rab Women's Kinetic 2.0 Pant. These retail for $200. 3L stretch woven nylon fabric provides waterproofing and durability. An elastic waist with an integrated eye lock easily adjusts (*RAB Kinetic 2.0 Pant - Women's - Clothing*, n.d.).

Secondly is the Title Nine Women's Cold Killer Pants. These pants retail for $129 and similarly to the other competitor product is specifically designed for high aerobic activities. These feature a front softshell for wind and water resistance, a yoga pant style waistband with an infinite drawcord, high rise and zippered leg pocket (*Women's Winter Pants: Cold Killer - Regular*, n.d.). Images of the product are featured below in the described order.

Figure 3.



Note. From Burchard – Comp Product Images

Product Anatomy

Outerwear must do many jobs for the athlete and therefore is nuanced and complex. Each company approaches construction slightly differently but there are core components that make a hard-shell jacket successful. Jackets will feature a hood, typically a storm hood where the hood is connected to the collar of the jacket or a drop hood where the hood and collar are separated. Storm hoods provide improved face coverage and comfortability when the hood is worn up, though drop hoods are typically more comfortable when the hood is worn down (Ding & Reed, n.d.). This is a feature that is subjective and athlete specific.

Ventilation zippers are placed under the arms and maybe elsewhere as well. These zippers are typically water resistant or waterproof and allow the athlete to personalize their ventilation needs. Pockets are placed at the hip, chest, interior, and forearm and typically feature water-resistant zippers and potentially dividers or loops inside the pocket. Hard shell jackets feature different styles of cuffs, typically they are Velcro adjustable so the athlete can keep out wind and water. Cuffs occasionally feature a knit liner as well with a thumb cut out to provide additional comfort and environmental protection. The front of the jacket also utilizes a water-resistant or fully waterproof zipper. Zippers may have details such as a zipper garage or storm flaps for additional utility. In addition to this, seams will be fully taped for a water-resistant seal.

The Empire Wool and Canvas Arctic Anorak jacket offers the same idea of weatherproofing but through a different means and construction. With all-natural tightly woven canvas face fabric the user is protected from cold winds while still maintaining breathability. An extra-long skirt protects the buttocks and legs from losing heat, Velcro adjustable cuffs offer adjustability, and extra-large pockets have reach-through ports for accessing inner layers. This jacket also offers a cinched hood and a detachable ruff (Empire Wool and Canvas Company, 2024).

Hardshell pants feature several similar details to hardshell jackets due to their shared end-use. From the top down these pants may feature one of several closure/size adjustment features. Many pants, including the Arc’teryx Sentinel pants, utilize an integrated belt (Sentinel Pant Women’s, n.d.). Other closure options include belt loops in addition to a zip or button fly. Hardshell pants also feature ventilation zips, usually placed at the inner thighs. Some higher-quality pants will be patterned with articulated knees to improve athlete mobility. Pants may or may not have a thin fabric lining for comfortability and added warmth. This though can cause

issues with layering comfortably and may cause the athlete to get too hot. Pants will also feature side zips. These are placed at the bottom of the leg so the pants can easily fit over boots, or they can be a full side zip that lends itself towards easier donning and doffing. Inside the leg openings is a woven and elastic cuff to further keep out water and snow and create a tight seal over boots. Similarly to the jacket, high-quality versions of these pants will always feature fully taped seams. Product anatomy diagrams are depicted in the figure below.

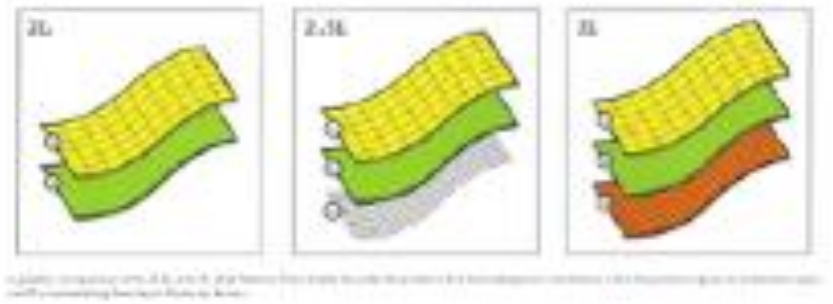
Mid-layers are constructed with similar "anatomy" to jackets with certain key differences. Some mid-layers may have no hoods for layering ease. When looking at hybrid mid-layers they almost always have a tight-fitting hood that still functions well with layering but can also provide elemental protection. Hybrid mid-layers usually have a slim fit designed to work within a layering system. They might have elastic cuffs or cuffs with thumb holes. Hybrid mid-layers designed for mountaineering or climbing pursuits often have stretch panels on the arms and side targeted at improving athlete range of motion. Other features on a hybrid mid-layer may be ventilation zones or laser cut areas. They also might have gussets to improve range of motion.

Softshell pants also boast similarities to hardshell pants but with different functions. Stretch woven fabric allows the athlete to move while the finish is usually what provides weather protection. These pants often feature a stretch waistband with some sort of adjustment mechanism. They have side pockets typically with a zip closure. These kinds of pants may have a small side zipper at the leg opening to assist with layering over boots, some might even have an integrated gaiter to improve water protection.

Materials

Hardshell jackets and pants consist of several layers of material. Figure 2 below references common material configurations including 2L, 2,5L, and 3L construction.

Figure 4.



Note. From Ding, H. D., & Reed, H. R. (n.d.). *A guide to technical Shell jackets*. Curated. (https://www.curated.com/journal/350000/a-guide-to-technical-shells)

Most commonly an outer or face fabric will consist of nylon or polyester. This layer will provide environmental protection. Sandwiched in between layers is a membrane that is intended to provide waterproofing and breathability (Cramer, 2020). A backing layer may also be included to protect the membrane and be comfortable against the skin. This layer often consists of mesh, taffeta, or nylon (*Switchback Travel | Ski Jacket Construction: 2L Vs. 3L*, n.d.). Arc'teryx uses a C-knit backer on some jackets and pants which is a fine circular knit backing designed to be more lightweight and breathable (SLU, 2024).

The materials used in the Empire Arctic Anorak are quite different as this item has a focus on natural materials and traditional construction. The body fabric consists of a pre-shrunk 6-ounce Organic Cotton Canvas. There is a fur ruff often made of beaver, wolf, or rabbit. There is also a poly-fleece lined face covering to prevent icing up, nylon trim, and plastic toggles/zippers (Empire Wool and Canvas Company, 2024). Other more traditional jackets that aim to strike a balance between natural and synthetic materials use a 4-ply nylon Taslan or Supplex fabric, a nylon material engineered to have a similar hand feel to cotton. This woven fabric is breathable and provides a durable layer to protect against wind. A DWR finish can be applied to this fabric to protect against water as well.

Common materials used for mid-layers are synthetic fleece, grid fleece, wool and softshell fabrics such as polyester, nylon and elastane blends. Popular in the space is Polartec materials. Some athlete favorites use Polartec WindPro fleece, Polartec gridfleece and Polartec Alpha Direct. Alpha Direct is a revolutionary fabric made for rapidly changing outdoor conditions, it's list of benefits is long including regulating warmth, lightweight, highly breathable, fast drying, compressible and durable (Llc, 2024a).

Softshell pants are designed for flexibility, weather resistance and breathability. Common materials used to construct softshell pants are nylon and polyester blends, usually with elastane for stretch. These materials provide weather resistance, durability, moisture wicking and quick drying. Common brands in this space are Polartec, Shoeller and Pertex. These layers also typically utilize a DWR coating to increase weather resistance and help water bead off the garment. The Rab Kinetic 2.0 pants use a specially engineered 3L material called Proflex that "…combines the performance and protection of a traditional hardshell with the comfort, stretch and feel of a softshell" (*RAB Kinetic 2.0 Pant - Women's - Clothing*, n.d.).

Jobs to be Done

Hardshell layers are your first layer of defense against environmental conditions. In contrast to this, they are the furthest layer from your body and need to aid in moisture management and thermoregulation. Often time shell jackets can create a micro-environment trapping heat and moisture and creating unfavorable conditions for the athlete. Hardshell layers must perform impeccably and therefore have many '*jobs to be done'.*

The overarching jobs of a hardshell jacket are wind and waterproofing as well as ventilation. The cuffs of the jacket work to keep out snow and provide environmental protection to the athlete. Zippers work to open and close the garment, provide waterproofing, and allow the

athlete to easily dump heat. The hood provides comfort, weather protection, and face/head coverage. Pockets on the garment allow easy access and food / small equipment storage. Pockets are especially important on this layer as it's the most accessible layer to the athlete and where they will likely store things they need quick access to. Taped seams and the DWR membrane provide wind and waterproofing.

The pants have very similar jobs to be done but for the bottom half of the body. Cuffs keep out snow, ventilation zips allow airflow, articulated knees provide mobility, side zip allows for easy don / doff and allows heat dumping, and the belt/fly closure provides security and adjustability. In addition, like the jacket, the taped seams and DWR membrane provide wind and waterproofing.

A mid-layer is an incredibly functional piece with several jobs to be done. Firstly, a mid-layer should provide insulation while regulating body temperature. This means it should have insulative features while also focusing on breathability and moisture management. It should wick sweat and help evaporate body moisture. It should be lightweight and fit properly for layering underneath outer layers. When considering a "hybrid" mid-layer it should also have some sort of weather resistance provided by a softshell fabric. Hybrid mid-layers will often be used when athletes are in high aerobic situations that are causing too much heat for additional layers, but they still need some weather protection.

Softshell pants should be comfortable and allow full range of motion, meaning they should have some sort of stretch to them. They need to provide weather protection and fight wind / water. With this protection they must also maintain breathability and aid in moisture management within a layering system. Durability is a key job for this layer too as athletes often

scrape their legs on things, kneel, sit and chafe between their legs while participating in repetitive motion.

Manufacturing

Beginning with the material, Gore-Tex is frequently used in hardshell jackets. Traditional Gore-Tex is manufactured by rapidly stretching a PTFE membrane which is then bonded to outer textiles (The GORE-TEX Membrane: What It Is, How It Works and Why You Need It, 2019). Once materials are finished patterns are cut using specialized cutting machines in the factory, typically these jackets consist of numerous pattern pieces. Patterns, once cut, are then sewn with some finishings attached. Zippers are sewn in, and seams are taped. Following these steps, the remaining finishings are attached (drawcords, grommets, toggles, etc. These are usually attached by hand. After this, some garments may be subject to postproduction testing to ensure quality waterproofing (Newcomb, 2019).

Hardshell pants are constructed in a very similar fashion. Patterns are cut using specialized cutting machines. Depending on the factory these machines may utilize a fine blade or be laser cut. Before cutting, machines will lay material out on cutting tables in several layers by folding a continuous sheet of fabric back over itself numerous times. Cut pieces are sewn section by section and like jackets zippers are then sewn in, seams are taped and finishings are attached. The described manufacturing process is depicted in the figure below.

