DualXX: Ultra-Running Hydration Pack for Females with C+ Cups

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Table of Contents

INTRODUCTION

Deconstructed into its literal meaning, the term *ultra-endurance* in the context of running provides a deeper understanding of the sport. The prefix *ultra-* means "beyond limits" or "carried to the furthest degree possible," while the word *endure* means "to suffer or undergo" and the suffix *-ance* simply means "the state of" (Merriam-Webster, 2016). Ultra-endurance runners push their bodies and minds to the furthest degree possible, in a constant state of suffering, to transcend beyond any limitations. The sport demands a tremendous amount of focus, perseverance, and strength and in return provides life balance, self-healing, achievement, and self-actualization.

Ultra-trail running is more than just a race against the clock. It is a sport many athletes discover in the most challenging parts of their lives. Over 50% of ultra-endurance athletes use the sport to manage mental disorders including depression, anxiety, bipolar disorder, PTSD, and alcohol & drug addiction (Colangelo, 2020). Of those athletes, 30% were reported at-risk for self-harm and suicidal thoughts (Colangelo, 2020). By gender, 47.9% of females have reported prior mental illness diagnoses compared to 26.5% of males reported (Colangelo, 2020).

However, the limitation that poses the greatest threat isn't within the body or mind, but instead put forth by societal gender bias. Permittance of females to participate in a sport and inclusion are two vastly different implications. Because of the positive mental benefits of exercise and running, discrimination against females therefore deprives them of a sport that could improve their mental stability and potentially save lives. Running long-distances is a skill belonging to anybody that has a body. There have been few research studies and products designed with female performance in mind. It's rare to find popular companies releasing any designs that go further than added cushioning or small alterations made to products tested on a small trial-pool of females.

By this point in time, gender bias is so far integrated into sport, that most female athletes go their entire lives unknowingly competing in equipment, apparel, and footwear designed by, and for the male body. If race results often indicate slower finishing times for athletes in the women's division, can designing for the anatomy, physiology, and biomechanics of a female begin to close the gap? How can race times be compared across genders when the sports product industry is more invested in the enhancement of male performance? In fact, in distances more than 200 miles, females are 0.6% faster than their male competition (Ronto, 2021) partly due to their physiological advantage with an increased amount of slow-twitch muscle fibers that are fatigue-resistant (Heward, 2020). So why is the sport still dominated by men?

Promoting equality and inclusion of females in the design of sports products can enhance female performance, encourage advancements in the sport, and support running as a coping mechanism for mental illness across genders.

SPORT HISTORY

The marathon originated as a men-only sport in the 1896 Olympics (Carroll, 2019). The International Olympic Committee (IOC) recognized the 40km marathon as an official sport, however, the modern marathon distance of 42.195km became official in the 1908 Olympic Games when an extra 2.195km was added so that the racers would start the race at Windsor Castle and cross the finish line in front of the spectators in the Olympic Stadium (Fenaux, 2009). The male finishers were celebrated for their strength and endurance, yet it wasn't for over 64 years until females were allowed to race (Fenaux, 2009). Nevertheless, women never needed men's approval to race, and so they found every way to participate.

A Greek female runner that had been denied entry because of her gender entered the race dressed as a man under the pseudonym Melpomene (Leder, 1996). She created her own opportunities and became the first woman to race alongside men when she crashed the starting line of the first Olympic Marathon in 1896 (Leder, 1996). Her brave statement was met with resistance from protestors and officials that stood outside the stadium gates to deny her access to officially cross the finish line (Leder, 1996).

Women have been in the race for equality since day one, fighting for fair footing on every starting line in every sport. Since long before the inauguration of the sport, female athletes have faced discrimination, exclusion, and acts of violence from people attempting to strip women of their right to take up space in the stadium. Women have been barred from sports and physical activities because according to the IOC, the actions are "too strenuous for women" (Lovett, 1997). Women's abilities are doubted by international sports committees, spectators, sport scientists, and recruiters of the 20th century, calling them weak, fragile, and incapable of performing the same physical tasks as men. The 1928 Olympic Games were the first time that women were allowed to even participate in races (Lovett, 1997). However, responding to many reports of women collapsing after running their 800m race, the IOC banned women from racing distances more than 200m (Lovett, 1997). Despite the efforts of exclusion, Roberta Gibb became even more motivated to race when her 1966 marathon entry got denied and returned to her with a note saying that "women were not physically capable of running a marathon" (Lovett, 1997). Women were not the only ones protesting this inequality in sport. Refusing to be deterred by men's opinions, in 1967, social activist Katherine Switzer ran for Syracuse University in the men-only Boston Marathon (Lovett, 1997). With the support of her coach, Arnie Briggs, college boyfriend Tom Miller, a hammer-thrower for the university who shoved aside the race director; and John Leonard, a member of the Syracuse University cross-country team, Switzer finished the race (Lovett, 1997).

(*Figure #1)* Katherine Switzer 1967 (Carroll, 2019)

In 1972, women were officially allowed to compete in the Boston Marathon for the first time on the condition that they get a 10-minute head start (Carroll, 2019). Every female racer sat on the starting line in protest as 10 minutes passed on the clock, and then Australian runner Adrienne Beames set the first sub-three-hour marathon women's record with 2:46:30 (Lovett, 1997). There were many more attempts to ban women from running races or lessen the intensity of the sport. Under the assumption that women's sports were not popular enough to sponsor, the 1979 Olympic organizers made yet another attempt to exclude women from running by declaring a popularity rile in an Olympic Charter stating that in order to host the women's race, competitors from at least 25 countries and 2 continents must participate (Lovett, 1997). After meeting that requirement with ease, gender equality activists continued to fight.

Although the notion of competitive long-distance running came from the journey of Pheidippides – an Athenian messenger who ran 250km in the 490 B.C. battle of Marathon – modern ultra-trail running began in 1974 with the story of Gordy Ainsleigh and his horse race (Given, 2019; Spartathlon, n.d.). Having dropped out of college while struggling to find direction through his depression, Ainsleigh discovered running when he decided to race in the Tevis Cup horse race, without his horse (Given, 2019). Five years later, the same trail from Olympic Valley to Auburn became the course of the first official Western States 100-mile race (Year by year, n.d.).

As females are now widely accepted in the sport of ultra-racing, the gender gap is more prominent in their acknowledgement and recognition. The gender gap is reflected in lesser prize money, fewer sponsorships, only 4% of media coverage, and most of all, the egregious lack of female-specific sports products. Even when female athletes, time after time, have beaten their male competitors in the same race, excuses such as "women don't work as hard," and "women have less competition" were used in attempts to justify their bias (Runs, 2015). Given fair opportunity and products made for females to enhance performance, the future records to be set in the women's category will challenge the assumption that male long-distance runners are faster than females.

SPORT

An ultra-marathon may be described by spectators as a long-distance running race or with a slight specificity, is defined as a footrace that exceeds 42.4km – the distance of a traditional marathon. However, ultra-runners assign a different kind of value to their grassroots sport. Endurance running is a unique relationship between the physical limitations of the body, and the internal limitations of the mind. These athletes run to find new limits, push themselves to achieve the impossible, and run to be engulfed in the pain.

Ultra-endurance running puts an immense amount of stress on the body both mentally and physically; without proper preparation and training of the mind and body, this type of distance alone could be fatal. A single-stage race, or a continuous race without sleeping, lasts anywhere from the typical 24 hours allotted, to a cutoff time of 46.5 hours in Ultra-Trail du Mont Blanc (UTMB, 2021). Demanding such strength and endurance from your body requires discipline, determination, and experience. As the distances increase, athletes can begin to lose control of their body, hallucinate, and collapse due to sleep deprivation, electrolyte disturbances, hydration imbalances, heat-related illness, and cardiovascular compromise (Krabak, 2017).

Mental health plays a large role in the sport of ultra-running. Many athletes use trail running as a time to escape from the stresses of their daily lives and be alone with their thoughts. Running teaches routine, commitment, determination, and achievement. People often struggling with mental illnesses feel a lack of control over the events in their lives and the hardships they face. Endurance-running is 100% in

the hands of the athlete. Runners choose when to stop and when to push themselves out of their comfort zones.

One advantage to organized races is the access to aid stations. Everything is meticulously planned in a race environment. Athletes are knowledgeable of the distances between aid stations and checkpoints, which enables them to determine the optimal amount of supplies needed to make it to the next station while having the lightest pack weight.

ENVIRONMENT

Part of what makes ultra-trail running difficult is the lack of predictability. An athlete could run the same trail a year later and encounter weather conditions and environmental factors that changed the entire dynamic of the course. Ultra-marathon racing is a global sport, often held in extreme climates ranging from the frozen conditions in the Artic Circle to the scorching heat in the Sahara Desert. This level of competition requires environmental knowledge and experience, as well as physical and mental preparedness. Participants need to be knowledgeable of the grueling environments and how to survive in emergency situations. This research and product space is focused on the race environment of a 100-mile ultra-marathon held annually by the Hawaiian Ultra-Running Team (HURT) on the island of O'ahu and is thus named the HURT100 (Hurt100, 2021).

The race clock begins its count before dawn at precisely 6AM (Hurt, 2021). Runners are allotted 36 hours to complete five 20-mile loops with over 50,000ft of elevation gain and loss (Hurt100, 2021). In the mountains of a semi-tropical rainforest, athletes run on a muddy single-track trail while navigating around rocks, sharp roots, and cross 20 streams throughout the course of the race (Hurt100, 2021). In the month of January, racers can expect temperatures ranging from 52° - 88° Fahrenheit and more extreme daytime highs and nighttime lows on the exposed sections of the trail (Hurt100, 2021). For Honolulu, the monthly mean precipitation in January reaches 3.34 inches, with a single-day maximum record of 6.40 inches of rainfall and can fall in huge quantities over a brief span of time (Hurt100, 2021). However, the reported measurements are taken at the Honolulu airport, while heavier precipitation and expected in the rainforest as well as an average of 35 – 45% humidity (Hurt100, 2021; Weatherspark, 2021).

As the time of year permits 11 hours of daylight in January, darkness poses a tremendous challenge to athletes, especially those with little experience training at night (Hurt100, 2021; Weatherspark, 2021). As the course is unfamiliar to most participants, it is the race organizers' job to thoroughly mark the course with reflective tags in order to decrease the likelihood for runners to get off-course. In low-light conditions, any way to stand out in a semi-tropical rainforest bodes the best chance of rescue.

INJURY

With extreme sports, comes a higher risk of injury. Athletes have little room for error, and if ill-prepared, there could be fatal consequences. In an ultra-marathon held in China in 2021, athletes were not required to carry the gear necessary to be able to survive in cold conditions, so when temperatures unexpectedly plummeted more than 20° Fahrenheit and weather conditions turned extreme, 21 athletes died of hypothermia (China Marathon, 2021). It is both the race officials' and the athletes' responsibility to have extensive knowledge of the environment and plan for unexpected weather conditions and situations.

Often thought to be irrelevant information to many competitors in the Hurt100, hypothermia still poses a threat in a semi-tropical rainforest when there is wind, rainfall, and drops in temperature during the

nighttime (Hurt100, 2021). Seen in the latter half of ultra-marathons, competitors can fall into a state of hallucination often caused by extreme exhaustion, hitting their heads, or malnutrition. In an altered state of mind, racers can get lost or physically injured and need to survive until Search & Rescue (SAR) can find them.

RULES

The rules of the race are simple; the sport is anything but. Most high-profile races require the athlete to qualify from a previous race in order to ensure that the extreme distance is reasonably attainable with the athlete's current experience level. Racers are required to be over the age of 18 (Hurt100, 2021).

Ultra-marathon races range anywhere from 50km to nearly 5000km in distance, and courses and rules are identical across genders (Rawal, 2018). Explained in the pre-race briefing the day before, runners face time penalties or disqualification if runners don't abide by the rules listed in the Book of HURT 2021-2022 (Hurt, 2021). Runners may not stash supplies along the course or accept supplies from other runners (Hurt100, 2021). Racers cannot wear cooling vests or similar performance aids outside of the aid stations (Hurt100, 2021). Other ways to get disqualified are being more than 100 meters off course, not wearing a red light on your pack all throughout the night, accepting or requiring the administration of IV fluids, accepting assistance along the trail, etc. (Rules & Regulations, 2021).

It is common for events to have a mandatory equipment list stating all the gear and supplies every competitor must carry at all times (Rules & Regulations, 2021). Lists are specific to each race environment, but typical requirements to be carried or worn include: >2000 calories per day, thermal layer, sleeping bag, backpack, shoes, headlamp, electrolytes, red flashing light, and a compass (Rules & Regulations, 2021). Thermal layers are recommended in the semi-tropical environment; however, racers must be cognizant of their bib number needing to be worn on the front side of the outer-most layer and remain visible at all times (Hurt100, 2021)

Some races, including the HURT100, allow pacers after a certain mile marker. Pacers are team members that are recruited by the athlete to run alongside them to either watch over them in their current condition, or for most leaders, pacers are there to keep the runner on pace. Pacers are not allowed to "mule," which means they cannot carry anything the runner might need unless it's a medical emergency that will result in the runner leaving the race (Hurt100, 2021). Pacers cannot intentionally light the path for their runner, which means the runner needs to have their own light source at all times (Hurt100, 2021).

There are minimal product rules to be mindful of other than the pack must carry all required belongings and must not be an artificial cooling vest (Hurt100, 2021).

PRODUCT LINE PLAN

The goal is to design an innovative hydration pack that is capable of carrying supplies to support a female ultra-distance trail runner with the consideration of gear, water, and safety equipment. To enhance female performance, the pack needs to accommodate for anthropometric, physiological, and biomechanical differences between sexes. The pack must (1) fit the body shape of females, (2) allow storage and easy access, and (3) facilitate heat & moisture management all while being compact to minimize energy exertion. Shown in the competitor products section, the target weight for an unpacked running pack is 0.5 – 0.65 lbs.

PRODUCT CLASSIFICATION

Equipment; Ultra-Endurance Trail Running; Women's; Running Packs

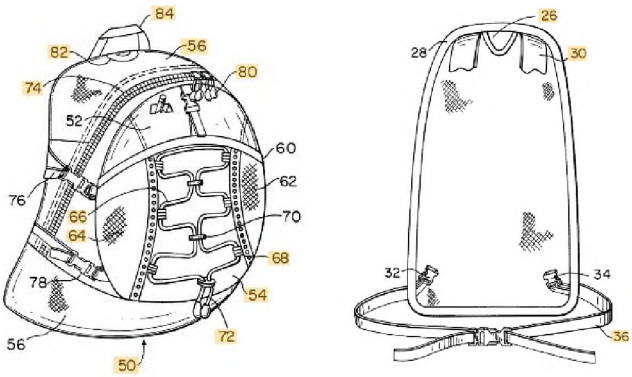
PRODUCT HISTORY

Originating in the sport of cycling, the first hydration pack was described as a breakthrough for human hydration management that could easily make the water bottle obsolete (Dodd, 2016). In 1988, a paramedic named Michael Eidson introduced his "personal hydration system" to facilitate staying hydrated. He concocted his own delivery system by packing an IV bag filled with water into a tube sock he had sewn to the back of his jersey (Felton, 2013). By rigging a surgical tube to run over his shoulder and secure to his chest using a clothes pin, he could access the water with only a small movement as opposed to reaching for a water bottle (Felton, 2013).

Eidson's improvised invention was a catalyst to the evolution of the modern running pack. Now there are carrying devices in the form of waist packs, hand-held water bottles with pockets, vests, traditional backpacks, etc. Current running hydration packs are a combination of a vest and pack. A vest forms to the shape of the body and acts similarly to a piece of apparel, while packs have more structure and a separate main compartment for more storage. The evolution of the hydration running pack has covered adjustability, weatherproofing, visibility, thermoregulation, and comfort for majority male runners. The nuance of female-specific sports gear is entering the market and there are few women's department running packs that are made with the female body in mind.

Patents + Intellectual Property

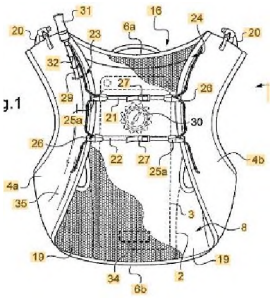
Michael Eidson's "Personal Hydration Pack" patent was a trail blazer in the sports equipment industry. It remedied the most prominent problem in ultra-endurance sports at that time which was dehydration.



Eastern Mountain Sports
US6422439B1 (Status: Expired)
Combination backpack and hydration pack

(Figure #2) Eastern Mountain Sports Combination backpack and hydration pack patent (Kelliher et al., 2001).

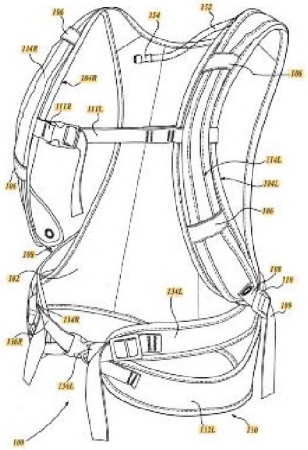
"A combination backpack and hydration pack has a hydration pack portion and a standard backpack portion which are detachably connected to each other. The two portions can thus be used together as a hydration pack/standard backpack combination or separately as a pack solely for hydration purposes. The hydration pack portion has a bladder portion for holding liquid. The backpack portion is attachable to and circumscribes the hydration pack portion for providing additional carrying space" (Kelliher et al., 2001).

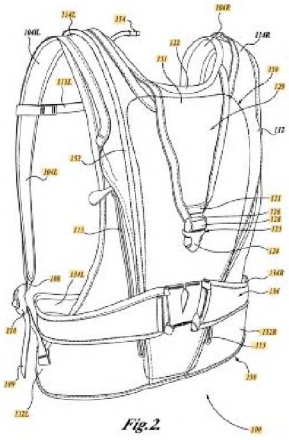


Salomon SAS
US8833619B2 (Status: Active)
Backpack, such as a hydration backpack

(Figure #3) Salomon SAS Backpack, such as a hydration backpack patent (Chapuis, 2009).

"The invention relates to a backpack including a main rear pocket adapted to receive a load and carrying straps configured to position and maintain the main rear pocket on the user's shoulders, whereby the main rear pocket is formed by the juncture of a first base panel, made of flexible material, adapted to be in contact with the body of the user, and of a second external panel, also made of flexible material, the first base panel being extended at the ends of the main rear pocket to form two closed side loops for passage of the user's arms, forming the carrying straps" (Chapuis, 2009).





Marmot Mountain LLC
US20060000856A1 (Status: Abandoned)
Hydration pack

(Figure #4) Marmot Mountain LLC Hydration Pack Patent.

"A hydration pack is disclosed including a backpack, a bladder assembly, and a split belt assembly. The backpack includes a front panel and a back panel that are interconnected with baffle panels to define a volume for receiving the bladder of the bladder assembly. The split belt includes a lower belt portion and an upper belt portion. The upper belt portion extends behind the backpack, over the bladder, this compressing the fluid bladder and prevents it from shifting. In the disclosed embodiment, the split belt includes an elastic portion that is retained in a keeper disposed on the back panel. The back panel includes elongate straps that are slidably retained along the shoulder straps. A cover is attached to the front panel and is attachable to the back panel" (Zachary, 2004).

COMPETITOR PRODUCTS

Within the women's running equipment market, there are two big classifications that are relevant to ultra-running: packs and vests. Packs are designed to have shoulder straps and a main rear compartment, while running vests are a hybrid between packs and apparel have a built-in compartment for storing gear. There are examples of top market competitors that showcase the advantages and disadvantages of each type. The packs being compared are UltrAspire Momentum 2.0, UltrAspire Alpha 4.0, and Nathan VaporAir.

(Figure #5) Competitor Products

When analyzing the research on relevant state-of-the-art running packs, comparisons are made between gear capacity, unpacked weight, water-carrying capacity, materials, features and benefits of each model and brand.

PRODUCT ANALYSIS

PERFORMANCE

Current women-specific packs on the market individually solve some of the functional issues, but no single pack addresses them all. Often done subconsciously by consumers, different running pack on the market are compared to one another to establish value delineated by positive and negative relations the user has while interacting with the pack. In the design and marketing industry, a more in-depth analysis of products on the market is defined with the acronym SWOT. During this process, the **S**trengths and **W**eaknesses of a product are exploited to reveal **O**pportunity in market gaps, along with **T**hreats that may interfere with the success of a product in stages such as ideation, design, development, and production. Top-performing products in the running pack product space are isolated as the benchmark product to out-perform.

Three running packs with designs that best fit the project goal were selected to be the benchmarks for creating the optimal female ultra-running pack. Screening factors included the level of activity, sex, and needs of the intended user. Further breaking the SWOT into pack parts and pieces provides the framework of individual jobs to be done without designating a particular solution. Analyzing packs from three different brands will begin to answer the question: do the running packs on the current market meet the biomechanical and psychological needs of female ultra-runners?

Part: Strap Structure

	UltrAspire Momentum 2.0 Pack
Strengths	→ Thin Polyester power mesh exposes skin to facilitate heat dissipation → Trims made of a Nylon / Spandex blend provide user next-to-skin soft-touch comfort → Overall use of lightweight materials and construction decreases energy expenditure
Weaknesses	→ Stitches along mesh promotes chafing beneath straps and nape of the neck → Mesh fails to stretch to account for different chest sizes → Materials trap micro bacteria and body odor
Opportunity	→ Utilize soft-touch materials that are breathable, lightweight, and antimicrobial → Avoid compromising abrasion-resistance for thin layers and UV protection less coverage
Threats	→ More surface area for coverage adds weight + requires heat dissipation method → Promoting strap structure without adding bulk or discouraging heat dissipation

	UltrAspire Alpha 4.0 Pack
Strengths	→ Polyester mesh for breathability and lightweight → Tapers toward neck and connects fluidly into lower side panel for secure fit and continuation
Weaknesses	→ Many stitch lines penetrating through the mesh directly abrasion to the skin beneath straps → Mesh bunches allowing unwanted shifting in the pack and inconsistent distribution of weight
Opportunity	→ Configure a way to add pockets on strap while providing a uniform panel against skin → Maximize mesh properties to stretch and contract without unnecessary bunching or pulling
Threats	→ Wide and thin straps for fuller chest coverage may cause the pack to shift and bunch → Pockets on strap may be accessible, but applies pressure and allows bouncing

	Nathan VaporAir Pack
Strengths	→ Shoulder strap shaping design to promote weight distribution and provide a comfortable fit → Nylon + Polyester provide comfort through softness → Thick straps allow deep storage for more gear
Weaknesses	→ Nylon-covered, ripstop pattern pockets cover majority of mesh on the strap hindering heat dissipation efficiency → Straight strap shape applied pressure and discomfort on the bust area
Opportunity	→ Find method to promote heat dissipation while maintaining stretch control from woven Nylon → Develop shoulder shaping design that extends usability and comfort toward larger chests
Threats	→ Shoulder strap shaping applied to larger chest may interrupt proper weight distribution → Substituting more breathable fabrics may make the design weaker/different structure

How could we facilitate heat dissipation and circumvent abrasion by adapting a soft, breathable, and absorbent fabric to be lightweight while applying structural shaping to the shoulder straps.

