SN0

SN0, A DRY SLOPE SNOWBOARDING APPAREL COLLECTION

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ABSTRACT

SPORTS PRODUCT DESIGN

SN0, A Dry Slope Snowboarding Apparel Collection

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Capstone under the direction of Dr. Susan Sokolowski

Dry slope sport facilities have been increasing in popularity since their invention in 1927. As climate change threatens to make snowfall more volatile and shorten ski seasons, skiers and snowboarders will look for alternative ways to practice their snow sports and resorts will look for additional off-season revenue. In this paper, the anticipated growth of dry slopes is founded on current evidence and plays an important role to facilitate the longevity and popularity of snow sport industry participation. In the face of climate change that will ultimately affect the amount of snow and the length of the snow sports season around the globe, dry slopes provide an opportunity for future popularity and participation in snow sport industries as dependability of snowfall becomes more uncertain. Dry slope expansion provides an entirely new segment category specifically in the snowboard apparel and equipment market.

This paper explores the current snowboard apparel and equipment market landscape with research in snowboarding sport history, biomechanics, and assessment of needs associated with the sport. In addition, the dry slope snowboard market demographic is explored and defined including material, color, and graphic trends.

This thesis capstone aims to develop a collection of apparel and accessories for dry slope snowboarding specifically for the resort off-season (spring, summer, and fall) at Japan's outdoor dry ski slopes 100 meters or greater in length. This capsule will be designed for launch in Spring/Summer 2035.

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SECTION I

SPORT OVERVIEW

The Dictionary Britannica defines snowboarding as a winter sport with roots in skiing, surfing, and skateboarding where the primary activity is riding down any snow-covered surface while standing on a snowboard with feet positioned roughly perpendicular to the board and its direction, further differentiating it from skiing, in which riders face forward (Bright, 2020). Snowboarding requires specific apparel, footwear, and equipment to stay protected and comfortable.

Note, the terms "snowboarders," "riders," and "snowboarding athletes" are frequently and interchangeably used throughout the following discussion. The interchangeable terms indicate the same population of athletes unless otherwise stated. The term "dry slope" will be used interchangeably with the terms "artificial slope" with or without "surface" and "synthetic slope" to describe a man-made slope surface.

DRY SLOPE SNOWBOARDING

Dry slope snowboarding can be considered a close relative of mountain snowboarding. The primary difference is the slope material, referred to as "synthetic slopes" or "artificial slopes" this man made is made from variety of synthetic materials into a matting surface. Dry slopes offer versatility with slope, stable at any temperature making it functional year round. Synthetic slopes can be utilized in virtually any location (indoors or outdoors)(Clayton, 2018) unlike its predecessor (mountain snowboarding) that requires a downhill snow-covered surface (Bright, 2020).

HISTORICAL REVIEW

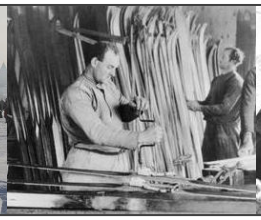
To provide an accurate historical review of dry slope snowboarding it is necessary to cover three separate snow sport historic timelines: the history of skiing, the history of snowboarding, and the history of dry ski slopes; each uniquely important contributors to the emergence of dry slope snowboarding (Sumedha, 2010).

History of Skiing

Skiing plays an important role in the evolution of snowboarding - this is the first time humans slid down snow with an apparatus on their feet and culminated in widespread resorts and popularity of snow sports for recreation. Skiing history dates back nearly 20,000 years. The earliest known record of ski fragments were discovered by archaeologist Grigoriy Burov in 1960, in Russia (approximately 1,200 km northwest of Moscow) and made from dense wood (Sumedha, 2010). They were used in 6000 BC by Cro-Magnon man (Figure 1) who utilized skis as a means of travel and survival to navigate icy tundras to hunt as a means for survival (Roland, 2000).

FIGURE 1-5

HISTORY OF SKIING

F. 1	*F. 2*	*F. 3*	*F. 4*	*F. 5*
				
8000 - 6000 BC. *The first community believed to have skied were the ancestors of the Sami, the only indigenous people to Scandinavia. (Free The Powder, 2020).*	**1700s** *Sometime in the 18th century skiing began its evolution as a recreational sport in the Telemark region of Norway (Free The Powder, 2020).*	**1800s** *The first ski made of hickory (imported at great expense from the United States) produced in Norway (Free The Powder, 2020).*	**1936** *The first chairlift created and installed in Sun Valley, Idaho, USA (Free The Powder, 2020).*	**1967** *The first World Cup of ski racing created by U.S. Ski Team Coach Bob Beattie, French Ski Team Coach Honore Bonnet, and French journalist Serge Lang (Free The Powder, 2020).*

The next evolution in skiing took place during the Norwegian and Swedish infantries out of military necessities in the 1760s (Figure 2). Training records provide detailed training exercises on challenging terrain while armed (History of Skiing, 2000). During the 1800's the first skis made from hickory were imported from the United States to Norway (Figure 3). It wasn't until the 1860s that the first ski race occurred in Oslo (Sumedha, 2010). Soon after in 1868, mountain resorts emerged to make access easier (History of Skiing, 2000). In 1880, Europe and Norway saw a shift in popularity from nordic skiing (cross-country skiing), to alpine skiing (downhill skiing) which offered the added thrill of downhill speed (Sumedha, 2010).

In 1924, the first Winter Olympics took place in Chamonix, France and Nordic skiing (also referred to as classic – cross country skiing) was introduced in Burgeoning (Sumedha, 2010). The popularity of alpine skiing (or downhill skiing) resulted from its debut in the 1936 Winter Games (Sumedha, 2010). This year proved eventful for the sport

with the introduction of the first ski book, "The Story of Modern Skiing," by author John Fry. He noted the first installation and use of a chairlift in Sun Valley (Figure 4), USA, the tipping point for mass popularity of skiing as a recreational sport (Sumedha, 2010).

Skiing's popularity continued to grow from 1955 to 1965 reflected by newly accessible slope access and the release of two new ski equipment inventions: the metal ski in the 1950s, and the plastic boot during the 1960s. In 1967 the first ski World Cup took place (Figure 5). The development of competition and recreation advancements in this snow sport continued through the 20th century. The popularity of snow sport recreation and wide availability of resort terrain left an industry primed for a new invention (Sumedha, 2010).

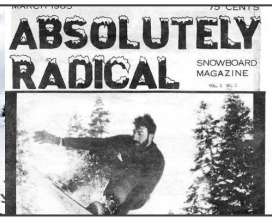
History of Snowboarding

The history of snowboarding is controversial, discrepancies are abundant and offer varying accounts of the origins of the sport (Bright, 2020). Skateboarding and surfing influenced the early styles and traditions in snowboarding and continue to influence overall snowboarding culture. The snow sport industry initially resisted acceptance of snowboarding as a valid competitor to skiing (Blomfield, 2010).

The precursor of the modern snowboard was developed by engineer Sherman Poppen in Muskegon, Michigan constructed as a toy for his daughters in 1965 (Figure 6). Poppen is widely acknowledged as the "father of the snowboard" and granted his invention the name "Snurfer" (Bright, 2020). Brunswick Corporation purchased the license and sold over one million Snurfers by the end of 1970 (Bright, 2020).

FIGURE 6-10

HISTORY OF SNOWBOARDING

F. 6	*F. 7*	*F. 8*	*F. 9*	*F. 10*
				
1965 *Sherman Poppen Invents the Snurfer (McArthur, 2010).*	**1969** *Dimitrije Milovich Drops Out of Cornell to Snowboard (McArthur, 2010).*	**1977** *Burton Snowboards was founded by Jake Burton (McArthur, 2010).*	**1985** *The first snowboard magazine ever published was Absolutely Radical (Klemen, 2020).*	**1998** *Snowboarding makes an auspicious debut at the Winter Olympics (Yang, 2018).*

The next decade brought in a new wave of innovation along with growing popularity for snowboarding. Surfer Dimitrije Milovich developed the next snowboard model in 1969 (Figure 7), working with surfboard maker Wayne Stovekin to develop the "Winterstick;" patented in 1971 (Bright, 2020). In 1975 Newsweek, Playboy, and Powder featured magazine articles surrounding the product and offered substantial exposure to the sport (Bright, 2020). In 1977 Jake Burton (Figure 8) launched a snowboard company in Londonderry, Vermont (Bright, 2020). Tom Sims and Chuck Barfoot launching the 'Skidboard" under their new company Sims (Bright, 2020). The first halfpipe debuted 1979 in Tahoe City. The first National Snowboarding Championship was held in 1982 in Woodstock, Vermont (Bright, 2020).

However, in the 1980s few ski resorts allowed snowboarders, reflecting the then widespread disdain that skiers exhibited toward the sport and its nonconformist reputation, based on its roots in the skateboarding community. Snowboard apparel was inspired by grunge and hip-hop and was far from the ski style aesthetic of the day (Bright, 2020) which only deepened the divide between skiers and the newcomers. The first snowboarding magazine debuted in 1985 (Figure 9): Absolutely Radical (later renamed International Snowboard Magazine) (The House, 2020).

During the 1990's snowboarding became the fastest growing winter sport with more than 6 million people participating. This trend of popularity continued ultimately resulting in the majority of ski resorts allowing access to snowboarders. Younger generations vastly preferred snowboarding over skiing (80% of youth who participated in a snow sport chose snowboarding) and played a critical role in growth of the snow sport industry (Bright, 2020). Snowboarding was finally recognized by the International Olympic Committee (IOC) in 1994 and debuted at the Winter Games in Nagano, Japan, in 1998 (Figure 10). The most recent advancement to the sport took place in 2014 when adaptive snowboarding (known as "para-snowboarding") debuted in the Paralympic Winter Games held in Sochi, Russia (Thorne, 2020).

History of Dry Slopes

Dry ski slope history began in 1927 that the first indoor ski hall opened (Secret Vienna, 2017). Developed by Norwegian skier and ski jumper Dagfin Carlsen who conceptualized the idea after witnessing a Berlin temporary exhibition ski hall (Figure 11). Constructed in an abandoned train station, Nordwestbahnhof, it provided ample

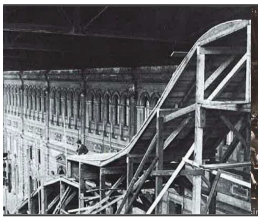
room for the ski slope, ski jump, sledding hill, and bleachers for onlookers. A series of unfortunate events and mounting criticism surrounding the fake snow used on the slope (an unknown chemical substance with a yellow tinge that caused severe skin irritation) hindered the popularity of Carlsen's ski hall. The snow substance was easily displaced leaving the underlying structure of mats and wood exposed, causing skiers to crash. The Schneepalast closed in May 1928 in considerable debt, but the idea of an artificial ski slope in Vienna did not die with it (Skiing inside of a train station, 2020).

Temporary dry slopes continue to emerge in the UK where the second dry slope appeared in 1935, inside the London department store Lillywhites (King, 2020). Various indoor and outdoor dry slopes emerged over the next century using a variety of different materials: pine needles and dirt in 1938 (Figure 12) opens in Hollywood, using a plastic over a matting (made from nylon parachutes) atop a base of cotton batting later patented as an "Artificial Skiing Mat" (King, 2020). In the 1950's Austrian Ski Instructor Herbert Neurauter set up weekly ski instruction in England using a portable dry slope using 'brush boards' (Figure 13) for demonstrating techniques (King, 2019). In 1961, a company called Dendix began manufacturing dry ski slope surfaces that are still seen on dry slopes today. In 1962 Ski Dek Corporation patented a moving belt dry ski slope. In 1963 the first permanent UK dry slope opened in Torquay (Figure 14) (King, 2020).

FIGURE 11-15

HISTORY OF DRY SLOPES

F.11



1927
Vienna's Schneepalast offers fake 'snow' on matting (King, 2019).

F.12

1938
250m Pine Needles on Sand Slope opens in France ((King, 2019).

F.13

1952
Herbert Neurauter teaches skiing on portable ski surface boards (King, 2019).

F.14

1963
First permanent UK dry slope opens in Torquay (King, 2019).

F.15

2017
"Copenhill" a dry ski slope atop Copenhagens waste management plant (Surfaces Reporter, 2020).

The next phase in dry slope history can be categorized by various attempts at building the longest dry slope in the world. The title was quickly passed from a 200 m slope, in Hillend, Scotland (1965), to Dieppe, France (1967).

Today, several locations are tied for the honor of longest slope with 1.1 km installations: Kagura, Japan; Kopaonik, Serbia; and Chechnya, Russia (King, 2020).

The last decade multiple new manufacturers of dry slopes have emerged including; Snow-flex, and Neveplast. The manufacturers main goal is to provide skiers with a man-made slope that offers a nearly identical experience to that of mountain skiing and snowboarding. The growth and expansion of dry slopes provides riders that cannot easily access or afford to travel to the geographically mountain locations a chance to experience downhill snow sports.

One of the most recent dry slopes, CopenHill opened in 2017 (Figure 15) sitting atop of the cleanest waste-to-energy power plant in the world. Its architectural design is a cultural landmark that uses the facade of the building to facilitate a cultural hub. Its roof is hike-able, the walls climbable, and the roof skiable (Crook, 2019). The dry ski slope measures 400 m, and runs from the top of the 90-meter-high building to its base, with a 180-degree turn halfway down the ski run (Crook, 2019). CopenHill shown in Figure 15, has become more than the sum of its parts, it symbolizes a desire to reimagine the built environment for future generations, and in turn, bring joy back to cities (Baldwin, 2019). Also known as Amager Bakke, this building represents the changing world of possibilities for sport, recreation, and the power of architecture. It proves there is potential to give form to the future that the human race wants to live in and can serve as an example of what future generations will embrace while combating climate change (Crook, 2019).

DRY SLOPE SURFACE MANUFACTURERS

With dry slopes not being well known in the industry, public record information is challenging to collect. The following manufacturer list has been compiled from several sources across the internet. The following manufacturers are listed in alphabetical order (not by industry introduction).

- Dendix: One of the most iconic and oldest dry slope materials on the market. Produced by Osboren, it debuted in 1961. Known for its PVC-based brush arranged in a honeycomb that appears in a hexagonal pattern (with holes that allow for reduced friction). Dendix was the first widely deployed dry ski surface. Known for its hard bristles, it is

installed on a number of dry slopes. Dendix dry ski slopes require a sprinkler system to keep the slope wet to reduce friction that leads to a much better skiing experience (King, 2020).

- Innova-Ski: Manufactured in Belgium was released to the public in 2009. It developed a mat with a plastic base insert with PBT filaments (ski.com© 2020). It can be used for a variety of winter sports, and testers at all levels from beginner to racers agree it provides a realistic snow-like grip for edging, turning and stopping as well as excellent sliding properties. Two versions are available, one with squares filled with filaments and one with open squares but no gaps in the base or metal on the surface, for safety. Sections are fixed together with clips and only use new materials (Thorne, 2020).
- JF Dry Ski Mat: Designed and made by KGW Sports Equipment Co., Ltd and was in released in 1995. The mat was first installed in China on a slope in 2011 due to the delayed popularity of snow sports. Subsequently, it was used to create more slopes including facilities in Japan (Thorne, 2020).
- Maxx-Grass: Surface material consists of extruded yarn and monofilament pile. Maxx-Grass is differentiated by its promise of 'long-life" with replacement needed between 5,000 – 6,000 hours and very low depreciation per hour (Thorne, 2020).
- MK Enterprises: Over 35 years of design and construction experience within the ski industry. They invented the playgrass ski carpet in 1999. They focus on ongoing product development and research to deliver an innovative, user friendly artificial surface for skiers and snowboarders of all abilities from the beginner to the ski expert, including freestyle areas and fun parks (Thorne, 2020).
- Nevaplast: Developed in Italy in 1998 (King, 2020). Its technology addresses many of the safety concerns of Dendix and according to the manufacturer rides notably faster and cooler. It holds an edge better than Snowflex and Dendix. It has nonetheless been adopted as an all-around surface, appearing in terrain parks, main slopes, and on some race courses. Neveplast has a range of different surface types for different activities. These include nordic skiing, drifting, snow tubing, alpine skiing/snowboarding (King, 2020). The slope material consists of mats with small circular holes, which aim to completely cool the heat generated by friction. That does not require additional water to function (Thorne, 2020). Neveplast currently holds the record for the longest ski slope in the world; the previously mentioned Veduchi dry ski slope in the Caucasus region of Russia. The Veduchi slope is 1.13 km in length, using

Neveplast technology (Thorne, 2020). Neveplast does not use recycled materials. However, the slopes themselves can be recycled (Neveplast, 2020).

- Proslope: Launched in 2012 and based in the UK, technology claims its surface is extra shock absorbent, forgiving, durable and easy to replace. "Using tried and tested brush technology, Proslope's secret lies in it's Variable Height Filament. This allows skis or snowboards to glide with less surface contact and therefore less friction build up, thus increasing speed. All this is done whilst allowing for better edge grip, when both upper and lower filaments are engaged" (King, 2020).
- ProSno: One of the most recent products in the dry slope market, and claims to bring the best of the newest safety features without sacrificing edge control. ProSnow claims to replicate the same feeling as a snow surface, creating an experience that mirrors that of natural snow (Thorne, 2020).
- Skitrax: Over 40 years of experience. They offer fast installation with dual layer fleece sitting beneath the Skitrax slope material. The surface can be used without water misting and has low operating costs. It can be used for alpine or cross-country skiing and different colors are available (King, 2020).
- Snowflex: Developed by Briton Engineering launched in 1996 and boasts carpet-like flexibility. It is known for its easy installation and variety of shapes. However it can be problematic as it can bunch up similarly to a rug (Thorne, 2020). Snowflex has approximately 250 snow-sports projects already completed. With more projects on the horizon, they are starting to prove their expertise. Snowflex offers an extremely flexible dry slope surface, which has become particularly popular with terrain parks and undulated surfaces (King, 2020).
- Snowtrax: Manufactured in Dorset (UK) and is one slope that has had success using Proslope's artificial surface. After acquiring ProSlope, they are now looking to double the amount of UK slopes using ProSlope. With the aim of dramatically increasing the amount of people learning to ski or snowboard on outdoor dry ski slopes (Thorne, 2020).

SPORT RULES: SUCCESS TO WINNING/ACHIEVING

Dry slope locations provided a convenience for riders who are not geographically close to snow mountain resorts. With easier location access and the option of year round snowboarding, riders goals include learning how to snowboard or expanding their skills and riding ability. Alternatively riders can simply desire the activity of snowboarding, an intention that is purely social.

As innovation and technology increase so will slope size and course diversity. With it the level of riders will slowly grow and offer more experienced riders a year round training opportunity.