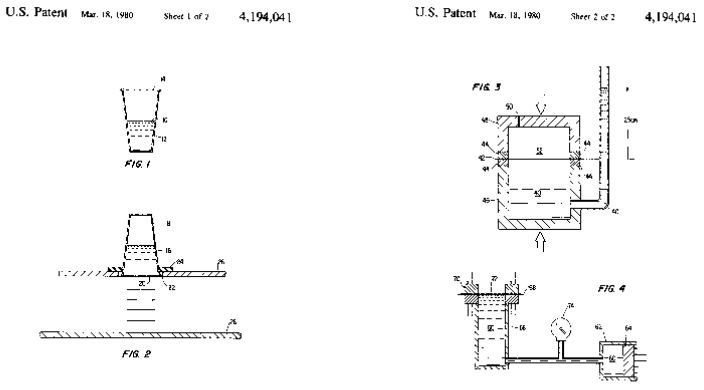
Mid-layers and softshell pants undergo similar apparel manufacturing processes. Material is selected and sometimes will receive additional treatments such as a DWR finish. Brands will usually source material from a vendor although sometimes they will develop new material technologies in house. Patterns are usually edited from company blocks, though for innovation styles or completely new products they will be drafted by a technical designer using a CAD

software. This pattern will be sent off for samples and undergo rounds of fit testing. The final will then be cut and sewn at a factory using industrial cutting machines and industrial sewing machines by the hands of skilled factory workers. It will undergo a quality check and be distributed from there.

Intellectual Property Landscape

Patent research is vital in determining the intellectual landscape of the market and understanding limitations on potential design ideas. Gore-Tex was top of mind when conducting preliminary research, as the technology is so frequently used in the outerwear market. W.L. Gore and Associates originally filed for and held US Patent # 4194041A. This patent, which has since expired, takes claim over the innovation of a waterproof laminate to prevent moisture ingress while simultaneously allowing breathability for the athlete (Gore & Allen, 1978). See Figure 4 below.

Figure 5.

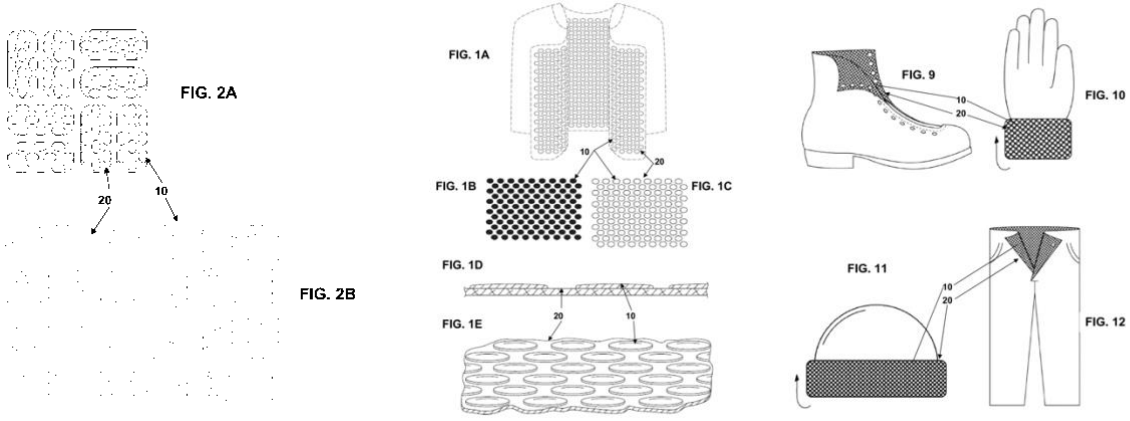


Note. From Gore, R. W., & Allen, S. B., Jr. (1978). *US4194041A - Waterproof laminate- Google Patents* (https://patents.google.com/patent/US4194041A/en)

Though expired it is interesting to look at the monolithic impact Gore-Tex has had and continues to have on the current outerwear marketplace. While other brands are lawfully free to innovate in this space none are challenging Gore-Tex in a major way. The name recognition of Gore-Tex among customers is so valuable that even without an active patent they are still by far the biggest player in this space.

Columbia is a moderately priced competitor in this landscape. With this being said, however, they pride themselves on countless unique innovations that make their outerwear successful. One such innovation is Omni-heat technology. US Patent # 8424119B2 is an active patent assigned to Columbia Sportswear that covers "patterned heat management material". This material referred to in the marketplace as "Omni-heat" consists of a base fabric that utilizes reflection and conductivity to transfer heat (Blackford & C. S. N. A, 2009). See Figure 5 below.

Figure 6

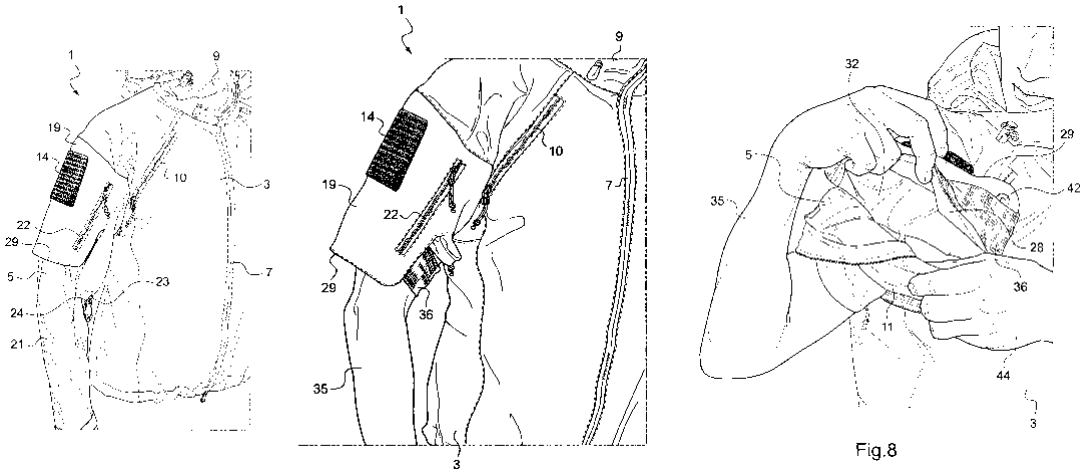


Note. From Blackford, M. E., & C. S. N. A. (2009) *US8424119B2- Patterned Heat Management Material- Google Patents* (https://patents.google.com/patent/US8424119B2/en)

Another formidable marketplace contender is Arc'teryx. As this project will have a focus on adjustability both for ventilation and range of motion reasons, it is important to consider patents for adjustable features on outerwear so as not to infringe. US Patent # 8341769B2 is held

by Arc'teryx Equipment Inc. and is based on a garment having "roll-up and stow sleeves". This was designed to help athletes adapt to real-time weather changes and allows a jacket to convert from long to short sleeves (Fayle, Pedersen, Richardson, AE, 2008) See Figure 6 below.

Figure 7



Note. From Fayle, Pedersen, Richardson, A.E. (2008) US8341769B2- Garment having roll-up and stow sleeves- Google Patents (https://patents.google.com/patent/US8341769B2/en?assignee=arcteryx&oq=arcteryx)

Trend Research

In addition to intellectual landscape research, trend research is also of utmost importance when ideating on a new product. For the scope of this project, both present-day state-of-the-art and future-trend research were conducted. Color, graphics, and branding were considered in this preliminary research.

Current Color Trends

There are some issues with current color trends in the women's outdoor apparel marketplace. Athletes often complain of limited options or options being overly "feminine". Certain core considerations go into defining color trends in outdoor apparel, especially durability.

Light colors can dirty very easily and not last as long so lots of technical outerwear is designed in darker color pallets to alleviate this. Typical colors for outdoor gear are maroon, navy blue, black, grey, and occasionally army green. Kelly Hill, Chief Product Officer for Stio, says that at her brand they "…joke that you can't break blue…" (Hicks, 2023). See sample current trend pallet in Figure 7 below.

Figure 8.



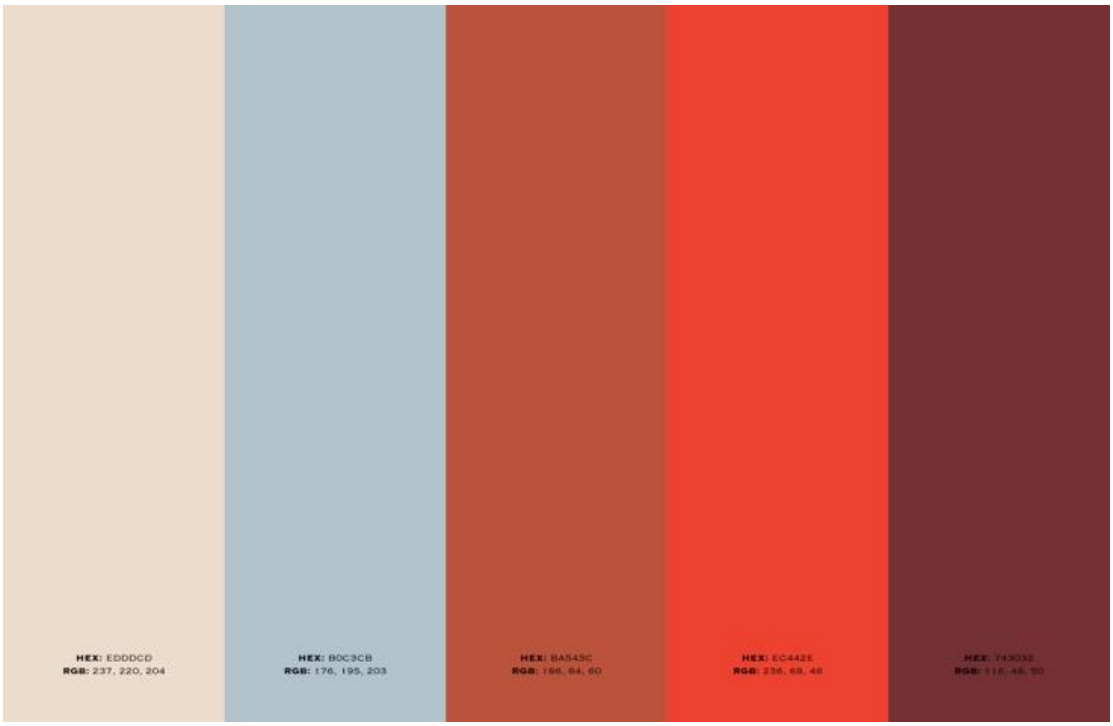
Note. From Hicks, (2023) Why is Outdoor Gear All the Same Colors?- Medium (https://tristanjhicks.medium.com/color-strategies-of-outdoor-gear-design-9fad13becfa4#:~:text=Another%20consideration%20for%20these%20brands,by%20signing%20up%20for%20Medium)

Future Color Trends

There are many emerging color trends in apparel for A/W 25-26 and A/W 26-27. This project has identified several trends that apply to this product space while also taking heavy

inspiration from the athletes and environment of the Iditarod itself. See the proposed pallet in Figure 9 below.