Part: Sternum Closure

Sternum Closure Structure

UltrAspire Momentum 2.0 Pack

Strengths	→ Bungee and hook system allows low-profile closure and leaves room for heat dissipation → Rigid hooks facilitate one-handed closure
Weaknesses	→ Bungees get tangled and are not symmetrical → Bungee cords aren't adjustable and cut into the soft tissue of the breast
Opportunity	→ Create a closure system in places other than the center front to provide better support → Use low-profile innovative components that are thick enough to stay on the surface & not dig → Optimize webbing thickness, strength, security, positioning, and ease of use
Threats	→ Thick sternum strap webbing reinforces pull but may be too bulky causing pressure → Buckle anchor proximity to zippers make closure unstable and difficult → Closing the front and placing the closure system else where may trap more heat

UltrAspire Alpha 4.0 Pack

Strengths	→ 2 hooks allow for quick release and closure → Pulls equally from both sides and allows for quick adjustment
Weaknesses	→ Small pieces not easy to connect and adjust when cold or have arthritic fingers → Pulls at upper layers, leaving underlayer to bunch
Opportunity	→ Consider all anchor points and where the best compression and reduction of pressure is right → Incorporate system fully into pack, not as 2 systems combined together
Threats	→ Bungee cord is weak to abrasion, breakage, and is difficult to maneuver when exhausted → Elastic cord is small and hard to control, often frustrating user. Avoid using unnecessarily

Nathan VaporAir Pack

Strengths	→ V closures pull from 6 points, therefore allowing even compression in closure system → Sliding rail sternum strap for quick and easy single-handed use and adjustability
Weaknesses	→ Hard to adjust length of webbing → Added buckles also add complication
Opportunity	→ Allow single-handed use and adjustability for compression and strap placement with ease → Create securement system that is adjustable in 4 directions, intuitive, easy to use
Threats	→ Justifying benefits of sliding rail = difficult to move but also means it won't shift while running → Two straps may cause bumps and not enough points of closure and security

How can we (1) optimize even compression, (2) allow single-hand operation and height adjustability, and (3) allow for heat dissipation.

Part: Strap Attachment + Elastic System

Strap Attachment + Elastic System

	UltrAspire Momentum 2.0 Pack
Strengths	→ Connected panels from straps to back promote equal force distribution and continuity → Pulls and stretches uniformly across underarms, back, and shoulders
Weaknesses	→ Minimal, single line adjustability via elastic pulls at base → Sternum system and single panel pulls everything forward for poor posture and running form
Opportunity	→ Align strap connection bottom with sternum strap → Optimize proper fit across neck nape using precise measurements and possible adjustment
Threats	→ Adding adjustability and transition at neck may add too much uncomfortable fit → Fluid curved from neck to chest to ribcage to underarms many not be enough fabric in front

	UltrAspire Alpha 4.0 Pack
Strengths	→ One fluid panel from strap to back for simplicity → Includes subtle pockets to maximize carrying capacity
Weaknesses	→ No back tension system → Full pockets interrupt the pack's ability to lie flat against the body
Opportunity	→ Incorporate tension system from anchor points for even cinching → Create system to pull from behind with more than 1 cord and more evenly dispersed
Threats	→ Nylon doesn't stretch out but is slippery and hard to hold when wet → Nylon doesn't snag as easily as mesh, so if mesh is used, it needs to be ultra-strong

	Nathan VaporAir Pack
Strengths	→ Cinching technology in multiple origins → Underarm material placement optimizes compression and allows expansion
Weaknesses	→ Heavy components and materials to achieve the strengths → Difficult to release the tension to expand the pack → Cords degrade and break over time
Opportunity	→ Design for pack to cinch in the back first to allow security moving from back to front → Make system virtually undetected on the back using foam and/or padding
Threats	→ All the comforting and useful layered add up to be too bulky and heavy → User abandoning proper way to use pack because of a lack in intuitive design

How could we use multiple bungee elastic anchors to apply primary tension from rear of pack to promote stability and further adjustability without interfering with comfort of back paneling and pocket space.

Part: Back Panel

Back Panel

	UltrAspire Momentum 2.0 Pack
Strengths	→ Sits longer in the back for efficient dispersed capacity → Tapered back panels with breathable mesh
Weaknesses	→ Mesh is too thick; back panel cooling is obstructed → Close mesh and the bladder warm the water through conduction
Opportunity	→ Fluid transition between shoulder bridge, underarm, and back panel allowing snug fit → Wick moisture upward and laterally
Threats	→ Back panel sitting too low will cause riding up and chafing if too low and touching hips → Balancing benefits between heat transfer from body to bladder, but warms water

	UltrAspire Alpha 4.0 Pack
Strengths	→ Power mesh and honeycomb channeling allows for expandability and cooling → Easily permeable mesh for sweat to pass through
Weaknesses	→ Hard to dissipate sweat via evaporation because sandwiched between pack and user's back → Water gets trapped in hydrophilic water channels and chafes
Opportunity	→ Incorporate smooth transition from back panel to underarms that allows evaporation → Chimney-wicking system to create space for heat dissipation via convection and evaporation
Threats	→ Adding foam for cushioning effects weight and evaporation rate → Thin and minimal back paneling provides less structure but more cooling efficiency

	Nathan VaporAir Pack
Strengths	→ Multi-layered back paneling provides cushioning and structure → Polyester maximizes comfort against the skin
Weaknesses	→ Polyester traps moisture and therefore heat → 3 layers of material interrupt the beneficial properties of each other
Opportunity	→ Shape the back panel for storage, but exclude unnecessary coverage → Find a way to provide support while also allowing breathability
Threats	→ Maximizing thermoregulation opportunities/patches makes pack protrude or too small → Slender profile and central compartment allow more storage but more posterior weight

How could we incorporate a wicking system that facilitates heat dissipation without warming the bladder water or designing too much coverage.

Part: Main Compartment

Main Compartment

UltrAspire Momentum 2.0 Pack

Strengths	→ 1 main compartment with top buckle for securing gear → Made of mesh for breathability and heat dissipation
Weaknesses	→ Doesn't carry a bladder → Doesn't have fastening system
Opportunity	→ Design a pack to carry more equipment in the back, but remain accessible → Maximize space on upper back and lower back for storage
Threats	→ Weight versus carrying capacity tradeoff → Find a way to evenly distribute weight while allowing space for various items in each area

UltrAspire Alpha 4.0 Pack

Strengths	→ Zipper pocket for total security of gear → Carries 2L bladder
Weaknesses	→ No compartmentalization system → All weight sags to the bottom
Opportunity	→ Make compartments within the main pocket to organize gear and distribute weight → Include bladder space
Threats	→ Bladders take up a lot of space and are not the only methods of carrying water → Small back panel and large main compartment reduced compression and stability

Nathan VaporAir Pack

Strengths	→ 3 pockets that open to main compartments → Access to 2L quick release bladder and bladder sleeve
Weaknesses	→ Bungee system interferes with ease access to main compartment → Made of nylon = heat retention
Opportunity	→ Use materials that minimize heat retention while providing enough structure for gear → Incorporate more than one large compartment in the rear of the pack
Threats	→ Pocket use differs between athletes, find the average satisfactory design → Bungees add compression but are hard to pack while tight. What's the middle ground?

How can we design a flexible but structured main compartment that opens to show a majority of needed gear without user struggling to close compartment using a system for compression.

Part: Strap Pockets

Strap Pockets

	UltrAspire Momentum 2.0 Pack
Strengths	→ 4 strap pockets with flexible use descriptions → Dry pocket for pills
Weaknesses	→ Bottles are hard to store in pockets and phone hits against clavicle → Places without pockets wastes easy-access storage space
Opportunity	→ Maximize the carrying capacity and versatility of strap pockets → Design the front pockets to hold soft bottles without bouncing
Threats	→ Bouncing is a major problem when storing items in front strap pockets → As body sizes and shapes differ, the pockets will fall and bunch in different parts

	UltrAspire Alpha 4.0 Pack
Strengths	→ 4 pockets → Accounts for phone, pills, and water
Weaknesses	→ Full pockets interfere with donning and doffing of the pack → Phone pocket not secure or large enough for iPhone 12
Opportunity	→ Design waterproof pill pocket and phone pocket to fit most recent iPhone dimensions → Optimize front storage by adding pockets
Threats	→ Since pockets are used for multiple applications, how can the design indicate their purposes → Pockets straying from front risks interfering with arm swing but puts pressure on breasts

	Nathan VaporAir Pack
Strengths	→ Fits large bottles in front pockets, as well as a phone, gels, goos → Pockets cinch at the top to secure items
Weaknesses	→ Pockets extrude to promote bouncing → Pockets interfere with arm swing
Opportunity	→ Find a middle ground between external and internal pockets → Ensure security of gear in pockets
Threats	→ Structure is often solved with nylon. Find another support system → Placing pockets too high interferes with range of motion

How could we design at least 6 strap pockets to (1) hold soft flasks comfortably without pressuring the chest while staying secure and easy to refill and insert, (2) store goo, gels, and bars securely with easy one-hand access while allowing easy access and flexible order of packing that doesn't interfere with arm swing.

Part: Additional Pockets

Additional Pockets

	UltrAspire Momentum 2.0 Pack
Strengths	→ Magnetic pocket closures for gear security → Stretch pockets with structure
Weaknesses	→ Only 2 additional pockets (plus 1 main pocket and 4 strap pockets) → Cannot hold all essentials
Opportunity	→ Add more individual pockets for each item or set of items → Dump pocket and sleeve pocket leading to back of main compartment is smart storage
Threats	→ Magnets are too strong to use on the back and side pockets → Be meticulous about pocket opening placement

	UltrAspire Alpha 4.0 Pack
Strengths	→ Kangaroo pocket accessible from either side → 2 back pockets
Weaknesses	→ Location of kangaroo pocket too high → Security of side pockets questionable
Opportunity	→ Design for security and accessibility in additional pockets → Consider range of motion for pockets meant to be accessed by reaching back
Threats	→ Easy-access pockets may lack security of items → Reachable areas are often too low or high on the body

	Nathan VaporAir Pack
Strengths	→ Dump pockets and 7L storage capacity → Pocket sizes vary
Weaknesses	→ Zippers combined with loose mesh requires 2-handed pull → Hard to differentiate pockets from the rest of the pack (no contrast)
Opportunity	→ Design contrast for easy location of pockets → Stack pockets for optimal use of space and personalization of storage
Threats	→ Expandable pockets are often less secure when full → Mesh stretches and rips with use

How could we design the optimum number of additional pockets for trash dumping, clothing layer storage, waterproof pocket to be accessible and avoid interfering with arm swing or user movements while being easily accessible.

Part: Bladder System

Bladder System

	UltrAspire Momentum 2.0 Pack
Strengths	→ No bladder system
Weaknesses	→ No bladder system
Opportunity	→ Make pocket big enough to allow bladder storage, even if not included in the design → Adaptability for user preferences
Threats	→ User may feel forced to use a bladder → Bladders take up a lot of space and require sleeves for security

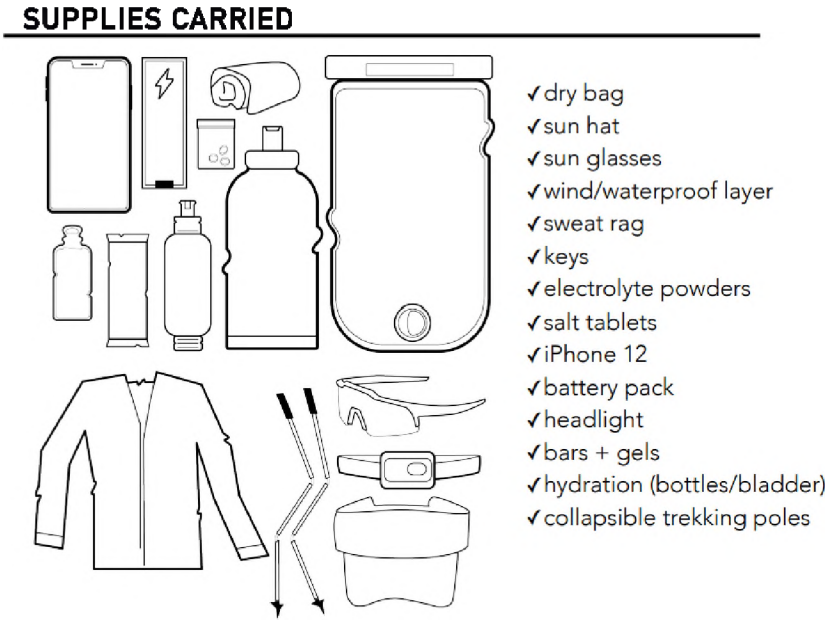
	UltrAspire Alpha 4.0 Pack
Strengths	→ Accommodates 2L bladder → Included bladder sleeve to keep water cool or warm depending on intention and environment
Weaknesses	→ Difficult to remove and replace → Fills space outward when full and sags
Opportunity	→ Integrate bladder with support and structure system → Allow the option of bottle or bladder water storage
Threats	→ Typical bladders expand into a rounded shape, therefore taking up space and sagging → Find a way to incorporate both the bladder and bottle storage

	Nathan VaporAir Pack
Strengths	→ 2L quick release bladder → Tube tracks over should and attaches to a magnet
Weaknesses	→ Water is difficult to access when pack is full → Only able to carry 1 drink
Opportunity	→ Incorporate magnetic clip for bladder tube → Allow for switching between water and electrolyte drink
Threats	→ Variety of fluids takes up more room → Design a bladder pocket to stay cool but not block the cooling effect of athlete

How could we design for universal bladder compatibility that provides even weight distribution while allowing more than 1 drink to be carried all while keeping the athlete cool.

PRODUCT ANATOMY

Athletes are prompted to carry essential gear and preferential gear to aid in their individual performance. Shown below are some requirements and recommended items in the HURT100 race (Hurt100, 2021).



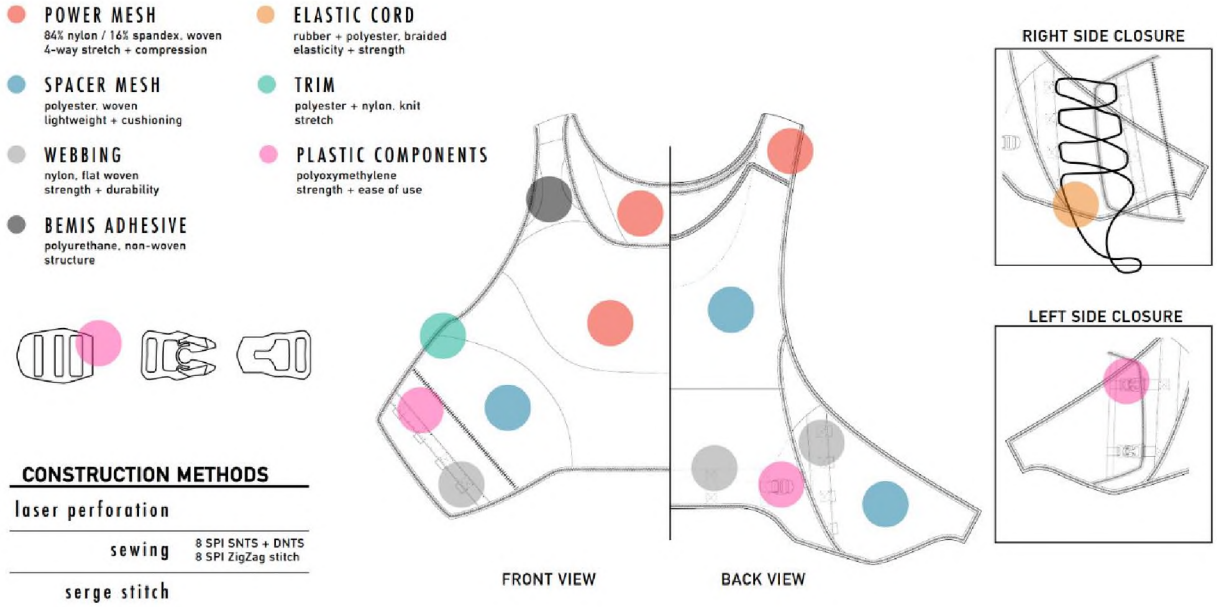
(Figure #6) Pack Anatomy

A pack needs to accommodate for the biomechanical needs of the athlete, as well as be capable of storing and organizing essential gear to be easily accessible and useful.

(Figure #7) Pack Part Functions

MATERIALS & MANUFACTURING

There is a causality conundrum pertaining to the advancement of the sport versus sports product innovation and technology. Change in what and how parts are assembled continues to push innovation further. Ultra-endurance trail running athletes are discovering more efficient ways to run faster, longer, and further. Companies are constantly developing innovative textiles that have greater protective properties, more efficient manufacturing methods, and new technologies to further aid in enhancing athletic performance. A majority of pack components are sewn together using a specific order of operations.



(Figure #8) Materials and Manufacturing.

HOW COULD WE STATEMENT

How could we use anthropometry & physiology to design an ultra-running hydration pack for females with C-DD cup sizes that provides performance benefits such as (1) supportive fit & comfort, (2) storage accessibility, and (3) heat and moisture management while competing in hot & humid environments such as the HURT 100-mile trail race.

ATHLETE / TARGET CONSUMER

Approximately 140,552 females participated in ultramarathons in 2018, making up 23% of the athlete pool, compared to only 4,816 females and 29,585 males in 1996 (Ronto, 2021). the number of ultra-marathon runners has increased 1676% since 1996 (Ronto, 2021). With the most participants recorded in history, there are over 611,000 people racing each year (Ronto, 2021). Compared to 23 years ago, participation has grown from 34,401 with 14% of those participants females (Ronto, 2021). Recent trends show an increase in participation to 23% female, meaning that for every 4 racers to cross the finish line, 3 are male, and 1 is female (Ronto, 2021). Unfortunately, female ultra-distance runners are a grossly underrepresented population that is often misunderstood by sports product companies.

There are numerous examples of when designers failed to recognize key design elements that are unique to females. As for most industries, the sports industry categorizes their consumers into gender, making products for men and women. With stereotypes tied to each gender, women's products tend to be pink and designed to further sexualize women. Named for such classifications, running packs aren't made for *females*, they're made for *women*. The equipment designed for women doesn't holistically consider female characteristics, which have been proven different in the study of anatomy, physiology, and biomechanics. Product areas for female athletes are neglected all around the world, so there is a global demand for women's ultra-running packs that are designed for body-specificity. Since there is little scientific exploration in this space, athletes of small and large frames complain of similar problems.

The target athlete is female with experience in ultra-trail running. Based solely on the fact that the athlete can travel 100 miles on foot in less than 36 hours, age is not a pertinent factor in the definition of the target athlete. Ability is an identifying factor, although a hypothermic athlete could have similar dexterity to an older athlete with arthritis. Having the ability to run 100 miles is a pre-defined target market group.

ATHLETE NEEDS

Biomechanical

Ultra-running athletes rely on proper running form to be most efficient in their stride. The performance apparel and equipment used may enhance or interfere with factors of biomechanics such as arm swing and posture. Running posture looks like (1) neutral head positioning focusing on the horizon, (2) shoulders positioning back, down, and engaged but relaxed, and (3) arms swing along the sagittal plane holding a 90-degree angle to optimize stride aerodynamics and conserve energy ("Trail-Running," n.d.). Athletes lean slightly forward while keeping their shoulders squared and aligned with the spine to reduce pressure and allow space for proper lung expansion ("Trail-Running," n.d.). Athletes swing their arms in coordination with their legs to provide forward and upward momentum as well as form relaxed fists with their hands to optimize aerodynamics while pumping their arms ("Trail-Running," n.d.). On technical terrain, athletes focus their attention on the trail to continuously plan their next steps.

Stride and form of a runner changes as the terrain shifts. When running on flat spots on the trail, athletes optimize their stride by keeping their feet underneath their body to maintain balance while staying over their center of gravity ("Trail-Running," n.d.). When terrain steepens, runners shift their weight forward onto the balls of their feet while keeping their back straight and core engaged ("Trail-Running," n.d.). To control their body and speed on downhills, athlete's elbows wing out to improve balance ("Trail-Running," n.d.). While transitioning to running uphill, runners shorten their stride even further to optimize energy exertion, stride, and cardiovascular output ("Trail-Running," n.d.). Additional to running, athletes in ultra-marathons experience stages of the race where crouching, climbing, sitting, and wading through water is required (Hurt100, 2021). When creating a running pack, movements other than running must be factored into designing for weight distribution and load stability.

When researching female athletes, note that they have narrower shoulder, smaller neck girth, and lower and more posterior center of gravity than men (Rosenberg, n.d.). Females also have varying breast sizes that affect and often times interfere with the biomechanics of running by shift their center of gravity forward and obstructing certain movements involved in running. To female runners, fit and security are top priorities that vary significantly to the design of men's packs.

Physiological

The current state and efficiency of physiological systems and related factors in ultra-runners can be the difference between winning a race and dropping out. In the Hurt100 race, as environmental

temperature increase, the effectiveness of heat loss decreases by conduction, convection, and radiation (McArdle et al., 1991, p. 552). When relative temperatures exceed an athlete's body temperature, heat is actually gained by these mechanisms of thermal transfer, which leaves the most efficient way to dissipate heat through evaporation (McArdle et al., 1991, p. 552). The total sweat vaporized from the skin of an athlete depends on three factors: (1) the surface exposed to the environment, (2) the temperature and humidity of the ambient air, and (3) the convective air currents about the body (McArdle et al., 1991, p. 552). By far, relative humidity is the most important factor that determines the effectiveness of evaporative heat loss, however, sweat per se does not cool the skin; evaporation cools the skin (McArdle et al., 1991, p. 552). What's important to understand as it applies to pack design is that evaporative heat loss can occur only when the materials become wet (McArdle et al., 1991, p. 554). When evaporation is a successful, a relative state of dehydration sets in, and the athlete needs to be able to replenish the fluids being lost. Additionally, excessive sweating leads to more serious fluid loss and an accompanying reduction in plasma volume which can cause circulatory failure, and core temperature to rise to lethal levels (McArdle et al., 1991, pp. 556-557).