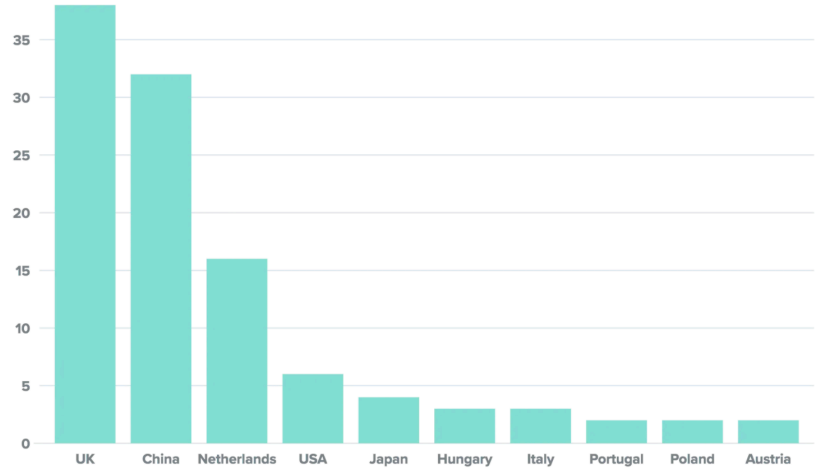
SPORT PLAYING FIELD

Environment

The majority of slopes, also referred to as dryland, artificial, and plastic slopes are intended to mimic the attributes of real snow (Wikipedia, 2020). Over the past 50 years dry slope materials developed and differ in a variety of shapes and sizes. Dry slopes can be found in over 50 countries around the world (Thorne, 2020). The diversity in length ranges from just a few meters long to a kilometer long. The dry slope offers resorts the option of year-round skiing, or at least a slope coverage guarantee due to the unreliable seasonal temperatures due to climate change. Dry slopes, though usually static, can be constructed as conveyor-style machines – like giant runner's treadmills for skiers with varying speeds and at various gradients, creating an endless run (Thorne, 2020). This diverse product category has played an essential role in teaching millions of people to ski or snowboard, and have been a successful addition to the global ski industry (Thorne, 2020). The graph below shows the amount of outdoor dry ski slopes per country across the globe.

FIGURE 16

OUTDOOR DRY SLOPES PER COUNTRY



Note: Estimated amount of outdoor dry ski slopes global distribution 2020 (King, 2020).

The current dry slope environment is highly dependent on the manufacturing landscape of dry slope materials. There are a number of manufactures in the industry today which have developed varying models for dry slope surface to suit specific slope needs ranging from downhill skiing and snowboarding, cross country skiing, to snow tubing (Thorne, 2020). Slopes are produced in sections with the idea that sections can be easily replaced. Some key differences include: thickness (ranging generally between one to 5 or 6 cm), overall durability (its projected lifespan), the cost/value, and grip and slipperiness (how equipment slides over the surface) (Thorne, 2020). Some surfaces require water sprinklers to mist the surface to make it more slippery.

SPORT EXECUTION

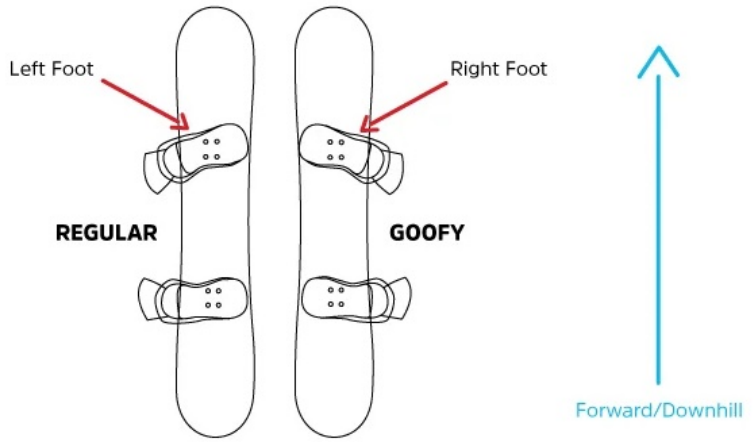
At its core, snowboarding involves the rider executing a number of turns down a hill. Prior to riding the snowboarder must set up their equipment binding angle and stance riding direction which is determined by the dominant foot that leads when the rider is facing down hill (Phillip et. al., 2017). Riders who lead with their left foot are referred to as regular and those who lead with the right foot are referred to as goofy (the default orientation stance for riders is "regular" thus the following references will allude to a regular stance binding setup) (Phillip et. al., 2017).

BASIC SNOWBOARD STANCE

Like most sports, snowboarding relies on balance. This can be broken down into stationary balance and dynamic balance (Phillip, et. al., 2017). Stationary balance position requires the rider to evenly distribute weight over the board in natural equilibrium, known as the "basic stance", a position in which riders can easily move in and out of. Weight is evenly distributed over both feet, the ankles, knees, and hip joints are relaxed and slightly flexed. The hips and shoulders are in alignment with the position of the feet and the contact edge of the board. The torso is upright with the arms relaxed by the sides. The head turned and eyes look in the direction of travel (Phillip et. al., 2017). Proper body position is required to keep the riders center of mass in motion and also known ad the neutral position. A rider's center of mass is not a fixed point. It changes as the rider moves and transitions through various positions (Phillip et. al., 2017). A rider's "dynamic balance" is considered the action of finding equilibrium via reactive movement to the forces acting on the rider's body or board (Phillip et. al., 2017).

FIGURE 17

SNOWBOARD STANCE DIRECTION



Note: Regular vs. goofy snowboard stance (Evo, 2000).

Binding placement angles vary, and depend on the rider's skill level, type of riding, and terrain surface, in addition to personal rider preference variations comfortable for the rider (Phillip et. al., 2017). Binding placement is considered with zero degrees when placed flat across the snowboard. A positive angle denotes the boot placement with toes of the foot pointing towards the nose or front of the board, and negative angle when toes are towards the tail or back of the board (Phillip et. al., 2017). Riders keep both knees and ankles flexed to improve stability and balance while keeping the back straight and hands relaxed at the sides (Dicks, 2020). Riders should focus

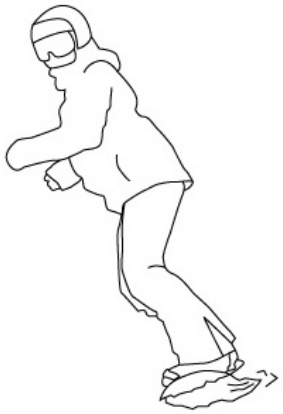
their eyes forward facing/downslope while keeping hips and shoulders aligned with the snowboard, riders shift their weight forward to apply pressure to the front of the snowboard and move their bodies forward towards the nose of the board, this movement is used to initiate a turn (Evo, 2020).

TURN SEQUENCE

When beginning to snowboard, it is important to weight the front foot as the body leans into the turn, and then consciously weight the back foot to bring the boarder through the turn (Evo, 2020). Toeside and heelside (Figure 18) turns differ depending on riders natural stance direction (regular - left foot will be in front or if goofy then the right foot leads down the hill) (Evo, 2020). Riding on the heelside edge of the board is typically more natural for both goofy and regular stance riders as it will position riders leaning back when going down a hill or steep grade (Evo, 2020). Riders may be tempted to stop and weave back and forth down the slope using only heelside turns. However the toeside turn is a necessary technique needed for skills on more difficult terrain (Evo, 2020).

FIGURE 18

SNOWBOARD STEERING/MANEUVERING TECHNIQUES

TOESIDE	*HEELSIDE*
	

Note: Toeside vs. heelside snowboard turns (Evo, 2000).

Toeside turns often seem intimidating but are necessary and the key is to distribute the weight from the riders front foot as they lean into the turn. Riders will find the toeside edge by leading with their front foot, and rolling the ankle over to follow (Evo, 2020).

Snowboarding requires a sequenced pattern which is led by the rider's front foot, followed by the back foot (Phillip et. al., 2017). The rider then rolls their hips, transferring the pressure to the front foot, as the hips roll, the weight should transfer from the front to back

foot. With time the transition turn will become natural. Turns provide a change of direction but also slow down the traveling speed (Evo, 2020).

Stopping on a snowboard can be executed on either the heelside or toeside edge (Phillip et. al., 2017). The act of stopping is a more aggressive turn. Instead of slowing riders down that aggressive turn will bring the rider to a complete stop (Phillip et. al., 2017). To achieve this motion the riders should pivot the board and rotate their body aggressively across the slope, putting weight on the uphill edge until the board is perpendicular across the slope, with the majority of riders weight distributed on the uphill facing edge (Phillip et. al., 2017).

MOVEMENT

There are four directions that riders move: vertical, moving body parts vertically; laterally, moving the COM across the board toward the heelside or toeside; rotationally, moving the body around an axis; and longitudinal, moving COM towards the nose or tail of the board (Phillip et. al., 2017). All four planes are required for riders to maneuver various terrain and conditions (Phillip et. al., 2017).

TURN FORCES

Snowboarding is unusual in that, unlike other sports, where speed and forward movement is attained by internal, muscular strength and forces, the main source of speed and forward motion in snowboarding is gravity. However control is needed to use gravity effectively (Phillip et. al., 2017).

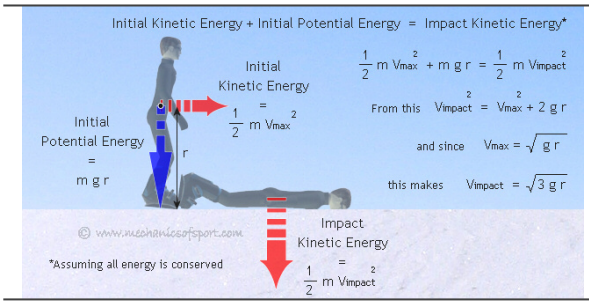
The key to snowboarding success is the ability to create lateral movements on the board (Phillip et. al., 2017). Lateral movement is controlled by the legs, starting with the ankle joint using dorsi and plantar flexion. The knee joint helps snowboarders create lateral, longitudinal, and vertical movements and the hip joint creates both flexion, extension, and rotation needed to steer and control the board (Phillip et. al., 2017).

HOW TO FALL

There are two instinctive reactions riders experience when they crash: use of arms to soften impact, and the use of the neck to protect their head. When using arms to brace for a fall, riders should use forearms rather than hands. Using hands to soften an impact is the main reason people break their wrists while snowboarding. Forearms offer more resilience. The second reaction from falls involves riders pulling the head back and tucking the head by curing the neck backward or forward depending on the direction the head into a curled position. This reaction has potential to strain muscles and in some cases results in whiplash that causes soreness or pain incurred that can last from days to weeks. Rather, riders should attempt to keep neck muscles relaxed to prevent injury.

FIGURE 19

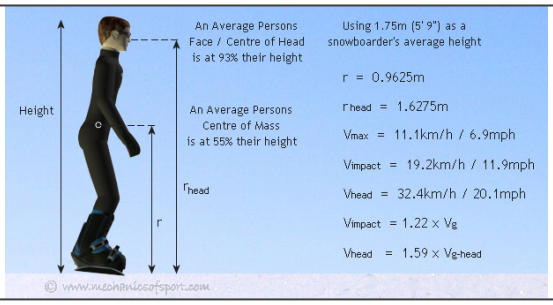
IMPACT VELOCITY



Note: Now the maximum entrance velocity for a pivot edge catch can be measured by the impact velocities it creates. Assuming that all energy is conserved during the crash which means that the initial kinetic and potential energy, will b e both kinetic energy at impact. Assuming there is no wind resistance, the snowboard edge will remain in the snow until impact and the centre of mass is also level with the snow (Unrealistic assumptions used for a basic concept understanding of impact velocity on the centre of mass (impact) providing a calculation that us easily digested - but not accurate) (Resultant velocities Mechanism of Sport, 2011).

FIGURE 20

MAX. VELOCITIES: PIVOT EDGE CATCH FLAT SLP



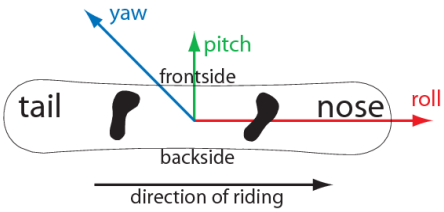
Note: Assigning the force of gravity and measurements of an average person for the following equations, where the general resultant velocities can be calculated, and compared to the sideways velocity at which the edge will throw the rider to the ground (where the hardest being 11km/h (7mph), and the riders head will impact the ground at 32km/h (20mph). Resulting impact force 1.6 times harder compared to the rider falling from their head height. This data represents the ability of slower movements to create a substantial impact without added speed. At this rate of speed riders will impact the ground in 1.3 seconds (when considering the average human reaction time falls between a fifth and a quarter of a second, impact will occur before the rider can respond (Resultant velocities Mechanism of Sport, 2011).

BIOMECHANICS

Like most sports snowboarding relies heavily on balance, which can be broken down into stationary and dynamic balance. Stationary referees to the natural snowboard stance while the rider is stationary, and dynamic balance referring to the equilibrium while in motion (reactive movements to the forces acting on a riders body in motion). Snowboardings basic biomechanics involve the main joints used and their relationship to the muscles, tendons, and ligaments they interact with (Vernillo et al., 2018). The load placed on the the muscle system is directly influenced by the accelerative force, relative to body weight, and the velocity of the snowboarder (Vernillo et al., 2018).

FIGURE 21

SNOWBOARD STEERING/MANEUVERING TECHNIQUES

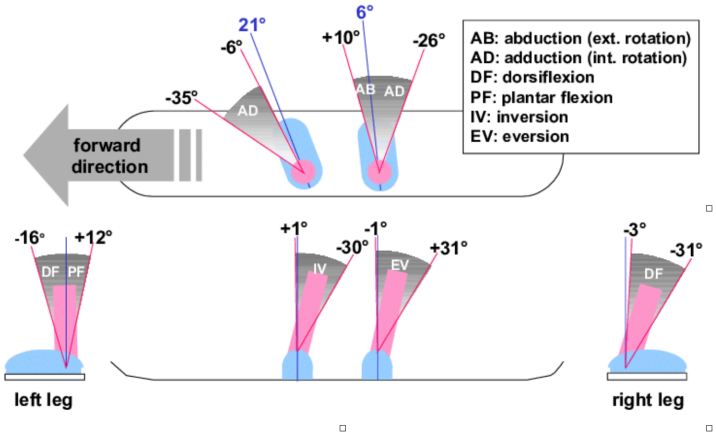


Note: Snowboarders position feet sideways on the board. The backside of the board is refereed to as the "heelside edge" and the front side is referred to as the "toeside edge". The front of a snowboard is referred to as the "nose" and the back end as "tail" (Holleczek, 2010).

Snowboard bindings and boots allow the rider to attach their feet to the snowboard and transfer energy forces to the board. Riders move with one shoulder and leg leading the way down the slope (Figure 21). This creates a partial blind side, increasing the risk of collision. Catching the toe or heel edge of the board on snow can cause falls forward onto riders' hands and knees or backward onto the occiput and sacrum, respectively (Delorme, 2002). Approximately 75% of lower extremity injuries involve the lead foot (Delorme, 2002).

FIGURE 22

SNOWBOARD LOWER EXTREMITY DIRECTION KINEMATICS



Note: Diagram represents a riders foot placement along with the ankle range of motion during snowboarding (Delorme, 2001).

Riders can shift their weight distribution towards the nose or tail of the snowboard which limits the ankles range of motion in a transverse plane (Delorme, 2002). Riders with forward ankle adduction placement will differ from a rider with abducted binding placement (Delorme, 2002). Riders should consider their natural foot orientation in the transverse plane and can experiment measuring the effect of binding angle orientation compared to range of motion (Delorme, 2002).

The ankle joint is the key to the success of a snowboarder and their ability to create lateral moments on their snowboard (Phillip et. al., 2017). Riders can shift their weight distribution towards the nose or tail of the snowboard which limits the ankles range of motion in a transverse plane (Delorme, 2002). Riders with forward ankle adduction placement will differ from a rider with abducted binding placement (Delorme, 2002). Riders should consider their natural foot orientation in the transverse plane and can experiment measuring the effect of binding angle orientation compared to range of motion (Delorme, 2002). Ankles can also aid in vertical movement when used with other joints. These movements are known as dorsi and plantar flexion (producing lateral movements over the board). Plantar refers to the opening of the ankle joint, when toes are pushed down or away from the shin (Phillip et. al., 2017). Dorsi flexion is the opposite, when the toes are lifted and move closer to the shin. The ankle is a complex joint and can make other movements such as inversion (ankle is rolled to the outside of the foot) and eversion (ankle rolls towards the inside of the foot). These movements can aid in the rider's ability to move longitudinally on their board (Phillip et. al., 2017).

The knee is a modified hinge joint and the most commonly mentioned joint in snowboarding. It largely impacts riding as it manages two of the larger levers, controlling the femur (large bone in the thigh) and tibia/fibula (two bones in the lower leg). The knees help snowboarders create lateral, longitudinal, and vertical movements. Knee range of motion is critical to snowboarders.

A ball and socket joint, the hip joint supports the ability to create flexion, extension, and rotation. The width and flexibility of this joint directly impacts a snowboarders riding style and capabilities (Phillip et. al., 2017).

Connective tissue (ligaments, tendon, and cartilage) connects the muscles and joints. The muscles make three types of contractions based on muscles working with or against one another as they contract or relax and include concentric muscle contraction (where muscles shorten), eccentric muscle contraction (where the muscle lengthens when contracting), and isometric muscle contraction (where the muscle does not change in length when contracting) (Phillip et. al., 2017). Muscles are controlled by the brain as it sends commands to relax or contact. The more time that is spent sending relative messages to the same muscle groups the quicker the reactions become, referred to as "muscle memory" (Phillip et. al., 2017). Proprioceptors within the muscle fiber act as sensors measuring movement of contraction and flexion which provides confirmation to the brain that the body is executing movement (Phillip et. al., 2017).

Riders on synthetic slopes will have a slightly different experience than on natural snow, which affects biomechanics of the sport. Slope makers also make adjustments to try to mimic the feel of snow more closely. To begin, the synthetic slope speed differs from snow surfaces due to the coefficient of friction between the snowboard face and the slope surface. Synthetic surfaces have a higher coefficient of friction, meaning that the surface will feel a little “slow” compared to natural snow (Urban Snow, 2018). In addition, the angle of dry slopes is often designed to be a steeper gradient angle to provide a quicker coefficient (Urban Snow, 2020).

Despite the few manufacturing claims made by dry slope manufacturers limited studies have been conducted on dry slopes surfaces specifically (Brooks, 2011). Research provides accurate data that can be used in research and development, to further understand dry slope snowboarding kinematics. This includes necessary tools to address dry slope snowboarding such as rug burn riders encounter from contact with the dry slope surface, impact protec-

tion specific to the material surface density, and biomechanics pertaining to future injury mitigation and prevention.

This presents the snow sport design market an opportunity to develop dry slope snowboarding specific products, effective solutions involving protective equipment and provide advancement in solutions to address dry slope environmental demands, such as apparel intended for year round temperatures (spring, summer, and early fall). Therefore, it is essential to understand the biomechanics in snowboarding offering sport specific growth and market opportunity (Krüger & Edelmann-Nusser, 2009).

INJURY

Most snow sport injury reports are based on data from self-reports, ski patrols, or tertiary trauma centers. In general, the rates of injuries in these settings have been reported as 1 to 5 per 1000 participants (Kim et. al., 2012). The data below summarizes mountain snowboarding injuries; there is currently no formal studies on dry slope snowboarding specific injuries.

The sport of snowboarding has potential for severe injury. As participation in snowboarding continues to rise, so does levels of competition and overall number of injuries (Barker, 2020). Since 2001, injuries among snowboarders have occurred at a higher rate than those among skiers, with falls causing 80% – 90% of injuries (Helmig et. al., 2018). The overall injury rate is approximately 5 per 1000 snowboarder per day.