Figure 9.



Note. From Burchard – Pantone Proposed Color Palette

When identifying this palette, it was important to consider current trends and how to keep what is working and innovate from there. The goal of this palette is to showcase classic technical apparel coloration with hints of newness and vibrancy. The Women of the Iditarod Trail Invitational have expressed the desire for enhanced visibility within their kit. Aside from reflective trims and tapes, they want to be seen easily on the trail. This is accomplished through the contrast of bright maroons and reds against the winter environment. Lighter colors in the kit hint at winter landscapes and an appreciation for the environment. Warm hues and creams hint at vintage inspirations and traditional apparel. In the figure below is a mood board that has been developed for this project, directly feeding into the proposed color pallet.

Figure 10.



Note. From Burchard – Mood Board

Current Graphic / Material Trends

Graphics are tricky in outerwear and not frequently utilized. This has a lot to do with keeping material integrity. Graphics may poorly interact with finishes or membranes on the garment. In addition, outerwear should last a long time and not be something that will quickly go out of style due to graphic decisions. Some commercial products or seasonal offerings from

brands like The North Face or Columbia showcase graphics but it is uncommon to see more technical offerings without solid colors.

One very popular graphic trend, however, in this product space is color blocking. Many brands use color blocking to add multiple colors to technical outerwear. Not much outerwear has graphic prints on it, so this is a popular way to add visual interest.

Future Graphic / Material Trends

Several trends were evaluated for the future of graphic design in this product space. The graphic research was combined with future materials research as technical outerwear often uses texture in place of graphic prints.

Two trends were referenced directly from WGSN. 'Haptic Warmth' is a trend in outdoor apparel where materials and textures are used in key areas to signal feelings of coziness and comfortability to the athlete (*WGSN, n.d.*). ITI Athlete Kari Anne Gibbons mentioned that she likes to layer a fleece mid-layer in her kit solely to snuggle up to it and get feelings of "coziness" while in the extreme Alaskan environment. Key areas for utilizing haptic warmth may be the collar around the face and wrist cuffs.

The next trend pulled from WGSN is titled 'Mystic Mountains'. This trend references the ability to utilize spiritual and nature-driven prints to emphasize the spiritual importance of time spent outdoors. This is very applicable as ITI athletes have a strong connection to nature and their surrounding environment (*WGSN, n.d.*).

'Looking Backwards' is the last identified trend for this product space and looks at referencing traditional outerwear materials and techniques to innovate current ITI products. Many athletes utilize old-school jackets similar to what original dog mushers used on the trail or

Indigenous solutions. This may include natural fabrics, real fur, tight weaves, ornate construction and waxed waterproofing solutions.

Current Branding Trends

Current branding trends in this product space and future trends are slightly intertwined. One popular branding technique in this product space that has been on the rise in recent years is 'branding your features'. Companies like Gore-Tex and PrimaLoft do this. By using name recognition and large branding appliques, many companies will brand the exterior of the garment to visually signal customers to the benefits. Another current trend in branding is event-specific branding. This is seen a lot in marathon and trail running gear where apparel is customized for the specific race. This is an opportunity for ITI-specific gear and was similarly used in previous years of the Freeride World Tour.

Future Branding Trends

One identified future branding trend is 'hardware hits.' This is achieved when companies brand small details like toggles, zipper pulls, hardware etc. Interior branding is also a huge opportunity for this product space. Tags can cause chafing, itching, and general irritation on any garment. Though small, these athletes are wearing so many layers that alleviating any bulk is important and can prevent future irritation. Imagine being frustrated by an itchy tag while also wearing 5+ layers and bulky gloves. To alleviate this, branding can be printed directly onto the interior of the garment so as not to add any bulk. The last self-entitled trend is 'branding excites'. Branding can be used as an opportunity to excite and inspire athletes. By printing motivational quotes in pair with branding, these moments can inspire a personal connection between the brand, event, and athlete. See Figure 11 below.

Figure 11



Note. From Burchard – Branding Trend Research Examples

Physiological Research

Beyond branding and aesthetics, it is critically important to understand how the body responds to the extreme demands of the Iditarod Trail. Trekking 1,000 miles on foot, ski or bike in a frigid environment presents both predictable and unique physiological stressors. For starters, traveling long distances in the cold has a noticeable effect on the respiratory system. Repeatedly breathing in cold air can lead to inflammation and excess mucus production in the body causing perceived shortness of breath and chest tightness in athletes (American Lung Association, n.d.). Several female athletes have been diagnosed with double pneumonia after coughing up blood and reporting severe shortness of breath while on trail. This phenomenon is not well studied but athletes are reporting this as a misdiagnosis and instead are suffering from pulmonary edema or excess fluid in the lungs.

Aside from the environment, the sheer distance of the Iditarod Trail presents physiological challenges. A cross-institutional study conducted in 2022 showed that

ultramarathon athletes displayed an 8.2% decrease in memory test performance following an ultra-endurance event. This study also showed that athletes simple reaction times decreased by 30.2% following the race. This impaired cognitive function is influenced by cardiovascular changes and severe sleep deprivation (Perrotta et al., 2022). Athletes describe feeling “drunk” and experiencing hallucinations following long stints of physical activity with limited sleep.

Calorie management is vital in a self-supported race like the ITI. Nearly 50% of calories burned go towards maintaining core temperature (Patel, 2024). When in extreme cold more calories are needed to maintain homeostasis and these athletes quickly burn through calories due to the physical demands of the race. This presents a unique physiological dilemma to solve, as apparel plays a clear role in calorie maintenance.

Two issues mentioned by ITI athletes that present performance issues for Women competing in the ITI are Raynaud’s and Edema. Raynaud’s is extreme vasoconstriction that occurs in response to cold weather. The resulting lack of blood flow causes extremities to become cold, numb, and lose color. Some women may experience a reaction from something as simple as briefly reaching into a freezer. Raynaud’s can be a precursor to severe frostbite, a real worry for women on the trail (Roberts, 2015). There is limited research into why it seems more women are affected by Raynaud’s than men or why several women partaking in extreme cold weather sports are affected.

Edema is another understudied, but very real issue for women in the ITI. When first speaking with ITI athlete Kari Gibbons she emphasized the effects this has on her fellow female athletes. Edema is swelling caused by fluid buildup in the body. Most often this affects people in the lower extremities, especially legs and feet (*Edema - Symptoms and Causes*, n.d.). The strange physiological experience women in the ITI are having is full-body edema. Kari mentioned how

women often become unrecognizable within a few days of race kickoff because of the amount of facial swelling they endure. She said women can change up to three whole pant sizes due to swelling in the stomach and even three shoe sizes due to swelling in the feet. This is a relatively understudied physiological response. Potential contributing factors to edema are dehydration, vasoconstriction, or even hormonal changes occurring because of extreme cold weather (*Edema - Symptoms and Causes*, n.d.). Kari Gibbons commented on one race that "Tales of frostbite and deep fatigue, knee pain, shin splints, edema/swelling, have been mentioned more than once. For those continuing, their task is to find a way to keep the body happy while they attempt to cross an often-unfathomable distance." (News-ITI, 2024)

Biomechanical Research

Cold weather, combined with the demands of endurance sports, significantly alters the body's biomechanics. Athletes adapt their natural movement patterns to navigate frozen, uneven, and snow-covered terrain. Frozen underfoot conditions cause a decreased stride distance. Cold weather also causes a decreased range of motion, stiffened muscle and tissue which takes a longer time to become pliable when moving, and an overall increased propensity for injury. On top of this, impaired muscle contractions can lead to quicker fatigue when participating in aerobic activity in cold environments (Uhan, 2023).

ITI athletes traveling on foot or ski drag a sled behind them carrying their supplies, a task which has requires unique biomechanics. The spine and abdomen muscles work overtime to keep the body upright. The athlete will lower their center of gravity to brace the load, and they will tend to lean forward. Hip and knee muscles work harder to propel the body forward with the extra weight (Harman, Hoon, Frykman, Pandorf, 2000).

Psychological Research

This paper has briefly discussed, under athlete jobs to be done, the mental stamina required to partake in ultra-endurance events, especially one as intense as the ITI where athlete's lives hang in the balance. One study examined the psychology of ultra-endurance event athletes and determined that athletes embody two key qualities; they are motivated to achieve personal goals, and they have a psychological drive to push their physical and mental limits (Roebuck, Fitzgerald, Urquhart, Ng, Cicuttini, Fitzgibbon, 2018). Jill Homer, an ITI participant states "There's something magical about the Iditarod Trail — a place so relentlessly challenging and remote that you have to gaze deep into the darkness just to get through it. And yet it's also a place of beauty, joy, and kindness." (News – ITI, 2024). Additionally, winter ultra racing provides a community for athletes and many describe the experience as addicting. This type of race is often referred to as type 2 fun, a kind of activity that is dangerous or painful during participation but extremely rewarding after the fact.

The psychological effects of the ITI may vary between athletes and their individual experiences, but the following effects are generalized to the event. One study states that over one hundred hours of adventure racing causes significant mood state disruption (Anglem, Lucas, Rose, Cotter, 2008). Identified stressors that impact athlete mood state are lack of recovery, severe sleep deprivation, constant mental workload from tasks like navigation and safety, as well as difficult and unpredictable environmental conditions. In addition to all of this, athletes are often alone during the race, occasionally encountering others along the trail. This requires strong mental stamina and self-sufficiency and has a strong impact on athlete psychology. Interviewing athletes has highlighted the acute psychological impacts of severe sleep deprivation during the race as well, with athletes reporting visual and auditory hallucinations and erratic behavior.

Shell Jacket Competitor SWOT Analysis

Following deep aesthetic, physiological, psychological, and psychographic research the competitor product previously identified was examined closer to highlight new product innovation opportunities before finalizing designs. Each product was analyzed for strengths, weaknesses, opportunities, and threats by anatomical part. The following analysis will cover the hood, ventilation zips, pockets, cuffs, and materials for competitor hardshell jackets.