Dehydration is one of the top physiological performance inhibitors throughout the history of ultra-running (Felton, 2013). It is imperative for athletes to be knowledgeable of the signs of dehydration and how to prepare in advance to prevent the extra stress on the body. This is easiest achieved by beginning the race hydrated and continuously drinking water throughout the race. Mentioned as a job to be done, keeping water cool in the ultra-running pack facilitates staying hydrated because cold fluids (5°C; 41°F) are emptied from the stomach at a faster rate than fluids at body temperature (McArdle et al., 1991, p. 561). Athletes run into problems in longer races because matching fluid loss with fluid intake may be virtually impossible because approximately 800 ml of fluid can be emptied from the stomach each hour during vigorous exercise (McArdle et al., 1991, p. 561). This is insufficient to match a water loss that may average nearly 2 liters per hour (McArdle et al., 1991, p. 561).

Women are at a disadvantage when it comes to heat dissipation through evaporation because they start to sweat at a higher skin and core temperature, however, they also produce less sweat than men ultimately retaining a higher water reservoir, decreasing the risk of dehydration by a miniscule amount (McArdle et al., 1991, p. 567). A favorable dimensional characteristic for heat dissipation specific to females is a relatively large surface area-to-mass ratio; that is, per unit of body mass females have a larger surface exposed to the environment (McArdle et al., 1991, p. 561). Consequently, under identical conditions of heat exposure, women tend to cool at a faster rate than men and have to propel a smaller body mass (McArdle et al., 1991, pp. 567-568).

As evaporation is the ideal form of heat dissipation in Hawaii in January, the pack needs to be most efficient at facilitating heat dissipation through evaporation and assisted by small amounts of engineered conduction, convection, and/or radiation. Sweating expels water and salt from the body. Salt is an electrolyte that prevents muscles from cramping. Electrolytes lost through sweating can be replenished with electrolyte drinks mixed with water, sports bars, salt tablets, etc. to prevent cramping.

Psychological

Kept secret by many athletes, the key to success in ultra-running is knowing that 90% of the sport is mental toughness (Spires, 2018). Explained by Tim Noakes' Central Governor Theory, the brain acts to limit the body's ability to push beyond perceived fatigue to prevent biological harm (Noakes, 2007). Simply stated, an athlete's mind will give up before their body does, and it's the athlete's job to draw strength and determination from within themselves to reject the impulse and keep moving forward. As athletes gain more experience, they develop techniques to overcome mental obstacles. Ultra-runners begin by visualizing the race; mentally practicing the worst parts of the race, training and redirecting their focus in

a deep meditative state (Spires, 2007). Another technique entails making the race smaller by segmenting the 100-mile task into shorter-distance goals that are deemed easily achievable by the athlete, such as reaching the next aid station (Spires, 2018). Nikki Kimball, the 2012 record holder of the 273-mile Long Trail ultra-distance explains how the self-inflicted pain of running would never hurt as much as the pain she had no control over as she struggled with depression (Jacobsen & Dye, 2014). This exemplifies the third strategy: pain-comparison (Spires, 2018).

Ultra-athletes are often labeled insane judging by the physical stress and strain they choose to subject their bodies to. A Harvard study consisting of 523 endurance-runners presented the prevalence and distribution of mental illness diagnoses seen in distance runners (Colangelo, 2020). Data reflecting the 30 (18 female; 12 male) endurance athletes who train >20 hours per week shows that 56.67% of participants reported having been diagnosed with mental illness prior to joining the sport (Colangelo, 2020). Between the prevalence of prior diagnoses in the U10 category (28.3%), 10-20 category (38.9%), and the >20 category (56.67%), prior diagnoses increase 200.24% and 145.68% respectively, which supports the claim that ultra-runners with mental illnesses seek out longer, more extreme training and racing distances (Colangelo, 2020). Of the focus group, mental diagnoses include depression (20%), anxiety (26.7%), eating disorders (20%), PTSD (10%), and bipolar disorder (6.67%) (Colangelo, 2020). Ultra-endurance athletes replace negative coping mechanisms to alleviate common mental illness symptoms. Ultra-endurance athletes run as a therapeutic way to achieve mental clarity and use natural chemicals released during exercise to treat chemical imbalances caused by mental illness. The sport is used by some athletes as a trade of addiction. Over 11% of the ultra-runners studied identified as recovering drug and alcohol addicts using the sport as an alternative habit that still activates the body's opiate receptors while remaining non-addictive (Colangelo, 2020; Merriam-Webster, 2016). Because the body produces a group of hormones called endorphins, athletes experience euphoria as a "runner's high" that diminishes the perception of both physical and psychological pain (Bruce, 2020).

In the end, the sport of ultra-running has as many different definitions as there are runners. Ashprihanal Aalto, a runner in the longest ultra-marathon on Earth that covers 3100 miles in 52 days, defines the sport as a form of prayer, a path to enlightenment, and a way of healing the body and mind (Rawal, 2018). Nikki Kimball describes her relationship with ultra-running as a love for a sport that makes you want to die, but at the same time, be the only thing keeping you alive (Jacobsen & Dye, 2014). Dean Karnazes, also named the "Ultra Marathon Man," says that the marathon is not about running, rather it's about salvation and opportunity that only you can make a reality (Karnazes, 2014). Nonetheless, these runners train year-round, travel abroad to race, and lose sleep to be the first hundred entries in the next year's race to do it all again.

JOBS TO BE DONE

Product success in ultra-running packs revolves around three categories: fit & comfort, storage accessibility, and heat & moisture management.

Fit and comfort

Fit entails compression and support of a product, while comfort entails heat and moisture management, skin sensitivity, and ergonomic wear comfort (*Textile Testing*, 2021). A running pack is a very intimate possession to runners because it's felt as an extension of their bodies. The most prominent complaint from females with larger busts about their packs is that they don't fit their body properly. Improper fit

can cause chafing, bouncing, and shifting of load. Athletes even avoid running only in sports bras due to chafing, making it harder to regulate their body temperature. Bust size and frame are two commonly known differences in females that account for inconsistencies in first and failure of universal sizing. When female athletes wear running packs that were designed for the male body, due to anatomical differences between sexes, there is room in the shoulder straps to cause discomfort and poor running posture. When athletes are putting their bodies through immense pain during training and racing, irritation could affect their performance and invade their mind-space.

The product job to be done related to fit and comfort is to provide soft to touch methods of support and security that is adaptable to runners of varying sizes.

Storage and Gear Accessibility

Storage and access to items plays a large role in the performance of ultra-athletes. The goal of a running pack is to carry the supplies needed to maximize performance without interfering with the athlete's stride, range of motion, or significantly altering their center of gravity. Females with larger busts have more surface area and it's not being taken advantage of in the current pack designs. Pack weight should be equally distributed on the left and right sides of the pack; however, female biomechanics, anatomy, and physiology determine the optimal distribution of weight posteriorly and anteriorly for performance. Without proper balance, the athlete could fall and get injured, especially when they're already tired and delusional. Another factor that is unique to females is the wide Q-angle; increased Q-angles transfer lateral force into stress on the knee (Horton & Hall, 1989). This difference in anatomy could off-set the balance and stability of females when their performance is compared to that of a male with a pack designed for their anatomy. Female athlete's strides are also affected by their wider Q-angle (Horton & Hall, 1989). Load stability is also pertinent in providing the athlete with a running pack for optimal carrying performance. It is detrimental to performance when gear jostles around inside the pack. The design needs to account for varying amounts of gear being carried by the athlete during a race.

In addition to weight distribution, athletes need to be able to quickly access their fuel and gear while moving. In aid stations, when the athlete takes off their pack, they need to be able to replace items in the pack with ease.

How could we design the equal distribution of weight across the sagittal plane while optimizing load distribution between the front and back of the athlete based on female-specificity.

Heat and Moisture Management

Thermoregulation is achieved by focusing the design to manage heat and moisture for the athlete. The intensity of exercise and current environmental conditions determine the need for temperature regulation and also communicates the optimal way of achieving a comfortable state. Moisture is ever-present on the island of O'ahu and in semi-tropical rainforests (Hurt100, 2021). Another source of moisture is from the athlete when the onset of sweating occurs. Sweating is the bodies way of dissipating heat in attempts to cool the skin.

Athletes are especially susceptible to heat illness on the island of O'ahu where high environmental temperatures and humidity makes methods of heat dissipation such as convection, conduction, and evaporation difficult (Watkins & Dunne, 2015, p. 175). Overheating can lead to more serious illnesses such as heat stress, heat exhaustion, heat stroke, and could potentially be fatal if left untreated (Watkins & Dunne, 2015, p. 174-175). The job of a running pack for hot environment entails protecting the athlete

from heat illness by helping to cool the body and maintain a steady-state temperature. This is accomplished with cooling textiles, layering systems to aid in heat dissipation, and designing for female-specific sweat patterns. There is a necessary balance between keeping the athlete dry and their clothing wet. Moisture-wicking technology aims to move moisture off the skin of the athlete and into the environment to promote cooling. In order for evaporative cooling to work, the material must be wet.

In conclusion, the first job to be done to have product success is designing a way to keep the athlete cool and their skin dry, while still facilitating heat dissipation when the athlete sweats and the environment is moist.

USER JOURNEY

An ultra-runner's journey begins before the start gun goes off. Ultra-running is less of a sport than it is a lifestyle. It takes years of training for athletes to learn the way of their own body, how it reacts to climate, how it reacts to particular foods and drinks, the frequency of fueling, what products work best, even down to the type of socks an athlete wears. During this self-discovery and exploration, ultra-runners grow to be immensely self-aware. Athletes train year-round for various distances and technical terrain. This is often done by running and hiking on trails.

Runners constantly adapt their fueling methods as well. It takes athletes months to find energy bars or electrolyte powders that work best for their body. It's an ever-changing responsibility to be in-check with your body and prepare the food and fuel that will enhance your performance. Being knowledgeable about nutrition and mineral balances is crucial in performing best in competition. When an athlete's body is exhausted, making important tasks as easy as possible can be the difference between fueling the body properly, and abandoning the attempt to excerpt extra energy in order to find and access their fuel. Demanding such extreme performance from your body increases the likelihood of digestion issues. To add the job of digestion on top of athletic performance takes a toll on your body. A common issue is vomiting, which denies the ability for your body to absorb any nutrients. It's important to train hard and know how your body reacts in difficult environments and with different stressors. The real competition begins before the athlete even starts the race. Every athlete is different in that some runners perform well by fueling their body with food, bars, electrolytes, and goo. While other athletes maintain the ability to digest more solid foods while racing. Regardless of the type of fueling, both athletes need to be able to reach and access these food items during their run and at checkpoints along the way. An athlete needs to plan how to react in different scenarios their body may present.

Once a particular race is in mind, athletes then begin to tailor their training frequency and intensity in preparation for the race. Weeks before the race, athletes taper their training to allow their body sufficient time to recover before in time for the race. This is also the time to acquire a crew. Depending on the athlete's goals, crews can be preparing for months. Crews can include pacers, physical therapist, trainers, nutritionists, doctors, and friends that are familiar with the routine of racing. At checkpoints, a well-oiled team will be able to judge what kind of condition their athlete is in and know the steps they need to take in order to get them through the checkpoint and back onto the course as soon as possible. This includes changing out clothing, equipment, footwear, food, liquids, and anything else their runner may need. As athletes are often disoriented while racing, it's their responsibility to communicate and organize this long before the race.

Reviewing the course is a strategy used by many ultra-athletes. If they have the opportunity, they'll train and practice on the course. However, enough information can be found about any planned course, so that

athletes can train in a near similar environment. This allows them to potentially adjust their bodies to different terrain, altitude, climate, or just help to gain familiarity with the demands of the environment.

On race day, the team coordinates which aid stations to put a drop bag for runners and pacers and ensures that everything the runner could need is in the bag. During the race, athletes are on their own outside of official aid stations. When they enter an aid station at mile markers specified in the briefing, athletes and assisting crew members are responsible for refueling and preparing for the next stages of the race. The most important thing a runner needs to carry is water. Hydration is another frequent task that is harder than it sounds. Hyponatremia is observed in almost 51% of participants in single-stage ultramarathons (Krabak, 2017). Throughout the 36-hour race, runners change out of sweaty clothes, change into or out of thermal layers, and add layers to their pack depending on how fast they're moving and what the next stretch of trail entails.

If an athlete is to officially drop out of the race, they must alert the nearest aid station director (Hurt100, 2021). As a part of popular ultra-marathon events, competitors wear ankle monitors to track progress and trip sensors when entering and exiting any aid stations or crossing start of finish lines. This is to keep track of the runners' progress, record official times, and also to narrow a search area if a runner goes missing. There are non-participant runners called "sweepers" who follow the last racer on the course to ensure the course is clear and all racers are accounted for.

However, for the runner, the race doesn't end at the finish line. Rest and recovery are important for athletes to continue the sport remining injury-free.

TRENDS

Analyzing state-of-the-art and future color, graphics, and logo application trends allows for the isolation of patterns in both aesthetic and function and provides project direction.

Color Trends

(Figure #9) Color trends.

Combinations of vibrant and natural colors are often seen in outdoor sporting equipment for multiple reasons. Ultra-endurance athletes run far along trails to escape the city, seeking serenity and solitude in nature. Blending colors with the Earth tones evokes a sense of connectedness and belonging in nature. Runners encounter an abundance of wildlife on or near trails and there are times when neutrality is advantageous for camouflage and conflict avoidance. Vibrant colors with reflective properties are useful in emergency situations where contrasting with the environment helps search and rescue teams find a lost or injured athlete. Contrast also helps the athlete locate zippers or differentiate between segments of their pack in low light situations.

Additionally, there are many ways that color influences athlete performance and provides design benefits. Blue, for example, has been proven through color psychology to be calming and reduce anxiety, therefore helping the athlete feel less agitated and facilitate a lower body temperature (Cherry, 2020). Packs get dirty with continuous use and darker colors hide stains and discoloration. As the color black is associated with weight, white material can appeal to the athlete as lighter in comparison, which is a useful psychology trick for carrying heavy packs (Lischer, 2021). Black or darker colors absorb the shorter wavelengths of radiant energy, while white or lighter colors reflect them (Watkins & Dunne, 2015, p. 182). This means that wearing black colors close to skin attracts heat and wearing white reflects radiant energy resulting in the athlete staying cool (Watkins & Dunne, 2015, p. 182).

Graphics Trends

(Figure #10) Graphic trends.

The objective of a minimalist running pack is to strip down the design to its bare necessities and only add features that aid in performance. By focusing on the athlete's needs for a specific environment, the application of any layers, textures, and textile selection is collectively feeding into the functionality of the pack. Texture and graphics provide visibility and proprioceptive feedback to make the design intuitive. Graphics and textures also respond to weather elements such as channeling rain or deflecting heat in an array of directions (Watkins & Dunne, 2015, p. 182).

Logo & Branding Application

(Figure #11) Logo and Branding trends.

Symbols are used as additional tools to aid in intuitive design. Similar to washing instruction tags, a pack requires small indications so the user can be fully knowledgeable of the intentions of the design and can effortlessly utilize the full extent of their pack when their cognition isn't completely present.

ATHLETE INSIGHTS

Athlete insight research is collected using questionnaires, surveys, and interviews.

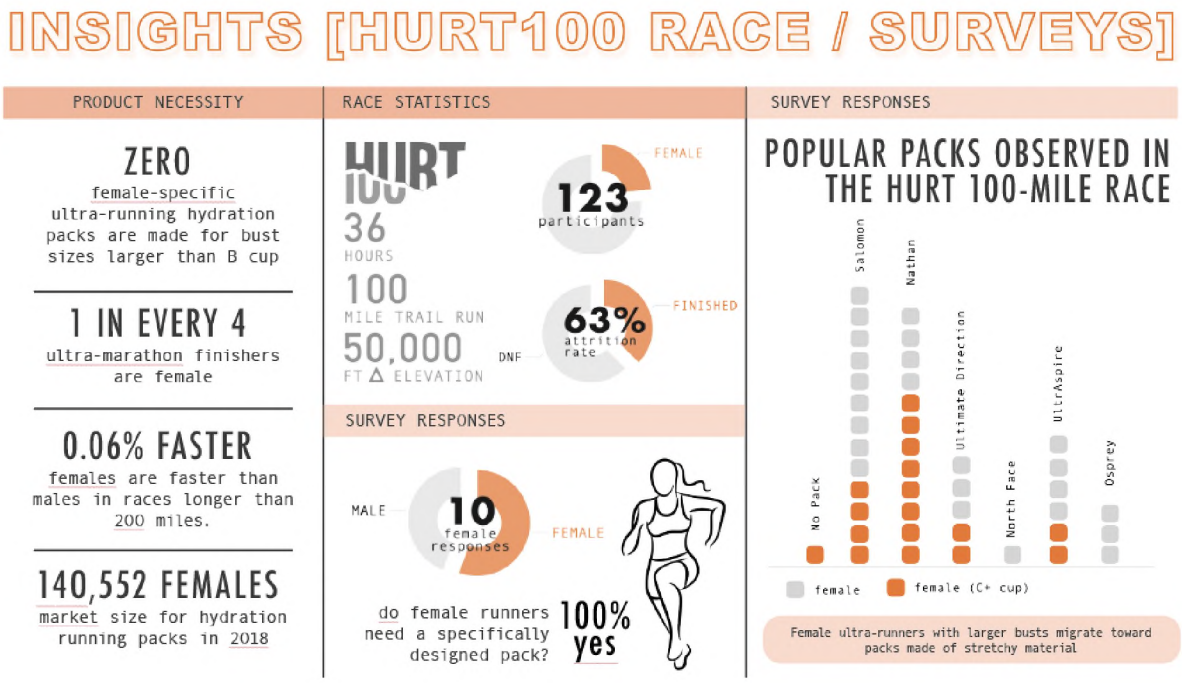
Initial Questionnaire

- Name
- Email (by providing your email, you may be included in follow-up emails)
- Sex
- Height
- What is your bra size? (Example: 32D)
- Do you think women need a specifically designed pack for ultra-racing? Y/N. Why or why not?
- What pack are you currently using for ultra-racing? Provide brand and model.
- Does your ultra-racing pack chafe? Y/N. Where?
- Have you ever experienced overheating during training or racing while wearing your ultra-racing pack?
- Does your pack carry and allow access to everything you need? Y/N. Explain how.
- Has your ultra-racing pack ever hindered your performance? Y/N. If yes, explain how.
- Has your ultra-racing pack ever enhanced your performance? Y/N. If yes, explain how.
- How do you prefer to carry your water/electrolyte drinks? Provide location on body, size of containers, number of containers.
- What kind of adjustments or alterations have you made to your ultra-racing pack to fit or function better?
- Any additional comments about your pack for ultra-racing?

Secondary Questionnaire

- What features do you like most about your pack?
- What features do you like least about your pack?
- Explain any issues with the packs you've tried (Example: chafing, overheating, etc.)
- Do you carry any medical devices? (Example: inhaler, EpiPen, glucagon, etc.)
- How do you prefer to carry fluids and manage electrolytes?
- Do you race with a cellphone?
- If your pack allowed for it, would you just wear a sports bra?

Questionnaire Insights



Observational Insights

At the HURT 100 race in Hawaii, additional insight was collected via filming and photography. At aid stations along the course, researcher collected notes on the number of packs from specific brands including Salomon, Nathan, Ultimate Direction, Osprey, UltrAspire, and The North Face. Key issues and problem areas were confirmed or further identified.

BENCHMARK TESTING

Packs

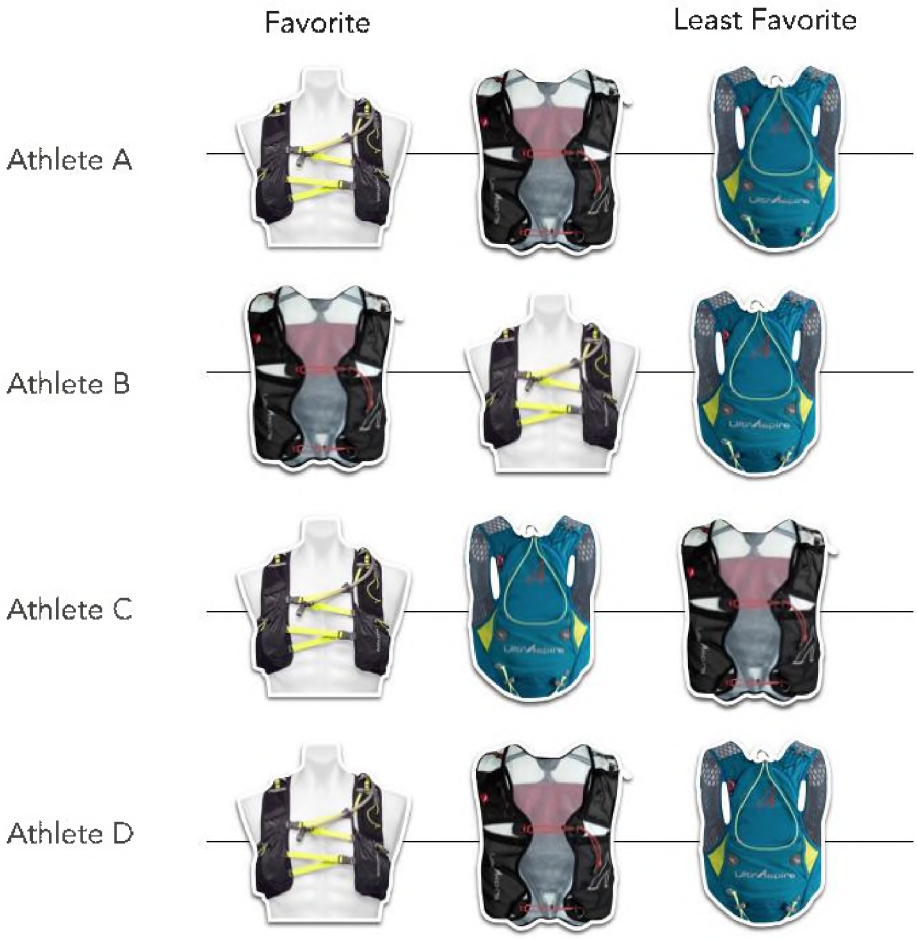
Benchmark Testing Plan

Benchmark testing includes the evaluation of fit & comfort, storage & accessibility, and heat & moisture management. Benchmark packs include: UltrAspire Momentum 2.0, UltrAspire Alpha 4.0, and Nathan VaporAir.