Furthermore, correlations between the type of equipment used and the injury were found (Kim, Endres, Johnson, Ettlinger, & Shealy, 2012; Made & Elmqvist, 2004; Rust, Gilmore, & Treme, 2013; Covassin & Elbin, 2010). Thus, the development of enhanced snowboard equipment, to reduce the risk of equipment-related injuries, is considered in literature (Kim, Endres, Johnson, Ettlinger, & Shealy, 2012; Rust, Gilmore, & Treme, 2013; Covassin & Elbin, 2010; Strand, 2013).

Influential Factors

While snowboarders are at substantial risk for a multitude of injuries, beginner-level participants between the ages of 15 and 19 are at the highest risk of injury (Barker, 2020). Beginners are three times more likely to get injured than more experienced riders (Young, 1999). Beginners' muscles have to work harder and get tired sooner, which

can lead to injury. Fortunately, beginner injuries also tend to be less severe (Baker, 2020). Additionally, equipment that is poorly turned or broken can lead to injury (Barker, 2020). Slope crowding has also been shown to increase overall injury rates to all snow-sport participants (Helmig, Treme, & Richter, 2018). Further, snowboarding and terrain parks have steadily increased in popularity, leading to an increase in snowboarding injuries (Helmig, Treme, & Richter, 2018).

Soft boots are now the more popular boot type and have decreased the incidence of knee injuries, but elite-level athletes often still wear hard boots and perform jumps and tricks, thus increasing their risk of ACL injury (Davies et. al., 2009). Ehrnthaller et. al., showed this trend toward more injuries to the knee in professional compared to recreational snowboarders (Torjussen & Bahr, 2006; Florenes, Nordsletten, Heir, Bahr, 2012; Xiang, Kelleher, Shields, Brown, Smith, 2005; Torjussen & Bahr, 2005; de Roulet, Inaba, Strumwasser, Chouliaras, Lam, Benjamin, Grabo, Demetriades, 2017).

MUSCULOSKELETAL AND NON-MUSCULOSKELETAL

While musculoskeletal injuries are the most common type of injury in snow sports, the non-musculoskeletal account for a number severe injuries likely to affect the head, face, spine, chest, and abdomen and more likely to occur from collisions rather than falls (Helmig et. al., 2018). While relatively rare compared to extremity injuries, head injuries are the leading cause of death and critical injury in snowboarding and range from concussion to severe traumatic brain injury. The rates of head and neck injuries among skiers and snowboarders vary between 0.09 – 0.46 per 1000 outings; snowboarders have a 50 percent higher rate of head and neck injury as compared to skiers (Hadier, 2014). Concussions are the most prevalent type of head injury in snowboarding and result of aerial moves and landing failures and are more frequent at terrain parks (Helmig2018). Injuries also include spinal injuries where the lumbar spine is the most common site of injury. When chest injury occurs, the most frequent are rib fractures, lung injury, pneumothorax, hemothorax, and clavicle fractures (Helmig, Treme, & Richter, 2018).

UPPER EXTREMITY

Research by Krüger, & Edelmann-Nusser (2009) findings show the upper extremities are the most common site of injury among recreational snowboarders. In a study evaluating 7,430 upper-extremity injuries over ten sea-

sons at Colorado resorts, a research study by Idzikowski Janes, & Abbott (2000) found that just under half of all snowboarding-related injuries involved the upper extremities (Idzikowski et. al., 2000).

Upper-extremity injuries included fractures (56.4%), sprains (26.8%), and dislocations (9.7%). They found that wrist injuries made up 44% of all upper-extremity injuries and 21.6% of all snowboarding injuries (Idzikowski et. al., 2000). As the upper extremities play a lesser role in comparison to the lower in snowboarding, general themes for return after these injuries include full functional range of motion and strength so that athletes can protect themselves and minimize additional risk (Krüger et. al., 2009).

LOWER EXTREMITY

Lower-extremity injuries in snowboarding range from ligament sprains to fractures, and can involve the entire lower extremity from hip to toe. Lower extremity injury, although less common than upper-extremity injuries among snowboarders, still accounted for 12.3% of all snowboarding injuries, with ankle injury being the most common at 28% (Owens et. al., 2018; Kim et. al., 2012; Made & Elmqvist, 2004; Sachtleben, 2011). As boot and binding technology has evolved lower-extremity injuries have decreased in incidence (Helmig et. al., 2018). However, lower-extremity injuries are more common among skilled snowboarders (Helmig et. al., 2018).

Ishimaru et al. reviewed nearly 8,000 snowboarding injuries that presented to their emergency department between the 2004–2005 and 2008–2009 seasons (Ishimaru et. al., 2011). They found that the mechanism responsible for most lower-extremity injuries was collision with other participants, obstacles (38.9%), or isolated falls (36.1%) (Ishimaru et. al., 2011; Kirkpatrick et. al., 1998). Many lower-extremity injuries can be attributed to the type of boot worn (Sachtleben, 2011). Approximately 90% of snowboarders wear soft boots, but racers and professional snowboarders often wear hard boots (Ishimaru et. al., 2011). Ankle injuries are more common among athletes who wear soft boots, and knee injuries are more common among athletes who wear hard boots (Owens et. al., 2018).

When elite snowboarders are compared to recreational snowboarders, knee injuries are responsible for the largest increase in injury incidence (Wijdicks et. al., 2014). Whereas knee-injury rates occur in about 6% of the general snowboarding population, these rates more than triple to about 20% in the elite-snowboarding population (Torjussen & Bahr, 2006; Flørenes, Nordsletten et. al., 2012; Xiang et. al., 2005; Torjussen & Bahr, 2005; de Roulet et. al., 2017).

Dry Ski Slope Specific Injury

There is a lack of relevant information on artificial slope injuries research studies (as of December 2020). The only available research study relevant to dry slopes by Shephard & Saab (2000) was specific to upper limb injury in dry ski slope skiing (Shephard, Saab, 2000). The study evaluates 174 patients in the accident and emergency department over a period of three years who had sustained injuries from dry ski slope skiing (Shephard, Saab, 2000). Prospective registration was used to collect the data where findings showed sixty-seven per cent of the patients had received instructions prior to skiing (Shephard & Saab, 2000). Upper limb injuries outnumbered lower limb injuries by a ratio of 7.9 to 1 (Shephard & 2000). Thumb injuries outnumbered other injuries in the upper limb (Shephard & Saab, 2000). The mechanism of injury was due to a fall in 94.2% of patients (Shephard & Saab, 2000). It is concluded that the lattice network on dry ski slopes significantly contributes to the platform of injuries to the upper limbs, and ways in which the lattice network may be improved are recommended (Shephard & Saab, 2000).

With limited research industry professionals; dry slope expert James King (founder of ski blog Sunsnowsee and instructor with 15 plus years of experience on dry slopes who recalled hand injuries accounting for the majority of dry slope injuries for snowboarders followed by abrasions burns), Isaac Gibson (King, personal communication, November 4, November 5, 2020). Burns are a result of riders falling with exposed skin, exposure to the slope surface material is abrasive, but have vastly improved with advances in material technology innovation (King, personal communication, November 4, November 5, 2020).

Further research is vital to understanding dry slope injury which in turn help mitigate the risk factors it is associated with. This data serves as a tool for industry designers to develop slope materials and for apparel and equipment designers to develop specific clothing to this growing sport.

INJURY CONCLUSION

Despite the many injuries seen in snowboarding, objective data about rehabilitation and return to sport is lacking. Additionally rehabilitation data and return to sport research and studies are lacking, providing an opportunity for future research for general and sport-specific injuries (Helmig, et. al., 2018). Additionally injury prevention efforts should be conducted to evaluate modifiable extrinsic risk factors, such as strategies to increase sports-specific instruction/education including risk awareness (imperative for any level of rider) and the available protective equipment can mitigate the potential risk factors (Russell & Selci, 2018).

INDUSTRY INSIGHTS

Growth Analysis

Snowboarding apparel and equipment is a growing industry that is currently benefiting from interest from young people and those new to winter sports and whose continued growth depends on engagement/interest and accessibility. Globally the snow sports apparel market was valued at USD $2.4 billion in 2018 (Grand View Research, 2019). In recent years, entry into the snowboarding space has become a primary goal across the entire winter sports industry (Walsh, personal communication, November 4, 2020). According to Snow-sports Industries America (SIA), snowboarding participation and resorts will play a major role as a key driver of the winter sports equipment market. Associations such as Snow-Sports Industries America (SIA) and the National Ski Areas Association (NSAA) exist primarily to increase participation in winter sports. The goal of the associations is to retain existing customers and entice new customers, ensuring uniform footfall even in off seasons (Transparency Market Research, 2019).

Media plays a key role in continued growth as well. Media coverage (such as the 2014 Winter Olympics broadcast which was aired by 464 global television channels driving winter sports youth engagement to increase overall interest which can potentially add to market growth (Grand View Research, 2019). Additionally, youth interest in the sport is encouraged though government policy as a part of the academic curriculum (Grand View Research, 2019).

Further, consumers have shown increasing interest in nature-based gateways which may provide opportunities for both leisure and competitive snow sport apparel, accessories, and equipment manufacturers (Grand View Research, 2019). Already, international sport/lifestyle giants have tapped the interest for clothes inspired by mountain life, the great outdoors, and consumer preferences for eco-friendly apparel (Grand View Research, 2019).

During the 2020 resort season Covid-19 caused resort closures across the globe and notes a substantial loss in revenue. The 2021 season opened with new protocols and operating enforcements limiting the overall number of lift tickets sold per day and enforcing strict face mask and social distancing policies (Walsh, personal communication, November 4, 2020). The winter sports market has also see a market shift towards sales towards backcountry apparel, accessories, and equipment. (Walsh, personal communication, January 21, 2021).

Distribution Channel Insights

Historically, consumers prefer offline channels when purchasing snowboarding apparel and equipment. As of 2018, the offline category dominated the market and accounted for a share of 76.5% (Grand View Research, 2019). Even prior to Covid-19, online channels were expected to expand at CAGR (Compound Annual Growth Rate - rate of return that would be required for an investment to grow from its beginning balance to its ending balance, assuming the profits were reinvested at the end of each year of the investment's lifespan) rates of 6.1% from 2019 to 2025 (Fernando, 2020). As virtual shopping continues to gain popularity, manufacturers and retailers will increase the ease and confidence with which consumers shop for snowboard equipment and apparel online. For example in December 2016, Adidas A.G. launched a 360° shopping experience by incorporating VR to e-commerce retailing (Grand View Research, 2019). Despite this, physical retail locations will likely continue to play a role to consumers as they provide the opportunity for physical verification to consumers (Grand View Research, 2019). As with other product segments, social media (YouTube, Instagram, and Facebook) is an emergent key driver for access to and sales of sports apparel (Grand View Research, 2019).

Regional Insights

North America led the market and accounted for a 37.8% share of the global revenue in 2018. However, the Asia Pacific region is projected to expand at the fastest CAGR of 6.3% from 2019 to 2025 (Grand View Research, 2019). This is due to rising disposable income, population growth, and urbanization in the region (Grand View Research, 2019). Japan and outlying Asian markets currently have one of the fastest-growing apparel markets in the world (Kim, 2020). Additionally, an increase in the number of professional snow sports leagues including the Asian Winter Games (AWG) has laid a foundation for increased interest in and expenditures on snow sports apparel (Grand View Research, 2019).

TARGET CONSUMER DEMOGRAPHIC

Consumer Data Overview

This design collection will cater to dry slope snowboarding apparel and accessories intended for Spring/ Summer 2035. The target demographic is unisex and between the ages of 17 and 31 years of age located geographically in Japan or in globally who consider their primary report locations within Japan. The below research provides detailed statistics defining the target demographic and reasoning for the specified delivery date and location.

Demographic

Gender. The target demographic for this collection is a unisex consumer. Unisex design is symbolic for both inclusion and diversity and progressive leadership in cultural fashion expression (Anyanwu, 2020). As the spectrum of self-identification and expression is expanding, gender, in the binary sense, is no longer constrained by a set of dated ideals. Preferred pronouns give younger generations the opportunity to broaden their definition of personal identity and shape the public perception though fashion. The future will unquestionable represent as non-binary and genderless founded in the current breakdown of gender norms across the fashion industry. Asia specifically has shown out of the box thinking when it comes to defining gender and will be considered a norm by the year 2035 when this collection will be released (Gender Codes, 2020).

- Age. 17-37 including all ranges of relationship status (single, dating, committed relationship, married, married with children).
- Income. Consumers tend to purchase products considered higher quality with similarly higher prices (2–3x higher).
- Residence: Smaller satellite cities and mixed-use residential complexes in mega-cities.
- Defining Personal Characteristics:
    - Fashion. Japan is a capital of fashion innovation from street style to heritage and couture (Varnam, 2020). In the latter half of the twentieth century, Japan underwent an organic style evolution with strong alignment to subcultures and the recreational movement. As a result, Japan is home to outdoor brands whose key design

combines fashion and function (Varnam, 2020). The reimagined focus on clean and sophisticated design has resulted in customers reconnecting with the outdoors through products and comes at a time when consumers are invested in value, along with practical and well-made apparel and equipment (Varnam, 2020). This emergence in outdoor brands has given birth to a new generation of outdoor enthusiasts living in rural areas who prioritize wilderness exploration and adventure (Varnam, 2020). In addition, Japanese brands stand out for their adherence to historic design practices and fabrics. Its current rapid expansion in e-commerce will continue to present opportunity specifically in the future of fashion.

- Brand Loyalty: Apart from the snow, Japan offers visitors a fascinating cultural convergence that translates to fashion, blending historic tradition with the ultra-modern. In a market once dominated by heritage brands, Japan has welcomed new players that appeal to customers with different tastes and needs. Japan is a relatively new market with endless potential for skiwear and equipment and there is growing demand for these products as well as a growing customer base (Kim, 2020).
- Sport Proficiency: Snowboarding proficiency is intermediate to advanced level of rider. This demographic are considered fashion-conscious consumers.
- Delivery Date: The projected delivery date of 2035 is primarily driven by anticipated effects of climate change and the resulting reduced overall snowfall resorts will face by that date (Donal O'Leary, personal communication, 2020). By analyzing the current climate change impact on snowfall, one can predict the difficult future snow-dependent resorts are up against. By the year 2035, the landscape of snow sports will look very different: the increase and expansion of dry ski slopes is highly probable as an adaptation to keep resorts profitable given shorter snow seasons. Dry slopes have the potential to support the current level of participation in snowboarding and skiing in a future of unreliable snowfall which will eliminate the current snow season as it is experienced today.
- Delivery Season: The intended product season is considered the 'off-season' by resorts and takes place during the Spring, Summer, and early Fall seasons Japan and correlates to calendar months of March - September. Temperature projections average range from 6 to 24 degrees Celsius (42 to 76 degrees Fahrenheit) (Climate Impact Map, 2020).

- Geographic Location: Japan is known for its abundant snowfall and selected for its ideal location and destination to over 500 ski resorts, and hosted two Winter Olympics Games. With this many opportunities to visit resorts and the popularity boost from two Olympic games, it isn't surprising that Japan boasts a strong snow sport culture (Pow, 2019).

FIGURE 24

JAPAN TOP RESORT STATISTICS

RANK	RESORT	ELEVATION	MARCH - SEPT. AVE. TEMP C	TERRAIN AREA	OPEN	CLOSE
1	*Rusutsu*	*3,261 ft*	*-(2.2)-19.9*	*524 ac*	*11.27.2020*	*04.08.2021*
2	*Niseko*	*3,937 ft*	*-(7)-21*	*-*	*11.21.2020*	*05.06.2021*
3	*Hakuba 47 & Goryu*	*5,499 ft*	*-(4)-28*	*-*	*12.05.2020*	*05.06.2021*
4	*Happo One*	*6,007 ft*	*-(3)-28*	*437 ac*	*12.07.2020*	*05.07.2021*
5	*Sapporo Teine*	*3,356 ft*	*-(7)-23*	*188 ac*	*11.21.2020*	*05.04.2021*
6	*Nozawa Onsen*	*5,413 ft*	*-(3)-28*	*734 ac*	*12.04.2020*	*05.05.2021*
7	*Shiga Kogen*	*7,569 ft*	*-(9)-23*	*677 ac*	*12.03.2020*	*04.24.2021*
8	*Furano*	*3,524 ft*	*-(5)-25*	*1,101 ac*	*11.26.2020*	*05.06.2021*
09	*Kiroro*	*3,871 ft*	*-(7)-20*	*297 ac*	*11.24.2020*	*05.07.2021*
10	*Kagura*	*6,053 ft*	*-(3)-22*	*418 ac*	*11.22.2020*	*05.27.2021*

Note: Japans top 11 Ski Resorts ranked by (SnowPak (SnowPak, 2020).

Japan is known as the powder mecca of the world. It is one of the world's most popular ski destinations due to snowfall that can easily average 600 inches per year (SnowBrains, 2019). Japan's high snowfall can be attributed to its geographic location. Unlike most resorts that depend on snow storms for the majority of their yearly snowfall, Japan's snow originates from a unique wind pattern progression that develops from wind blown across Asia. Air crosses Earth's longest continent East to West then picks up moisture off the Sea of Japan (SnowBrains, 2019). The Japanese coastal mountain elevation of 10,000 ft forces the moisture-laden air to rise quickly which returns this moisture as 'lake-effect snow' but at sea-level, producing an unadulterated powder season that is one of the

snowiest in the world (SnowBrains, 2019). Niseko in particular is known for the quality, quantity, and consistency of its snow (Pow, 2019). Niseko is favored for its position in a thermal sweet spot means that the ambient temperature at sea level is not too hot and not too cold. "Put it all together and you get perfect dry snow, plenty of powder days, and long winters the envy of ski resorts across the globe." Niseko was ranked as the number two top ski resort in Japan in 2020 (SnowPak, 2020).

CLIMATE CHANGE

Climate has long ruled the fortunes of winter destinations dependent on snow for winter sports (Impact Lab, 2020). According to the Fourth Assessment Report of IPCC, global average surface temperature had risen 0.74±0.18 °C during the period from 1906 to 2005. Global climate change prediction based on six emission scenarios indicates that global average surface temperature will rise 1.1–6.4 °C over the 21st century. The study shows that future climate warming is expected to be greater in the high latitude of the Northern Hemisphere. It is very likely that hot extremes, heat waves and heavy precipitation events will continue to become more frequent. Increases in the amount of precipitation are very likely in high latitudes, while decreases are likely in most subtropical land regions (IPCC, 2007).

FIGURE 26

JAPAN AVERAGE CHANGE FROM HISTORIC ANNUAL TEMPERATURE PROBABILITY

Note: Shows average change from historic annual temperatures under high emissions (RCP 8.5) with a median probability for the next 20 years (2020-2039) will raise by at least 1 degree Celsius (Climate Impact Data Lab, 2020).