Men's Kangri GORE-TEX Jacket $425

Anatomical Part	Strengths	Weaknesses	Opportunities	Threats
Hood	storm hood protects the neck from the environment, adjustable hood, fleece lined chin guard	the collar may pull towards the face while the hood is down, with no cinching around the face	more adjustability, zonal fabric usage	hoods with more protective features
Ventilation Zips	2-way waterproof zippers	zipper tabs small	more vent placement, better toggles	jackets with more placements
Pockets	ample storage options	no specialized pocket features	female-specific pocket placement, pockets for keeping food/drinks unfrozen	bags/vests with better pocket options
Cuffs	adjustable, "anti-snag" Velcro	no liner/thumb holes, hard to adjust with one hand	integrating with the glove, help provide durability to the glove	jackets with easier adjustability
Materials	waterproof, durable, 70D 3L Gore-Tex	not breathable enough	room for "PFA-free" and DWR innovations, better breathability	natural fibers, other companies innovating

Women's Arc'teryx Beta AR Jacket $400

Anatomical Part	Strengths	Weaknesses	Opportunities	Threats
Hood	drop hood, laminated brim, adjustments designed for mitten usage, chin guard with microsuede backing	With less protection, layering may be difficult	emphasizing the microsuede backing, new hood configurations beyond storm and drop	athlete preference for other hood types or hats
Ventilation Zips	waterproof zippers, pit zips with cords for easy pull	zips may get stuck in the surrounding fabric	more vent placements	jackets with more placements
Pockets	high volume hand pockets, internal chest pocket	pocket zippers are not fully waterproof	fully waterproofed storage, insulated food storage	fully waterproof pockets and bags
Cuffs	die cut Velcro adjustors, lightweight	no liner/thumb holes	can be designed to consider better interfacing with gloves / trekking poles, preventing abrasion	jackets with better glove interfacing
Materials	N40d Most Rugged 3L GORE-TEX PRO	not breathable enough, not PFA free	room for "PFA-free" and DWR innovations, better breathability	PFA-free innovations, companies with popular proprietary waterproofing tech

Empire Wool and Canvas Company Arctic Anorak $440

Anatomical Part	Strengths	Weaknesses	Opportunities	Threats
Hood	generous sizing, single hand cinch, detachable fur ruff, poly fleece lined face guard	minimal adjustability	blending more technical elements into this design	athlete preference for modern solutions
Pockets	zippered chest pocket placed for bag/belt usage, reach through port for accessing things stored inside your other layers	limited pockets	more pockets, sleeve pockets	more technical jackets with several pocket placements
Cuffs	Velcro closure	Velcro can be irritating	soft bits on cuffs like on the face guard	not interfacing well with athletes' chosen gloves
Materials	naturally breathable woven cotton canvas	no adjustable ventilation, no waterproofing	blending more technical elements into this design, adding adjustable vents	Gore-Tex

Shell Pants Competitor SWOT Analysis

Below is each previously mentioned pant competitor option, similarly, broken down into strengths, weaknesses, opportunities, and threats by anatomical part. Each pant offering is broken down into a closure mechanism, ventilation zips, pockets, cuffs, and materials. The tables below detail each SWOT analysis in an easy-to-reference format.

Arc'teryx Sentinel Pant Women's $600

Anatomical Part	Strengths	Weaknesses	Opportunities	Threats
Closure	integrated belt, easy adjustability, "slide and lock" feature to attach to jacket to prevent snow ingress	Hardware could be uncomfortable	more adjustability, one-hand-specific hardware, soft hardware	athlete preference for other closure mechanisms
Ventilation Zips	outer thigh placement is comfortable	can be difficult to quickly unzip with gloves	Place on the inner thigh or back as well for cross-breeze	Pants with better zipper pull / more placements
Pockets	zipper for security, phone sleeve, key loop	limited amount of storage, placement could interfere with movement	better placement based on athlete feedback, accessible food storage	pants with more considered pocket placement
Cuffs	durable Cordura fabric fits over boots, keeps out snow	designed for ski boot compatibility, not for winter runners	can be designed to consider better interfacing with footwear/gaiters	gaiters etc
Materials	waterproof, durable, reinforced in areas, PPFA-free comfortable flannel backer	not breathable enough	room for "PFA-free" and DWR innovations, better breathability	natural fibers, other companies innovating

Outdoor Research Women's Headwall GORE-TEX 3L Pants $400

Anatomical Part	Strengths	Weaknesses	Opportunities	Threats
Closure	dual snap fly, Velcro adjustments	Velcro can malfunction when wet and can irritate if skin contact occurs. Snapfly can press on a bloated stomach and cause irritation	Adjustability designed for ease of use in cold, wet weather and when swelling occurs	pants designed for a wider size range of adjustability
Ventilation Zips	YKK Aquaguard waterproof, full separating side zip, easily adjustable and removable	could be difficult to get zipped back together once unzipped, toggles not designed for glove usage	can consider ease of use with gloves	pants with better toggles / more placements
Pockets	zip hand pockets, easy to reach into, secure	A limited amount of storage and placement could interfere with movement especially when squatting	better placement based on athlete feedback, accessible food storage	pants with more considered pocket placement
Cuffs	keeps out snow, snap adjustable, tear-resistant scuff guards	designed for ski boot compatibility, not for winter runners	can be designed to consider better interfacing with footwear/gaiters	gaiters etc
Materials	waterproof, durable, 3L	not breathable enough	room for "PFA-free" and DWR innovations, better breathability	natural fibers, other companies innovating

Mammut Taiss Pro HS Pants Women $479

Anatomical Part	Strengths	Weaknesses	Opportunities	Threats
Closure	"Special wide" waistband, stretch panels/side adjustments	Velcro adjustability can lose integrity in wet environments and can cause chafing when misaligned	Rethink adjustment mechanism	Velcro malfunctioning
Ventilation Zips	3/4 length waterproof side zipper, easily adjustable, dumps lots of heat	zipper pulls are not designed for glove use	place the zippers on the inner thigh or back as well for cross-breeze	pants with better toggles / more placements
Pockets	leg pocket placement better for movement, waterproof zippers	leg space already limited for women with big quads pocket placement will not accommodate everybody	patterning for more space in the thigh if using thigh pockets	pants with more pockets and features
Cuffs	leg width adjustment, Cordura for crampon protection	designed for mountaineering boot compatibility, not for winter runners	can be designed to consider better interfacing with footwear/gaiters	gaiters etc.
Materials	proprietary waterproofing technology, Cordura for crampon protection	not breathable enough	better breathability	natural fibers, Gore-Tex

Hybrid Mid-Layer Competitor SWOT Analysis

Below are both previously mentioned hybrid mid-layer competitor products broken down into strengths, weaknesses, opportunities, and threats by anatomical part. Each offering is broken down into zippers, pockets, materials, and hood. The tables below detail each SWOT analysis.

Mammut Eiger Speed ML Hybrid Hooded Jacket $200

Anatomical Part	Strengths	Weaknesses	Opportunities	Threats
Zippers	Contrast colors so athletes can easily see where to grab	Coil zipper is not athlete preferred	Larger zipper pulls	Coil breaking on trail , athlete DIY's
Pockets	Quick access mesh pockets for ease – one zippered stash pocket	Only front pockets no others	Other placements like chest or arms	Items falling out of front pockets
Materials	Polyester, spandex blend stretches, breathes and wicks moisture	Smells bad, no insulation	More loft of liner for insulation	Alpha Direct material
Hood	Fitted hood for high winds, ponytail slot for hair maintenance	No adjustability	More hood adjustability, detachable ruff	Balaclavas, hoods with detachable ruff

Norrona Women's Falketind Alpha120 Zip Hooded Jacket $219

Anatomical Part	Strengths	Weaknesses	Opportunities	Threats
Zippers	Closes jacket	Coil zipper is not athlete preferred , sewn too close to alpha direct and will get caught	Larger zipper pulls	Coil breaking on trail , athlete DIY's
Pockets	Harness compatible side access pockets, small chest stash pocket	Small zippers for entry can get caught and be difficult to use with gloves	Better closures	Zippers breaking and pockets being non-functional
Materials	Alpha Direct breathes and insulates, stretch panels provide mobility aid	No protection from wind	Zonal incorporation of softshell fabrics	Athletes not being able to wear this without another layer on top
Hood	Fitted hood for high winds, optimized for layering	No adjustability	More hood adjustability, detachable ruff	Balaclavas, hoods with detachable ruff

Softshell Pant Competitor SWOT Analysis

Below are both previously mentioned softshell pant competitor options broken down into strengths, weaknesses, opportunities, and threats by anatomical part. Each offering is broken down into waistband, pockets and materials. The tables below detail each SWOT analysis.

Rab Kinetic 2.0 Pant $200

Anatomical Part	Strengths	Weaknesses	Opportunities	Threats
Waistband	Integrated eye lock and elastic cord	Grip on inside might be uncomfortable	more expansion	Waistband with more adjustability
Pockets	Spacious	Small zippers make access difficult	Easier accessibility, bike compatibility	Pants with better pockets
Materials	3L stretch fabric for comfortable waterproofing	Waterproof breathable doesn't always work in ITI environment	Zonal waterproofing	DWR finish

Title Nine Cold Killer Pants $129

Anatomical Part	Strengths	Weaknesses	Opportunities	Threats
Waistband	Thick yoga band style for comfort	Flimsy elastic cord	more expansion	Waistband with more adjustability
Pockets	Waistband pocket	Only one leg pocket	More pockets, easier access	Pants with more pockets
Materials	Stretch softshell with DWR for breathable water resistance	Too thin in the back	Excess material in the butt	If athletes prefer waterproof breathable

SWOT Findings

After completing each SWOT analysis some common threads were found between products. As far as both jackets and pants go a common weakness overall was a lack of proper breathability. Whether concerning ventilation zips or overall material properties each item had unique struggles in this area. Next was a general lack of adjustability. This provides an

opportunity for future products to stand out in terms of adjustability and sizing. The pocket placement was also an issue as generally pockets weren't large enough or had a placement that hindered the performance of ITI female athletes. Toggles and zipper pulls on several garments were also too small to conveniently use with gloves. Overall, adjustability, sizing, and breathability are problems that must be tackled in future designs.

User Insights

Research was conducted among the user population over a 10-month period with varying methodologies and goals. The first step was meeting with athletes to get a general feel for this sport space and the potential problems to be solved. Once it was solidified that this was a critical sport space in need of innovation a set of probing questions was developed as listed below.

1. Describe to me your current ITI apparel kit from the base layer up.

2. What are the top 3 problems you experience with your apparel during the race?

3. What are the top 3 problems you experience with your equipment during the race (specifically gloves, bags, trekking poles, sled, etc)?

4. How would you describe your thermoregulation/moisture management strategy during the race - describe to me your challenges.

5. Do you struggle with any trims/toggles? Think pockets, zipper pulls, adjustable ventilation, etc.

6. Do you struggle with Edema during the race? Does swelling cause you to adjust or size up in your apparel?

7. Is your range of motion affected by your layering strategy - describe any uncomfortably or impacted movement caused by your layering system.

8. How do you feel about traditional apparel vs modern solutions - opinions on traditional solutions like fur or waxed cotton canvas?