Fit & Comfort

Fit entails compression and support while *comfort* refers to heat and moisture management, skin sensitivity, and ergonomic wear comfort (*Textile Testing,* 2021). Wear testing the benchmark pack on athletes for field-testing provides the collection of qualitative feedback directed toward fit and comfort. Video analysis is used to track movement in the strap region during climbing or running.

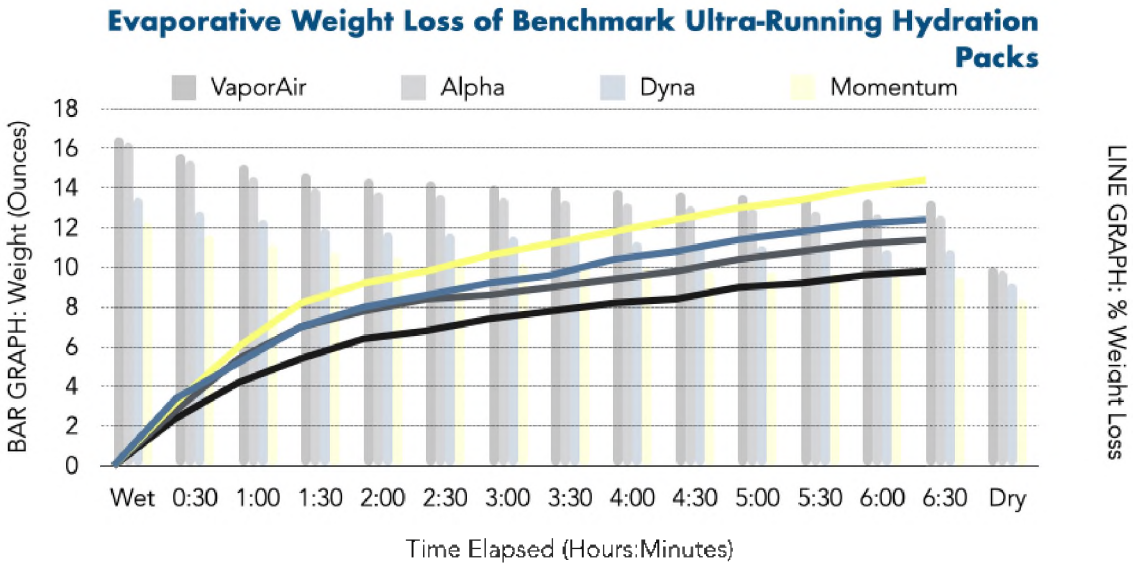
Goal: Pinpoint problem areas on ultra-running benchmark packs.
Method: Qualitative verbal feedback and images; Wear-testing
Results:



Heat + Moisture Management

The back panel of the ultra-running pack needs to form a moisture-wicking and dispersal system to facilitate thermoregulation and physiological comfort via heat and moisture managements in the areas

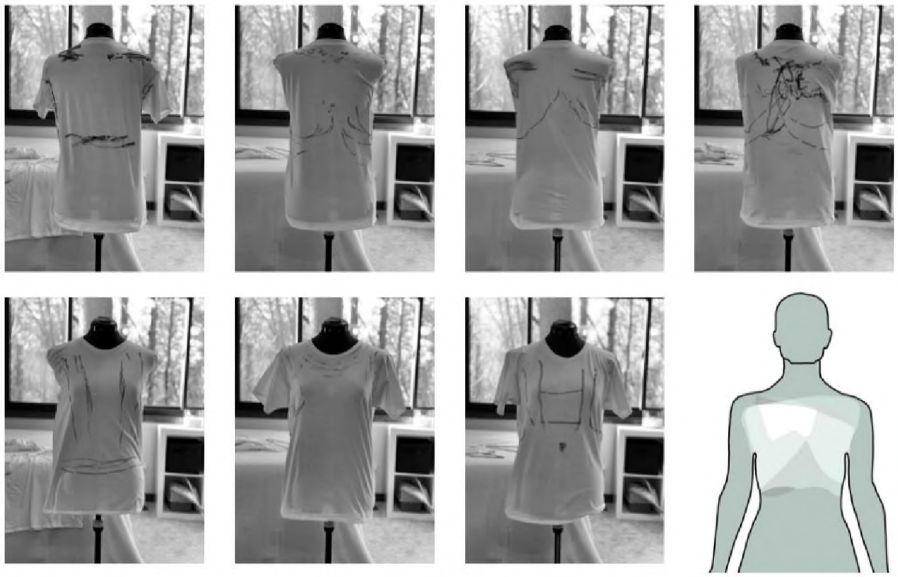
of the body that generate the most heat. The system needs to be next to skin to maximize the effectiveness of both cooling textiles and heat dissipation using evaporation as the main transportation method. Water weight retention testing measures the quantitative rate at which the textile can promote evaporation. The method takes place in a controlled lab and includes soaking the packs in water and placing them on a rack to drip dry while measuring changes in weight at different time intervals.



Comparing the evaporation rate and efficiency between the different packs, the UltrAspire Momentum 2.0 had the fastest rate of evaporation, followed by the UltrAspire Alpha 4.0 pack, then the Nathan VaporAir. This means that the Momentum pack is best at heat dissipation for the athlete in this scenario. Field testing will be performed later.

Storage and Accessibility

Using fit models, range of motion tests were performed using a marker and blank t-shirt. Athletes were instructed to mark where their thumb could reach (pinching motion) and then the data was compiled to show where on the diagram was the hardest place to reach.

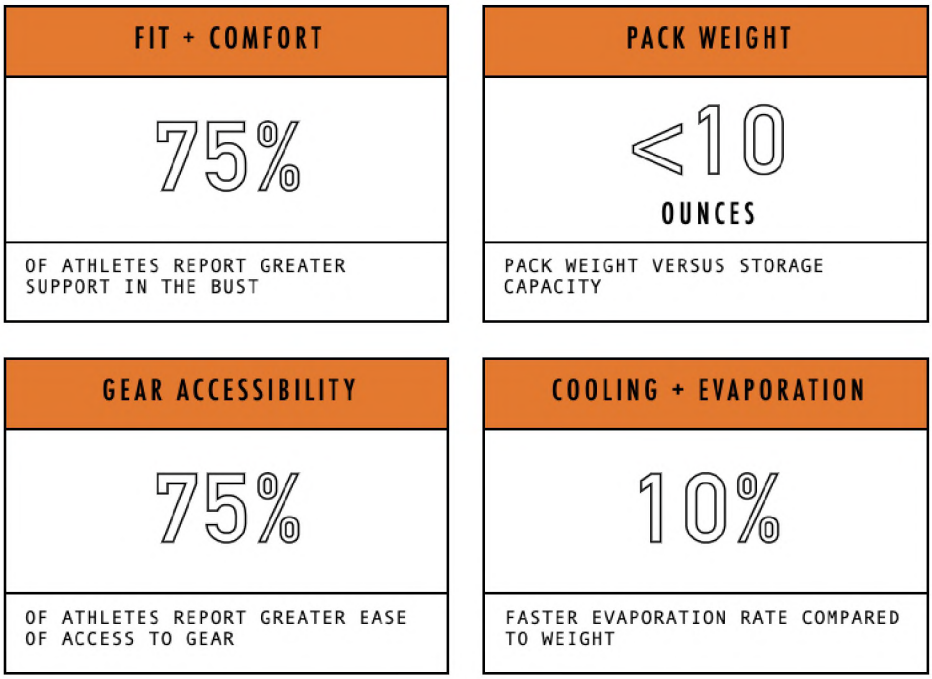


PERFORMANCE TESTING

Performance Testing Plan

Performance testing is conducted using wearing-testing, evaporative testing, and storage testing.

Performance Metrics Goals



Three innovation technologies were developed to solve for fit & comfort, storage accessibility, and heat & moisture management.

QuadPlane addresses fit & comfort.

QUAD PLANE

COMPRESSION IN 4 DIRECTIONS STEMMING FROM THE POSTERIOR TO ANTERIOR

PERFORMANCE GOAL

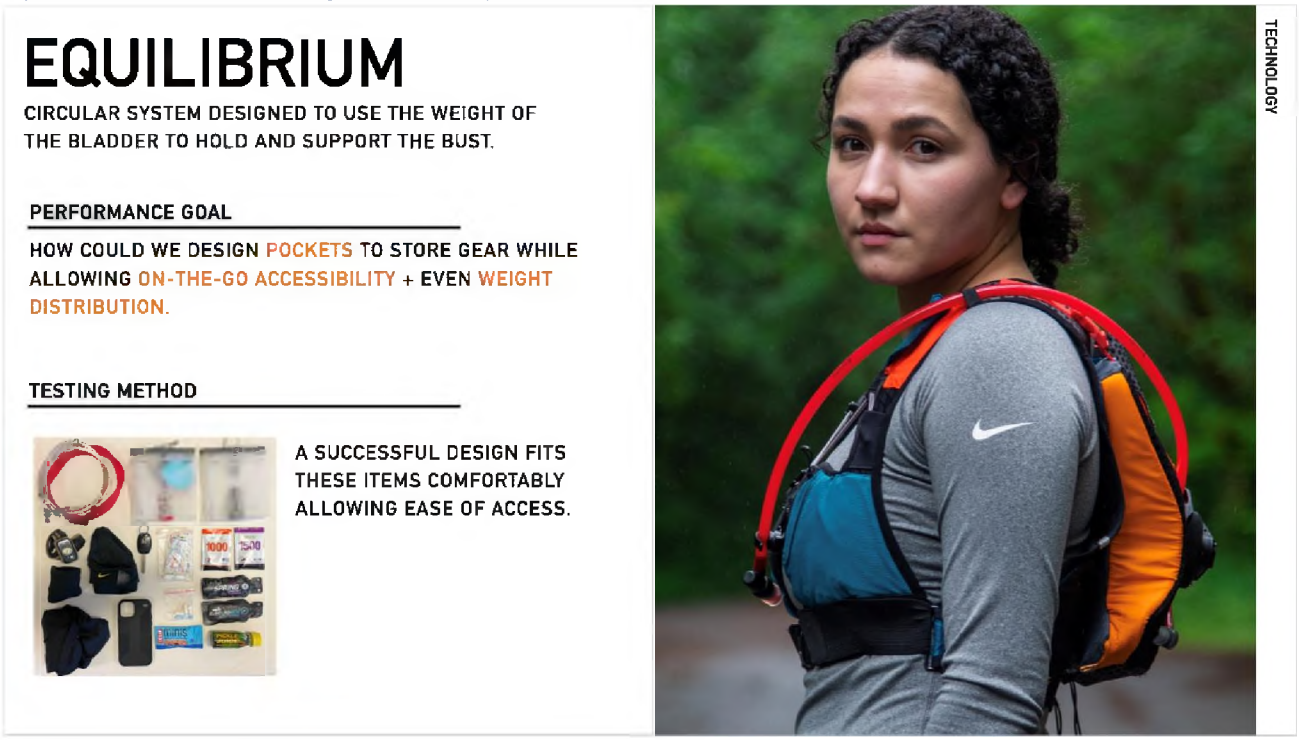
HOW COULD WE APPLY COMPRESSION TO PROVIDE SUPPORT UNDER THE BUST AND TENSION ALONG THE SAGITTAL PLANE WHILE ALLOWING ADJUSTABILITY.

TESTING METHOD

WEAR-TESTING - COLLECT VERBAL QUALITATIVE AND VISUAL FIT FEEDBACK.

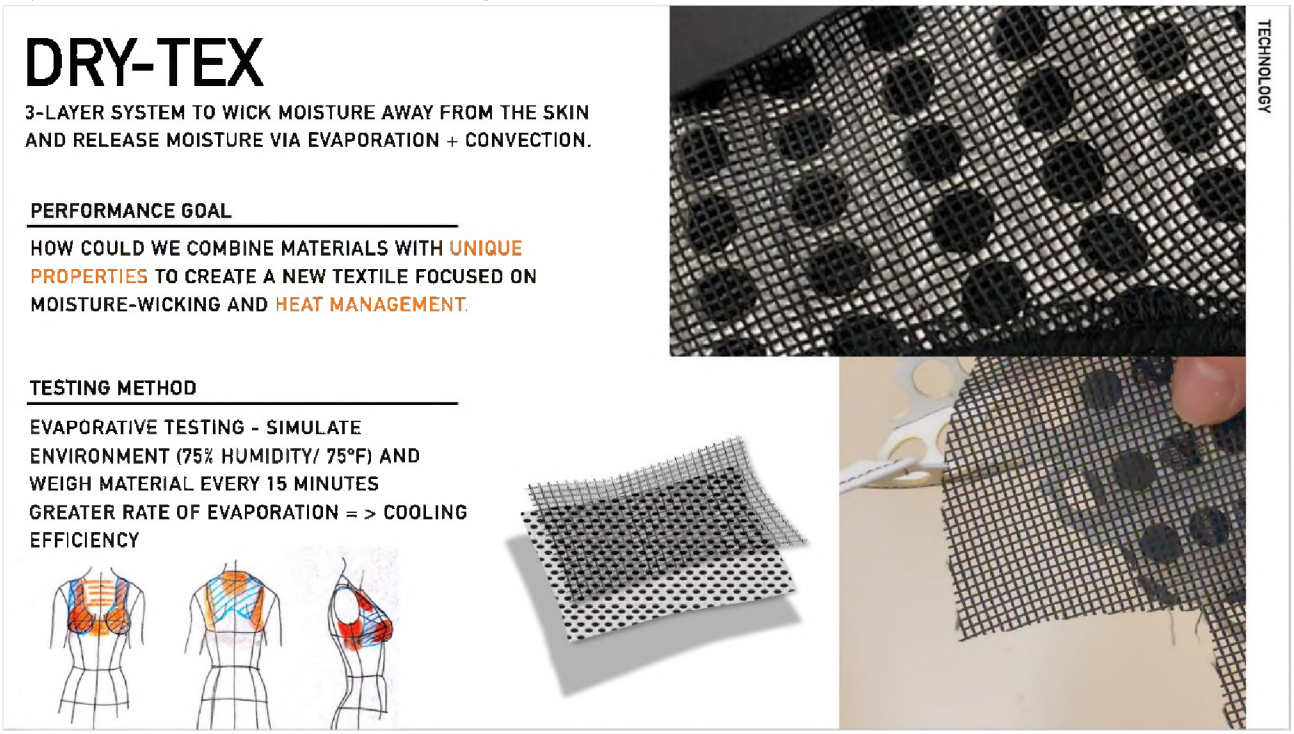
Quad Plane technology addresses and solves for the issues involved in balancing the weight of the gear and water in the back of the pack. Using a circular system, Quad Plane uses tension over the shoulders while using the weight in the back to support and hold the bust steady while running. The objective of this technology is to making running easier and more comfortable while reducing the bounce and increasing the support of the chest volume.

Equilibrium addresses storage accessibility.



Equilibrium technology plays off the support of the Quad Plane technology. Using the equal distribution of weight, the Equilibrium technology allows for storage in places of lessened pressure and compression. In benchmark packs, the weight of the water blocked the storage compartments. In the DualXX pack, the pockets are located in easy-to-reach locations all while not applying pressure directly across the bust or nipples.

Dry-tex addresses heat & moisture management.



Dry-tex is an innovative material technology that uses 3 layers of different fabrics to create space for moisture wicking and evaporation as a way to dissipate heat and cool the athlete. The base layer is a channeled polyester knit that moves the moisture off the skin and toward the surface. The middle layer is a closed-cell foam with laser cut holes to create the space necessary to move air and moisture away from the base layer. Lastly, the outer layer provides structure and is a wide mesh to allow for moisture and air to pass through with ease.

CONCLUSION

Creating an ultra-running pack to provide supportive fit, accessible storage, and heat & moisture management will all in all improve the experience of distance running for females and has the potential to grow into other running and outdoor markets. The materials and technologies used in the design of the DualXX pack, along with the silhouette and structural elements allow for a circular weight and moisture management system that improves the performance of female athletes. With the long overdue design of an ultra-running pack for C+ cup sizes, the gender gap seen in the finishing times will begin to diminish now that females have performance gear made for their bodies. The future of ultra-running is female, and with the DualXX pack, runners can finally compare athletic abilities on a level playing field.

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APPENDIX A: Project Scope + Alignment

I am dedicated to the work I do to empower and create equal opportunity for underrepresented athletes of diversity – sex, gender, ability, race, etc. – by designing performance-enhancing, body-specific equipment and apparel with foundation in anatomy, physiology, and biomechanics. I stand strongly for gender equality in sport and have made my mission as a designer to advocate and design for female athletes. As an innovator, I approach equal representation through the scope of sports product design.

My unique professional strengths are Command, Empathy, Relator, Strategic, and Individualization. As someone who possessed a "Command" strength, I show leadership and presence as I become the voice of underrepresented athletes in the sport. I use "Strategic" planning to develop a clear plan for my thesis. I have an abundance of "Empathy" that I use to understand the user and focus the product goals to the real gaps in the market that are expressed by the consumers. I utilize my "Relator" strength by valuing consumer participation during the product development stage. "Individualization" is reflected in my work because I design for individual athletes with common problems.

In my capstone thesis, I've chosen to explore the grassroots sport of ultra-trail running. Because I grew up around the trail-racing environment and started distance running at an early age, my experience and knowledge of the consumer is extensive and the connections I've made are more personal. I represent and empower female runners by validating their needs, separate from the needs of male runners. Being a runner myself, I can relate to the runners and experience the physical and mental obstacles they face in the sport. I empathize with athletes that are forced to wear equipment and apparel that were not made with Her in mind, and I devised a strategy to begin closing the gender gap in the sports industry. Therefore, this capstone thesis project is important to me because it aligns with my mission to empower females and design body-specific products.

As I enter my career in the sports industry, I will carry my mission further into the workplace and collaborate with other diverse-minded creatives to change the future of designing for bodies instead of stereotypes or the average male anthropometry. I will share and utilize my strengths in the design industry to be part of a holistic team that designs for every athlete, but not in one product.

Taegan Morgan; Sr Industrial Designer (Freelancer) / Previous Job: Lululemon (5 years); Running Pack Design Experience

From Taegan Morgan on 2021/11/23 17:53

Details Plain text

Hi Juliana,

Thank you for reaching out. It sounds like you are up to some amazing things. I would love to set up a zoom call and you can tell me more about your project.
I am happy to meet 1-2 times each month as well.

Happy to connect and learn more about your project.
All the best,
Taegan

Megan Erspamer; Product Manager @Nike; Athlete Insight Specialist

From Megan Erspamer on 2021/11/26 02:23

Details Plain text

Hey Juliana!

Thanks for reaching out. It sounds like a super cool project, and I'd be happy to be a thought partner with you on this over the coming months. :)

I will be living in Europe during this time, but I don't think that should be a problem in terms of finding time to meet. I'm planning to ski in the mornings and work afternoons and evenings for the most part!

I'm going to give you my work email so that our meetings show up on that calendar: megan@youneedabudget.com

Looking forward to it!
Megan

--

Megan Erspamer <she, her>

Product Manager, You Need A Budget

Tim Clark; VP & Director of Product Dev @Kitsbow, Design Director+ Sr Director @Nike; Design Process

Tim Clark

to me

Sure Juilana. Happy to help.

I could do 1 meeting per month, half-hour each time.

APPENDIX B: RESEARCH

Initial Questionnaire Results

Claudette Courogen (#1)

claudette.courogen@gmail.com
Sex: Female
Height: 5'6"
Bra Size: 32A

Do you think women need a specifically designed pack for ultra-running / racing? Why?
Yes, most women find "male" designed packs to be very uncomfortable in the chest area, thus compromising comfort + neck/back pain. Endurance distance athletes would welcome as must controllable comfort as possible.

What pack are you currently using for ultra-running / racing? Provide brand + model.
For racing - Nathan VAPORMAG racing vest, 2.5L fluid capacity, no bladder, XS.
For training - Ultimate Direction Signature Series ADVENTURE VESTA, 1.5L fluid capacity with the choice of an additional 1.5L bladder, XS.

Does your ultra-running / racing pack chafe? Where?
No, even when I wear a sports bra.

Have you overheated during running while wearing your ultra-running pack?
Yes.

Does your pack carry and allow access to everything you need? Y/N. Explain how.
Both packs have many pockets for storage. Nathan vest - I like most of the pockets + location except the small pockets outside the bottle holder in front, very hard to access when pack is loaded + the Velcro is annoying. Pretty well designed + efficient. I like the large back pocket. It holds ice during hot conditions. The only other annoyance, but it's the same for every pack I've tried, is the difficulty putting the soft bottles back in the pockets, mostly when half full. Ultimate Direction - lots of usable pockets. I like the front arrangement with one bottle + easy access zip pocket on one side and large phone/food pocket on other. has the same annoying Velcro pocket in front of bottle pouch. I like the size + placement of both small + large front zip pockets. Back bladder pocket is good, with or without bladder. Large main pocket good, lots of room. Outside slide in pocket + bungee is hard to use for me. I like the idea but would like to see a more efficient design. Overall rating for both is good, I would buy again.

Has your ultra-running / racing pack ever hindered your performance? Explain how.
I use the larger pack for longer races, where the aid stations are farther apart, and long unsupported training runs. I definitely need to take it off to access most of the storage, it would be nice to have a little more easily accessible storage.

Has your ultra-running / racing pack ever enhanced your performance? Explain how.

Race vest is ideal for entering aid stations with empty pre-made electrolyte bottles to fill, while being able to either store a second round of full bottles (if not used) or keep empty pre-made bottles at easy reach. Potential to fill 1-4 pre-made 160z. bottles with ease. The Velcro pockets in front hold the extra electrolyte packs, but they get wet easily if it's super-hot or rainy and are difficult to handle.

How do you prefer to carry your water/electrolyte drinks? Provide location on body, size of containers, number of containers.
Race pack holds up to four 16oz. soft bottles pretty well, two in front and two in back pocket, does not fit a bladder, but that's my preference while racing. Training pack holds a 16oz. soft bottle in front and a 1.5L bladder in the back. It can hold a larger bladder, but I don't like to carry the extra weight. Can hold an additional two 16oz. bottles in place of food or clothes if needed.

What kind of adjustments or alterations have you made to your ultra-running / racing pack to fit or function better?
None.

Any additional comments about your pack for ultra-running / racing?
Keep in mind that I am a very petite person with small chest. I regularly hear people with larger chest complain about fit and chaffing.