Within the next 20 years, the number of days at or below freezing in some of the most popular ski towns will decline by weeks or even a month (Impact Lab, 2020). If global greenhouse gas emissions continue to rise at a sim-

ilar pace as they did in this century, ski resorts could see half as many sub-freezing days (McCusker & Hess, 2018). Seasonally, winter has warmed the fastest, causing those in the winter sports industry to consider how to manage future changes in snow season length, and amount, reliability, and quality of accumulated snowfall (Scott, 2018). While efforts to reduce global emissions will slow the pace of this decline, ski resorts worldwide will still face significantly shorter seasons in the years ahead (McCusker & Hess, 2018). Climate projections in Figure 25 below uses climate projection methodology daily projections from this analysis are based on Representative Concentration Pathway 2.6, 4.5, and 8.5 (Rasmussen et al., 2016 ; van Vuuren et al., 2012) experiments run by global climate models participating in the Coupled Model Intercomparison Project Phase 5 (CMIP5) exercise (Taylor et al., 2012). This dataset is bias-corrected and downscaled using the Bias-Correction Spatial Disaggregation (BCSD) method (Thrasher et al., 2012).

FIGURE 26

JAPAN - SUMMER (JUNE, JULY, AUGUST) AVERAGE TEMPERATURE (CELSIUS)

	Average									
	1986-2005	2020-2039			2040-2059			2080-2099		
RCP 8.5		5th	50th	95th	5th	50th	95th	5th	50th	95th
	23.4	**23.7**	**24.4**	**25.2**	**24.2**	**24.2**	**26.4**	**25.5**	**27.2**	**30.6**
	AVERAGE	2020-2039			2040-2059			2080-2099		
RCP 4.5	1986-2005	5th	50th	95th	5th	50th	95th	5th	50th	95th
	23.4	23.6	24.2	25.0	24.0	25.0	26.1	23.7	25.1	26.5

Note: Shows Japan's increase in average temperature over the next 100 years for the months of Spring/Summer/Early Fall (Climate Impact Data Lab, 2020).

Resort Impact Response

A study conducted in 1999 by Mendelsohn and Markowski projects a decreases resort revenue loss between 1990 to 2060 as high as $3.7 billion (51%) and $4.6 billion (62%) with linear and loglinear demand models, respectively, if temperature increases by 5°C and precipitation increases by 7% (Chapagain et. al., 2018). By employing an input-output model of economic activities in the snow resort industry, estimated loss of $1.07 billion in aggregate revenue in a low-snowfall year compared to high-snowfall years (Chapagain et. al., 2018). Although the level of climate change severity impact is debatable but will eventually incur a shortened ski season length and a decrease in snow depth up to 100% (Chapagain et. al., 2018). Resulting in a severe economic loss of the tourism industry

income and profits as temperatures continue to rise and snowfall variability increases and the overall snowfall amount decreases (Chapagain et. al., 2018).

The collective snow sport industry is already struggling with the implications brought on by climate change, with more unpredictable and warmer winters making it increasingly difficult to bring in steady revenue (Olick, 2019). In Figure 26 the Japan map is representative of average temperature change predictions based on current emissions: predicted to increase by 5 degrees celsius by 2039 (Climate Impact Lab, 2020). This 5 degree change seriously jeopardizes the length and quality of snow sport season in Japan putting the future of 500 resorts and a major consumer and tourism sector in limbo (Secon, 2020).

Some resorts are already adapting by making up for lost snow through artificial production (Secon, 2020). However, snowmaking requires energy to run equipment, significant water resources, and sub-freezing temperatures which won't be reliable in the future (McCusker & Hess, 2018).

An additional adaptation resorts are using is installing dry slopes on existing resort runs (Neveplast, 2020). Dry slopes offer natural snow compatibility: snow can cover the dry slope and grooming machinery can still operate over it. Once the snow melts the dry slopes present a year round revenue opportunity for resorts that typically have a 3-4 month operating season (Snowpak, 2020). Outside of resorts, dry slope installations can provide city centric downhill experiences for locals and tourists (DeZeen, 2020). Dry slope manufacturers are exploring renewable materials which can be recycled or reused into other products after their life as a slope.

There is a critical knowledge gap which must be addressed with regard to climate change adaptation in the winter sports tourism industry. In regards to producing fake snow, as a replacement for the lack of natural snow caused by climate change is only adding to fossil fuel energy usage exasperation. An Australian Alps study predicts that resorts will not be able to afford the additional cost incurred where artificial snow is currency, a stop gap insurance policy that can not replace the level necessary to continue to operate and will ultimately surrender to the impending financially viability. The industry impact doesn't offer alternative that can tackle the issues resulting from the impending climate crisis (Hood, 2018). The solution could be the one solution not on the table, the implementation and expansion of dry slopes. This alternative is an unrecognized alternative that the industry has yet to fully

consider (Hood, 2018). A sustainable alternative that can promise a future to ski resorts in any location along with 365 days operational revenue. It may be the only valid contender with profit potential for all industries evolved.

DRY SLOPE SNOWBOARDING MARKET

The dry slope snowboard apparel market is nonexistent in the current retail market (James, 2020). A quick Google search produces no entries specific to this equipment market segment. Due to the absence of a defined segment within the current market landscape, participant outfitting relies heavily on spring-specific, mountain-specific snowboard apparel, equipment, and accessories along with borrowed apparel from other sports to assemble a dry slope wardrobe (King, 2020). Riders must rely on a hodgepodge of garments from other sectors to meet the demands associated with dry slope snowboarding. Therefore, in order to give an accurate overview of the current state of the art product landscape its necessary to look outside the snowboard industry.

STATE OF THE ART PRODUCT CATEGORIES

The below apparel include the product categories specific to this design capstone and are presented by category. For each category a general breakdown of the current market offering and explanation of the design features associated with the category is included. Following, each category will feature one 'state of the art' product (representing the top choice offered within the current market). State of the art products can be found in the following Figure s: outerwear jacket (Figure 30), outerwear bibs (Figure 33), base layer top (Figure 38), base layer bottom (Figure 40), neck gaiter (Figure 44), impact protection short (Figure 48), impact protection knee pad (Figure 50), and impact protection elbow pad (Figure 52). Each state of the art product description includes the product name, retail price, material content, and care instructions, along with any additional relevant information. Each state of the art product detail also includes information on materials and manufacturing and the step-by-step process of assembly. Finally, a features and benefits chart provides the following information: competitor product market landscape (including price-point), state of the art materials landscape, and patent landscape (please note referrals to alternative sections providing duplicate/repeated information, with page number references).

Outerwear

The outer-most layer worn by riders is known as outerwear and includes pants/bibs and a jacket/shell, or a one piece bodysuit. This is considered the most important part of a rider's uniform, and is typically the most expensive (Evo, 2020). This layer is the only part of a rider's uniform that comes in direct contact with the slope and elements.

As such, outerwear garments offer the rider protection from the elements. The level of protection offered is noted by the garments waterproof rating, a measurement unit of millimeters of water that can pass through one square meter of the fabric/material over the course of 24 hours (Tactics: Choosing Snowboard Outerwear, 2020). Several factors can detract from a garment/material's overall efficacy over time such as exposure to dirt, oil, and sweat (Evo, 2020). Below in Figure 27 depicts the waterproof rating chart and it's in correlation to the water resistance provided along with the conditions it is intended to be used for.

FIGURE 27

WATERPROOF RATING CHART

RATING (MM)	WATER RESISTANCE PROVIDED	CONDITIONS
0-5,000 mm	*No resistance to some resistance to moisture.*	*Light rain, dry snow, no pressure.*
6,000-10,000 mm	*Rainproof and waterproof under light pressure.*	*Light rain, average snow, light pressure.*
11,000-15,000 mm	*Rainproof and waterproof except under high pressure.*	*Moderate rain, average snow, light pressure.*
16,000-20,000	*Rainproof and waterproof under high pressure.*	*Heavy rain, wet snow, some pressure.*
20,000 mm+	*Rainproof and waterproof under very high pressure.*	*Heavy rain, wet snow, high pressure.*

Note: Fabric waterproof ratings chart measured in millimeters of water that can pass through one square meter of the fabric/material over the course of 24 hours (Evo, 2020).

Breathability for temperature regulation and sweat evaporation is an important factor for rider comfort. Breathability ratings are measured using two different approaches; the two most common ones are grams per square meter (g/m^2) and Resistance Evaporating Heat Transfer (RET) (Outdooreer, 2021). The breathability rating that is measured in units by grams refers to the amount of moisture vapor that can pass through a square meter of the fabric in 24 hours time, represented in below Figure 28 (the higher the rating the more breathable the fabric) (Outdooreer, 2021).

FIGURE 28

BREATHABILITY (g/m²) RATING CHART

RATING (g/m²)	BREATHABILITY PROVIDED
5,000 – 10,000 g/m²	*Satisfactory breathability It is fine for more static activities*
10,000 – 15,000 g/m²	*The fabrics are still considered breathable at a satisfactory level, but it is uncomfortable at a high activity rate.*
15,000 – 20,000 g/m²	*The fabric is slightly breathable. It is moderately comfortable at a low activity rate.*
20,000 g/m² +	*Not breathable. Uncomfortable.*

Note: Fabric breathability measured in g/m², grams of moisture vapor can pass through a square meter of the fabric in 24 hours time. In this case, the higher the rating, the more breathable the fabric is (Outdooreer, 2021).

The breathability rating measured in RET or Resistance to Evaporating Heat Transfer approach indicates the resistance of a fabric to water vapor measured in m²Pa/W (Pa = water vapor pressure in the air) represented in Figure 29 (Outdooreer, 2021). RET is the only method that takes into account the aspect of comfort (the lower the RET value, the more breathable the fabric and the more comfortable the fabric will feel during activities) (Outdooreer, 2021).

FIGURE 29

BREATHABILITY RET RATING CHART

RATING (m²Pa/W)	BREATHABILITY PROVIDED
RET 0-6	*The fabric is extremely breathable. It is comfortable at a higher activity rate.*
RET 6-13	*The fabric is very breathable. It is comfortable at a moderate activity rate.*
RET 13-20	*The fabrics are still considered breathable at a satisfactory level, but it is uncomfortable at a high activity rate.*
RET 20-30	*The fabric is slightly breathable. It is moderately comfortable at a low activity rate.*
RET 30+	*Not breathable. Uncomfortable.*

Note: Fabric RET (Resistance to Evaporating Heat Transfer) breathability ratings indicates the resistance of a fabric to water vapor. The RET value measured in m²Pa/W, where Pa = water vapor pressure in the air (Outdooreer, 2021).

Wind resistance is important to snowboarding outerwear as Intense wind chill can drastically influence the temperature experienced by riders. High wind resistance will keep riders warm and dry (Tactics; Choosing Snowboard Outerwear, 2020). A garment's windproof or wind-resistance is controlled through the textile material construction and by the fiber's construction. The tighter the fibers or yarns, the more resistant the fabric will be to wind penetration.

Insulation is another important factor for warmth. Jackets and pants come in both insulated and non-insulated models. Insulation can take the form of either synthetic (typically spun polyester) or natural (duck or goose down) material. Using "body mapping," insulation is placed where heat is needed around the body (heavier around the core and a lighter version for the arms and/or hood)(Evo: Outerwear Construction Guide, 2020). Synthetic insulation weights are expressed in grams per square meter (of the fabric) for example: 100 gram insulation is warmer and thicker than 60 gram insulation (Evo: Outerwear Construction Guide, 2020). A typical winter jacket insulation will feature 80 grams (body) and 60 grams (arms and hood)(Evo: Outerwear Construction Guide, 2020).

Outerwear utilizes layered construction techniques which include: 2 layer (2L), 2.5 layer (2.5L), 3 layer (3L) (Evo: Outerwear Construction Guide, 2020). The most common type of outerwear layer consists of the 2L construction where the liner is constructed separately from the the jacket, adding considerable bulk (Evo: Outerwear Construction Guide, 2020). In 2.5L construction, a very thin raised pattern is typically screened onto the outermost membrane which is used to separate the material from the rider's skin, providing protection from body oils, sunscreen, or other substances that can potentially break down the material over time. The 3L construction consists of an outer layer, referred to as the fabric face which is typically made of nylon or polyester and a bonded membrane (Evo: Outerwear Construction Guide, 2020). The 3L construction is the most advanced, protective, packable, durable, and breathable, as well as the most expensive (Evo: Outerwear Construction Guide, 2020).

Outerwear silhouettes can range from baggy to a skin tight fit (King; Personal Communication, 2020). That being said, snowboarding-specific apparel that takes into account range of motion, biomechanics, and injury prevention, as well as integration with required equipment such as boots is essential for riders comfort and performance (Walsh, personal communication, November 4, 2020). Notably, overly baggy outerwear can get in the way and catch on artificial slopes (King; Personal Communication, 2020). Common features found in snowboarding outerwear includes, but is not limited to:

- Articulated Elbows/Knees: Built in angles around major joints (knee, hip, shoulder, and elbow that affect the riders range of motion (Tactics; Choosing Snowboard Outerwear, 2020).

- Cuffs: Located at the wrist and ankle of the garment to accommodate space for riders gloves and boots and prevent precipitation from entering using a trim closure such as a cinch Velcro(Tactics; Choosing Snowboard Outerwear, 2020).
- Durable Water Repellant Coating (DWR): Additional water protection shield without any sacrifice in breathability (Tactics; Choosing Snowboard Outerwear, 2020).
- Hood (Jackets): Can be fixed, attached, or removable and typically adjustable through cinching cords or Velcro straps. Design can feature hoods that can be worn over or under the helmet or include a chin guard to protect the riders chin (Tactics; Choosing Snowboard Outerwear, 2020).
- Pass Pockets/D-Rings: Access for resort using electronic pass scanners for season passes/lift tickets and typically located on the jacket sleeve near the arm-cuff straps (Tactics; Choosing Snowboard Outerwear, 2020).
- Reinforced Seat/Knees (Pants/Bottoms): Reinforcement around the seat and knees, where most contact with the snow happens as patches, dual layer reinforcement using stronger materials or thicker fiber weaves to combat accelerated wear and tear.
- Seams: Use either seam tape or welding to prevent moisture leakage (Evo: Outerwear Construction Guide, 2020). Seam protection will typically cover exposed sections of the seams (Tactics; Choosing Snowboard Outerwear, 2020).
- Storm Flaps: Additional piece of material meant to keep out snow, rain or wind from breaking through the tiny spaces in the zippers (or other openings). Typically located on the outside of a zipper (Tactics; Choosing Snowboard Outerwear, 2020).
- Utility Pockets: Additional storage for riders items (Tactics; Choosing Snowboard Outerwear, 2020).
- Vents: Provide additional airflow for added thermoregulation and vents are typically found in the underarm area (called "pit zips"), chest, and/or across the back to keep your torso in jackets and along the seams leg interior on bottoms. Vents are often lined with mesh allowing air flow (Tactics; Choosing Snowboard Outerwear, 2020).
- Zippers: Trims will include added strength in gauge, unusually more robust and hefty with technical closures that can be utilized with gloves or mittens and tend to be fully waterproof that prevent moisture from entering through the zipper teeth (Tactics; Choosing Snowboard Outerwear, 2020).

Outerwear Top: Jacket

Jacket product categories led the market and held a revenue share of 60.4% in 2018 (Grand View Research, 2019). Tops are considered an essential component of a style statement, and expected to remain a favorable factor for the industry (Grand View Research, 2019).

Due to the target season of the collection (Spring, Summer, early Fall), the state of the art product selected is a 3 layer shell that is highly breathable with waterproof protection, windproof protection, and trim accessories located in the top-most tier of market price point range.

FIGURE 30

SNOWBOARD STEERING/MANEUVERING TECHNIQUES

BRAND	*Arc'teryx*
PRODUCT NAME	*Rush Jacket Rebird - Mens*
RETIAL COST	*$749.00*
FABRIC CONTENT	*Outer Shell: 96% Polyester, 4% Aramid* *Inner: 100% Nylon*
WEIGHT	*590 g/1 lb 4.8 oz*
COLOR	*Kingfisher/Sundance*
CARE	*Machine wash in warm water (40°C), Double rinse, Do not use fabric softener, Tumble dry on medium heat, Do not iron.*
SIZING	*XXS, XS, S, M, L, XL, XXL, XXXL*
FIT	*Regular Fit, Hip Length, Centre back length: 79.5 cm / 31.25 in*
MANUFACTURING FACILITY	*Karian (Taicang) Sports Apparel Co. Ltd., China*

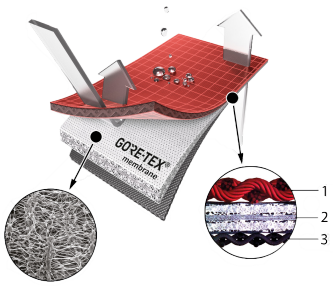
Note: Arc'teryx Rush Jacket Rebird product details (Arc'teryx, 2020).

MATERIALS AND MANUFACTURING

Both the outerwear top and bottom use the same Rugged GORE-TEX Pro fabric; N80p-X 3L, and N100p-X for collar (Arcteryx, 2020). GORE-TEX Pro technology follows a standard 3 layer (3L) construction, including a face (outer) layer, mid (Polytetrafluoroethylene (ePTFE)) layer, and inner (micro-grid) construction. However, updated technology and material innovation set it apart (refer to Figure 31) resulting in the GORE-TEX Pro 3L (Astramael, 2018).

FIGURE 31

GORE-TEX PRO 3L MEMBRANE FABRIC STRUCTURE DIAGRAM



Note: Gore-Tex Pro 3L breakdown. Annotation 1 is the outer face textile. Annotation 3 is the inner micro grid textile. Annotation 2 is the ePTFE membrane. Annotation 4 is a picture of Gore-Tex under a microscope showing its porous structure. This image is a composite of marketing materials from W. L. Gore and Associates (Astramael, 2018).

GORE-TEX Pro 3L development took over three years to make (Wittman et. al., 2020). Bringing together users' requests led to the development of a superior, more rugged technology than previously offered in the GORE-TEX line. Arc'teryx addressed feedback from consumers, athletes, and core users about whiplash (from tree branches) they encounter when exploring off trail in heavily treed areas (Wittman et. al., 2020). Although the new technology isn't 'tree proof,' it offers added protection by increasing durability, which increases its ability to take impact. A benefit applicable not only to the extreme user athletes but additional applications for anyone who encounters substantial impacts to their everyday garments. Additionally, the pro laminate technology offers stretch for the first time and has the ability to react faster than before, supporting thermoregulation accommodating for the body's temperature during high intensity activity (Koksal, 2020).

The face fabric (Figure 31, annotation 1) N80P-XL GORE-TEXT Pro consists of an 80 denier nylon (layer fabric: 5.7oz/yd , 193g/m) (GORE Naming Schema, 2020). The hydrostatic head for the gore proof stretch remains at 28,000 mm and an RET of 13 (Trekitt, 2020). This is a plain weave, it is very tight and does not lose thread integrity easily. It is extremely light and offers breathability and stretch.

Usually for GORE-TEX materials, the color dye process occurs after garment construction, applied using a bath process and dye pigments. A new technology called solution dying allows color to be applied to the nylon yarns when still in pellet form. Solution dying process saves roughly over 50 percent of the water usage (Wittman et. al., 2020).