9. If you could own anything - currently existing or not - for the race, what would it be and why?

10. Aesthetics: do you have preferred colorways, graphics, or silhouettes and why?

These questions were used in interviews with Amanda Harvey and Nan Pugh, ITI bike athletes. Following these structured interviews, further interviews were conducted with Frances DeBlare, Kendall Park and Kari Gibbons. These interviews were open-form conversations regarding everything from race conditions to garment materiality etc. and provided a greater understanding of these athletes, their environment, apparel and problems to be solved.

Additionally, I traveled to Alaska for the 2025 ITI race kickoff to meet with athletes in person. Here I connected with formerly mentioned Kari Gibbons, Kendall Park and Amanda

Harvey. I also connected in person with countless other athletes including Laura Rushfeldt, Sunny Stroeer, and Kate Coward. Through this I was able to connect with record-breaking women across disciplines who informed the final product designs. In addition to these one-on-one conversations, I hosted several discussions in the Wild Winter Women Facebook page, creating a space for women to talk about their apparel needs in the comments which was insightful for my final designs.

Provided below is the information from the first two structured interviews I conducted with Amanda Harvey and Nan Pugh.

1. Describe to me your current ITI apparel kit from the base layer up.
    a. Amanda:
        i. A Smartwool base layer – t-shirt or long sleeve, brings lightweight ¾ sleeve and heavier base layer with hood, Revelate designs fleece mid-layer with home attached zipper for detachable fur ruff, cycling jacket with an insulated thermos for water, 2 puffy coats (lightweight and heavyweight with waterproofing), bike shorts, wool long johns, 45 North Men's Naughtubind pants.
    b. Nan:
        i. Base layer – Polartech alpha 60 grams – likes them because they breathe super nicely. Wears Patagonia Capilene air or Icebreaker heavier Merino wool for colder rides. Wild Rye pants for warmer weather. For colder weather, she wears soft shell ice climbing pants. Features she likes about these are: full side zips and extra material on the backside above belt loops so it protects you when bending over. For weather below 10 degrees

Fahrenheit, she also wears Scott puffy shorts that a local seamstress put side zips in. She owns several mid-layers including a Brynje wool mid-layer, Alpha Direct fleece, and a Revelate designs Polartech hoodie that she had a full zip put in. She also has a Patagonia Airone full zip that she wears interchangeably with her Revelate top. 75% of the time she will wear the Patagonia Houdini as an outer layer, and she treats this with DWR. When below 10 degrees Fahrenheit she will wear a "huge mega puff" from Mountain Hardware rated around 8000m. She mentioned that a hardshell designed for wind resistance might be nice.

2. What are the top 3 problems you experience with your apparel during the race?
    a. Amanda:
        i. Venting heat is difficult, sweat management, fit (having to size up or down because waist/thigh/hip fit doesn't correspond, having to sew Velcro onto her pants for adjustments)
    b. Nan:
        i. Stink factor when wearing layers for an extended period, the fit of garments while in motion – needs extra give in hips, chest, and shoulders of her garments, water carrying – carrying 3L of water under jacket + having a large chest makes her feel uncomfortable and "barrel-chested".

3. What are the top 3 problems you experience with your equipment during the race (specifically gloves, bags, trekking poles, sled, etc.)?

a. Amanda:
    i. Hydration vest freezing, visibility/reflectivity lacking, toggles / clear plastic elements on bags shatter in cold temperatures.
b. Nan:
    i. Headwear – hasn't figured out the best layering system for wearing a helmet, ruff, hood, and face covering. Nose hat –prevents frostbite but glasses fog up, wears a headband under her nose to warm up her sinuses because if her sinuses stay warm she feels better and overall stays warmer – doesn't have a piece of equipment to alleviate this need.

4. How would you describe your thermoregulation/moisture management strategy during the race - describe to me your challenges.
    a. Amanda:
        i. She starts with just base layers and gradually adds layers as she gets cold. Has issues sweating through when even wearing just her base layers and is very uncomfortable with wet base layers. Her jacket doesn't have pit zips.
    b. Nan:
        i. Nan often says there can be "no sweating" because of how cautious you must be not to get wet. She feels she doesn't need a lot of layers and prefers not to wear hats unless necessary so her head can vent. She has modified a lot of gear to have a full zip for easy removability and ventilation.

5. Do you struggle with any trims/toggles? Think pockets, zipper pulls, adjustable ventilation, etc.
    a. Amanda:
        i. Yes- replaced toggles on all her jackets with bright yellow reflective paracord
    b. Nan:
        i. Yes - On the main jacket she's added a larger zipper pull – must stop and tension her pit zips to get them undone.

6. Do you struggle with Edema during the race? Does swelling cause you to adjust or size up in your apparel?
    a. Amanda:
        i. Yes – the first time it happened was during ITI. Legs swelled up and base layers cut into her lower legs. Was not impacted badly enough that she had to stop but was uncomfortable.
    b. Nan:
        i. Yes - did a trip where her breasts swelled up and were much larger, her hands swelled up and her finger with ring got numb, and her clothes started feeling snug – upsizes clothes for winter ultras in preparation.

7. Is your range of motion affected by your layering strategy - describe any uncomfortability or impacted movement caused by your layering system?
    a. Amanda:

        i. Generally, feels comfortable because she sizes up. She avoids tight sleeves and purposefully doesn't bring certain jackets because she knows they don't layer well but dislikes this because it means she must purchase more gear.

    b. Nan:

        i. Feels her range of motion is affected. Slim-fit items never work. Sizing up helps but still has issues in her chest, hips, and quads.

8. How do you feel about traditional apparel vs modern solutions - opinions on traditional solutions like fur or waxed cotton canvas?

    a. Amanda:

        i. Likes a blend. Would be very anxious about a waxed canvas solution. Likes gear that is ultralight and packable. Likes her down items because they are compressible. Synthetic items are also cheaper which she likes.

    b. Nan:

        i. Likes a blend. Some synthetic like her alpha breathes well but she worries about the stink and durability of synthetic products. Loves her beaver and wolf ruff – loves the performance but feels claustrophobic when she gets too much around her face.

9. If you could own anything - currently existing or not - for the race, what would it be and why?

    a. Amanda:

i. Her fur ruff with beaver facing and wolf outer. Keeps face and head extremely dry and warm. Feels cozy.

b. Nan:

i. Women's bib and base layer set with drop seat. She doesn't currently own one but would love this. She would like a bib but the issues with going to the bathroom hold her back.

10. Aesthetics: do you have preferred colorways, graphics, or silhouettes and why?

a. Amanda:

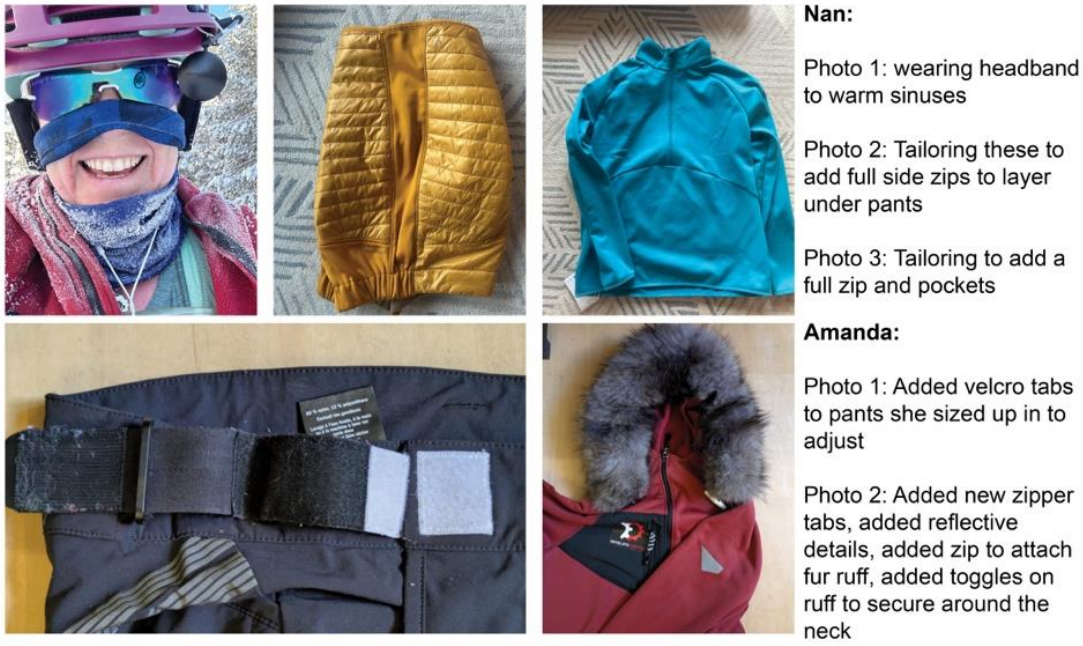
i. Bright and reflective - when everything is black it's too hard to tell what's what when in a bag or sleeping bag and can be dangerous when camped around snowmobiles. Likes reds and oranges. Loves "cute" details like anything that makes you feel fun and distinguishes your gear from others while at checkpoints

b. Nan:

i. Visibility is the most important factor. Chooses her wind shirt/outerwear on visibility and ability to pop – loves fuchsia, yellow, and red for high vis – particularly on grey days. More reflective accents are needed especially on pants, studies show high vis on feet and lower legs pops more because it's moving.

The figure below consists of images shared with me by Amanda and Nan of gear alterations they have made that were shared during our interviews.

Figure 12.



Note. From Burchard – User Photos.

Listed below are several quotes obtained during interviews, in person or from discussions on the Wild Winter Women Facebook page that have been impactful on this project.