Anonymous (#2)

Sex: Male
Height: 6'6"
Bra Size: N/A

Do you think women need a specifically designed pack for ultra-running / racing? Why?
Yes, presumably.

What pack are you currently using for ultra-running / racing? Provide brand + model.
Salomon Advanced Skin 12

Does your ultra-running / racing pack chafe? Where?
No.

Have you overheated during running while wearing your ultra-running pack?
Yes.

Does your pack carry and allow access to everything you need? Y/N. Explain how.
Yes, expandable back capacity and pole loops means it's great even for winter racing.

Has your ultra-running / racing pack ever hindered your performance? Explain how.
Yeah, if you can't get to stuff and have to stop it's a pain in the ass.

Has your ultra-running / racing pack ever enhanced your performance? Explain how.
Yes - if nutrition is easy to get to then it makes it easy to stay on top of eating.

How do you prefer to carry your water/electrolyte drinks? Provide location on body, size of containers, number of containers.
Two 500ml chest soft flasks.

What kind of adjustments or alterations have you made to your ultra-running / racing pack to fit or function better?
None.

Any additional comments about your pack for ultra-running / racing?
Need different packs for different races!

Nate (#3)

Sex: Male

Height: 6'3"
Bra Size: N/A

Do you think women need a specifically designed pack for ultra-running / racing? Why?
Different bodies, boobs, and different needs calls for female packs.

What pack are you currently using for ultra-running / racing? Provide brand + model.
Salomon Agile 6

Does your ultra-running / racing pack chafe? Where?
Nothing so far at the 30k distance even in the rain.

Have you overheated during running while wearing your ultra-running pack?
Yes.

Does your pack carry and allow access to everything you need? Y/N. Explain how.
I'd like more access to food and gear without taking off my pack

Has your ultra-running / racing pack ever hindered your performance? Explain how.
Could be faster without taking off my pack.

Has your ultra-running / racing pack ever enhanced your performance? Explain how.
Being able to carry water on my chest and having a pack that doesn't bounce around has been a huge help.

How do you prefer to carry your water/electrolyte drinks? Provide location on body, size of containers, number of containers.
2 0.5 L soft flasks on my chest.

What kind of adjustments or alterations have you made to your ultra-running / racing pack to fit or function better?
N/A

Any additional comments about your pack for ultra-running / racing?
Great pack for the reprice just needs more front access to food.

Anonymous (#4)

Sex: Female
Height: 5'1"
Bra Size: 34B

Do you think women need a specifically designed pack for ultra-running / racing? Why?
As long as the range is smaller, can be okay - but I don't have a large bust to manage.

What pack are you currently using for ultra-running / racing? Provide brand + model.
Nathan VaporHowe, Salomon Adv Skin 8

Does your ultra-running / racing pack chafe? Where?
No.

Have you overheated during running while wearing your ultra-running pack?
No.

Does your pack carry and allow access to everything you need? Y/N. Explain how.
Yes - lots of separate pockets.

Has your ultra-running / racing pack ever hindered your performance? Explain how.
No.

Has your ultra-running / racing pack ever enhanced your performance? Explain how.
No.

How do you prefer to carry your water/electrolyte drinks? Provide location on body, size of containers, number of containers.
Bladder – currently have 1.8L

What kind of adjustments or alterations have you made to your ultra-running / racing pack to fit or function better?
None - just tightening existing parts.

Any additional comments about your pack for ultra-running / racing?

Ian MacDonald (#5)

Sex: Male
Height: 6'0"
Bra Size: N/A

Do you think women need a specifically designed pack for ultra-running / racing? Why?
Depends on the body shape.

What pack are you currently using for ultra-running / racing? Provide brand + model.
Salomon Advanced 12

Does your ultra-running / racing pack chafe? Where?
No.

Have you overheated during running while wearing your ultra-running pack?
No.

Does your pack carry and allow access to everything you need? Y/N. Explain how.
Yes, lots of space and I travel light.

Has your ultra-running / racing pack ever hindered your performance? Explain how.
No.

Has your ultra-running / racing pack ever enhanced your performance? Explain how.
Yes, I can carry water and snacks.

How do you prefer to carry your water/electrolyte drinks? Provide location on body, size of containers, number of containers.
One or two soft chest bladders. For shorter runs I prefer brining just a handheld water bottle and no vest.

What kind of adjustments or alterations have you made to your ultra-running / racing pack to fit or function better?
Just adjust the straps as needed

Any additional comments about your pack for ultra-running / racing?
Downside to vest is you get much sweatier, this is a downside even more for warm runs.

Anonymous (#6)

Sex: Female
Height: 5'3"
Bra Size: 32DD

Do you think women need a specifically designed pack for ultra-running / racing? Why?
Yes, we need a greater chest to waist ratio.

What pack are you currently using for ultra-running / racing? Provide brand + model.
Nathan VaporHowe 2.0 4 Liter

Does your ultra-running / racing pack chafe? Where?
No.

Have you overheated during running while wearing your ultra-running pack?
No.

Does your pack carry and allow access to everything you need? Y/N. Explain how.
Yes. Bladder. Ample pockets for food in the front.

Has your ultra-running / racing pack ever hindered your performance? Explain how.
No.

Has your ultra-running / racing pack ever enhanced your performance? Explain how.
No.

How do you prefer to carry your water/electrolyte drinks? Provide location on body, size of containers, number of containers.
2L bladder

What kind of adjustments or alterations have you made to your ultra-running / racing pack to fit or function better?
None.

Any additional comments about your pack for ultra-running / racing?
I switched from the UD Race Vesta because the plastic in the lower back chafed and the adjustment strings broke repeatedly from rubbing in the plastic piece. Think they fixed it in a later model.

William Mathiowdis (#7)

wmathiowdis@gmail.com

Sex: Male
Height: 5'6"
Bra Size: N/A

Do you think women need a specifically designed pack for ultra-running / racing? Why?
Yes.

What pack are you currently using for ultra-running / racing? Provide brand + model.
Naked Waist Belt

Does your ultra-running / racing pack chafe? Where?
No.

Have you overheated during running while wearing your ultra-running pack?
No.

Does your pack carry and allow access to everything you need? Y/N. Explain how.
Yes.

Has your ultra-running / racing pack ever hindered your performance? Explain how.
No.

Has your ultra-running / racing pack ever enhanced your performance? Explain how.
No.

How do you prefer to carry your water/electrolyte drinks? Provide location on body, size of containers, number of containers.
One hand-held bottle 20oz

What kind of adjustments or alterations have you made to your ultra-running / racing pack to fit or function better?
None.

Any additional comments about your pack for ultra-running / racing?
Love it.

Anonymous (#8)

Sex: Male
Height: "tall"
Bra Size: N/A

Do you think women need a specifically designed pack for ultra-running / racing? Why?
Yea.

What pack are you currently using for ultra-running / racing? Provide brand + model.
Ultimate Direction Mountain Vest

Does your ultra-running / racing pack chafe? Where?
No.

Have you overheated during running while wearing your ultra-running pack?
No.

Does your pack carry and allow access to everything you need? Y/N. Explain how.
YEA.

Has your ultra-running / racing pack ever hindered your performance? Explain how.
Nah.

Has your ultra-running / racing pack ever enhanced your performance? Explain how.
Yes, carries fuel, extra layers, clothing, phone, sunglasses, headphones.

How do you prefer to carry your water/electrolyte drinks? Provide location on body, size of containers, number of containers.
Chest and extra in the back.

What kind of adjustments or alterations have you made to your ultra-running / racing pack to fit or function better?
None.

Any additional comments about your pack for ultra-running / racing?

Jennifer Pinarski (#9)

jpinarski@gmail.com
Sex: Female
Height: 5'3"
Bra Size: 38B

Do you think women need a specifically designed pack for ultra-running / racing? Why?
Y

What pack are you currently using for ultra-running / racing? Provide brand + model.
Ultraspire Astral 4.0, Nathan Vaporhowe

Does your ultra-running / racing pack chafe? Where?
Y, inside of my arms, my back along the bra line.

Have you overheated during running while wearing your ultra-running pack?
Yes.

Does your pack carry and allow access to everything you need? Y/N. Explain how.
Yes.

Has your ultra-running / racing pack ever hindered your performance? Explain how.
No.

Has your ultra-running / racing pack ever enhanced your performance? Explain how.
No.

How do you prefer to carry your water/electrolyte drinks? Provide location on body, size of containers, number of containers.
In the vest in a larger rear bladder, smaller.500ml flasks to 150 mL flasks

What kind of adjustments or alterations have you made to your ultra-running / racing pack to fit or function better?
N/A

Any additional comments about your pack for ultra-running / racing?

Pam Kennedy (#10)

pam@pamdjs.com
Sex: Female
Height: 5'7"
Bra Size: 34C

Do you think women need a specifically designed pack for ultra-running / racing? Why?
As long as it's something that's flexible across the chest.

What pack are you currently using for ultra-running / racing? Provide brand + model.
Salomon Skin Advanced 12L

Does your ultra-running / racing pack chafe? Where?
Only the dump pouch that is attached to the vest when I wear a tank, under my arm, I'm going to cut it out.

Have you overheated during running while wearing your ultra-running pack?
No.

Does your pack carry and allow access to everything you need? Y/N. Explain how.
Y tons of pockets, good sizes and easy access.

Has your ultra-running / racing pack ever hindered your performance? Explain how.
Not the current one.

Has your ultra-running / racing pack ever enhanced your performance? Explain how.
Yes, having easy access to trek poles, Raidlight is a great vest for front stashing.

How do you prefer to carry your water/electrolyte drinks? Provide location on body, size of containers, number of containers.
Bladder in back and flasks in burrito pockets.

What kind of adjustments or alterations have you made to your ultra-running / racing pack to fit or function better?
See above, going to cut out the dump pouch.

Any additional comments about your pack for ultra-running / racing?
Most vests are really not trek pole friendly, I have no idea why companies can't make a pole friendly vest, Raidlight does the best job at this.

Marian Yasuda (#11)

mnyasuda@hawaii.rr.com
Sex: Female
Height: 5'0"
Bra Size: 34A

Do you think women need a specifically designed pack for ultra-running / racing? Why?
Torso length, location of sternum straps.

What pack are you currently using for ultra-running / racing? Provide brand + model.
Nathan Vapor Airess 7

Does your ultra-running / racing pack chafe? Where?
Yes, sometimes at the neck and sometimes at the lower back.

Have you overheated during running while wearing your ultra-running pack?
No.

Does your pack carry and allow access to everything you need? Y/N. Explain how.
I would prefer more up-front storage - particularly for phone, hydration flasks, and pills.

Has your ultra-running / racing pack ever hindered your performance? Explain how.
No.

Has your ultra-running / racing pack ever enhanced your performance? Explain how.
Yes, easy access to frequently needed items has been helpful.

How do you prefer to carry your water/electrolyte drinks? Provide location on body, size of containers, number of containers.
70 oz bladder (with hose) and 750 ml soft flask up front.

What kind of adjustments or alterations have you made to your ultra-running / racing pack to fit or function better?
Added elastic ties and carabiners to the back for jacket, poles, and additional bag for food for unsupported efforts.

Any additional comments about your pack for ultra-running / racing?
There always seem to be improvements - the lighter weight with more storage is always better.

Myles Thompson (#12)

Sex: Male
Height: 6'3"
Bra Size: N/A

Do you think women need a specifically designed pack for ultra-running / racing? Why?
Yes, different shoulders plus boobs.

What pack are you currently using for ultra-running / racing? Provide brand + model.
Nathan…

Does your ultra-running / racing pack chafe? Where?
No.

Have you overheated during running while wearing your ultra-running pack?
No.

Does your pack carry and allow access to everything you need? Y/N. Explain how.
Yes, access to phone and quick snacks near shoulder. No, doesn't hold more than a half-day worth of equipment/clothing.

Has your ultra-running / racing pack ever hindered your performance? Explain how.
No.

Has your ultra-running / racing pack ever enhanced your performance? Explain how.
Yes, easy access to water and fuel.

How do you prefer to carry your water/electrolyte drinks? Provide location on body, size of containers, number of containers.
2L bladder in pack.

What kind of adjustments or alterations have you made to your ultra-running / racing pack to fit or function better?
None.

Any additional comments about your pack for ultra-running / racing?

Peter Courogen (#13)

p**gen@gmail.com
Sex: Male
Height: 5'11"
Bra Size: N/A

Do you think women need a specifically designed pack for ultra-running / racing? Why?
Yes, as needs differ depending on morphology, kinematics, and biomechanics.

What pack are you currently using for ultra-running / racing? Provide brand + model.
Ultimate Direction, models fastpack and vest.

Does your ultra-running / racing pack chafe? Where?
Under my arms, and lower back.

Have you overheated during running while wearing your ultra-running pack?
Yes.

Does your pack carry and allow access to everything you need? Y/N. Explain how.
Yes, but hard to reach some pockets when wearing it.

Has your ultra-running / racing pack ever hindered your performance? Explain how.
Yes, by chafing me and needing to stop to address with anti-chafing cream, or resolve with adding a protective layer. Also, when needing to stop to access pockets I can't reach, especially when fatigued.

Has your ultra-running / racing pack ever enhanced your performance? Explain how.
Yes, by allowing me to carry all my needs throughout the distance. I wouldn't be able to go the distance without.

How do you prefer to carry your water/electrolyte drinks? Provide location on body, size of containers, number of containers.
On my front. Soft bottles that are easy to access, refill on the go, or carry in my hands for added cooling when filled with ice and fluids.

What kind of adjustments or alterations have you made to your ultra-running / racing pack to fit or function better?
None.

Any additional comments about your pack for ultra-running / racing?

Sophia Thompson (#14)

sophsthompson@gmail.com

Sex: Female
Height: 5'7"
Bra Size: 34DDD

Do you think women need a specifically designed pack for ultra-running / racing? Why?
Yes, chest dimensions and anatomy between males and females doesn't allow for a "one-size fits all" option.

What pack are you currently using for ultra-running / racing? Provide brand + model.
Nathan…

Does your ultra-running / racing pack chafe? Where?
Yes, under arms, front and back.

Have you overheated during running while wearing your ultra-running pack?
Yes.

Does your pack carry and allow access to everything you need? Y/N. Explain how.
Yes, but a little more convenient pockets on the front would be helpful (rather than one or two big pouches where everything gets shoved).

Has your ultra-running / racing pack ever hindered your performance? Explain how.
No.

Has your ultra-running / racing pack ever enhanced your performance? Explain how.
No.

How do you prefer to carry your water/electrolyte drinks? Provide location on body, size of containers, number of containers.
Bladder in the back of the pack – 1.5L

What kind of adjustments or alterations have you made to your ultra-running / racing pack to fit or function better?
Usually with wear. I have to tape the strap adjustments in place because the fasteners or Velcro wears out.

Any additional comments about your pack for ultra-running / racing?
None.

Kristina (#15)

kristinakurcinka@gmail.com
Sex: Female
Height: 5'10"
Bra Size: 36C

Do you think women need a specifically designed pack for ultra-running / racing? Why?
Big chested women yes, smaller chested women not as much.

What pack are you currently using for ultra-running / racing? Provide brand + model.
Salomon Vest 12L

Does your ultra-running / racing pack chafe? Where?
Not yet, first one not to!!

Have you overheated during running while wearing your ultra-running pack?
No.

Does your pack carry and allow access to everything you need? Y/N. Explain how.
Yeah, I've used packs in the past and the vest is so much better! Keeps everything close to the body.

Has your ultra-running / racing pack ever hindered your performance? Explain how.
Yes, with a pack that moves around on your back a lot when filled to the max.

Has your ultra-running / racing pack ever enhanced your performance? Explain how.
The vest does because it allows for water and nutrition to be right next to your mouth.

How do you prefer to carry your water/electrolyte drinks? Provide location on body, size of containers, number of containers.
2x 1L soft collapsible bottles on chest

What kind of adjustments or alterations have you made to your ultra-running / racing pack to fit or function better?
None.

Any additional comments about your pack for ultra-running / racing?
For me personally zippers on the chest to hold valuables and then being able to keep water and nutrition very close on the chest or hip is key for me.

Heather (#16)

Heather.laptalo@gmail.com
Sex: Female
Height: 5'3"
Bra Size: 32B

Do you think women need a specifically designed pack for ultra-running / racing? Why?
Y – when racing you can carry less because there are aid stations. Less to carry = smaller pack. When just out for an ultra-run that's self-supported, you need a larger pack to carry more.

What pack are you currently using for ultra-running / racing? Provide brand + model.
Ultimate Direction, multiple models.

Does your ultra-running / racing pack chafe? Where?
Only when I'm running without a shirt or with an open back shirt… my whole back has gotten marked up with chafe spots.

Have you overheated during running while wearing your ultra-running pack?
No.

Does your pack carry and allow access to everything you need? Y/N. Explain how.
Yes.

Has your ultra-running / racing pack ever hindered your performance? Explain how.
No.

Has your ultra-running / racing pack ever enhanced your performance? Explain how.
Y – it holds what I need to stay fueled.

How do you prefer to carry your water/electrolyte drinks? Provide location on body, size of containers, number of containers.
Bladder in the back for long unsupported days and small chest bottles for short or supported runs.

What kind of adjustments or alterations have you made to your ultra-running / racing pack to fit or function better?
None.

Any additional comments about your pack for ultra-running / racing?
None.

Jack Marshall (#17)

marshalljack7@gmail.com
Sex: Male
Height: 6'10"
Bra Size: N/A

Do you think women need a specifically designed pack for ultra-running / racing? Why?
Yes, I would assume so. The female and male anatomy are different enough that having anatomy-specific gear seems beneficial.

What pack are you currently using for ultra-running / racing? Provide brand + model.
CamelBak Mule (not ultra-running specific)

Does your ultra-running / racing pack chafe? Where?
No. However I have not done extensive ultra-running in the CamelBak Mule.

Have you overheated during running while wearing your ultra-running pack?
No.

Does your pack carry and allow access to everything you need? Y/N. Explain how.
No. It does not have a good place to store trekking poles. It has one main compartment, so it is difficult to access items at the bottom of the pack.

Has your ultra-running / racing pack ever hindered your performance? Explain how.
Yes. It is generally bulky and annoying to wear, and retrieving items can be time-consuming.

Has your ultra-running / racing pack ever enhanced your performance? Explain how.
Yes. It has capacity for a large 3L water bladder, which has kept me hydrated.

How do you prefer to carry your water/electrolyte drinks? Provide location on body, size of containers, number of containers.
I prefer a bladder on my back. I prefer a larger (3L) bladder which I have the option to only partially fill if 3L is not needed.

What kind of adjustments or alterations have you made to your ultra-running / racing pack to fit or function better?
I have only made adjustments to the strap lengths to ensure a tight fit, and to ensure the waist belt sits at the top of my hip bones.

Any additional comments about your pack for ultra-running / racing?
I am due for a new pack, so I will be reaching out for a recommendation 😊

Denise Bourassa (#18)

Denbou2@gmail.com
Sex: Female
Height: 5'1"
Bra Size: 32B

Do you think women need a specifically designed pack for ultra-running / racing? Why?
Yes – smaller frames = smaller packs. Our [females] waistline and torso are smaller and for some shorter. If a pack doesn't fit to your back/waist snuggly you will get more chaffing due to the bounce with the pack. The pack also needs to be shorter for the petite frames hitting mid back and not hitting the tops of you buttocks (causing chafe/rub spots). Our [females] shoulders are also narrower and so you need a pack narrower through the shoulder area, otherwise again you will have slippage of the pack off the shoulders and rub spots.

What pack are you currently using for ultra-running / racing? Provide brand + model.
Currently for my 100-mile mountain races I am using UltrAspire Zygos 4.0 small size. For the HURT100 I will be racing in the UltrAspire Basham vest. Previously I raced in the older UltrAspire vest the Spry (I will bring this vest also as it has a bladder versus a bottle). It is a small women-specific race vest and can be used when you have a race where you don't need mountain gear and you have plenty of aid stations.

Does your ultra-running / racing pack chafe? Where?
T 2 above packs fit my frame exceptionally well. Only time I have chafe spot is when I run shirtless, then I get a chafe spot where the pack moves against my rib cage and back. With fabric as a buffer it is not an issue.

Have you overheated during running while wearing your ultra-running pack?
No.

Does your pack carry and allow access to everything you need? Y/N. Explain how.
Yes, if my race/adventure requires me to carry more gear like poles, 2L fluid, calories, waterproof clothes, etc. I use the appropriate size pack (Zygos 4.0). This pack has front and side pockets for storage and easy access to calories, gloves or other smaller clothing items, and it can hold my Black Diamond Z poles. Of which I can access reaching behind my back to release without removing the pack.

Has your ultra-running / racing pack ever hindered your performance? Explain how.
No – I have become more experienced with what I need in a vest as well as how fitted vests can benefit me in terms of comfort. While uncomfortable I would not say the vest hindered my performance. I will send you a pic of one of my first ultra-races where you will clearly see how poorly a vest can fit 😊

Has your ultra-running / racing pack ever enhanced your performance? Explain how.
Yes, my first race overseas (Croatia 100) I went solo, no crew or support outside of aid stations. I used the Zygos for the first time. It fit like a glove all my required gear, fluid, and calories and I had a great race.