The membrane utilizes revolutionary GORE-TEX expanded Polytetrafluoroethylene (ePTFE) (refer to Figure 31). ePTFE is macroporous and hydrophobic, due to the extremely small pores which are around 200 nanometers (nm) in size. This prevents water droplets, measuring about 500,000nm in size from permeating through the surface (Astramael, 2018). This is due to water's strong intermolecular forces which prevent molecules from leaving the droplet (Wittman et. el., 2020). Water vapor on the other hand measures just 1nm on average (Astramael, 2018). At this size, the vapor molecule can pass through the pore membrane, thus moisture generated by an athlete, such as sweat, is transported as evaporation. This breathability plays a crucial role in thermoregulation, keeping the athlete dry and warm. This is represented in Figure 31, annotation (layer 2 and made up of the dual-layer corrugated proprietary membrane technology sandwiched around an extremely thin middle layer of unknown composition (Koksal, 2020). The corrugation allows the material to stretch, mimicking a similar action to an accordion. The folds elongate when tension is applied until becomes fully taught and flat. Once strain is removed the membrane recedes to its original corrugated shape. The membrane allows the overall material a stretch capacity of 20%, more than any prior GORE-TEX material (Wittman et. el., 2020).

Despite this, the 3L construction of this garment has slightly reduced overall breathability as a tradeoff for the increased waterproofness. This piece does offer exceptional lightweight water and wind protection as well as durability (Arc'teryx: Rush Jacket ReBird Men's, 2020).

The material is then cut into patterns pieces prior to assembly. The cut material is joined with zippers and remaining trims are applied. The pieces are then transferred to a team to sew and follows a step-by-step construction line assembly process that includes lamination, embroidery, seam sealing, and drawcord attachment before the finial trims are added (by hand) including the drawcord, grommets, snaps, cuff tabs and toggles all get attached by hand. Seams tape is then applied. The entire process assembly requires roughly 100 steps and nearly 200 individual operations to ensure the highest quality standards (Newcomb, 2019).

In addition, in-line checks are randomly performed on 1/3 of all assembled components and randomly tested for waterproofness. By the time the garment is assembles many of the parts have undergone several inspections, by various operators and quality control personnel (Newcomb, 2019).

At this point Arc'teryx products must undergo extensive garment testing, passing multiple rounds of intensive tests developed in-house to replicate harsh environmental elements (Wittman et. al., 2020). The blow tests are summarized to emphasize the rigorous protocol that allows top quality products with life spans that can potentially outlive their owner (Astramael, 2018).

- Martindale Test: Replicates both conditions and intended uses. Wool or sandpaper is rubbed repeatedly against the fabric with considerable pressure and duration can last from hours to days depending on how tough the fabric needs to be (Astramael, 2018).
- Cold Flex Test: Fabrics are squashed and stretched repeatedly in extreme temperatures for hours on end (Astramael, 2018).
- Rain Room Test: Customized weather machine designed to simulate a variety of rain conditions. Specially engineered rain nozzles are strategically positioned inside the chamber where garments undergo the gamut of precipitation (Astramael, 2018).
- Storm Cube Test: Arc'teryx engineered weather machine built to replicate multiple wind conditions–even high force gales, generating up to 50 mph winds (Astramael, 2018).
- Instron Test: Rigorous stretch tests ensure garment strength including tear testing to ensure that any damage will not spread (Astramael, 2018).
- Comfort Test: Using laboratory measurements in addition to human wear testing to ensure comfort throughout activities and conditions (Astramael, 2018).

Following product test approval the product is prepared with handbags and any additional packaging necessary. On average outerwear jackets undergo 24.149 min. of cutting, 222.157 min. of sewing, 32.376 min. of finishing and pass through 67 different operators hands. Bringing the total assembly time of 259 minutes (Arc'teryx, 2021).

FEATURES AND BENEFITS

FIGURE 32

OUTERWEAR TOP: JACKET - FEATURES AND BENEFITS

PRODUCT	FEATURES	BENEFITS
ARC'TREYX *Rush Jacket Rebird*	- *Waterproof* - *Windproof* - *Breathable* - *Durable* - *Helmet compatible StormHood™* - *Adjustable hood drawcords* - *Internal laminated pocket with zip* - *Laminated die-cut Velcro® cuff adjusters* - *WaterTight™ zippers* - *RS™ zipper sliders* - *Taped seams for added weatherproofness* - *Articulated patterning* - *No-lift gusseted underarms* - *WaterTight™ pit zippers* - *Micro webbing zipper pulls* - *Adjustable hem drawcord* - *Drop back hem* - *Powder skirt with gripper elastic and snap closure* - *Hidden RECCO® reflector* - *Micro-seam allowance (1.6 mm)*	- *Regular fit provides room for movement and additional layers if needed* - *Articulated patterning offers unrestricted mobility* - *Relaxed cuffs to fit over any glove type* - *Made from reclaimed excess raw materials* - *Slide 'n Loc™ snap closures on powder skirt enable jacket to be fastened to specific ski pants to prevent snow entry* - *Seam allowance reduces bulk and weight* - *Taped seams add weatherproofness* - *Burly and breathable N80p-X 3L Most Rugged GORE-TEX PRO in the body with N100p-X face fabric for additional protection*

Note: Arc'teryx Rush Jacket Rebird features and benefits (Arc'teryx, 2020).

COMPETITOR PRODUCT LANDSCAPE

Jackets vary in retail price starting at $150 to upwards of $700 represented in diagram 32A. Representative of price range in relation to features and benefits (Walsh, personal communication, January 11, 2021).

FIGURE 32A

PRICING QUALITY MATRIX

Note: Philip Kotler's Price Quality Matrix centers on the cross-section between the two metrics that lend the nine variable model results are reflect interaction between the products price and quality (How to Use the Price Quality Matrix to Optimize Your Product Pricing, 2020).

The primary focus will include premium performance materials and trims, along with fashion forward brand aesthetic, with price points at the higher end of the competitor landscape (Rodriguez, 2020). The following list features similar brands featuring similar attributes, considered brand competitors that include but are not limited to; Acromym, Arc'teryx, Blackyak, Bogner, Goldwin, The North Face (Purple Label), Houdini, Mammut, Snow, Peak, Moncler Grenoble, Stone Island, W.L. Gore & Associates, and Veilance (Rakestraw, 2019).

STATE OF THE ART MATERIAL LANDSCAPE

Sustainable advancements have developed use of regenerated material technology offering an alternative to conventional mesh (Kommer, 2019). Mesh is specifically found in outerwear jacket underarm and bottom interior leg zipper lining that provide additional thermoregulation options (typically used when additional airflow is necessary to release water vapor buildup inside the garment). Econyl is 100 percent regenerated and regenerative nylon fiber made from nylon waste (such as fishing nets), manufactured by the Italian company Aquafil (Kommer, 2019). Using a global recovery program, partner suppliers recover waste from landfills and oceans; the waste undergoes multiple processing steps that result in new nylon fibers (Kommer, 2019). The fibers retain the benefits of conventional nylon in terms of functionality, durability, breathability, and tear-resistance, and can be recycled indefinitely (Kommer, 2019). According to Aquafil, 10,000 tons of Econyl save some 70,000 barrels of crude oil and prevent 57,100 tons of CO2 emissions (thereby reducing the greenhouse effect by approx. 80 percent in comparison to conventional nylon fibers) (Kommer, 2019).

Another sustainable alternative is the 100 percent recycled PES membrane (or Polyethersulfone is a high-performance thermoplastic and is the most temperature-resistant transparent commercially available thermoplastic (Ran, 2015)) developed by German manufacturer Jack Wolfskin (Kommer, 2019).

Additionally The North Face brand recently developed its proprietary Futurelight membrane using a nano structure that allows air to pass through for better venting and breathability without sacrificing waterproofness and durability (Futurelight™ Fabric Technology: The North Face, 2020). The company has recently implemented use of 100 percent recycled nylon material with a recycled polyester lining which boasts new sustainability methodology (Kommer, 2019).

DWR spray can play a vital role in athlete comfort and thermoregulation of outerwear garments (Evo, 2020). Applied during the dye phase or by spray after the garment construction, DWR has progressed substantially through technological advancements that were once associated with harmful side effects to the environment (Evo, 2020). The Filium process can be applied to any natural fabric and the developed technology is safe for the planet, lacking any nanoparticles or harmful chemicals that can break down and leech and into the skin and/or environment (Filium, 2021). Additionally Psyllium can repel liquid by allowing perspiration to evaporate through the brief breathable fabric, naturally resisting odors, repels water, dries faster, and along with additional properties of stain resistance and fast drying (Filium, 2020).

Outerwear: (Bottom) Bibs

Outerwear Bottoms (pants and bibs) product categories are projected to expand at the fastest CAGR of 6.8% from 2019 to 2025 (Grand View Research, 2019). Growing awareness regarding personal safety during sports is driving consumers to purchase bottoms that can provide protection from the elements and resist the wear and tear associated with sport participation (Grand View Research, 2019). Additionally, the implementation of stringent regulations by international snow sports organizations to ensure the safety of athletes is expected to play a key role in expanding the reach of the segment over the next few years (Grand View Research, 2019).

Outerwear bottoms follow the same general design elements found in outerwear shells/jackets. Rider preference dictates whether pants or bibs are worn, but bibs offer several important advantages over pants including better protection of the riders back-side from rain/snow when seated (necessary when riders strap into bindings after dismounting from the chair lift prior to proceeding downhill), adjustability, and comfort (due to the construction where a waistband is not essential and will not put pressure on the rider's core) (Evo, 2020). The primary drawback of bibs has been solved in recent designs which offer construction workarounds to make bathroom breaks for either gender effortless (Evo, 2020). The preceding design benefits led to the selection of the bib as the silhouette for this project. The Arc'teryx Rush RL Pant was selected as the state of the art product due to the brand reputation offering the most technologically advance materials and trims on the market. The retail price point classification is similar to the intended range specifically. Additionally Arc'teryx's recent brand collaborations and part-

nerships with luxury fashion brands, developing products the meet the intended high end fashion and functionality requirements that align with the intended capstones objective.

FIGURE 33

STATE OF THE ART OUTERWEAR BOTTOMS: BIBS

BRAND	*Arc'teryx*
PRODUCT NAME	*Rush FL Pant - Mens*
RETIAL COST	*$325.00*
FABRIC CONTENT	*Outer Shell: 96% Polyester, 4% Aramid* *Inner: 100% Nylon*
WEIGHT	*650g /1lb 6.9oz*
COLOR	*Enigma*
CARE	*Machine wash in cold water. Do not use fabric softener. Tumble dry on low heat. Do not iron.*
SIZING	*S, M, L, XL, XXL*
FIT	*Regular Fit, Hip Length, Centre back length: 79.5 cm / 31.25 in*
MANUFACTURING FACILITY	*Pt. Pancaprima Ekabrothers, Indonesia*

Note: Arc'teryx Rush FL Pant product details (Arc'teryx, 2020.

MATERIALS AND MANUFACTURING

Snowboard bibs use the same materials and construction techniques as jackets and shells. Refer to Outerwear: Jacket Materials and Manufacturing section.

FEATURES AND BENEFITS

FIGURE 34

OUTERWEAR BOTTOM: BIBS - FEATURES AND BENEFITS

PRODUCT	FEATURES	BENEFITS
ARC'TREYX *Rush FL Pant*	- *4-way stretch* - *Two zippered leg vents* - *Belt loops* - *Adjustable, removable suspenders* - *Keprotec™ instep patches* - *Articulated patterning* - *Gusseted crotch* - *Zippered hem gusset* - *Thigh pockets, left side interior key clip* - *100D Cordura® Quick adjust TouringCuff™*	- *Weather resistant* - *Stretch provides comfort, and flattering fit* - *Instep patches provide superior protection against damage by boots, crampons* - *Fabric has excellent next to skin feel* - *Patterning and crotch gusset allows for unrestricted mobility* - *Hem gusset accommodates various boot volumes* - *Cuff allows for easy buckle management*

Note: Arc'teryx Rush FL Pant features and benefits (Arc'teryx, 2020).

COMPETITOR PRODUCT LANDSCAPE

High-quality snow pants range from $100 to over $500, with premium performance materials and trims, along with fashion forward brand aesthetic, with price points at the higher end of the competitor landscape (Rodriguez, 2020). The following list features similar brands featuring similar attributes, considered brand competitors that include but are not limited to; Acromym, Arc'teryx, Blackyak, Bogner, Goldwin, The North Face (Purple Label), Houdini, Mammut, Snow, Peak, Moncler, Stone Island, W.L. Gore & Associates, Veilance (Rakestraw, 2019).

STATE OF THE ART MATERIAL LANDSCAPE

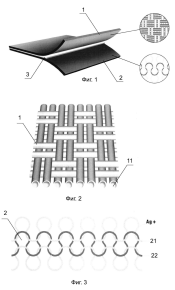
Refer to Outerwear: Jacket Materials and Manufacturing section.

PATENT LANDSCAPE

FIGURE 35

AIR-PERMEABLE TEMPERATURE-REGULATING CLOTHES

PATENT NUMBER: RU2731005C1

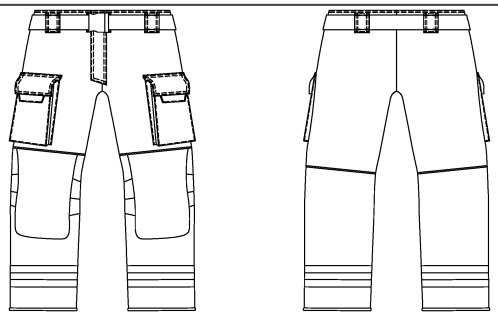


Abstract: "Present invention relates to light industry, namely to air-permeable thermoregulating clothes containing outer layer and inner layer, and can be used for production of sportswear, in particular sports clothes for children. According to the invention, the outer layer is made of hollow fibers, and the inner layer is a mixture material, in which at least 50 % of the fibers contain silver ions, wherein the layers are joined to each other by heat-gluing polymers by thermoregulation. Effect: providing an antibacterial effect while maintaining prevention of human overheating or overcooling" (Махтей, 2020).

FIGURE 36

FIREFIGUREHTER PANTS HAVING KNEE PADS

PATENT NUMBER: US20200316410A1



Abstract: "There are provided fireFigurehter protective pants including an inner liner, an outer shell and two pant legs. The outer shell is made of a flame-resistant material and extends over at least a portion of the inner liner. Each of the two pant legs includes a knee sleeve affixed to the inner liner at a knee height inside the corresponding pant leg and a knee pad held on the knee sleeve and extending across a front knee portion of the corresponding pants leg" (Barbeau,& Roy, 2020).

Impact Protection

As snowboarding continues to push performance boundaries injury rate and occurrence will subsequently continue to rise (Grand View Research, 2019). Recent (2019-2025) snow sport research reported a growing interest around safety awareness information due to increased fatal accident occurrence projections, permitting the development and usage of specific snowboard related protective product equipment and apparel (Grand View Research, 2019).

Snowboarding impact and padding protection is typically sold as a separate article of clothing/equipment and layered below the rider's outermost layer (Evo, 2020). Padding will vary from brand to brand, and offer unique solutions differing in the area of coverage, the impact technology or padding material used, resulting in a wide range of designs. Products can differ the following ways (but not limited to): pad coverage or placement - tailored for different rider preferences and coverage needed; padding density or thickness - ranging from one-quarter inch to half-inch thick (thicker padding offers more safety but increases the bulk and overall product weight); and, padding material, typically made from a soft foam or a combination of hard plastic and soft foam (softer foam initial impact force is dispersed over a wider area where hard plastic similarly disperses impact forces but offers additional puncture protection (Sicuro, 2020). Current snowboarding padding products fall within the below categories:

- Helmet: Required by resorts and highly recommended to prevent serious head injury (Sicuro, 2020).
- Wrist Guards: Brace developed for the hand impact, a rider's natural reaction when bracing for a fall (especially for beginners) (Sicuro, 2020).
- Knee/Elbow Pads: Can prevent bruising and general impact experienced when snowboarding, they provide an added layer of protection when learning to ride or attempting new tricks (Sicuro, 2020).
- Back Protectors: Although back injuries are uncommon when they do occur they can be severe. Back protectors can come with additional padding for riders shoulders, but seriously restrict riders upper-body movement (Sicuro, 2020).

Impact protection has the potential to mitigate impact and manage injuries but can not prevent injury occurrence or serious unavoidable injury associated with the sport of snowboarding. However developing specific padding to specified areas (defined through biomechanical injury analysis) can offer more protection than having no

protection at all. The overall performance of padding is directly correlated to the pad material thickness of the outer shell and the material content makeup, meaning that a thinner but stronger outer shell is equal to a thicker but less rigid material (Cazón-Martín, et. al., 2019). A compromise between weight and protection should be considered in order to improve the rider's comfort.

This capstone will address general body impact protection, including knee pads, and elbow pads (high impact snowboard injury areas). The state of the art products selected do not cater to the temperature demands required for dry slope snowboarding thermoregulation and will be used for research and performance application used to design dry slope snowboard specific apparel and accessories.

IMPACT PROTECTION: SHORTS

Shorts provide padding in several key areas including (but not limited to): the coccyx, the buttocks, the hip bones, and outer thighs.

Padding thickness and shape can afford different levels of protection to areas that encounter more frequent or harder impact. Harder materials can offer higher levels of protection but limit range of motion and mobility of the rider (Evo, 2020).

FIGURE 48

STATE OF THE ART IMPACT PROTECTION SHORTS

BRAND	*Burton*
PRODUCT NAME	*Total Impact Short, Protected by G-Form™*
RETIAL COST	*$129.95*
FABRIC CONTENT	***Mainbody:*** *DRYRIDE Ultrawick™ Lightweight 100 fabric* ***Padding:*** *G-Form™ impact protection padding (hips, leg, and tailbone)*
COLOR	*True Black*
CARE	*Machine-wash*
SIZING	*S, M, L, XL*
FIT	*Next to skin*

Note: Burton Total Impact Short, Protected by G-Form™ short product details (Evo, 2020).

MATERIALS AND MANUFACTURING

Burton Total Impact Short main body uses Dryride Ultrawick™ lightweight 100 fabric is proprietary technology containing 93% Polyester, 7% Spandex (Burton, 2020). Patent protection prevents any information regarding the material and/or manufacturing process aside from addressing the microscopic fiber that pulls heat away from the rider's body through moisture vapor transport (Burton, 2020). Fabric benefits include unrestricted stretch capability, high breathability and ultra fast-wicking properties. Although the knit construction remains unavailable the short uses softlock seams construction to mitigate any potential chafing if worn next to the rider's skin (evo, 2020). The short features a thick soft-waist elastic waistband with a rushed interior for comfort.

The padding consists of Smartflex™, G-Form's revolutionary technology, that offers freedom of motion that moves with the body (G-Form, 2020). SmartFlex™ pad interior foam core is made up of molecules that repel each other while sedentary (G-Form, 2020), making the material soft and flexible. Upon impact the form molecules bind together causing the pad to stiffen, as it absorbs the initial impact, and redistribute the energy (G-Form, 2020). After the impact foam molecules return to their original state, and the form reverts to its original soft and malleable state (G-Form).

FEATURES AND BENEFITS

FIGURE 49

PROTECTIVE GEAR | SHORT | FEATURES AND BENEFITS

PRODUCT	FEATURES	BENEFITS
BURTON *Total Impact Short, Protected by G-Form™*	*- Next-to-skin fit hugs the body with minimal extra fabric* *- Quick-drying* *- Highly-breathable* *- Uses G-Form's proprietary impact protection technology* *- Ergonomic hip, tailbone, and sit bones padding* *- Softwaist waistband* *- Imported*	*- Softwaist reduces chafing* *- Sleek, streamlined feel & silhouette* *- Stay dry & cool while working out*

Note: Total Impact Short, Protected by G-Form™ features and benefits (Burton, 2020).