1. “It is my firm belief that women are really good at getting through this race - they go out there and thrive. It is the great equalizer, if we can get past the barriers this is the place where we shine the most.” – Kari Gibbons

2. “I need insulation on the butt and hamstrings, they’re always cold and it’s really tough to find layers with extra in those key areas.” - Amber Crawford

3. “I think finding a way to keep the butt warm is key to success - as soon as my butt gets cold I have a hard time regulating my body temperature.” - Jessica Roschlan

4. “Men’s stuff fits better in the shoulders but doesn’t cover my hips / butt” - Beth Freymiller

5. “Going with men’s gear helps me with length but have added difficulty with hips / butt fit” - Frances DeBlare

6. “I buy very large men’s jackets, when they are smaller, they are too tight at the hips. It feels like longer would be better for everyone in our sport.” - Kate Coward

7. “My kit is too big when I start the race and usually fits by 2-3 days in” - Kari Gibbons

8. “I added extra Velcro to my waistband to cinch it tighter” - Amanda Harvey

9. “We love big zippers, at lease #5 molded tooth.” -Kendall Park

10. “Aquaguard zippers stick and are hard to do up, especially in the cold. Coil zippers can do weird things in the cold. I am afraid of breaking either of these while I’m out there.” – Kendall Park

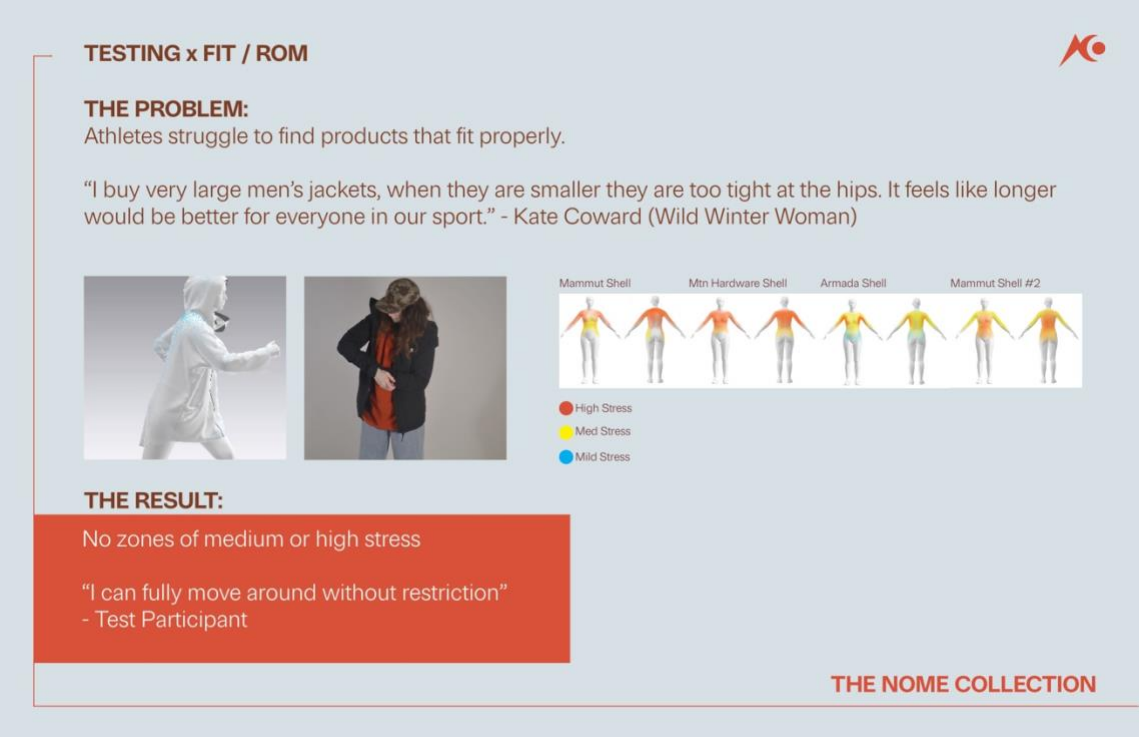
Performance Testing Plans

Following gathering athlete insights, product testing was conducted in three tiers, gut check testing, benchmark testing and high-fidelity testing. Some of the benchmark products

tested included competitor garments previously outlined in this paper, as well as commercially available items with similar features that could be purchased and evaluated in person. ‘Works like’ prototypes for each proposed product classification were created prior to testing and results were compared against the benchmark product. This process highlighted the ways in which product could be innovated to surpass what is available on the market, with the findings later applied to ‘looks like’ final prototypes. The prototype break down is Gust Parka (hardshell jacket), Gust Pant (hardshell pant), Vigor Jacket (hybrid mid-layer), and Vigor Pant (Softshell pant).

Hardshell jackets underwent high fidelity range of motion testing with an athlete. The athlete performed a series of motions including lunge, squat, arm reach forwards, arm reach overhead, and arm reach across chest. The athlete performed these activities wearing a two different Mammut Shell Jackets, a Mountain Hardware Shell, and an Armada shell. The athlete ranked areas of high stress, medium stress and mild stress in the jackets while performing motions. The results were used to build 3d stress maps of each jacket and are detailed in the figure below. The test was repeated with the Gust Parka prototype and showed no zones of high or medium stress. The athlete remarked that she could “…fully move around without restriction.”

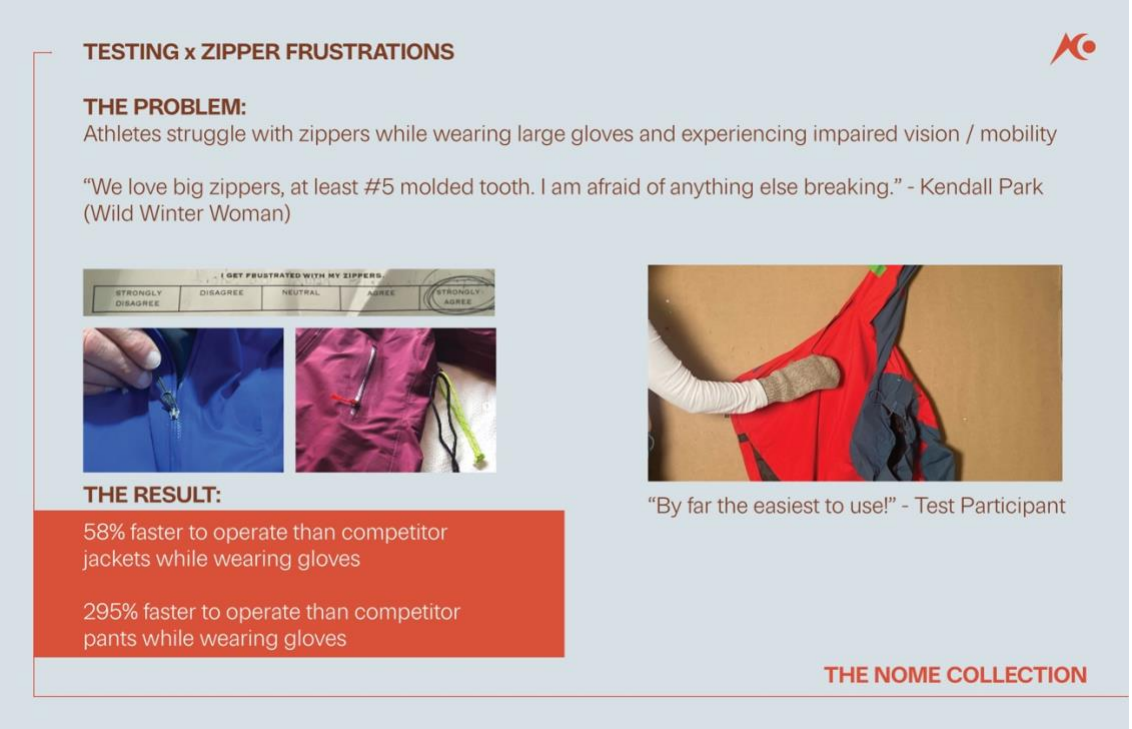
Figure 13.



Note. From Burchard – Testing Results

The hardshell jacket competitor products and Gust Parka prototype also underwent zipper pull testing. All jackets were tensioned on a rigid piece of cardboard using pins and 12-inch sections of zipper were marked. A user donned mittens and was timed to zip the zipper up / down 10 times each with the goal of capturing an average time. The results for each test are depicted in the figure below. The zipper technology utilized on the Gust Parka performed better due to the use of XL looped zipper pulls, YKK #5 molded tooth zippers, and a rigid zipper backing designed to not get caught in the zipper. The hardshell pants were also tested against zipper prototypes with the results also in the figure below.

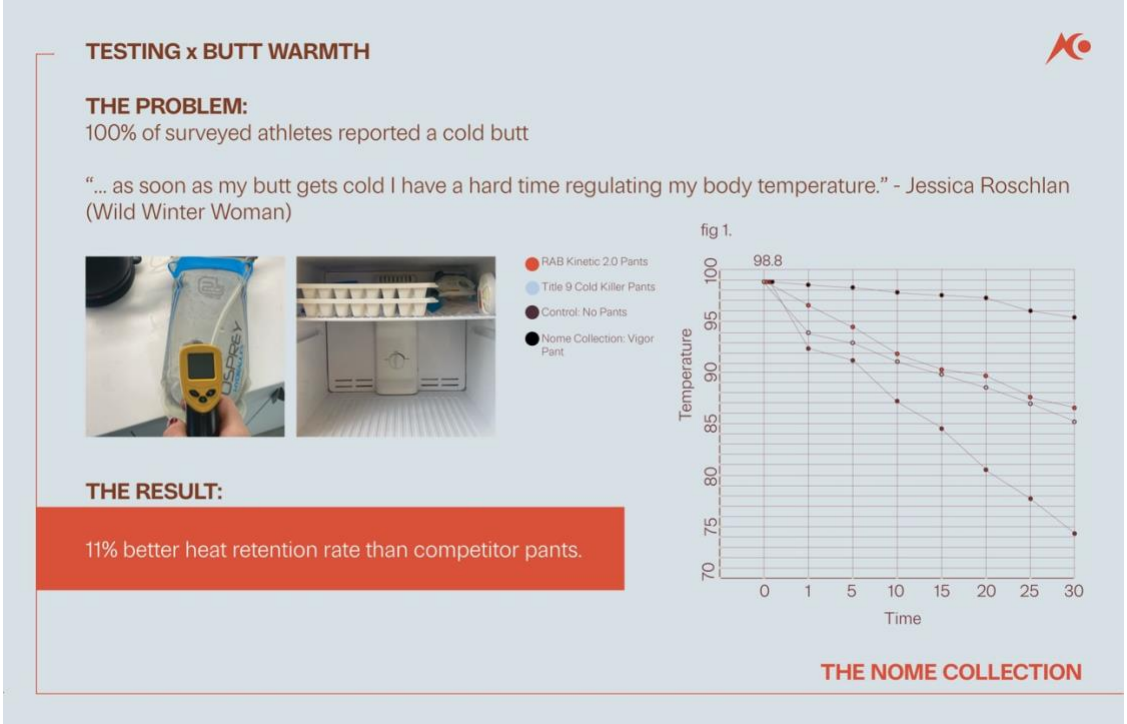
Figure 14.



Note. From Burchard – Testing Results

Butt warmth was tested in softshell pants by filling a 2L water bladder with 98.8 degree water. The water bladder was placed in a 0-degree freezer for 30 minutes and the temperatures were captured consecutively every 5 minutes. The control was captured with no pants and then each pant was tested by wrapping it around the bladder. The new prototype was also tested. The results are depicted in the table below with the new prototype performing 11% better than competitors.