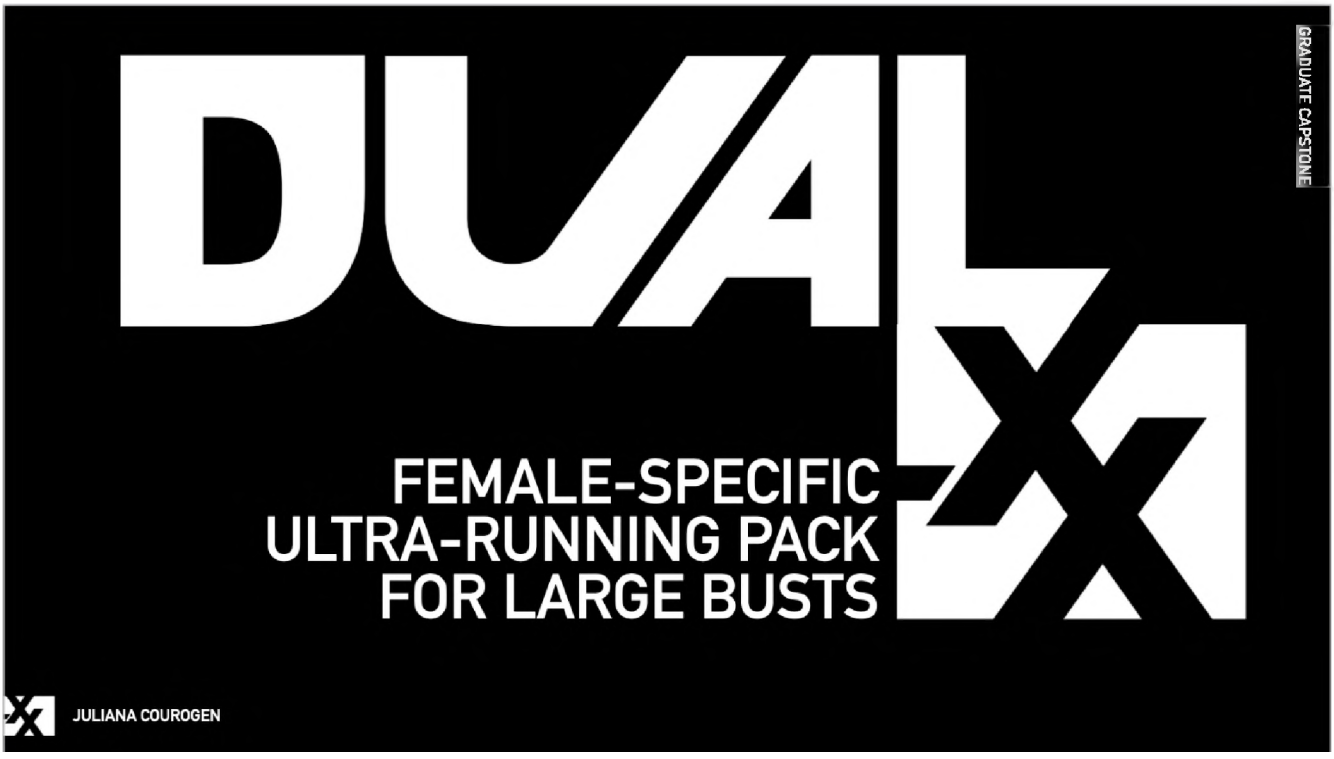
How do you prefer to carry your water/electrolyte drinks? Provide location on body, size of containers, number of containers.
Depends on the distance. My ideal is a single bottle 500mL or 1L bladder. My preference for both are at the small of my back versus the front of my pack.

What kind of adjustments or alterations have you made to your ultra-running / racing pack to fit or function better?
My previous favorite pack (the Spry) the company changed the design and size. I did send this one back to the company and they worked with me to have the vest sized to the Basham vest. Also, the company changed the sizing on the Zygos. I had a XS size of an older design and when they made some improvements on the vest I ordered the new version in XS. It was too small under my arms and so I ordered the SM, which was too big around my waist. So I took out my pocket sewing kit and made it a bit smaller at the waist to prevent it from chafing.

Any additional comments about your pack for ultra-running / racing?
Packs have come a long way since I began ultra-running. You are seeing more women-specific designs come out. North Face Howe Vest, UltrAspire Basham vest. Not that men can't wear them just as women can wear plenty of the designs not gender specific.

APPENDIX C: SLIDE DECK

Slides



JULIANA COUROGEN

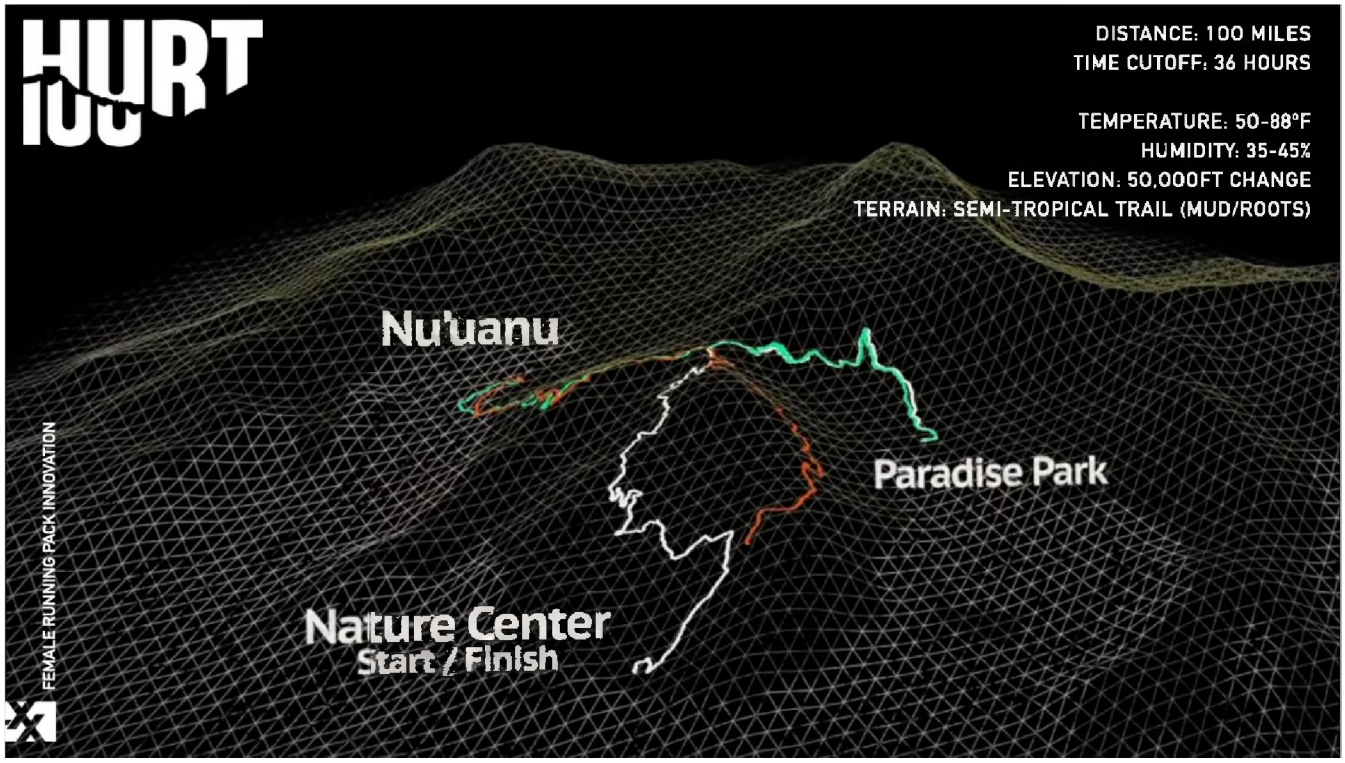
DESIGNER WITH A MAKER-MINDSET

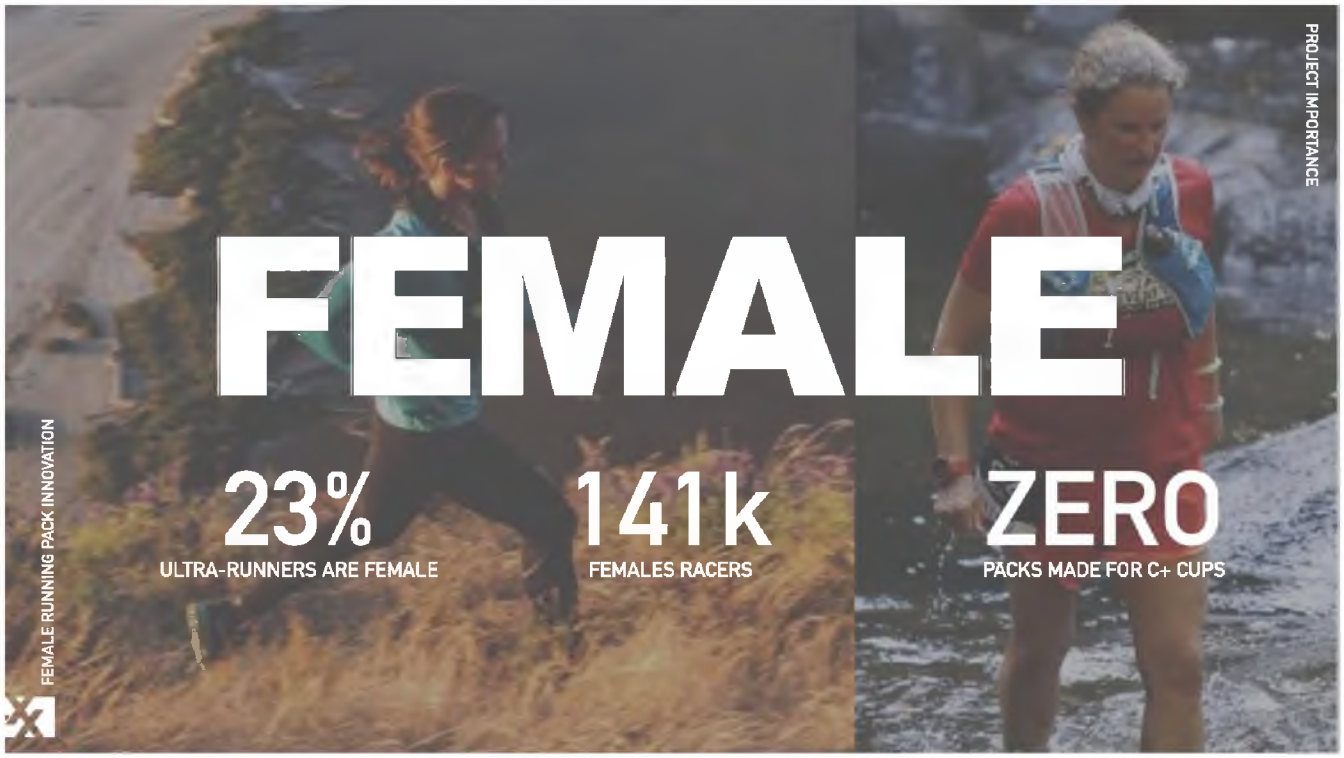
EMPOWER & INSPIRE ATHLETES OF DIVERSITY BY DESIGNING BODY-SPECIFIC APPAREL & EQUIPMENT ROOTED IN SCIENCE.

FEMALE RUNNING PACK INNOVATION

HOW COULD WE DESIGN AN ULTRA-RUNNING HYDRATION PACK FOR FEMALES WITH C+ CUPS TO PROMOTE SUPPORTIVE FIT, ACCESSIBLE STORAGE, & SWEAT MANAGEMENT WHILE RACING.


HURT 100 RACE
WE WOULDN'T WANT IT TO BE EASY
WHAT IS ULTRA-RUNNING?
running any consecutive distance further than the marathon (26.2 miles)
FEMALE RUNNING PACK INNOVATION


HURT 100
DISTANCE: 100 MILES
TIME CUTOFF: 36 HOURS
TEMPERATURE: 50-88°F
HUMIDITY: 35-45%
ELEVATION: 50,000FT CHANGE
TERRAIN: SEMI-TROPICAL TRAIL (MUD/ROOTS)
Nu'uanu
Paradise Park
Nature Center
Start / Finish
FEMALE RUNNING PACK INNOVATION


PROJECT IMPORTANCE
FEMALE
23%
ULTRA-RUNNERS ARE FEMALE
141k
FEMALES RACERS
ZERO
PACKS MADE FOR C+ CUPS
FEMALE RUNNING PACK INNOVATION

FEMALE RUNNING PACK INNOVATION

ZERO

EXISTING ULTRA-RUNNING PACKS FOR FEMALES WITH C+ CUP SIZES

140,552

FEMALE ULTRA-RUNNERS IN 2018

SINCE 1996, ULTRA-RUNNING INCREASED IN POPULARITY BY

1676%

1 IN 4

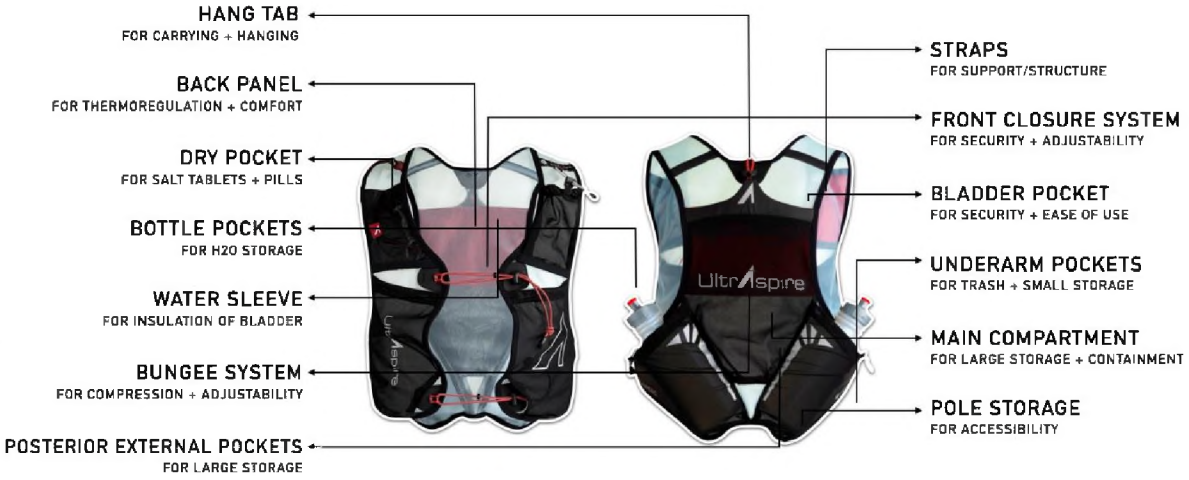
ULTRA-FINISHERS ARE FEMALES

0.6%

FEMALES ARE FASTER THAN MALES IN RACES > 195 MILES

NEW PRODUCT NEED

FEMALE RUNNING PACK INNOVATION



FEMALE RUNNING PACK INNOVATION

CHALLENGES

FEMALE RUNNING PACK INNOVATION

ATHLETE

ATHLETE

AGE: 20-60
BODY TYPE: C-DD CUPS
PHYSICAL CONDITION: ENDURANCE RUNNER
MILES RANGE: 5-100 MILES

FUEL FLUID FRICTION FORM (POSTURE) FATIGUE

PRE-RACE

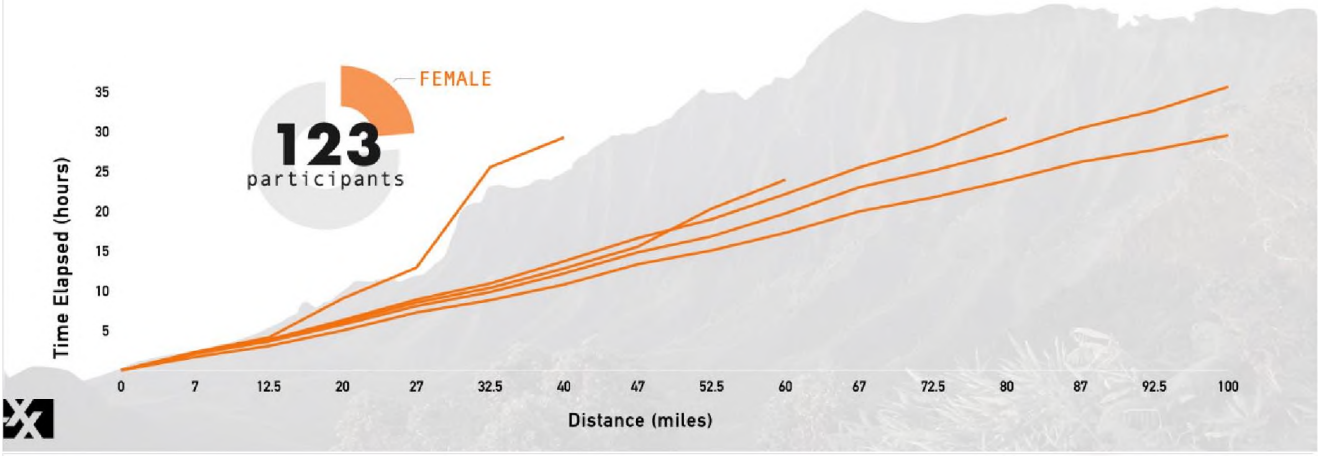
PREPARATION INCLUDES TRAINING, PACKING, AND WARM-UP

AID STATIONS

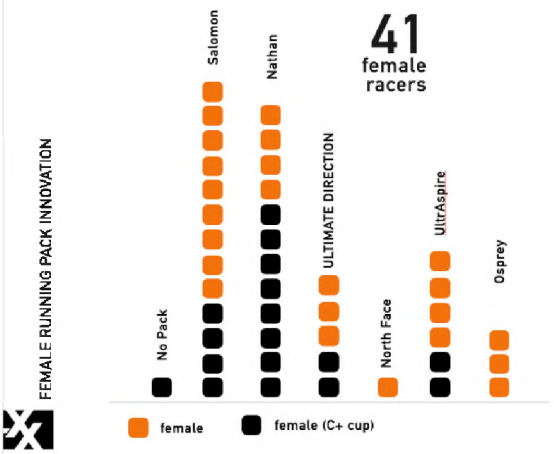
ATHLETES REPLENISH FLUIDS + FUEL AND CHANGE CLOTHES/SHOES.

ELEMENTS / TERRAIN

PERFORM ACTIONS RANGING FROM RUNNING TO CLIMBING.



1/3 of athletes surveyed report overheating wearing their current packs



do females need a specifically designed pack? **100% yes**

FEMALE RUNNING PACK INNOVATION

ULTRASPIRE MOMENTUM 2.0

CORD CLOSURE FOR ADJUSTMENT / EXPANSION

S-CURVED STRAP FOR FIT OVER BUST

REAR BOTTLE POCKETS FOR ACCESS / STORAGE

$90 USD
UNISEX / MEDIUM
PACK WEIGHT: 8.4 OZ
STORAGE CAPACITY: 6L
MATERIAL: NYLON / POLYESTER
BLADDER: NOT COMPATIBLE

ULTRASPIRE ALPHA 4.0

ANGLED NECK STRAP FOR FEMALE FIT

REMOVABLE INSULATING LAYER FOR THERMOREGULATION

HONEY-COMB MESH FOR HEAT & MOISTURE MANAGEMENT

ACCESSIBLE POCKETS FOR EASE OF USE / STORAGE

$120 USD
UNISEX / MEDIUM
PACK WEIGHT: 9.8 OZ
STORAGE CAPACITY: 6L
MATERIAL: 30D NYLON / POLYESTER / MESH
BLADDER: 2L

NATHAN VAPORAIR

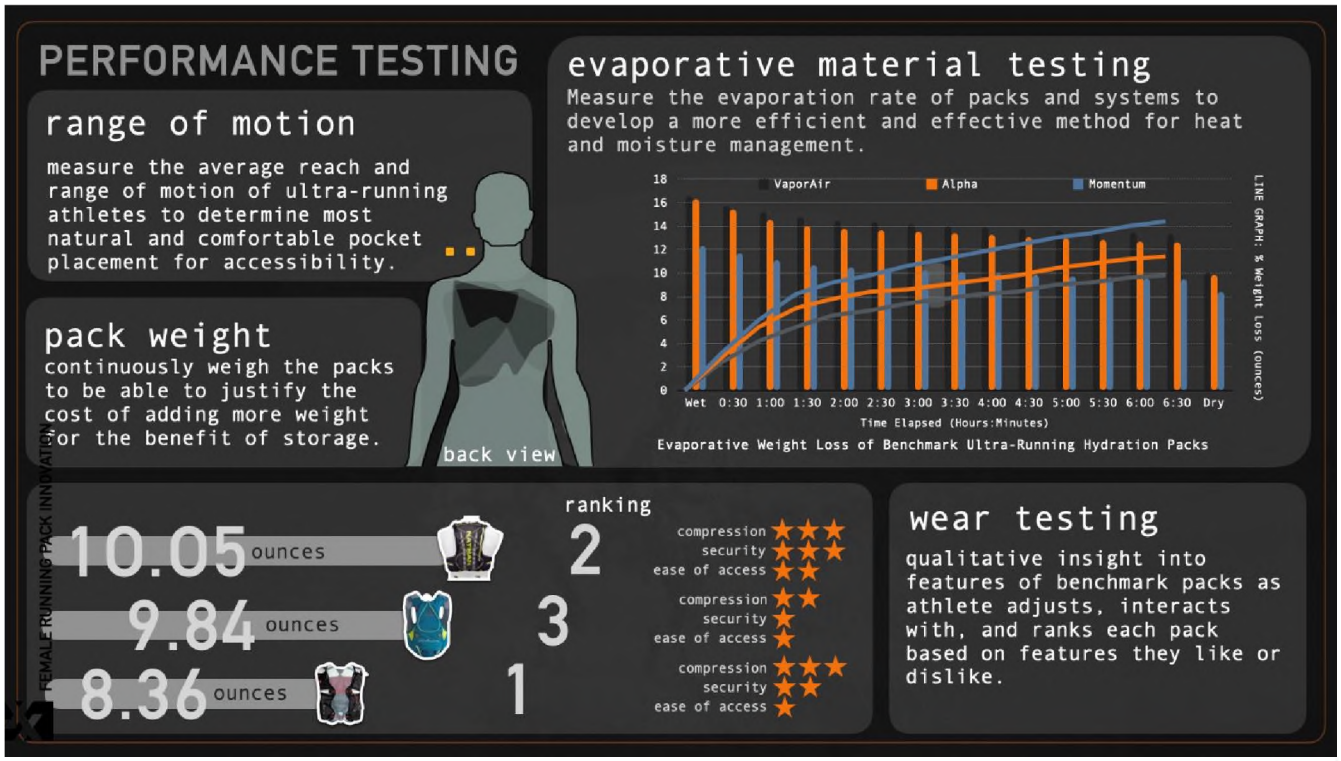
LOAD LIFTER TECHNOLOGY FOR WEIGHT DISTRIBUTION

ADAPTIVEFIT® SIZING SYSTEM FOR FIT / COMFORT

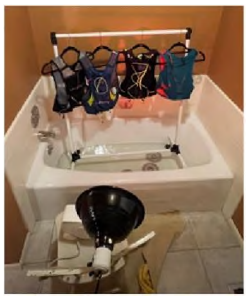
CINCH TECHNOLOGY FOR ADJUSTABLE COMPRESSION

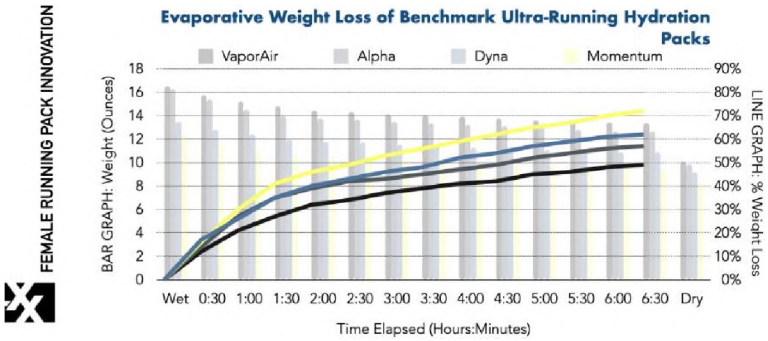
22 OZ SOFT FLASK POCKETS FOR MAXIMAL CAPACITY

$142 USD
MEN'S / SMALL / MEDIUM
PACK WEIGHT: 14 OZ
STORAGE CAPACITY: 7L
MATERIAL: 60% NYLON / 40% POLYESTER
BLADDER: 2L QUICK RELEASE



EVAPORATIVE WEIGHT LOSS TEST





Collect Data

PREPARE PACKS

- Prepare each pack the same, empty of all equipment.
- Submerge all packs in water for 10 minutes.
- Wring out packs evenly and leave to drip for 10 minutes.
- Prepare simulation room to be 75% humidity and 75 degrees Fahrenheit.