COMPETITOR PRODUCT LANDSCAPE

Impact short retail price range from $50.00 to $150 US dollars (King, personal communication, November 5th 2020). Impact protection shorts are offered by the following brands (but not limited to): Burton, Core, Ennui, G-Form, Powerslide, and Tortoise Pads (Evo, 2020).

STATE OF THE ART MATERIAL LANDSCAPE

Recent developments in 3D printed padding placed into the garment locations as an additional layer has shown to assist impact loading forces for snowboarders.

One of the most innovative proprietary products in this space is RHEON™ Technology innovation by RHEON labs. Their technology is primarily used in football helmets to control energy of any amplitude or frequency – from small vibrations to life-threatening single impacts by using an active polymer that intelligently changes its behavior in response to movement (Rheon, 2020). They have incorporated highly strain-rate sensitive polymers into functional structures, giving products unique levels of energy control which can give products properties previously thought impossible with conventional materials (Rheon, 2020).

In conclusion, the 3D printed pads modeled with reference to the shape of the 3D human body were superior in terms of comfort. Moreover, the open type-pad showed superior comfort, fit, and motion comfort to the original-type pad. With continued advances in 3D printing technology, print speed will become much faster, thus enabling the manufacture of personalized pads, leading to greater comfort. The results and methods of this research could be utilized in the development of various protector pads in 3D form and a protocol for the production of personalized pads in the future. Furthermore, these protocols can be applied as source technology in the field of clothing grafted with 3D printing and applied in diverse ways in the clothing industry. Moreover, 3D printing technology will become established as the leading technology in the clothing market, which is expected to be applicable in academia as well. However, in this study, research on the relationship between heat and comfort during long-term wear or exercise was not conducted; further research on these issues must therefore take place. Additional research is also necessary to produce a more objective investigation of protectors and field tests measuring the level of comfort of the new open-type protector pads compared to the original type, including the ease with which sweat is released. Moreover, application of new materials with better shock absorption and evaluation of their performance should be carried out as well. Furthermore, snowboard protectors for females should also be developed in future studies by applying the protocol established in this study (Hong, et. al., 2020).

FIGURE 50

CUSHIONS COMPRISING A NON-SLIP ELASTOMERIC CUSHIONING ELEMENT

PATENT NUMBER: US6253376B1

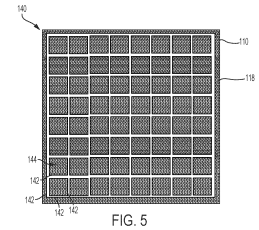


FIG. 5

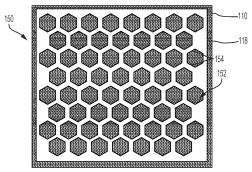


FIG. 6

Abstract: "A cushion includes a cover and a cushioning element having a top surface heat-fused to the cover. The cushioning element comprises an elastomeric material having a plurality of voids formed therein. At least 60% of a bottom surface of the cushioning element is exposed such that when the cushion is disposed over a surface at least 60% of the bottom surface of the cushioning element is in direct contact with the surface. Methods of foaming the cushion include disposing a cover adjacent a mold, conforming the cover to a selected shape of the mold, injecting molten elastomeric material into the mold, bonding the molten elastomeric material to the cover, solidifying the molten elastomeric material to form the cushioning element, and separating the mold from the cover. The cushioning element maintains the cover in the selected shape" (Pearce, Pearce, & Whatcott, 2016).

FIGURE 51

TEXTILE GARMENT WITH BALLISTIC PROTECTIVE EQUIPMENT

PATENT NUMBER: DE202020105724U1

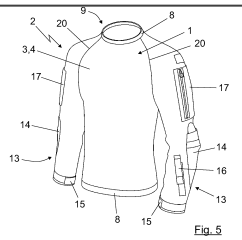


Fig. 5

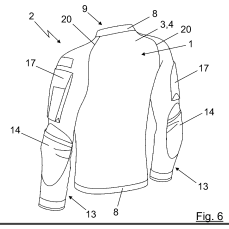


Fig. 6

Abstract: "Textile item of clothing (1) with ballistic protective equipment, the textile item of clothing (1) being formed from a material mix of several yarns (3, 4) with different properties that are knitted together so that the material mix has a ballistic component and at least one other Has proportion, characterized in that the textile item of clothing (1) consists of at least 80 wt The item of clothing (1) consists of at least 40% by weight of silk" (Textile garment with ballistic protective equipment, 2020).

Impact Protection: Knee Pads

Knee pads offer joint impact protection and additional cushion that require an extensive freedom in mobility (Mechanics of Sport, 2020). Knee pad design varies in functionality, fit (maneuverability), and various levels of protection. The main limitation is maneuverability restriction of joint flexion (Protective Gear For Snowboarding, 2020). This limitation can hinder riders' performance ability, and ability to perform tricks that specifically require jumping or rotation (Protective Gear For Snowboarding, 2020).

The current market landscape products intended as separate pieces of equipment which can aid in cold weather heat retention. However the warm temperatures specific to this capstone collection can cause riders to overheat.

FIGURE 52

PROTECTIVE GEAR | KNEE PADS

BRAND	*POC*
PRODUCT NAME	*Joint VPD Knee System*
RETIAL COST	*$150.00*
FABRIC CONTENT	*Tube: 95% Polyester, 5% Elastane* *Filter:*
COLOR	*Uranium Black*
SIZING	*S, M, L*

Note: POC Joint VPD System knee pad product details (POC, 2020).

MATERIALS AND MANUFACTURING

The main body consists of a neoprene using raw materials made from a powder base, or chloroform in addition to other ingredients that provide elasticity, foaming agents, cell conFigureuration, color, adhesion, and bulk, among other properties (Neoprene, 2021). This mixture of raw material powders is mixed several times through a chemical reaction using chloroprene and butadiene acting as a binding agent reaction which creates a dough like substance (Neoprene, 2021). The dough is then melted using heat and high temperatures and mixed together with foaming agents and pigment, this baking process help to expand the substance which is when the micro-cell structure neoprene is created. The formed sponge is then cooled and can be cut to carrying thicknesses before the final laminating process occurs (commonly using stretch textiles such as nylon, polyester, or jersey knits) to add additional strength and alter the overall appearance (Neoprene, 2021). The overall fabric fiber construction utilizing the polyamide yarns which creates a low friction surface with high abrasion resistance (Joint VPD Air Flow, 2020).

The padding is composed of proprietary VPD (Visco-Elastic Polymer Dough) technology that offers extreme impact absorption, highly adaptable and malleable which creates a customized form fit unique to the wearer. The padding is approximately .25-.5-inches thick and provides instant material transitions from a soft state to a solid once impact force is applied, and returning to its original state after impact. This padding design provides a highly efficient ventilation system and one of the most sophisticated protection materials on the market (Joint VPD Air Flow, 2020). This material retains the same high absorption levels after every impact thought its product lifetime.

FEATURES AND BENEFITS

FIGURE 53

PROTECTIVE GEAR | KNEE PADS | FEATURES AND BENEFITS

PRODUCT	FEATURES	BENEFITS
POC *Joint VPD Knee System*	- *Extremely flexible* - *Light weight* - *Certified EN 1621-1 Level 2 shock absorption* - *Low friction* - *High abrasion resistance*	- *Highly efficient ventilation system to stop the wearer overheating* - *The knee protector conforms to to the body shape without limiting movement*

Note: POC Joint VPN Knee System features and benefits (POC, 2020).

COMPETITOR PRODUCT LANDSCAPE

Impact protection knee pads retail price range $30.00 - $150.00 US dollars. Prevalent brands include (but are not limited to): Arc'teryx, Black Diamond, Burton, Dakine, G-Form, and POC.

STATE OF THE ART MATERIAL LANDSCAPE

Refer to Impact Protection: Short State of the Art Martial Landscape section.

PATENT LANDSCAPE

Refer to Impact Protection: Short Patent Landscape section..

Impact Protection: Elbow Pads

Elbow pads exist for various sports from volleyball to skateboarding and hockey and range from light soft padding to rigid plastic construction. The selected state of the art elbow padding, by POC, is the Joint VPD Air Elbow. It is lightweight, offering high impact absorption, and provides added safety without sacrificing flexibility (Joint VPD Air Flow, 2020). The selected elbow pads were initially developed for cyclists and offer enhanced flexibility, ventilation, and range of motion (Joint VPD Air Flow, 2020).

FIGURE 54

STATE OF THE ART ELBOW PAD

BRAND	*POC*
PRODUCT NAME	*Joint VPN Air Elbow*
RETIAL COST	*$70.00*
FABRIC CONTENT	*Main Body: Reinforced Stretch Fabric* *Neoprene Anti-Slip on the Inside* Padding: *Lightweight and impact absorbing VPD compound*
COLOR	*Uranium Black*
CARE	*Hand Wash*
SIZING	*XS, S, M, L, XL*

Note: POC Joint VPD Air Elbow pad product overview (POC, 2020).

MATERIALS AND MANUFACTURING

The main body of the elbow pad consists of a neoprene using raw materials made from a powder base, or chloroform, in addition to other ingredients that provide elasticity, foaming agents, cell conFigureuration, color, adhesion, and bulk, among other properties (Neoprene, 2021). This mixture of raw material powders is mixed several times through a chemical reaction using chloroprene and butadiene acting as a binding agent reaction which creates a dough like substance (Neoprene, 2021). The dough is then melted using heat and high temperatures and mixed together with foaming agents and pigment, this baking process helps to expand the substance which is when the micro-cell structure neoprene is created. The formed sponge is then cooled and can be cut to varying thicknesses before the final laminating process occurs (commonly using stretch textiles such as nylon, polyester, or jersey knits) to add additional strength and alter the overall appearance (Neoprene, 2021). The overall fabric fiber construction utilizing the polyamide yarns creates a low friction surface with high abrasion resistance (Joint VPD Air Flow, 2020).

The padding is composed of proprietary VPD (Visco-Elastic Polymer Dough) technology that offers extreme impact absorption, and is highly adaptable and malleable which creates a customized form fit unique to the wearer. The padding is approximately .25-.5-inches thick and instantly transitions from a soft state to a solid once impact force is applied, and returns to its original state after impact. This padding design provides a highly efficient ventila-

tion system and is one of the most sophisticated protection materials on the market (Joint VPD Air Flow, 2020).

This material retains the same high absorption levels after every impact throughout its product lifetime.

FEATURES AND BENEFITS

FIGURE 55

PROTECTIVE GEAR | ELBOW PAD | FEATURES AND BENEFITS

PRODUCT	FEATURES	BENEFITS
POC *Joint VPD Knee System*	- *Lightweight* - *Impact absorbing* - *Ventilated panels* - *Reinforced stretch fabric* - *Crash retention strap (CRS) for a comfortable fit* - *Neoprene anti-slip on the inside* - *Low profile*	*- Ventilation keeps riders cool and protected*

Note: POC Joint VPN Knee System features and benefits (POC, 2020).

COMPETITOR PRODUCT LANDSCAPE

Elbow pads are similarly priced with knee pads and retail prices range from $20.00 - $130.00 US dollars. Prevalent brands include (but are not limited to): Arc'teryx, Black Diamond, Burton, Dakine, G-Form, and POC.

STATE OF THE ART MATERIAL LANDSCAPE

Refer to Impact Protection: Short Materials and Manufacturing section..

Patent Landscape

Refer to Impact Protection: Short Patent Landscape section..

SWOT ANALYSIS

FIGURE 56

STATE OF THE ART PRODUCT SWOT ANALYSIS

	PRODUCT	STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
	**Arc'teryx** *Rush FL Jacket (Arc'teryx, 2020)*	- *Long bottom hem, covering the butt and upper thigh, perfect for snowboarders who spend more time sitting on the ground strapping in before a run* - *Limited edition design uses rare color block design*	- *This brand tends to model silhouettes off of skier rather than snowboarders which doesn't offer specific back length needed for snowboarders who tend to sit more that skiers*	- *A top of the line brand will be a go to for people with no price limitations*	- *Niche price point appealing to those with a disposable income*
	**Arc'teryx** *Rush FL Pant (Arc'teryx, 2020)*	- *Low profile and malleable moves with the riders without feeling bulky or limiting movement* - *Adjustable suspenders keep pants from shifting during movement*	- *While product accommodates snow sport needs its not designed specifically for snowboarding* - *Low waist height for a bib silhouette* - *Dark colors can result in overheating in warm environments*	- *Capitalize on patented technology unique to this product* - *Appeals to riders who trust Arc'teryx as a performance brand*	- *Could alienate skiers who want a ski specific product* -
	**Burton** *Burton Total Impact Short, Protected by G-Form (Burton, 2020)*	- *Specifically engineered, designed and developed for snowboarders*	- *One padding thickness, could cause pants not to fit* - *Specifically engineered, designed and developed for winter temperatures and climate* - *Can look and feel diaper like making riders self-conscious*	- *Capitalize on patented technology unique to this product*	- *Product requires an added layering component adding bulk and inhibiting ventilation potential*
	**POC** *Joint VPD Joint System (POC, 2020)*	- *High abrasion resistance exterior fabric withstands wear and tear* - *Highly efficient ventilation system supports thermoregulation* - *Gripper band adds pad slippage assurance*	- *Specifically engineered, designed and developed for winter temperatures and climate* - *Padding will become ineffective after a certain amount of impacts* - *Minimal stretch doesn't allow extensive adjustability*	- *Capitalize on patented technology unique to this product*	- *Doesn't provide as much impact protection as full, hard shell pads*

	**POC** *Joint VPD Air Elbow (POC, 2020)*	- *Neoprene interior non slip material keeps product from shifting from intended coverage location* - *Low profile and flexible padding design confirms around the elbow without restricting movement*	- *Specifically engineered, designed and developed for winter temperatures and climate* - *Padding will become ineffective after a certain amount of impacts*	- *Capitalize on patented technology unique to this product*	- *Doesn't provide as much impact protection as full, hard shell pads*

State of the art product SWOT Analysis, a compilation of the product's strengths, weaknesses, opportunities and threats that help identify opportunities that have not been addressed.

PRODUCT PITCH CONCLUSION

There is currently a gap in the snowboard market for dry slope snowboard specific performance apparel, equipment, and accessories. Currently, the snowboard brand landscape neglects to recognize the future growth potential of dry snowboarding specific apparel, accessories, and equipment. Dry slope snowboard riders are faced with the challenge when assembling an outfit that meets the demands of dry slope snowboarding which requires riders to expand their search, borrowing apparel and equipment from other sport specific categories that can ultimately fall short in terms of performance and protection needed by dry slope snowboards. This provides a substantial opportunity for expansion and growth by adding a new category to seasonal product line assortments - one that expands into the spring, summer, and early fall which is referred to as the resort "off-season."

Additionally, the impact of climate change on the sport specific market predicts future decline in revenue and participation as a result of global warming seasonal snow volatility, becoming less reliable, and will slowly shorten resorts' operational window - expanding the off-season. Dry slope sports offer resorts an alternative means of revenue through dry slope installation on current slopes, offering year round revenue that works seamlessly with grooming equipment when snow cover is available. In short, dry slope snowboarding presents a lifeline to today's snow resorts in the face of climate change.

Off-Season will serve as the dry slope snowboarding sport debut collection, including high fashion, high function apparel and accessories using sustainable materials and manufacturing techniques. This initial high fashion debut will cater to fashion-forward streetwear and luxury market culture that demands highly technical and func-

tional solutions, providing multiple use applications and act as layering components in winter specific snowboarding attire. Off-Season will deliver a revolutionary collection of unisex apparel and accessories to dry slope snowboarders that will accommodate impact protection, regulate heat and SPF protection, provide comfort, that offers alternative use scenario opportunities. Apparel and accessories will be designed using sustainable materials and responsible manufacturing processes to prevent further impact on the snow-sport season. There is an opportunity to utilize sustainable materials produced into a fully circular product lifecycle without any residual production manufacturing effects.

The items that will be developed for the Off-Season collection include impact protection integrated into singular apparel outer garment solutions. A base layer garment top and bottom, and a gaiter/face mask (that prevent virus transmission for future pandemic and general disease prevention measures) will be created with warmer off season temperatures in mind.

MENTOR MAPPING

Mary Walsh is a writer and photographer based in Southern California and Salt Lake City, Utah (season depending). She is the Senior Editor of Snowboarder Magazine, a contributor for Biglife Magazine and has written and/or shot photos for a variety of action sports, outdoor, and resort publications as well as collaborated with snow and skate brands. In her free time, she is the co-founder of Beyond the Boundaries, a women's snowboard camp and tour operation that focuses on community inclusion through spending time in the mountains (Walsh, personal communication, November 4, 2020). Mary's knowledge of the overall product landscape will play a vital role in the development and innovation insight of both products and accessories. As a snowboarder herself he understanding of product needs will be beneficial to the overall concept.

Dr. Donal O'Leary works to empower people to access, understand, and use NEON data for both teaching and scientific research. As a data science educator at the National Ecological Observatory Network (NEON), his duties include: teaching workshops in academic environments and at scientific conferences, curating and publishing open source tutorials for accessing and analyzing NEON data, and supporting researchers in their scientific objectives. Donal's expertise in remote sensing and higher education, combined with data science skills (R, Python,

Arc, etc.) and years of field experience, supports investigations spanning the broad range of NEON data products. Prior to pursuing higher education, Donal spent years gaining hands-on field experience working for the National Park Service as a trail crew leader and volunteer coordinator. Motivated to return to school by the emergence of GIS technology in conservation management, Donal earned his B.S. in Watershed Science with a minor in Spatial Information Management from Colorado State University, his M.S. in Geography from Western Washington University, and his PhD in Geographical Sciences from the University of Maryland. Over that time, Donal has taught numerous university courses in geography, environmental science, GIS, computer programming, and statistics, both in-person and online (Donal O'Leary Biography, 2020). Donal played a large role in understanding how climate change will impact the snow seasons future role in the expansion of dry slopes. His research and educational studies are specific to snowfall and helped in my educating and understanding of what snow seasons will look like in coming years (Donal O'Leary Biography, 2020).

Willie Marshall is a senior knit designer at Ralph Lauren where he has worked for the past 15 years. In 2006, following his graduation from FIT in New York City where he majored in menswear fashion and textile surface design he started his first role as a movie and Broadway costume designer, where he refined his patterns and tailoring expertise. In 2008 he moved to his next role at Ralph Lauren where he worked in the Men's Knit Department. His experience and in-depth knowledge of knitwear includes (but is not limited too); ideation, concept development (patterning, construction, tech packs, and product development), color, finish, fitting, and sourcing. He has led several of Ralph Laurens special projects including Wimbledon, US Open, Olympics, World Cup, and Major League Baseball. Additionally he posses a depth of experience in developing supplier and factory relationships across the globe. He posses a strong desire to continuously develop his knowledge and understanding of the current consumer market and the foreseeable future of industry trends. Willie's mentorship will play a crucial role in throughout the design ideation and development of apparel and accessories for this dry slope collection. I will utilize his vast wealth of knowledge in multiple construction, materials, trims, and manufacturing will His input and feedback is highly valuable and constructive and look forward to the next several months of working with one another.