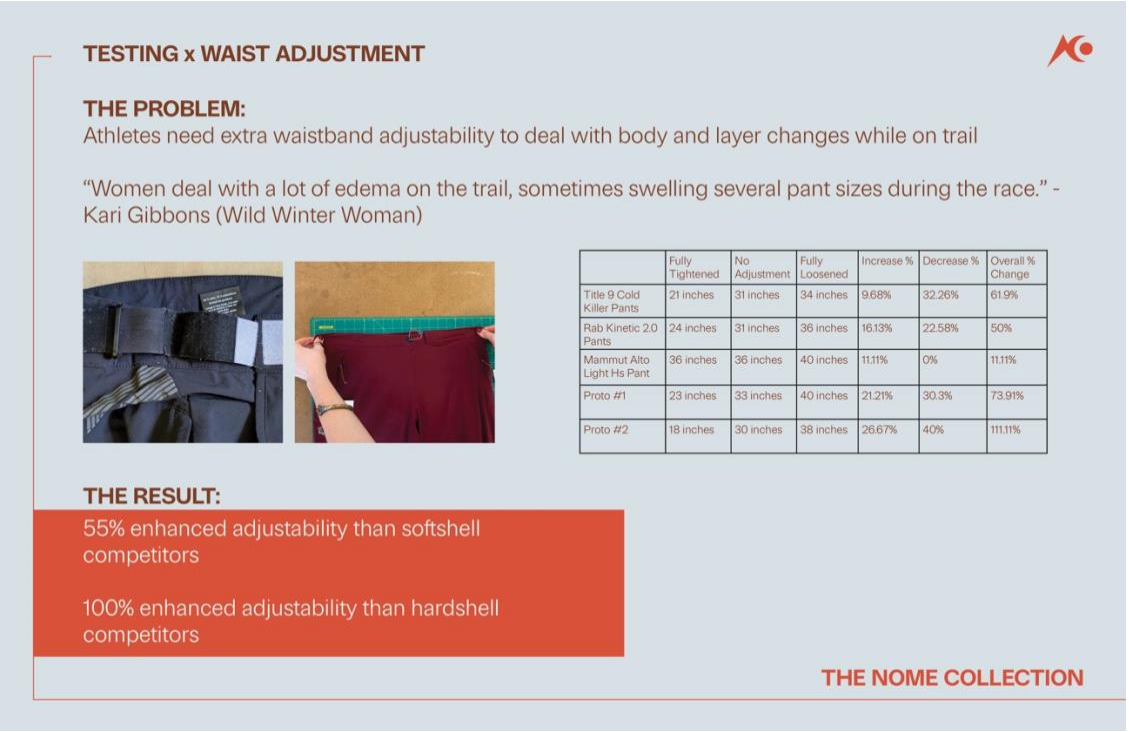
Figure 15.



Note. From Burchard – Testing Results

Waistband adjustment was tested in hardshell and softshell pants to determine the pants capacity to both expand and shrink. To do so, each pant was measured at rest, fully stretched / expanded and fully tightened. The results of the tests are depicted in the figure below.

Figure 16.



	Fully Tightened	No Adjustment	Fully Loosened	Increase %	Decrease %	Overall % Change
Title 9 Cold Killer Pants	21 inches	31 inches	34 inches	9.68%	32.26%	61.9%
Rab Kinetic 2.0 Pants	24 inches	31 inches	36 inches	16.13%	22.58%	50%
Mammut Alto Light Hs Pant	36 inches	36 inches	40 inches	11.11%	0%	11.11%
Proto #1	23 inches	33 inches	40 inches	21.21%	30.3%	73.91%
Proto #2	18 inches	30 inches	38 inches	26.67%	40%	111.11%

Note. From Burchard – Testing Results

The hybrid mid-layer was tested against several competitor products to create a "feature table". Through talking with athletes, a list of desired features was outlined for this layer and is as follows; detachable ruff, manual ventilation, zonal breathability, extra butt coverage, harness compatible products, 2-way front zipper and reflective detailing. The results are depicted in the figure below.

Figure 17.



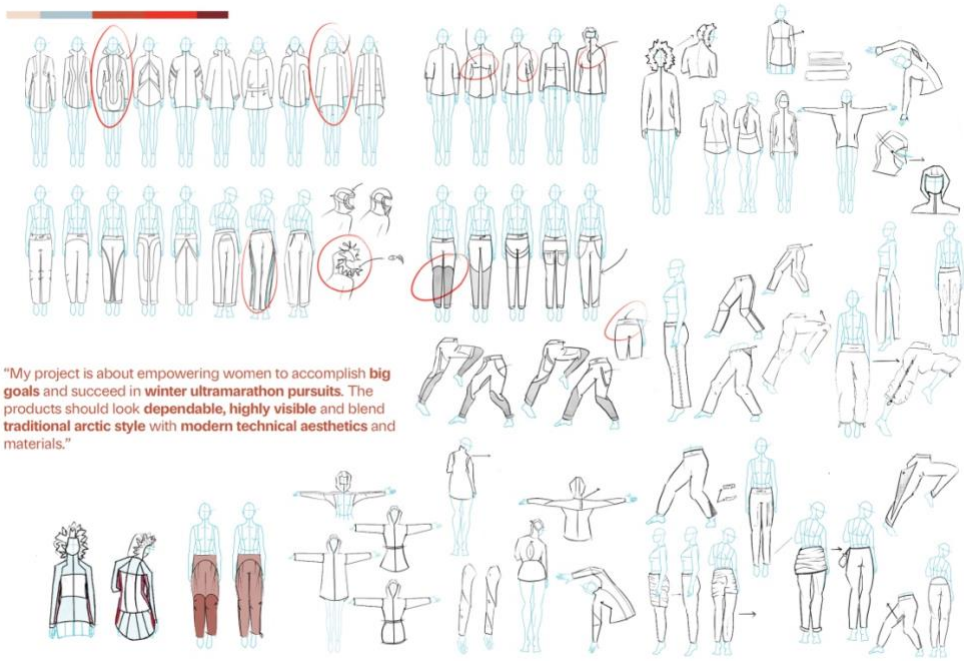
Note. From Burchard – Testing Results

Additionally, the hybrid mid-layer prototype was tested with athletes in person at the 2025 Iditarod Trail Invitational race kickoff in Knik, Alaska. Kari Anne Gibbons recommended to add softshell coverage to the chest and back rather than leaving the Alpha Direct exposed. Kate Coward commented that she appreciated that the mid-layer was longer in the back to add butt coverage. Kendall Park mentioned the need for extra manual adjustments to create "integrated modularity."

Final Garment Construction

Following the development of 'works like' prototypes and testing was an 11-week period of aesthetic refinement and final prototyping. This process blended all the research previously discussed into wearable, high performance, aesthetically driven final garments. The figures below depict some of the sketching process and final tech flat drawings in Adobe Illustrator.

Figure 18.



Note. From Burchard – Form Finding

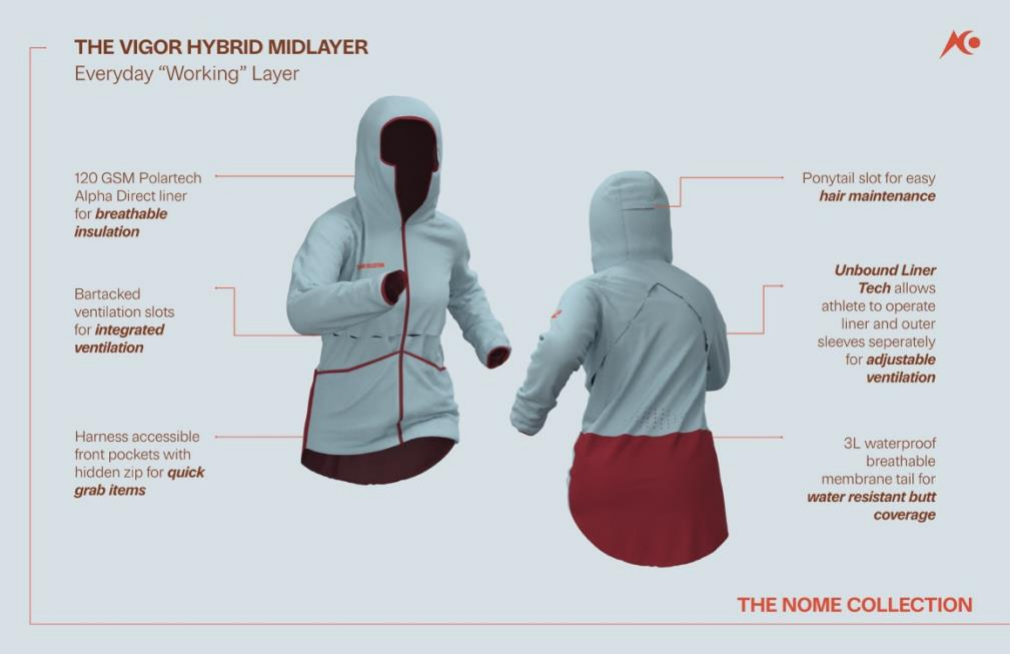
Figure 19.



Note. From Burchard – Tech Flats

From this process the designs were constructed in person as well as in Clo3D. Clo3D was utilized throughout the process to develop patterns and was leveraged during this final step to render the garments in realistic materials. The following figures show all final renders with the garment features and benefits.

Figure 20.



Note. From Burchard – Hybrid Mid-layer

Figure 21.



Note. From Burchard – Vigor Pant

Figure 22.



Note. From Burchard – Gust Parka

Figure 23.



Note. From Burchard – Gust Pant

Following the development of the physical garments they were taken up to Mount Hood Timberline where an athlete was able to wear the garments on a strenuous, cold and snowy hike. This served dual purposes as both a final wear check and to capture final photography. She said that she felt incredibly protected against the cold and wind in the garments and loved all the integrated and adjustable ventilation options. The below figures showcase some of the final garment photography.

Figure 24.



Note. From Burchard – Final Photography

Figure 25.



Note. From Burchard – Final Photography

Figure 26.



Note. From Burchard – Final Photography

Figure 27.



Note. From Burchard – Final Photography

Conclusion

The Iditarod Trail Invitational is more than a race, it is a proving ground for human resilience and grit, a magical place where tree stumps become living creatures in the sleep-deprived minds of athletes, and where gear is pushed to its limits in an environment so unforgiving that flaws are not only exposed, but they are also met with consequence.

Through extensive user interviews, field research, product benchmarking, and performance testing, this project illuminated the profound gaps in women's technical outerwear and provided a clear path for innovation. The "Vigor" and "Gust" systems developed through this work are more than garments; they are purpose-built tools that meet the extreme demands of female winter ultra-athletes. For the first time, providing these world-class athletes with gear designed specifically for them and their environment. By centering moisture management, mobility, adaptability, and female-specific physiological needs, these designs reimagine how apparel can support not just performance, but survival and exploration. The lessons learned on the Iditarod Trail extend beyond its frozen miles, offering insight into how human-centered design can elevate outdoor apparel for women in all environments. *Designed for Wild Winter Women who go where others would not dare, The Nome Collection exists to help them go further.*

References

1ST Alaska Tours. (2016, December 7). What Exactly is Dog Mushing? 1st Alaska Tours. https://1stalaskatours.com/what-exactly-is-dog-mushing/

Alaska Sports Hall of Fame. (2024, July 24). Joe Redington Sr. - Alaska Sports Hall of Fame. https://alaskasportshall.org/inductee/joe-redington-sr/

American Lung Association. (n.d.). Tips for outdoor exercise in cold temperatures. https://www.lung.org/blog/outdoor-exercise-winter#:~:text=The%20irritation%20of%20the%20cold,burning%20feeling%20in%20the%20chest.