MATERIAL TESTING PACKS

- Hang the packs on a rack in front of the heat source.
- Every 7.5 minutes, rotate pack location and position.

Report Data

RECORD WEIGHT IN SPREADSHEETS

- Weigh packs every 30 minutes for 6.5 hours.

Translating Data into Design

QUANTITATIVE DATA IN DESIGN

- Use the data collected to design a lighter and more ventilated pack capable of thermoregulation of the athlete through heat dissipation via evaporation.

strengths

- s-curved straps / angled neck for ERGONOMICS
- full chest coverage for STORAGE
- triangular strap closure for even COMPRESSION
- rear bungee system for SECURITY
- large front & rear-facing bottle pockets
- lightweight mesh + honeycomb wicking

weaknesses

- dense materials add weight
- water-proof materials trap moisture & heat
- bungee closure gets tangled
- underarm silhouette chafes too high
- no bladder or bladder tube not secure
- annoying to wash with cords & toggles
- not designed for females with large busts

opportunity

- lightweight & breathable materials
- create moisture-wicking system back panel
- design for large busts & female anatomy
- design way to easily launder
- account for adjustable compression
- add more pockets
- use body-mapping to determine strap shape

threats

- balancing sacrifice of weight for storage
- mesh needs soft touch & hydrophobic
- moisture gets caught against skin
- water-repellant pack, breathable next to skin

Additional Pockets

How could we design the optimum number of additional pockets for trash dumping, clothing layer storage, waterproof pocket to be accessible and avoid interfering with arm swing or user movements while being easily accessible.

Strap Pockets

How could we design at least 6 strap pockets to (1) hold soft flasks comfortably without pressuring the chest while staying secure and easy to refill and insert, and (2) store goo, gels, and bars securely with easy one-handed access while allowing access and flexible order of packing that doesn't interfere with arm swing.

Bladder System

How could we design for bladder compatibility that maximizes the benefits of carrying a bladder in the main compartment for either unique or universal bladders keeping in mind weight distribution and thermoregulation of user and water.

Main Compartment

How could we design a flexible but structured main compartment that opens to show a majority of needed gear without user struggling to close compartment while remaining water-resistant and not interfering with bungee technology.

Strap Structure

How could we facilitate heat dissipation and circumvent abrasion by adapting a soft, breathable, and absorbent fabric to be lightweight but minimize exposure to harmful UV rays while applying structural shaping to the shoulder straps.

Sternum Closure Structure

How could we (1) maximize structured fit and security by shaping shoulder straps and lower sternum straps to fluidly transition into underarm panels and (2) allow single-handed operation of closure system using buckles with adjustable heights for comfortable and distributed compression.

Strap Attachment + Elastic System

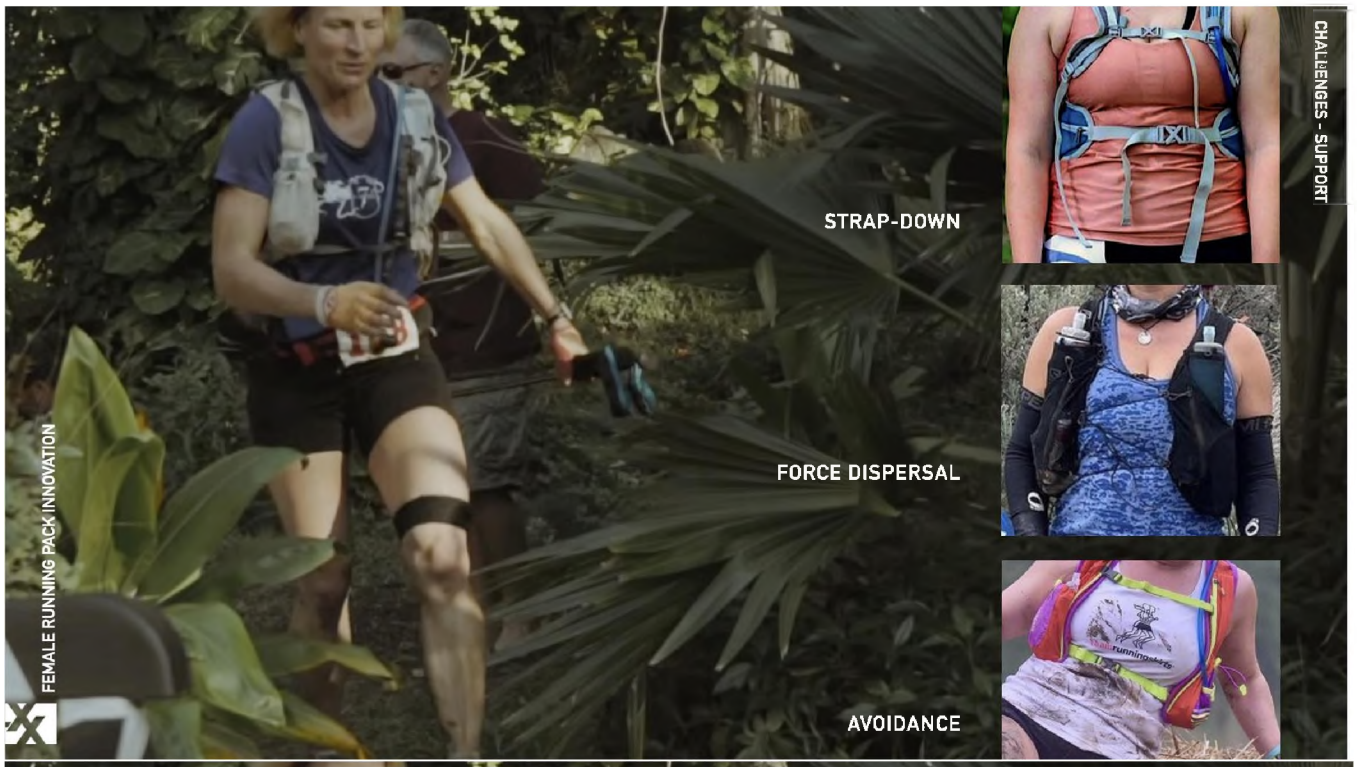
How could we use multiple bungee elastic anchors to apply primary tension from rear of pack to promote proper running posture and further adjustability to more users without interfering with comfort of back paneling and pocket space.

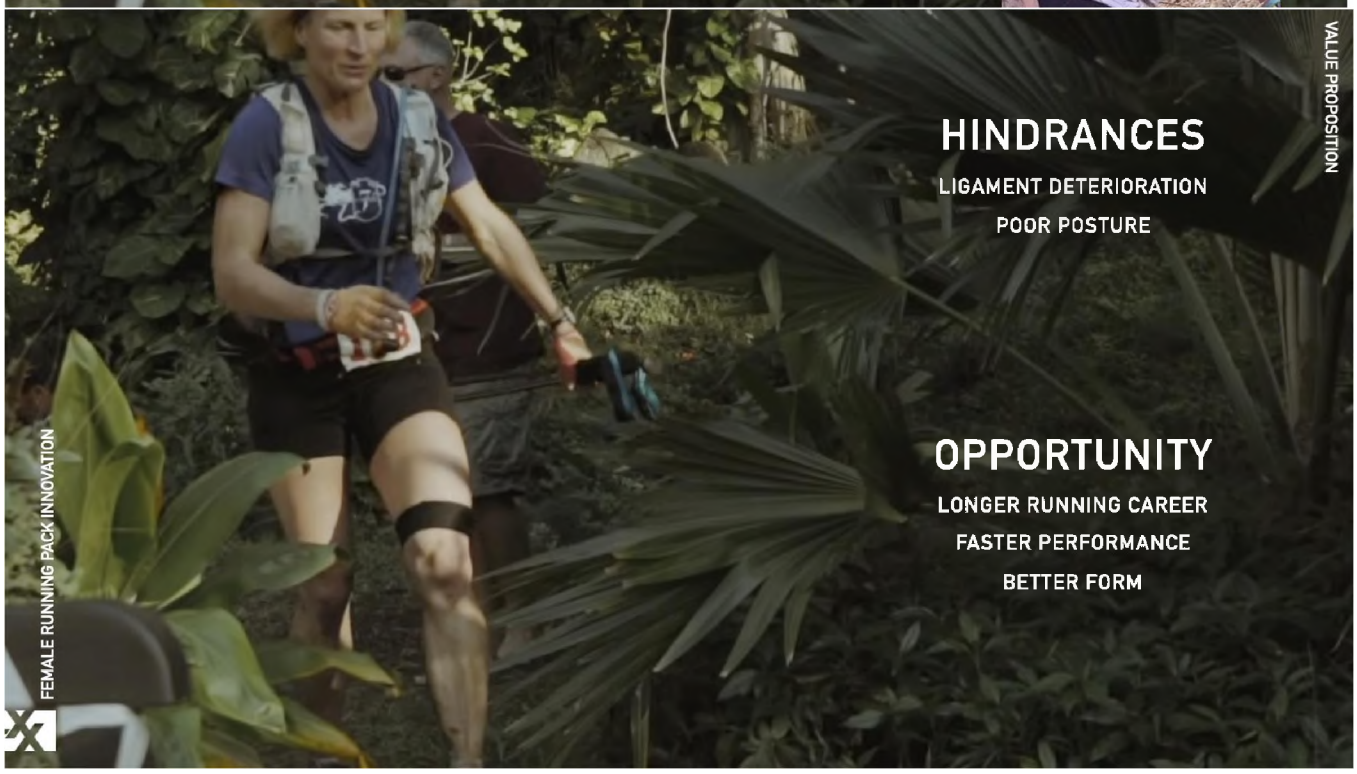
Back Panel

How could we incorporate tapered chimney-wicking heat dissipation method in the design of a maximal coverage back panel that's efficient in thermoregulation without warming the bladder water while also considering the pressure and coverage on the neck.

FIT + COMFORT	PACK WEIGHT
75%	<10 OUNCES
OF ATHLETES REPORT GREATER SUPPORT IN THE BUST	PACK WEIGHT VERSUS STORAGE CAPACITY

GEAR ACCESSIBILITY	COOLING + EVAPORATION
75%	10%
OF ATHLETES REPORT GREATER EASE OF ACCESS TO GEAR	FASTER EVAPORATION RATE COMPARED TO WEIGHT

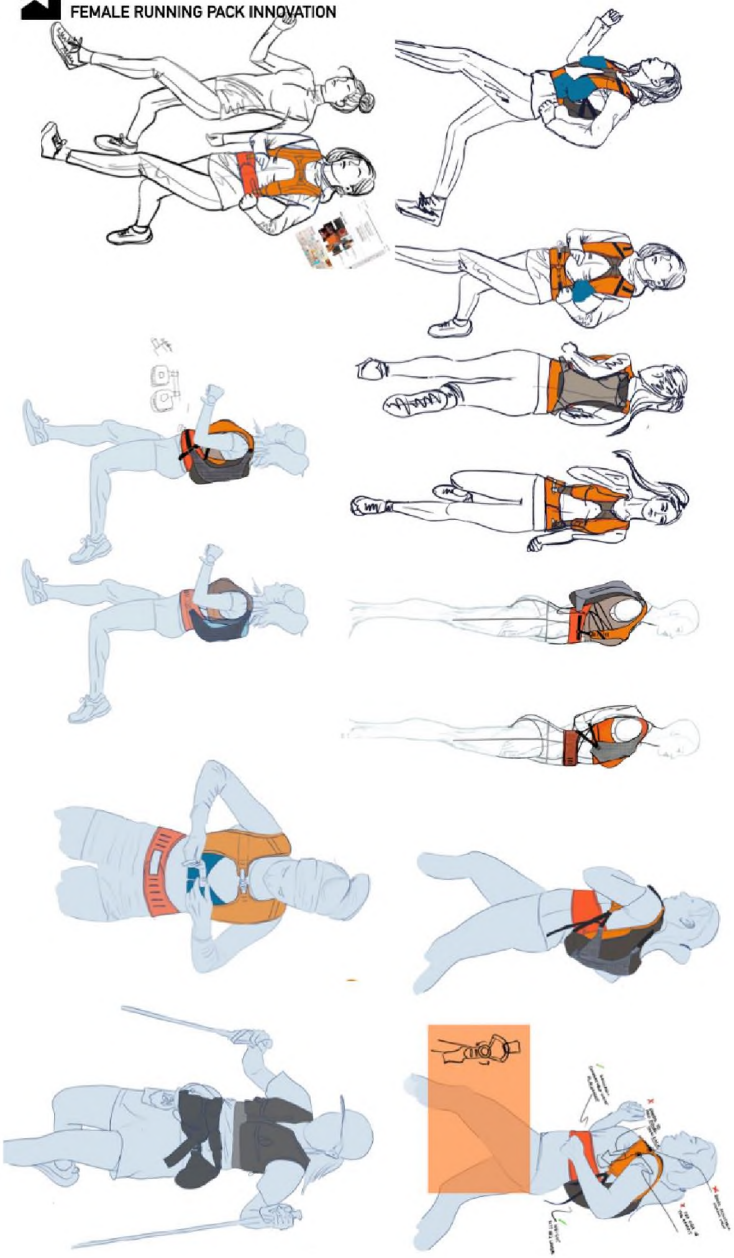

CHALLENGES - SUPPORT
STRAP-DOWN
FORCE DISPERSAL
AVOIDANCE
FEMALE RUNNING PACK INNOVATION


VALUE PROPOSITION
HINDRANCES
LIGAMENT DETERIORATION
POOR POSTURE
OPPORTUNITY
LONGER RUNNING CAREER
FASTER PERFORMANCE
BETTER FORM
FEMALE RUNNING PACK INNOVATION

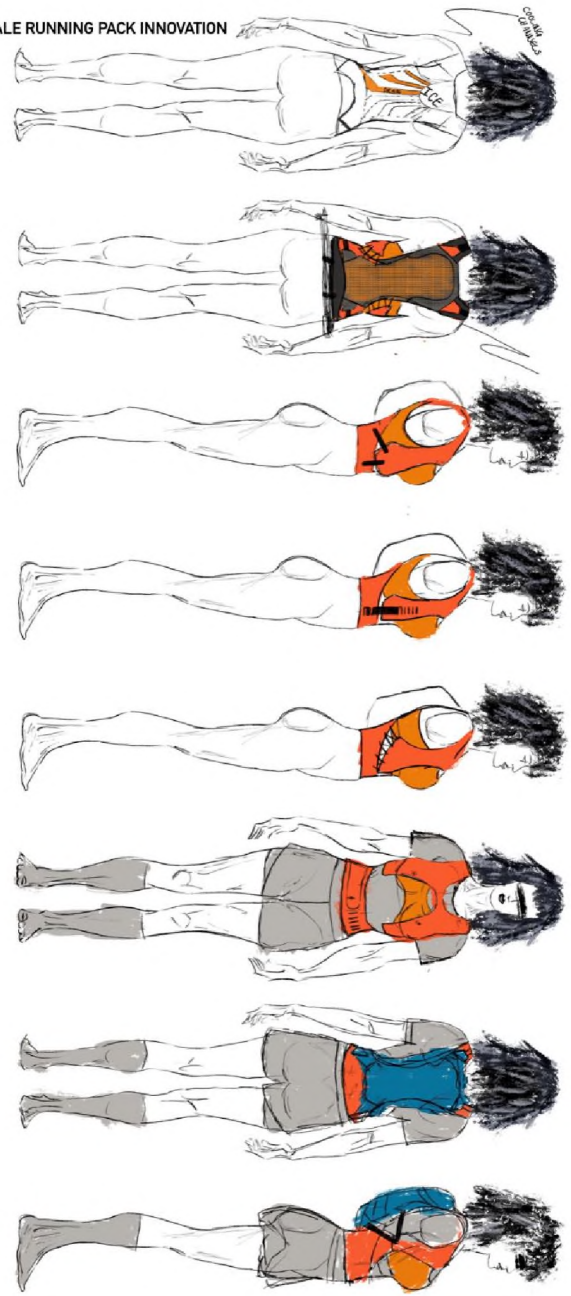

surface
PANIC
BLACK 6C
P45-8C
P116-16C
P24-8C
P45-8C
803 U
P115-8C


Fatigue is the thief of dexterity & coordination.
DO THE EASY THING FIRST
BENEFIT
SOUL
FEMALE RUNNING PACK INNOVATION

FEMALE RUNNING PACK INNOVATION

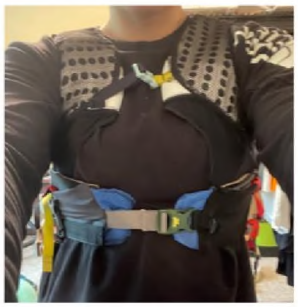


FEMALE RUNNING PACK INNOVATION



FEMALE RUNNING PACK INNOVATION

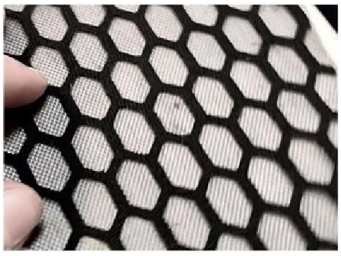





MATERIAL INNOVATION

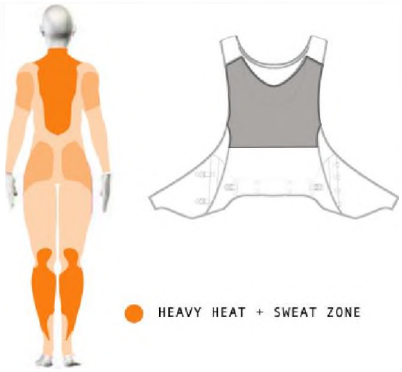
MATERIALS INSPIRATION

MATERIALS INNOVATION



BUILD

TEXTILE APPLICATION



MATERIAL GOALS

TOUCH-POINTS

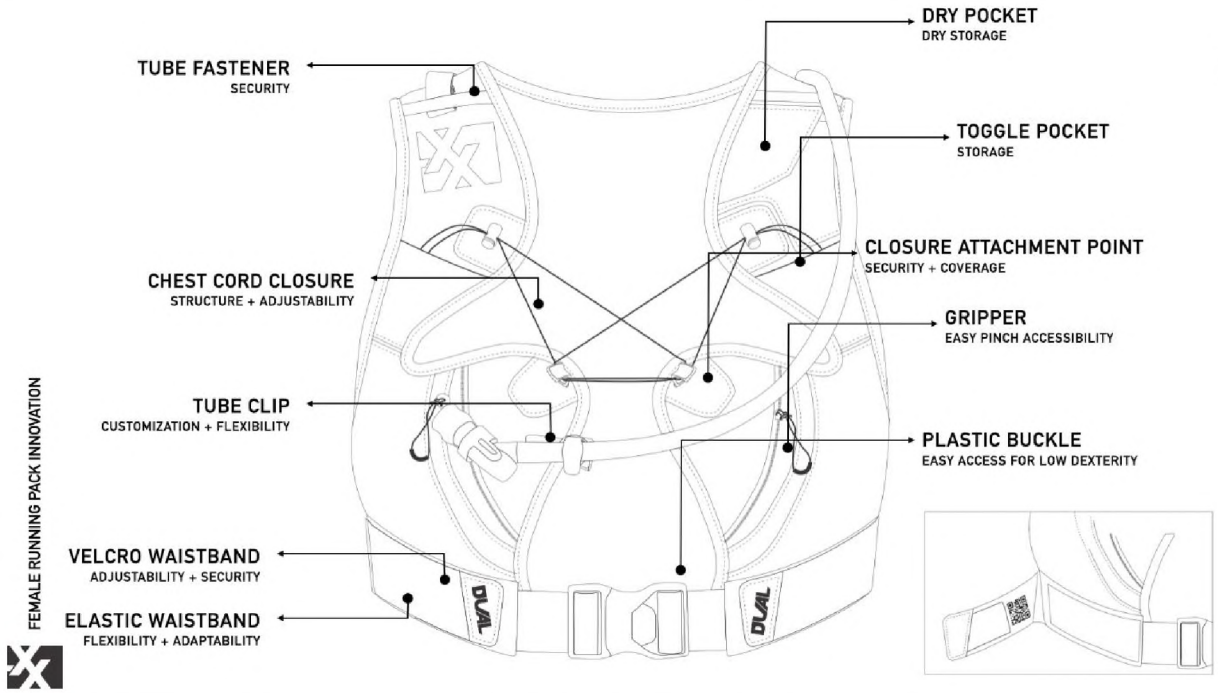
LIMIT THE AREA COMING IN CONTACT WITH THE SKIN.