Personal Innovator Strength Application

Five strengths below were assigned through the "Strengths Finder" assessment test developed by Tom Rath, determined from 34 defined strengths. Personal results are listed below in ranking order:

- Individualization: People exceptionally talented in individualization theme are intrigued with the unique qualities of each person. They have a gift for Figureuring out how people can work together productively.
- Ideation: Fascinated by ideas. Able to find connections between seemingly disparate phenomena.
- Includer: Accept of others. Show awareness of those who feel left out and make an effort to include them.
- Strategic: Create alternative ways to proceed. Faced with any given scenario, quickly spot the relevant patterns and issues.
- Restorative: Adept at dealing with problems. Good at Figureuring out what is wrong and resolving it.

The project topic can be considered a new segment in the snowboard market. This presented a number of obstacles to overcome when researching and collecting data needed for my research paper. These unique challenges mandated employing all five of the five defined strengths. Individualization and ideation were key in developing how the sport itself is defined. The lack of reports and resources forced me to piece together a plethora of information from several different resources. The process was fragmentary, which made it necessary to harness my restorative and includer strengths. Using inclusion which in this instance almost worked in reverse. I first had to strategies what contacts were necessary to reach out too, by compiling the necessary information to paint a complete picture of not only the sport but the direction of my project.

My strengths as an innovator will ultimately define the outcome of this project. My perseverance and industry knowledge that I have aggregated throughout the years will play an important role in how I develop my products throughout the design process. My overall strategy to develop this apparel and accessory collection will be multidisciplinary and applicable for usage in spring, and cold weather mountain snowboarding.

DESIRED ROLE CAREER APPLICATION

I chose this subject specifically to align with my goals after graduation. My ideal job working in design for a high fashion outdoor sportswear company. The contacts and research have already put me in direct contact with

industry professionals. As I have learned in my career thus far contacts can be everything, no matter your industry. I continue to confirm an additional professional specific to high end outdoor apparel, this could provide valuable insight throughout the next phase of design development and manufacturing.

SECTION I CLOSING

This report should be considered a collection of preliminary research, information collected that can provide insight and accurate representation of the past, present, and future of dry slope snowboarding. Although dry slope snowboarding is a relatively new sport, its growth potential is inevitable as a result of snow sports' limited future due to climate change. Dry slope snowboarding has an undeniably promising future and endless growth and profit potential across multiple industries. This dry slope snowboarding collection will be the first in its product speciality released to the public. The data collected over the past few months will lay the framework for the next steps in the design process which will be collecting athlete user data and performing a research study. This report will also serve as reference and inspiration throughout the ideation and development process of my final dry snowboard slope collection, Off-Season.

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SECTION II

DETAILED SWOT ANALYSIS

The design objective for this capstone collection aimed to address several problems that are detailed in the following "how could we" statement below:

> "How can we design innovative, luxury fashion, dry slope snowboarding apparel that properly address abrasion resistance, mobility, and thermoregulation needs necessary for off-season climate conditions."

The first step to this problem-solving process was to select current state of the art products on the market that aligned with the target consumer and price point (defined in section I of this report). For each of these selected products a detail SWOT analysis was created to identify specific product strengths, weaknesses, opportunities, and threats. This analysis improved. Each improvement area created a query path which present a creative space was designed to lead to product improvements where ideation develops through problem solving solutions.

The benchmark products that were selected as benchmark products and used for research and product function development in the design ideation process. These products were selected by meeting the following criteria, align with my target consumer demographic in terms of price point, functionality, performance, and style preferences. Products were further determined from research of product testing, scientific experiment/study findings, online consumer reviews, athlete recommendations. The following were the state of the art products selected; Arc'teryx Men's Rush Jacket Rebird, Arc'teryx Mens Fall Rush Pant, Burton Men's Total Impact Short - Protected by G-Form™, POC Unisex Joint VPD Knee System (knee pads), and POC Unisex Joint VPN Air Elbow. Due to the high price point of each individual product, the products that would best address my design objectives through testing. Two of the state of the art products were then eliminated (still accessible for in-person analysis at relatively close retail locations). Below youll find the five total state of the art products selected in detail including product summary (including, but not limited to, brand, product name, retail cost, fabric content, weight, color, care, sizing, fit, and manufacturing location) followed by a detailed SWOT analysis where product parts were dissected to include all design components.

State of the Art Outerwear Top: Jacket

FIGURE 57

SWOT ANALYSIS: OUTERWEAR TOP: JACKET

BRAND	*Arc'teryx*
PRODUCT NAME	*Rush Jacket Rebird - Mens*
RETIAL COST	*$749.00*
FABRIC CONTENT	*Outer Shell: 96% Polyester, 4% Aramid* *Inner: 100% Nylon*
WEIGHT	*590 g/1 lb 4.8 oz*
COLOR	*Kingfisher/Sundance*
CARE	*Machine wash in warm water (40°C), Double rinse, Do not use fabric softener, Tumble dry on medium heat, Do not iron.*
SIZING	*XXS, XS, S, M, L, XL, XXL, XXXL*
FIT	*Regular Fit, Hip Length, Centre back length: 79.5 cm / 31.25 in*
MANUFACTURING FACILITY	*Karian (Taicang) Sports Apparel Co. Ltd., China*

Note: Arc'teryx Rush Jacket Rebird image retrieved on 03.13.2021 from https://arcteryx.com/us/en/shop/mens/rush-jacket?CMPID=ps|txt|sb|google|Arc%27teryx_Google-Search_S20_Performance_BOF_R:NAM_C:USA_L:EN_DSA|Jackets||99638482306-430565360819&utm_souce=&utm_medium=ps|txt|sb&utm_campaign=Arc%27teryx_Google-Search_S20_Performance_BOF_R:NAM_C:USA_L:EN_DSA&gclid=Cj0KCQjwi7yCBhDJARIsAMWFScNfr_1ewOMg-cjVynCyJI9Q2YeL6U-TOvs4Y7cr23jfWT0DcR-A2CMaAvHBEALw_wcB.

Detail SWOT Analysis: Outerwear Top: Jacket

FIGURE 58

DETAIL SWOT ANALYSIS: OUTERWEAR TOP: JACKET

PART	*STRENGTHS*	*WEAKNESSES*	*OPPORTUNITIES*	*THREATS*
MAIN BODY MATERIAL	- *Waterproof - offers superior rain protection* - *Windproof prevents wind penetration* - *Offers breathability* - *Offers durability*	- *Lacks the thermoregulation properties necessary for high temperatures*	- *Reinforced elbows could can offer additional protection of high impact areas*	- *Technololgy does not offer a material currently on the market that offers the thickness and product strength*
MESH	- *Micro-seam allowance (1.6 mm)*	- *Very delicate fabric*	- *Replace with a more durable fabric*	- *Added durability can affect the thermoregulation*
ZIPPER	- *Waterproof zippers prevent precipitation penetration* - *RS™ zipper sliders* - *WaterTight™ pit zippers* - *RS™ zipper sliders*	- *Accessory zippers pulls are small and hard to operate with hand protection* - *Zipper placement can cause friction when walking*	- *Larger zipper pulls will allow easier access* - *Additional strength in gauge offering more durability and longevity*	- *Larger zipper pulls can create bulk*
VENTS	- *Gusseted pant leg interior zippers provide thermo relation*	- *Placement can cause friction when walking*	*- Add additional vents*	- *More trims could be overwhelming*
HOOD	- *Offers adjustable cording for size adjustment* - *Helmet compatible S tormHood™*	- *Fixed hood is not removable when not in use* - *Snowboarders rarely wear hoods over helmets, esp. in warm conditions (spring, summer, and early fall)*	- *Added chin guard can protect riders chin*	- *Removing hood altogether would prevent dual purpose use outside snowboarding*
CUFFS	- *Accommodate space for riders gloves* - *Laminated die-cut Velcro® cuff adjusters that protect from elements*	- *Velcro wears out and snags on equipment and material* - *Velcro wears out and makes the garment look worn*	- *Create an alternative adjustment mechanism for size adjustment*	- *Will require design of new parts*
SEAMS	- *Seam tape prevents any precipitation from penetrating*	- *Seams create bulk and add manufacturing prices and cost to the overall product*	- *Create a pattern with minimal pattern pieces*	- *Limiting pattern pieces can restrict movement*
ARTICULATED ELBOWS	- *Built in angles to afford riders mobility*		- *Add in padding with articulated seams*	- *This will create a challenge with pattern making*
POCKETS	- *Internal laminated pocket with zip offer waterproof pockets for electronics* - *Utility pockets for additional storage for riders items*	- *Pocket can be too specific and can overwhelm users which are user specific*	- *Limit the number of pockets and specific uses*	- *Pocket sizes might be difficult for all user accessories*

GRAPHICS/PRINT	*- Hidden RECCO® reflector* *- Unique limited edition*	*- Dark colors will not be practical for hot weather climates*	*- Pick lighter colors and limit the and overprints to keep products sustainable*	*- Lighter colors will show dirt unless the fabric tone is brown/tan*

State of the Art Outerwear Bottom: Bibs

FIGURE 59

STATE OF THE ART OUTERWEAR BOTTOMS: BIBS

BRAND	*Arc'teryx*
PRODUCT NAME	*Rush FL Pant - Mens*
RETIAL COST	*$325.00*
FABRIC CONTENT	*Outer Shell: 96% Polyester, 4% Aramid* *Inner: 100% Nylon*
WEIGHT	*650g /1lb 6.9oz*
COLOR	*Enigma*
CARE	*Machine wash in cold water. Do not use fabric softener. Tumble dry on low heat. Do not iron.*
SIZING	*S, M, L, XL, XXL*
FIT	*Regular Fit, Hip Length, Centre back length: 79.5 cm / 31.25 in*
MANUFACTURING FACILITY	*Pt. Pancaprima Ekabrothers, Indonesia*

Note: Arc'teryx Rush FL Pant image retrieved on 03.13.2021 from https://arcteryx.com/us/en/shop/mens/rush-fl-pant#search=1.

Detail SWOT Analysis: Outerwear Bottom: Bibs

FIGURE 60

SWOT ANALYSIS: OUTERWEAR BOTTOM: BIBS

PART	*STRENGTHS*	*WEAKNESSES*	*OPPORTUNITIES*	*THREATS*
MAIN BODY MATERIAL	- *Waterproof - offers superior rain protection* - *Windproof prevents wind penetration* - *Offers breathability* - *Offers durability*	- *Lacks the thermoregulation properties necessary for high temperatures*	- *Reinforced elbows could can offer additional protection of high impact areas*	- *Technololgy does not offer a material currently on the market that offers the thickness and product strength*
MESH	- *Micro-seam allowance (1.6 mm)*	- *Very delicate fabric*	- *Replace with a more durable fabric*	- *Added durability can affect the thermoregulation*
ZIPPER	- *Waterproof zippers prevent precipitation penetration* - *RS™ zipper sliders* - *WaterTight™ pit zippers* - *RS™ zipper sliders*	- *Accessory zippers pulls are small and hard to operate with hand protection* - *Zipper placement can cause friction when walking*	- *Larger zipper pulls will allow easier access* - *Additional strength in gauge offering more durability and longevity*	- *Larger zipper pulls can create bulk and cause p*
VENTS	- *Gusseted pant leg interior zippers provide thermo relation*	- *Interior leg zippers and can cause friction*	- *Add 2 way open on both side seams allowing open vents, eliminating the need for interior leg vents*	*- Could cause other mobility issues*
SUSPENDERS	- *Offer adjustable fit for different body types*	- *Can fall down during riding*	- *Design alternative closure using 3D printing that can prevent straps from slipping*	- *3D printing material may be limited by strength compared to the factory trim options*
SEAMS	- *Seam tape prevents any precipitation from penetrating*	- *Seams create bulk and add manufacturing prices and cost to the overall product*	- *Create a pattern with minimal pattern pieces*	- *Minimal design lines create fit issues and potentially limit mobility*
ARTICULATED KNEES	- *Built in angles to afford riders mobility*	- *Dart construction is intended for riding position and can be uncomfortable for athletes outside of riding*	- *Add in padding with articulated seams*	- *This will create a challenge with pattern making*
POCKETS	- *Internal laminated pocket with zip offer waterproof pockets for electronics* - *Utility pockets for additional storage for riders items*	- *Pocket can be too specific and can overwhelm users which are user specific*	- *Limit the number of pockets and specific uses*	- *Pocket sizes might be difficult for all user accessories*
GRAPHICS/PRINT	- *Dark color way*	- *Dark colors will not be practical for hot weather climates*	- *Pick lighter colors and limit the and overprints to keep products sustainable*	- *Lighter colors can get dirty quickly*

State of The Art Impact Protection: Shorts

FIGURE 61

STATE OF THE ART IMPACT PROTECTION SHORTS

BRAND	*Burton*
PRODUCT NAME	*Total Impact Short, Protected by G-Form™*
RETIAL COST	*$129.95*
FABRIC CONTENT	***Mainbody:*** *DRYRIDE Ultrawick™ Lightweight 100 fabric* ***Padding:*** *G-Form™ impact protection padding (hips, leg, and tailbone)*
COLOR	*True Black*
CARE	*Machine-wash*
SIZING	*S, M, L, XL*
FIT	*Next to skin*

Note: Burton Total Impact Short, Protected by G-Form™ image retrieved on 03.13.2021 from https://www.burton.com/us/en/p/mens-burton-total-impact-short%2C-protected-by-gform-/W21-102881.html.

Detail SWOT Analysis: Impact Protection: Short

FIGURE 62

IMPACT PROTECTION: SHORT

PART	*STRENGTHS*	*WEAKNESSES*	*OPPORTUNITIES*	*THREATS*
SILHOUETTE	- *Sleek, streamlined feel and low profile silhouette*	- *Tight fitting silhouette can feel suffocating*	- *Integration of padding into the riders outerwear will eliminate a layer and provide added thermoregulation capability* - *Removable padding can allow various levels of padding protection*	- *Proprietary material may not afford customization* - *Proprietary product may not be available to license for small production run quality* - *Price point can compromise other production and material necessities*
MAINBODY MATERIAL	- *Quick drying and high thermoregulation properties*	- *Added layer will impact overall ability for body thermoregulate*	- *Eliminating the product all together by integrating it into the outerwear component would substantially add to breathability*	- *Technology does not offer a material currently on the market that offers the thickness and product strength*
WAISTBAND	- *Brushed interior waistband reduced chafing*	*- Waistband and seams can cut into the rider when worn for long periods of time*	- *Eliminating the product all together by integrating it into the outerwear component would substantially add to breathability*	- *Riders may want to hide padding to avoid others from acknowledging they need additional protective equipment*
PADDING	- *Lightweight padding doesn't effect riders performance* - *G-Form's proprietary impact protection technology offers one of the most advanced material in the market* - *Padding coverage offers ergonomic hip, tailbone, and sit bones padding*	- *Padding thickness can protrude and catch on dry slope surface* - *Padding encasement is stiff and creates a diaper like feel*	- *Integration of padding into the riders outerwear will eliminate a layer and provide added thermoregulation capability* - *Removable padding can allow various levels of padding protection*	- *Proprietary material may not afford customization* - *Proprietary product may not be available to license for small production run quality* - *Price point can compromise other production and material necessities* - *Changing material padding thickness could effect impact mitigation potential*

State of The Art Impact Protection: Knee Pad

FIGURE 63

STATE OF THE ART PRODUCT: IMPACT PROTECTION: KNEE PAD

BRAND	*POC*
PRODUCT NAME	*Joint VPD Knee System*
RETIAL COST	*$150.00*
FABRIC CONTENT	*Tube: 95% Polyester, 5% Elastane* *Filter:*
COLOR	*Uranium Black*
SIZING	*S, M, L*

Note: POC Joint VPD System knee pad image retrieved on 03.13.2021 from https://na.pocsports.com/products/joint-vpd-system-knee?_pos=3&_sid=77589f8e7&_ss=r.

Detail SWOT Analysis Impact Protection: Knee Pad

FIGURE 64

IMPACT PROTECTION: KNEE PAD

PART	*STRENGTHS*	*WEAKNESSES*	*OPPORTUNITIES*	*THREATS*
SILHOUETTE	- *Tight silhouette offers a low profile* - *Ventilation pannel placement to support thermoregulation*	- *Tight fitting silhouette can feel suffocating* - *Materials can cause thermoregulation issues trapping in body heat leading to sweat build up and overheating*	- *Integration of padding into the riders outerwear will eliminate a layer and provide added thermoregulation capability* - *Removable padding can allow various levels of padding protection*	- *Proprietary material may not afford customization* - *Proprietary product may not be available to license for small production run quality* - *Price point can compromise other production and material necessities*
INTERIOR MATERIAL	- *Neoprene keeps product from slipping (anti-slip)* - *Stretch fabric allows for unrestricted movement*	- *Neoprene thickness does not support thermoregulation* - *Potential moisture buildup on the product interior*	- *Eliminating the product all together by integrating it into the outerwear component would substantially add to breathability*	- *Technololgy does not offer a material currently on the market that offers the thickness and product strength*
SHELL MATERIAL	- *Offers high abrasion resistance which offers longevity and resistance incurred on impact*	- *Lacks superior thermoregulation properties necessary for high temperatures*	- *Eliminating the product all together by integrating it into the outerwear component would substantially add to breathability*	- *Technology does not offer a material currently on the market that offers the thickness and product strength*
PADDING	- *Lightweight padding doesn't effect riders performance* - *Padding technology offers the most advanced material in the market* - *Impact absorption tests validating high impact mitigation* - *Conforms to to the body shape without limiting movement* - *Certified EN 1621-1 Level 2 shock absorption*	- *Padding thickness can protrude and catch on dry slope surface*	- *Integration of padding into the riders outerwear will eliminate a layer and provide added thermoregulation capability* - *Removable padding can allow various levels of padding protection*	- *Proprietary material may not afford customization* - *Proprietary product may not be available to license for small production run quality* - *Price point can compromise other production and material necessities* - *Changing material padding thickness could effect impact mitigation potential*

State of The Art Impact Protection: Comp Jacket

FIGURE 65

STATE OF THE ART PRODUCT: IMPACT PROTECTION: VPD AIR COMP JACKET

BRAND	*POC*
PRODUCT NAME	*VPD Alir Comp Jacket*
RETIAL COST	*$180.00*
FABRIC CONTENT	*N/A*
COLOR	*Uranium Black/Hydrogen White*
CARE	*Hand Wash*
SIZING	*S, M, L*

Note: POC Joint VPD Air Comp Jacket image retrieved on 03.13.2021 from https://na.pocsports.com/products/vpd-air-comp-jacket.