Anglem, N., J.E. Lucas, S., A. Rose, E., & D. Cotter, J. (2008). Mood, illness, and injury responses and recovery with Adventure racing. Science Direct, 19(1), 30–38. https://doi.org/10.1580/07-WEME-OR-091.1

Beta Jacket Women's. (n.d.). Arc'teryx. https://arcteryx.com/us/en/shop/womens/beta-jacket-9239?cmpid=pm%7Cmult%7Cperf%7Cgoogle%7CArc%27teryx_Google-PMAX_S22_Performance_BOF_R%3ANAM_C%3AUSA_L%3AEN&utm_source=google&utm_medium=pm%7Cmult%7Cperf&utm_campaign=Arc%27teryx_Google-PMAX_S22_Performance_BOF_R%3ANAM_C%3AUSA_L%3AEN&gclsrc=aw.ds&utm_source=google&utm_medium=cpc&utm_campaign=brand&gad_source=1&gclid=Cj0KCQjw99e4BhDiARIsAISE7P_qPUFqrDXPhisvdmxCKqRhRmp_4Kov76_gyuZRg-44KTpqKz5P0y8aAp48EALw_wcB

Blackford, M. E., & C. S. N. A. (2009, May 7). *US8424119B2 - Patterned heat management material - Google Patents*. https://patents.google.com/patent/US8424119B2/en

Cramer, J. (2020, November 8). Hunt down your perfect hardshell jacket - a buying guide for men. GearLab. https://www. outdoorgearlab.com/topics/clothing-mens/best-hardshell-jacket/buying-advice

Ding, H. D., & Reed, H. R. (n.d.). A guide to technical Shell jackets. Curated. https://www.curated.com/journal/350000/a-guide-to-technical-shells

Dobson, M. (2022, September 30). The history of the Iditarod Trail sled dog race. Iditarod. https://iditarod.com/edu/the-history-of-the-iditarod-trail-sled-dog-race/

Edema - Symptoms and causes. (n.d.). Mayo Clinic. https://www.mayoclinic.org/diseases-conditions/edema/symptoms-causes/syc-20366493

Eiger Speed ML Hybrid Hooded Jacket Women | Mammut. (n.d.). https://www.mammut.com/us/en/products/1014-05021-5924/eiger-speed-ml-hybrid-hooded-jacket-women

Empire Wool and Canvas Company. (2024, November 8). Arctic Anorak - Empire Wool and Canvas Company. https://empirecanvasworks.com/product/arctic-anorak/

Fayle, T. W. C., Pedersen, B. H., Richardson, A., & Inc, A. E. (2008, June 3). US8341769B2 - Garment having roll-up and stow sleeves- Google Patents. https://patents.google.com/patent/US8341769B2/en?assignee=arcteryx&oq=arcteryx

Gibbons, K. (2024, March 28). ITI by the numbers — ITI. ITI. https://itialaska.com/news/2024/3/27/iti-by-the-numbers

Gmrunner. (2023b, August 10). Iditarod Trail Invitational - A race like no other - EGONOMICS. EGONOMICS. https://egonomics.blog/2023/02/26/iditarod-trail-invitational-a-race-like-no-other/

Gore, R. W., & Allen, S. B., Jr. (1978b, June 29). *US4194041A - Waterproof laminate - Google Patents*. https://patents.google.com/patent/US4194041A/en

Gypsy. (2018, February 16). North or South? Iditarod. https://iditarod.com/zuma/north-or-south/

Harman, Everett & Hoon, Ki & Frykman, Peter & Pandorf, Clay. (2000). The Effects of backpack weight on the biomechanics of load carriage. 72. https://www.researchgate.net/publication/235127918_The_Effects_of_backpack_weight_on_the_biomechanics_of_load_carriage#:~:text=A%20protective%20gait%20adjustment%20when,torque%20increased%20less%20than%20expected.

Hicks, T. J. (2023, July 18). Why is Outdoor Gear All the Same Colors? - Tristan J. Hicks - Medium. *Medium*. https://tristanjhicks.medium.com/color-strategies-of-outdoor-gear-design-9fad13becfa4#:~:text=Another%20consideration%20for%20these%20brands,by%20signing%20up%20for%20Medium!

https://www.switchbacktravel.com/info/ski-jacket-construction#construction

Iditarod Trail Invitational. (2019). ATHLETE GUIDE. https://itialaska.com/athlete-guide

ITI 1000 — ITI. (n.d.). ITI. https://itialaska.com/iti-1000

ITI. (n.d.). ITI. https://itialaska.com/

Johnson, D. (2017, February 25). Joe Redington, Sr. Iditarod. https://iditarod.com/joe-redington-sr-remembered-for-his-service/

Johnsum. (2015, January 22). The Iditarod Trail Invitational. Sidetracked. https://www.sidetracked.com/iditarod-trail-invitational/

Julianne. (2022, November 2). Legacy of the land. Iditarod. https://iditarod.com/edu/legacy-of-the-land/

Llc, P. (2024a, December 18). *AlphaTM Active Insulation Fabric*. Polartec®. https://www.polartec.com/fabrics/insulation/alpha

Llc, P. (2024, December 18). *Wind ProTM Wind Resistant Fleece | PolarTec®*. Polartec®. https://www.polartec.com/fabrics/insulation/wind-pro

Lovett, R. A. (2024, April 2). The science of racing in the cold. RUN | Powered by Outside. https://run.outsideonline.com/training/the-science-of-racing-in-the-cold/

Men's Kangri GORE-TEX jacket. (n.d.). Rab® US. https://rab.equipment/us/kangri-gtx-jacket?srsltid=AfmBOor1APQLBkB47D5PveYjgjeLDaOQS23dDbFDJCdTAWSJXrT9YuEN

Newcomb, T. (2019, May 24). Everything that goes into making an Arc'teryx jacket. Popular Mechanics. https://www.popularmechanics.com/adventure/outdoor-gear/a27544723/arcterx-how-to/

News — ITI. (2024, March 27). ITI. https://itialaska.com/news

Norrona Falketind Alpha120 Zip hooded Jacket - Women's - clothing. (2024, August 27). Backcountry. https://www.backcountry.com/norrona-falketind-alpha120-zip-hooded-jacket-womens

Outdoor Research. (n.d.-a). Women's Headwall Gore-Tex 3L Pants | Outdoor research. https://www.outdoorresearch.com/collections/womens-hard-shell-pants/products/womens-headwall-gore-tex-3l-pants-322112

Patel, K (2024) Can you lose weight by turning down the heater. (n.d.). Examine. https://www.examine.com/faq/can-you-lose-weight-by-turning-down-the-heater/

Perrotta, A. S., Jeklin, A. T., Bredin, S. S. D., Shellington, E. M., Kaufman, K. L., De Faye, A., Miles, R. M., & Warburton, D. E. R. (2022). Effect of an Ultra-Endurance event on

cardiovascular function and cognitive performance in marathon runners. Frontiers in Physiology, 13. https://doi.org/10.3389/fphys.2022.838704

RAB Kinetic 2.0 Pant - Women's - clothing. (n.d.). Backcountry. https://www.backcountry.com/rab-kinetic-2.0-pant-womens

Race details — ITI. (n.d.). ITI. https://itialaska.com/race-details

Race history. (n.d.). http://alaskaultrasport.com/race%20history.html

Roberts, W. O. (2015, December 21). Raynaud's Syndrome in runners. Runner's World. https://www.runnersworld.com/uk/health/mental-health/a774284/raynauds-syndrome-in-runners/

Roebuck, G., B. Fitzgerald, P., M. Urquhart, D., Ng, S.-K., M. Cicuttini, F., & M. Fitzgibbon, B. (2018). The Psychology of Ultra-Marathon Runners: A Systematic Review. Science Direct, 37, 43–58. https://doi.org/10.1016/j.psychsport.2018.04.004

Sentinel Pant Women's. (n.d). Arc'teryx https://arcteryx.com/us/en/shop/womens/sentinel-pant-8896?cmpid=pm%7Cmult%7Cperf%7Cgoogle%7CArc%27teryx_Google-PMAX_S22_Performance_BOF_R%3ANAM_C%3AUSA_L%3AEN&utm_source=google&utm_medium=pm%7Cmult%7Cperf&utm_campaign=Arc%27teryx_Google-PMAX_S22_Performance_BOF_R%3ANAM_C%3AUSA_L%3AEN&gclsrc=aw.ds&utm_source=google&utm_medium=cpc&utm_campaign=brand&gad_source=1&gclid=Cj0KCQjw99e4BhDiARIsAISE7P9cfEuquGgOVSe74pwZnm2Gz7FnHRS6r4bJvhLRaCtrTNHh3-7TbokaAucpEALw_wcB

SLU, B. E. M. (2024, April 4). Gore® C-KNIT Backer Technology. Greater performance, better comfort | Blog Barrabes. https://www.barrabes.com/en/blog/gore-c_knit-backer-technology/a-

104#:~:text=C%2DKNIT%20has%20a%203,and%20a%20special%20lamination%20procedure

Snowsports Industries America. (2020). SIA Participation Study 2019-2020.

Switchback Travel | Ski Jacket Construction: 2L vs. 3L. (n.d.). Switchback Travel.

The GORE-TEX Membrane: What it is, how it works, and why you need it. (2019, December 3). GORE-TEX. https://www.gore-tex.com/blog/the-gore-tex-membrane-what-it-is-how-it-works-and-why-you-need-it

Uhan, J. (2023, April 24). Biomechanical considerations for winter running. iRunFar. https://www.irunfar.com/biomechanical-considerations-for-winter-running

WGSN - Login. (n.d.). https://www.wgsn.com/fashion/article/66cdf41dc813a0021119f12e

WGSN - Login. (n.d.). https://www.wgsn.com/fashion/article/66d96f75c813a002114add6a#page7

Whenoutsideblog. (2020, September 16). Iditarod 2020 Gear List. When Outside. https://whenoutsideblog.wordpress.com/2020/09/16/iditarod-2020-gear-list/

Women's Winter Pants: Cold Killer - Regular. (n.d.). Title Nine. https://www.titlenine.com/p/womens-winter-pants-chill-chaser-regular/100527.html?utm_source=google&utm_medium=cpc&utm_campaign=NB_PLA_PmaxPantsLeggings_GOOG&gad_source=1&gclid=Cj0KCQjw7dm-BhCoARIsALFk4v9ROhG4mhNM5JO2uCvBBoQPf3g3596Xy8SP1-3S4OzjU3mRAVvWWZ8aAtTHEALw_wcB