CHANNELING

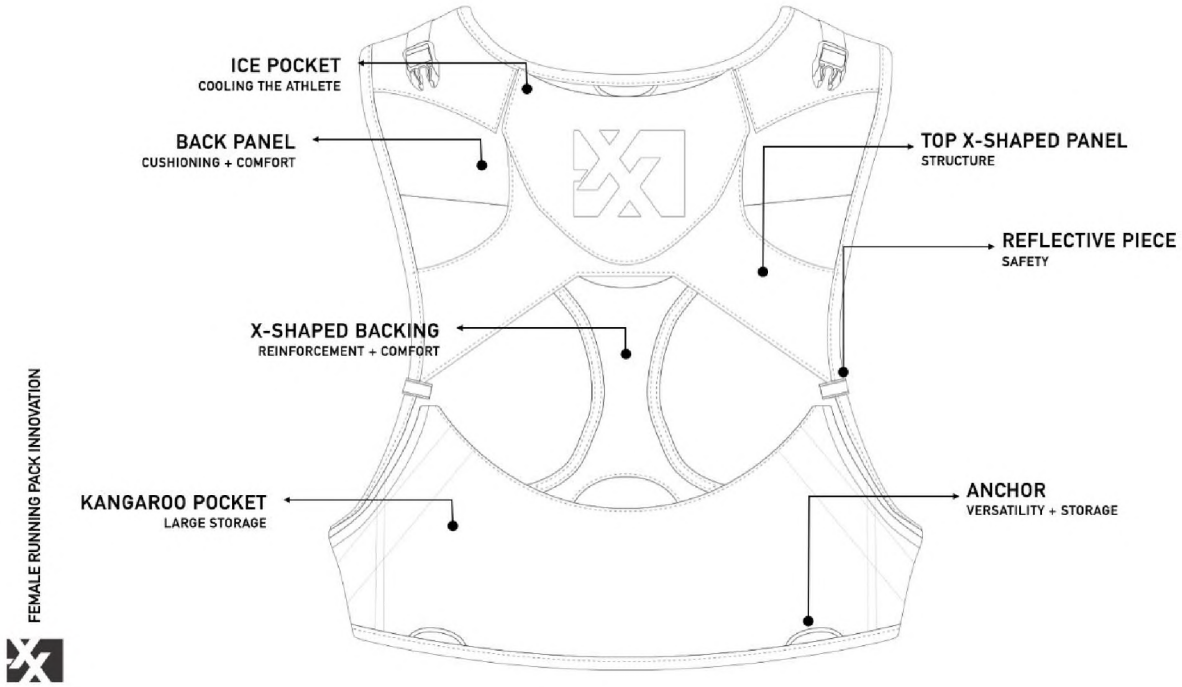
HONEY-COMB NETWORK TO SPREAD MOISTURE TO COVER A LARGER SURFACE AREA FOR FASTER EVAPORATION TO COOL THE ATHLETE.

DUAL-LAYER WICKING

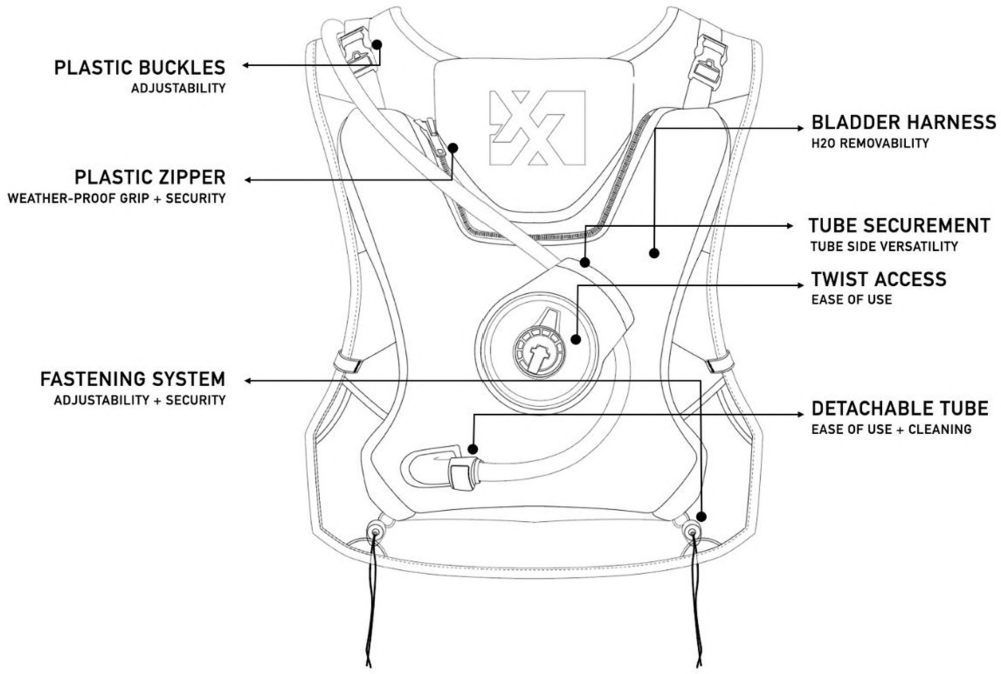
MINIMIZED TOUCH POINTS TO THE SKIN AND IMPROVED EVAPORATION RATE.



TECHPACKS



FEMALE RUNNING PACK INNOVATION

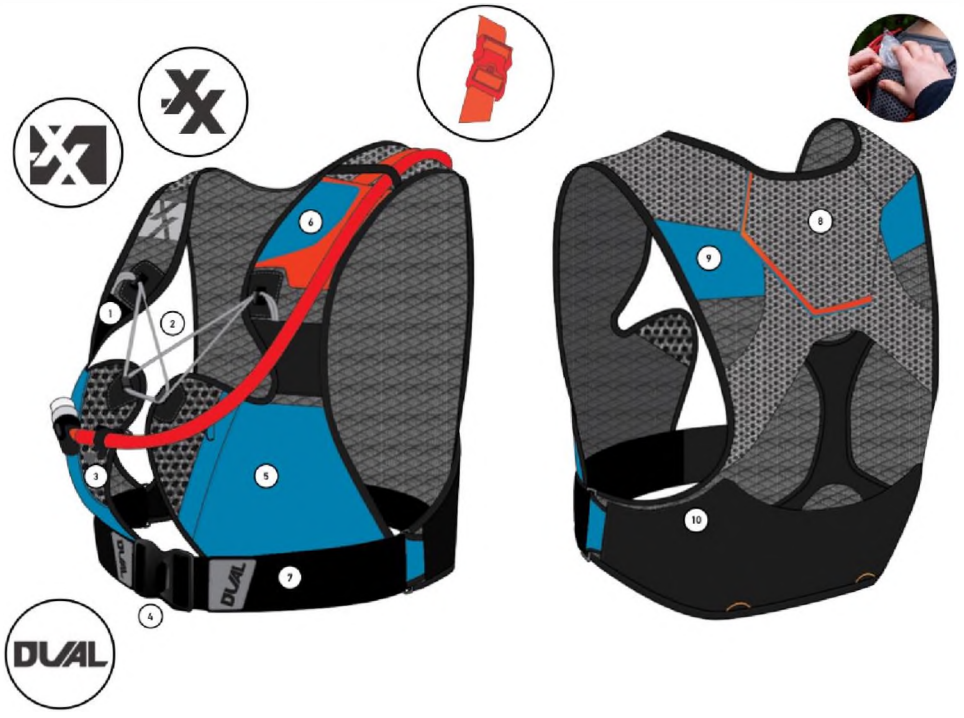


FEMALE RUNNING PACK INNOVATION

P45-8C | P116-16C | P24-8C | BLACK 6C

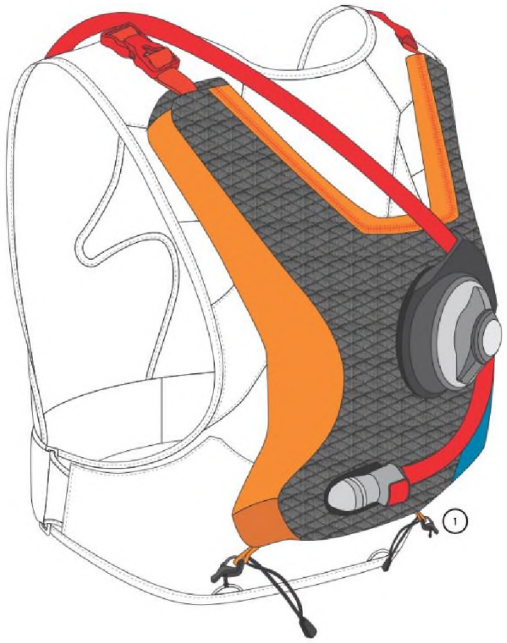
FEMALE RUNNING PACK INNOVATION

1. TOGGLE STORAGE
COMFORT + SECURITY
2. CORD CLOSURE
COMPRESSION + SUPPORT
3. WATER TUBE CLIP
COMFORT + SECURITY
4. SINGLE-HAND BUCKLE
LOW PROFILE + LOW DEXTERITY
5. SIDE POCKET
FUEL STORAGE
6. DRY POCKET
WEATHER-PROOF + SECURE
7. VELCRO SYSTEM
ADJUSTABILITY + COMPRESSION
8. THIN-LAYER POCKET
ICE + CLOTHING STORAGE
9. CLOSED-CELL FOAM
CUSHIONING + COMFORT
10. KANGAROO POCKET
STORAGE + SECURITY



FEMALE RUNNING PACK INNOVATION

① PLASTIC LOOP FASTENER
SECURE BLADDER + ADAPTABILITY



FRONT VIEW

POWER MESH
84% nylon / 16% spandex, woven
4-way stretch + compression

WEBBING
nylon, flat woven
strength + durability

ELASTANE
polyurethane knit
compression

BEMIS ADHESIVE
polyurethane, non-woven
structure

RIPSTOP NYLON
Nylon, woven
structure

Textile layers #1
Woven or knit nylon layering
Breathability

Textile #2
Woven or knit polyester
Moisture wicking

ELASTIC CORD
rubber + polyester, braided
elasticity + strength

TRIM
polyester + nylon, knit
stretch

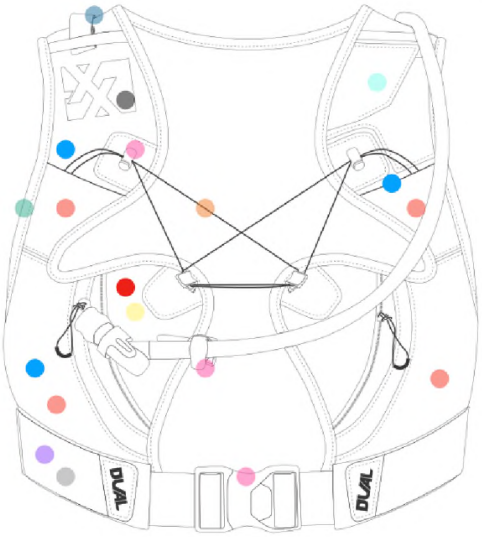
PLASTIC COMPONENTS
polyoxymethylene
strength + ease of use

VELCRO
polyamide, non-woven
closure

FOAM
Closed-cell, polyisocyanates + polyol
cushioning + breathability

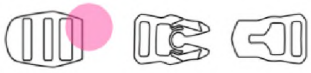
MESH
Nylon mesh woven, heat
Structure

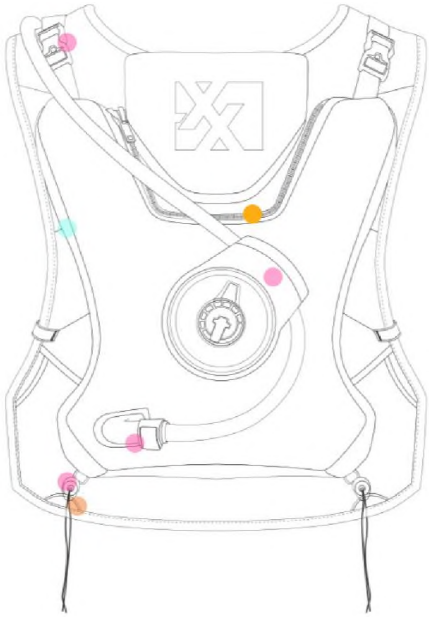
ZIPPER
polyoxymethylene
strength + ease of use



CONSTRUCTION METHODS

LASER PERFORATIONS	
SEWING	8 SPI SNTS + DNTS 8 SPI ZigZag stitch

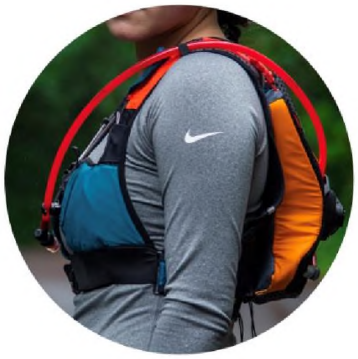




MATERIALS PALETTE

FEMALE RUNNING PACK INNOVATION

QUAD-PLANE
BUST SUPPORT



EQUILIBRIUM
ACCESSIBLE STORAGE

DRY-TEX
MOISTURE MANAGEMENT

QUAD PLANE

COMPRESSION IN 4 DIRECTIONS STEMMING FROM THE POSTERIOR TO ANTERIOR

PERFORMANCE GOAL

HOW COULD WE APPLY COMPRESSION TO PROVIDE SUPPORT UNDER THE BUST AND TENSION ALONG THE SAGITTAL PLANE WHILE ALLOWING ADJUSTABILITY.

TESTING METHOD

WEAR-TESTING - COLLECT VERBAL QUALITATIVE AND VISUAL FIT FEEDBACK.

EQUILIBRIUM

CIRCULAR SYSTEM DESIGNED TO USE THE WEIGHT OF THE BLADDER TO HOLD AND SUPPORT THE BUST.

PERFORMANCE GOAL

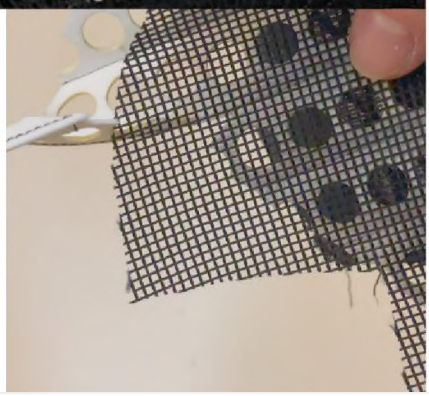
HOW COULD WE DESIGN POCKETS TO STORE GEAR WHILE ALLOWING ON-THE-GO ACCESSIBILITY + EVEN WEIGHT DISTRIBUTION.

TESTING METHOD

A SUCCESSFUL DESIGN FITS THESE ITEMS COMFORTABLY ALLOWING EASE OF ACCESS.

DRY-TEX

3-LAYER SYSTEM TO WICK MOISTURE AWAY FROM THE SKIN AND RELEASE MOISTURE VIA EVAPORATION + CONVECTION.

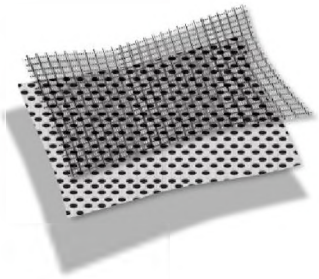


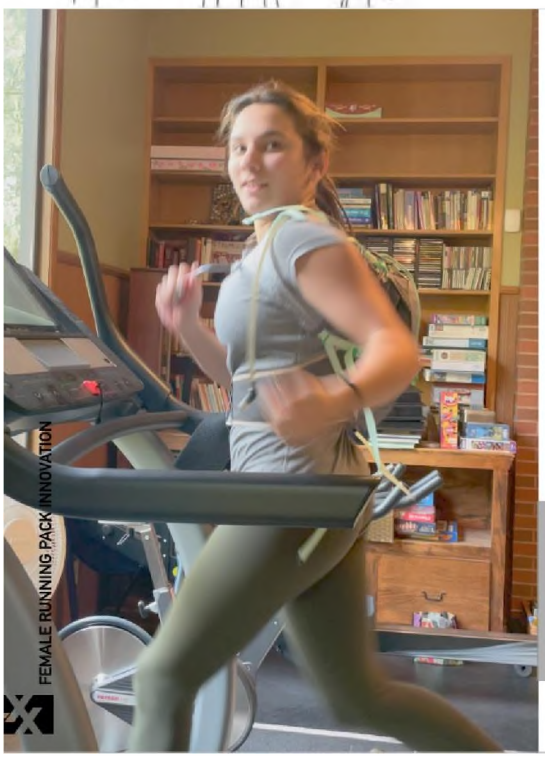
PERFORMANCE GOAL

HOW COULD WE COMBINE MATERIALS WITH UNIQUE PROPERTIES TO CREATE A NEW TEXTILE FOCUSED ON MOISTURE-WICKING AND HEAT MANAGEMENT.

TESTING METHOD

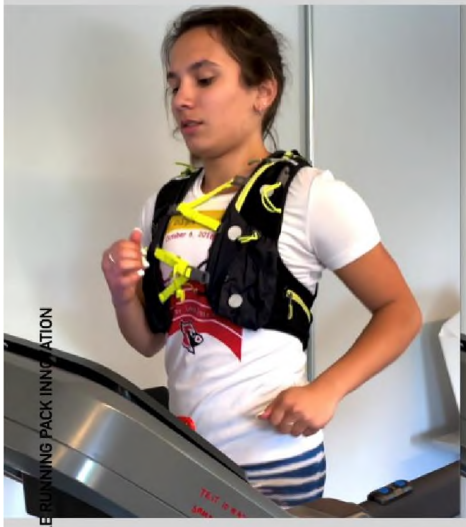
EVAPORATIVE TESTING - SIMULATE ENVIRONMENT (75% HUMIDITY/ 75°F) AND WEIGH MATERIAL EVERY 15 MINUTES
GREATER RATE OF EVAPORATION = > COOLING EFFICIENCY





FEMALE RUNNING PACK INNOVATION

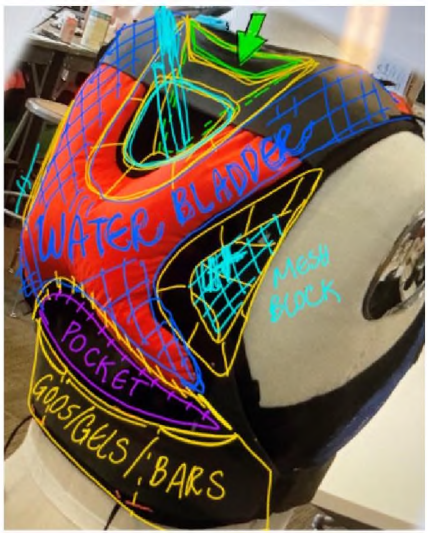
"I don't like how most packs squish your boob and mess up the natural shape of them. My sports bras are pretty supportive and I like a pack that lets the bra do its job."



"INCREDIBLY INNOVATIVE DESIGN TO SUPPORT THE UPPER THORACIC SPINE AND MINIMIZE BUST EXCURSION."

- KELLY CAMPBELL PT

"...SOME RIGIDITY TO THE BLADDER [AND BOTTLES] SO THAT IT'S NOT SO HARD TO PUT BACK IN... ESPECIALLY WHEN HALF FULL."


WATER BLADDER
MESH BACK
POCKET
GOOS/GELS/BARS

FEMALE RUNNING PACK INNOVATION

SUPPORTIVE FIT

HEAT MANAGEMENT

ACCESSIBLE STORAGE

EQUILIBRIUM

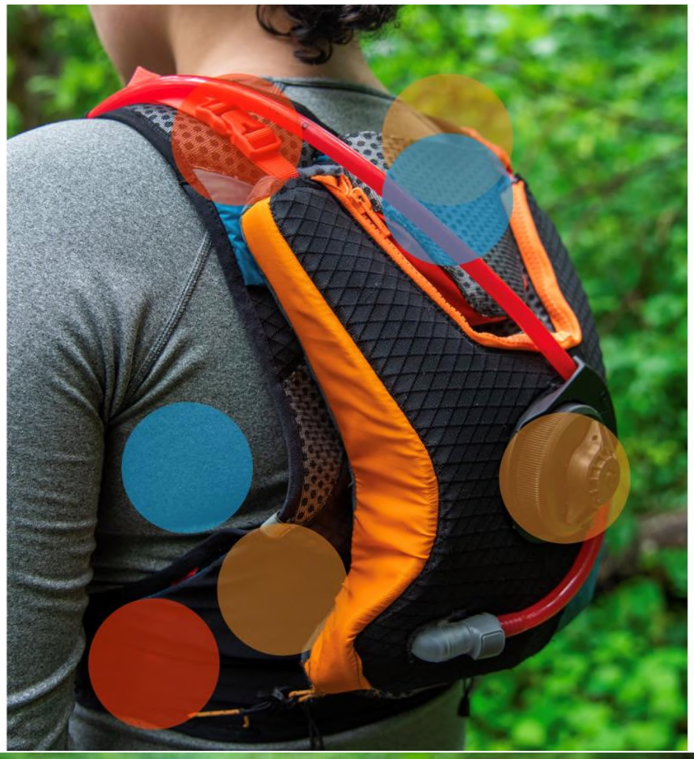
CLOSURE

FEMALE RUNNING PACK INNOVATION

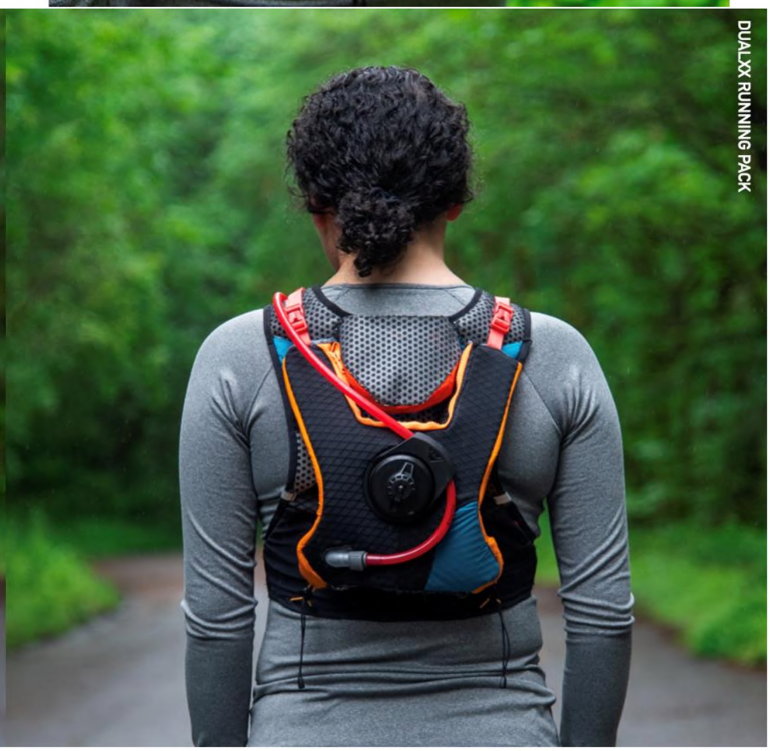
SUPPORTIVE FIT

HEAT MANAGEMENT

ACCESSIBLE STORAGE



FEMALE RUNNING PACK INNOVATION



DUALXX RUNNING PACK


BLADDER
FEMALE RUNNING PACK INNOVATION


BLADDER
FEMALE RUNNING PACK INNOVATION