Detail SWOT Analysis Impact Protection: Comp Jacket

FIGURE 66

IMPACT PROTECTION: VPD AIR COMP JACKET

PART	*STRENGTHS*	*WEAKNESSES*	*OPPORTUNITIES*	*THREATS*
SILHOUETTE	- *Short length jacket to ensure maximum freedom of movement and minimum bulk* - *Ventilation pannel placement to support thermoregulation*	- *Tight fitting silhouette can feel suffocating* - *Short silhouette and tight fit can pull on any layers below the garment, causing bunching*	- *Creating a loser fit could ease restriction* - *Lose fit can provide higher thermoregulation capacity*	- *Proprietary product may not be available to license for small production run quality* - *Expanding silhouette shape can create padding placement problems, as material shifts around the body*
INTERIOR MATERIAL	- *Stretch fabric allows for unrestricted movement*	- *Potential moisture buildup on the product interior*	- *Eliminating the product all together by integrating it into the outerwear component would substantially add to breathability*	- *Technololgy does not offer a material currently on the market that offers the thickness and product strength*
MESH UNDERARM	- *Creates breathability for thermoregulation regulation*	- *Delicate fabrication for high stress area and tight seam construction*	- *Providing seam tape reinforcement could prevent rips/tears*	- *Seam reinforcement can create underarm bulk causing chafing*
CF ZIPPER	- *Allows easy entry and exit for top*	- *Small zipper pull could be hard to operate without direct line of sight* - *Seemingly delicate for retail price point*	- *Larger zipper and pull will create easier access*	- *A larger gauge zipper can cause fabric tension and potentially rip or tear material (depending on its strength)*
HANGER LOOP	- *Interior hanger loop for hanging when drying*	- *Small and seems to be delicate and easy to rip*	- *Branding opportunity for exterior trim* - *Could provide a stronger trim*	- *Larger/nicer trim will add cost to garment*
PADDING	- *Upper arm protection: A sandwich construction of VPD Air and EVA* - *Lower arm protection: A sandwich construction of VPD Air and EVA. Lower arm protector is removable if user prefers to ride with hard-shell protectors on top of speedsuit* - *Shoulder blade protection: VPD Air protects from impacts with gates* - *Padding technology offers the most advanced material in the market* - *Impact absorption tests validating high impact mitigation*	- *Padding placement and density could cause mobility limitation* - *Padding is lined with this mesh material that lacks breathability and ability to absorb sweat* - *Padding shape and design could limit joint mobility and impact riders performance*	- *Integration of padding into the riders outerwear will eliminate a layer and provide added thermoregulation capability* - *Removable padding can allow various levels of padding protection*	- *Proprietary material may not afford customization* - *Proprietary product may not be available to license for small production run quality* - *Price point can compromise other production and material necessities* - *Changing material padding thickness could effect impact mitigation potential*

Research development planning involved determining what information needed to be collected. Research involved development of two individual testing plans: performance testing using state of the art benchmark products to frame-up performance metrics, and a consumer research survey to frame up unmet needs experienced by dry slope snowboard athletes.

"How will we" statements were used to frame up the intention of the individual research. Refer to Figure 67 below where performance research and consumer research featuring "How will we…" statements along with initial ideas for research plans.

FIGURE 67

STATE OF THE ART IMPACT MITIGATION PRODUCTS PURCHASED

BENCHMARK FIELD RESEARCH PLANNING

Initial research planning development was laid out to understand what research was needed and how that information would be collected.

> "This research will… actualize mobility, thermoregulation limitation, and overall effectiveness of state of the art impact mitigation products to define unmet needs of dry slope snowboarders apparel."

This plan consisted of two studies, the first focused on athlete performance testing and the second focused on consumer data collection. These two areas of research required two separate testing development planning methods. Both plans required determination of specific data collection methodology (additional limitations were considered due to the lock down restrictions associated with COVID-19 implications) to collect performance data. Further details were needed to define testing subjects who would provide data metrics. This step proved most difficult considering the limited access to dry slope locations (in addition to travel restrictions, and resort/facility closures due to the global pandemic). Potential research subjects who possessed the dry slope snowboarding experience necessary to quality as a potential participant were found primarily online through Google search and social media platforms as outreach methods.

Performance characteristic were determined including impact mitigation, abrasion resistance, mobility, and thermoregulation (specifically in off-season climate conditions; spring, summer, and early fall temperatures). Research was conducted across the market to uncover state of the art impact mitigation equipment products available. These products were purchased and metrics were established as the benchmark in performance. Three product were ordered for field research testing and included Burton Total Impact Shorts, POC Joint Knee System (knee pads), and the POC VPD Air Comp Jacket. Sizes were ordered specific to athletes secured for field testing experimentation.

FIGURE 68

STATE OF THE ART IMPACT MITIGATION PRODUCTS PURCHASED

Burton, Total Impact Shorts

POC Joint Knee System

POC VPD Air Comp Jacket

The next step outlined the performance and consumer testing methods ideation. Initial ideas included the use of 3D body imaging that would explore the relationship between the athlete and the state of the art impact mitigation products along with the other apparel used when dry slope snowboarding. A second testing method was needed to test the performance of the impact mitigation products during sport execution. This testing proved a substantial challenge as dry slope access wasn't accessible due to US imposedCOVID-19 travel restrictions. Methodology was devised to simulate conditions as similar to dry slope snowboarding conditions as possible. However, the test location availability was limited to on mountain testing using real snow opposed to dry slope surfacing.

The consumer research testing plan consisted of two studies: first, in-depth interviews with coaches of dry slope snowboarders; second, 10-15 min athletes online surveys.

PRODUCT PERFORMANCE RESEARCH PLAN

Below outlines include product performance research testing method plan and consumer research method testing plan. To reiterate, "these testing methods were devised to determine how design can be modified to develop innovative, luxury fashion, dry slope snowboarding apparel that properly addresses abrasion resistance, mobility, and thermoregulation needs necessary for off-season climate conditions", (ideally research would be conducted during the spring, summer, or early fall seasons at an outdoor dry ski slope).

1A. SPECIFIC AIMS/STUDY OBJECTIVES

The proposed research is an attempt to visually represent state of the art impact mitigation products using 3D scanning technology to measure and analyze the body. Using 3D scanning and layering, we are able to quickly capture accurate 3D body scan data (better than using body measurement data) as a visual representation, which can be further discerned by viewing individual planes through cross-sections. With this technology, 3D scan data can be used to learn about the relationship between the products design and the body. Lastly, multiple products can be visualized under futile layers/scans of clothing to accurately representat volume data unlike prior measurements techniques that failed to represent data. This data relevance creates a visual representation linking the athlete and the product, which will aid in the first designs to ever address dry slope snowboarding specifically.

Aims/Objectives for the Proposed Study, Include to Understand:

State of the art impact protection products through overall shape, measurements, cross-sections.

- What role do state of the art impact products in addition to body shape, measurements, and cross-sections?
- How does the addition of state of the art impact products alter room for mobility inside of the garment?

1B. METHODOLOGY

Location of Study:

- The data scan will take place at the University of Oregon Portland Campus (70 NW Couch St, Portland, OR 97209) in the Nucleus Lab.

Date:

- Thursday January 14th, 2021

Subjects:

- One female subject will be tested, sz. S.

Products: A total of three products will be scanned:

1. Burton, Total Impact Short, Protected by G-Form™ - women's sz. M
2. POC, Joint VPD Joint Knee System - men's sz. S
3. POC, VPD Air Comp Jacket - men's sz. S

FIGURE 69

BENCHMARK RESEARCH PLAN 1A

PHASE OF STUDY	PROCEDURE	DATA COLLECTED	TIMING
SUBJECT RECRUITMENT	*Subject confirmed via text*	*None*	*N/A*
PRE EXPERIMENT	*Cyberwar setup. Assuring the positioning of the scan needed and pose it determined for all scans (feet placement taped for consistency).*	*None*	*10 minutes*
DATA SCAN	*Subject is dressed in base layers only (outfit scenario 1). The athlete positioned for SCAN 1 - using the full body Cyberware scanner. The scanning image process to complete one scan will take between 1-3 min.*	*Cyescan software computes SCAN 1 full body scan.*	*5 minutes*
	Subject changes into outfit scenario 2 (base layer and three state of the art impact mitigation products). The impact mitigation products will be the outermost layer, overtop of the base layer. Once outfitted the athlete is directed back to the scanner and positioned using tape aiding the athletes pose to be static for each set of scans. The scanner conducts a full body - SCAN 2.	*Cyescan software computes SCAN 1 full body scan.*	*15 minutes*
	Subject is asked to change into outfit scenario 3 - the bottom layer (layer closest to the skin will remain the base layer, the second layer (middle layer) consisting on three impact mitigation products, and the outermost layer including typical outermost garments worn when snowboarding, i.e jacket and pants/bib, along with mittens, and snowboard boots. Once properly outfitted the athlete is repositioned on the platform for SCAN 3.	*Cyescan software computes SCAN 1 full body scan.*	*15 minutes*
DATA EXPORT	*Files Exported*	*Obj files are saved onto researcher laptop*	*10 minutes*

2A. SPECIFIC AIMS/STUDY OBJECTIVES

The proposed research is an attempt to better understand impact mitigation and thermoregulation of dry slope snowboarders, as it relates to designing dry slope specific apparel and accessories. With the current impact

medication technologies available, athletes have been offered state of the art products that can offer injury protection more than ever before through precise measurement and body surface image capture technology. There are no current studies using the state of the art impact mitigation tests conducted specific to snowboarding.

Aims/Objectives for the Proposed Study, Included to Understand:

- How relevant is impact protection in snowboarding;
- The comfort level of current state of the art impact products;
- The impact mitigation provided by current state of the art market products;
- The level of thermoregulation offered by these state of the art products;
- Product feedback.

2B. METHODOLOGY

Location of Study:

- The data collection will take place at Mt. Hood Meadows Ski Resort (14040 OR-35, Mt Hood, OR 97041, base elevation: 4,523′ 0″, peak elevation 7,300′ 0″.

Date:

- Friday January 15th, 2021

Weather:

- Detailed weather and climate details will be recorded for each separate study.

Timing:

- The research process is estimated to take 90 minutes. Each subject should expect to go through the study 1x. There will be a follow-up for each test subject about the products tested and their overall apparel preferences.

Subjects:

- A total of two female subjects will be tested; sz. S

Products: A total of four products will be tested:

1. Burton, Total Impact Short, Protected by G-Form™ - women's sz. M
2. POC, Joint VPD Joint Knee System - men's sz. S

3. POC, VPD Air Comp Jacket - men's sz. S

2C. ATHLETE PRE EXPERIMENT SURVEY QUESTIONS

1. Name
2. Age
3. Gender
4. Height
5. Weight
6. Dominate snowboarding stance (goofy or regular)
7. Snowboarding experience level

FIGURE 70

BENCHMARK ATHLETE FIELD RESEARCH PLAN 2A

PHASE OF STUDY	PROCEDURE	DATA COLLECTED	TIMING
SUBJECT RECRUITMENT	*Solicits subject via email, text, "word of mouth" & social platforms*	*None*	*N/A*
SUBJECT SIGN-UP	*Subjects are confirmed along with research date*	*Name, email, telephone, & apparel sizes*	*5 minutes*
SUBJECT TRANSPORT	*Subjects will be driven from Portland to the test site location.*	*None*	*105 minutes*
PRE EXPERIMENT	*Subject receive a debrief of the study overview along with the experiment process they will undergo from primary researcher.*	*Informed verbal consent*	*10 minutes*
	Subject complete initial survey (general demographics, body details, snowboarding level, & apparel shopping and product shopping perception)	*The following information will be collected (refer to C. Athlete Pre Experiment Survey)*	*15 minutes*
	Subject will change into apparel condition 2 (subject's own personal snowboarding apparel and equipment adding 3 impact mitigation products).	*None*	*15 minutes*
EXPERIMENT	*Subject will aggressively snowboard.*	*None*	*90 minutes*
EXPERIMENT	*Subject will remove 3 impact mitigation products. Athletes will continue to snowboard for (a minimum of) 30 min directly following the 90 min testing period allowing them to compare and contrast the products overall experience.*	*None*	*30 minutes*
SUBJECT TRANSPORT	*Subjects will be driven from the testing location back to Portland*	*None*	*105 minutes*
DATA COLLECTION	*The following day athletes engaged in an in-depth interview session to discuss their experiences with the impact mitigation products. Meetings took place virtually using Zoom. Each athlete interview lasted 30 min, which was recorded and transcribed in real time while asked questions or prompted to assure product to assure research aims and objectives were met*	*Remote meeting recording via Zoom and transcription of meeting discussion via Olli*	*30 minutes*

Consumer Research Plan

3A. SPECIFIC AIMS/STUDY OBJECTIVES

The proposed research is an attempt to collect athlete data as observed from coaches. This in-depth interview series will visit topic related to athlete practices, injury patterns, apparel and gear selection for various temperatures and climates, and brand loyalty specific to dry slope snowboarding. Coaches will be walked through each topic and asked to elaborate to compile accurate athlete consumer profiles and consumer behaviors. Each interview will take place virtually over zoom (recorded and transcribed) and each participant will be asked to provide images of examples such as (not limited to) damaged apparel, accessories, equipment, and or injuries.

Aims/Objectives for the Proposed Study, Included to Understand:

- Personal experience riding level
- Athletes elected types of apparel, accessories, impact protection, and thermoregulation
- Popular brands/products worn by athletes
- Dry slope injury history and descriptions
- Unmet needs of apparel and accessories of current apparel and accessories
- Current product feedback
- Ideal products to purchase if offered an unlimited budget

3B. METHODOLOGY

Study Location:

- Int. 1) Virtual Zoom conference video
- Int. 2) In person at Wy'East Academy 59550 US-26, Sandy, OR 97055

Date:

- Int. 1) January 14th 2021
- Int. 2) January 22nd 2021

Timing:

- In-depth Interview - scheduled for 60 minutes
- Surveys - estimated completion between 15 - 30 minutes

Subjects: 2 male, snowboarding coaches

- Isaac Gibson, Ski School Manager/Camp Director/Liberty University Ski/Snowboard Coach - Liberty University Mountain Snowflex Centre,
- Brian Sorel, Head Coach - Big Mountain at Wy'East Academy

3C. IN-DEPTH ZOOM INTERVIEW

The following information will be addressed (but not limited to):

1. Years of snowboard experience
2. Years of dry snowboard experience
3. Snowflex material properties overview
4. Common apparel and equipment worn in the spring, summer, and early fall temperatures, maintaining thermoregulation and when raining
5. Impact mitigation equipment apparel used by you or your team
6. Injury patterns
7. Apparel and equipment damage pattern from dry slopes
8. Photos examples of apparel/equipment from dry slopes
9. Additional needs of dry slope snowboarders
10. Snowflex specific needs
11. Additional comments/feedback

FIGURE 71

BENCHMARK CONSUMER RESEARCH PLAN 3A

PHASE OF STUDY	*PROCEDURE*	*DATA COLLECTED*	*TIMING*
SUBJECT RECRUITMENT	*Research subjects identified and confirmed via email, phone, and text.*	*Name, potential interview availability.*	*N/A*
SUBJECT CONFIRMATION	*Subject agrees to one hour Zoom interview.*	*Confirmed interview date and time.*	*5 minutes*
SUBJECT CALENDAR INVITE SENT	*Gmail calendar invite sent out to block off time and provide meeting access Zoom link and passcode.*	*None*	*5 minutes*
DATA COLLECTION - IN-DEPTH INTERVIEW.	*Subject interviewed via Zoom.*	*Verbal consent given prior to recording the zoom session which the following questions will be asked (refer to section 3C Survey questions)*	*45 minutes*
	Google Survey run-through.	*None*	*15 minutes*
FOLLOWUP EMAIL	*Followup email/thank you sent asking for any photo assets or information outstanding from in-depth interview. Reminder sent about the survey final deadline.*	*None*	*10 minutes*

4A. SPECIFIC AIMS/STUDY OBJECTIVES

The proposed research is an attempt to better understand dry slope snowboarding injury and current product market, as it relates to designing dry slope specific apparel and accessories. Addressing the current available market products, athletes and coached will utilize in-depth interviews, and athlete surveys to collect data. There are no current studies using the state of the art impact mitigation tests conducted specific to snowboarding.

Aims/Objectives for the Proposed Study, Included to Understand:

- The current use of products apparel and equipment being used in dry slope snowboarding
- The current injury landscape of dry slope snowboarding
- The needs of current dry slope snowboarders
- Current product feedback

4B. METHODOLOGY

Location of Study:

- Surveys will be accessed remotely using a device with internet access hosted by Google Survey

Date:

- Survey's will be collected from January 14th 2021 - January 23rd 2021

Timing:

- Surveys are estimated completion time between 30-90 minutes

Subjects:

- Surveys will be sent out by head coaches used in in-depth interview research (ref. Section 3A for details)

4C. DRY SLOPE SNOWBOARDING SURVEY

The Google Survey featured the following questions (verbatim):

1. Name - (short answer)
2. What is your gender - multiple choice: male, female, prefer not to answer
3. Whats is your current age - (short answer)
4. How many years how you been snowboarding - (short answer)
5. How many years have you been dry snowboarding - (short answer)
6. What injuries have you encountered (at any point) while dry snowboarding? (Can you describe where on the body the injury occurred). - (short answer)
7. Have you damaged any apparel when snowboarding on dry slopes? (short answer)
8. Do you have any photos you can provide? (short answer)
9. What current apparel do you wear dry snowboarding that helps you stay cool and dry (In spring, summer, and early fall)? (short answer)
10. What brands do you wear dry snowboarding? (Apparel and equipment - not including your board, boots, and bindings). (short answer)
11. Do you wear any impact protection apparel or equipment? (Impact shorts, knee pads, elbow pads, etc.) - (short answer)
12. If you answered yes to the following question what are the names/brands of these impact products? - (short answer)
13. If money was not an object what gear would you buy and why? - (short answer)

FIGURE 72

BENCHMARK CONSUMER RESEARCH PLAN 4A

PHASE OF STUDY	PROCEDURE	DATA COLLECTED	TIMING
Survey Access Distribution	*Two coaches are emailed google survey links and includes brief Capstone description, social media capstone account link, and estimated length of survey completion.*	*None*	*15 minutes*
Coach Survey Distribution	*Coaches mail out intro email with google survey link to additional coaches and snowboard athletes.*	*None*	*15 minutes*
Google Survey Completed.	*Subject complete Google Survey*	*In-depth interview questions are automatically collected (ref. Section 4c for question breakdown).*	*15-30 minutes*

TESTING RESULTS

Performance Testing Result Findings

3D BODY SCAN RESULTS

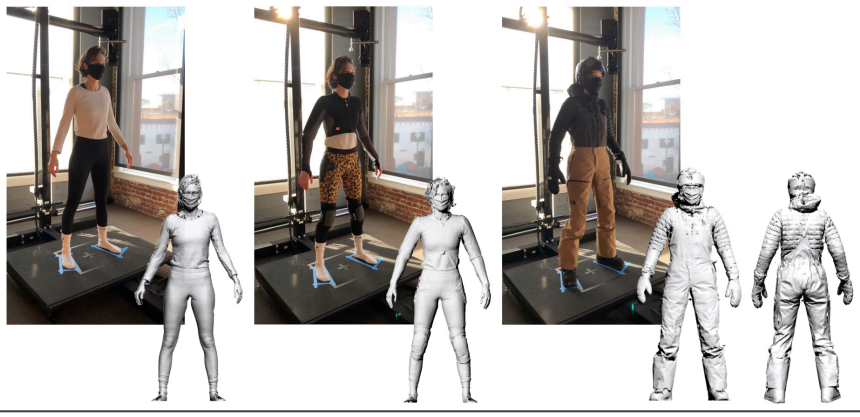
Using 3D full body scanning technology to analyze the relationship between state of the art impact mitigation products and the athlete through accurate digital generation allowed a visual relationship comparison of product and athlete interaction. Layering phases allowed a understanding linking the body dimensions and garment design in addition to the distribution of the dimensions across the body surface. Providing a level of image accuracy down to fraction of a millimeter allowing lifelike geometric features with complicated concave surface structures (a measurement not possible prior to 3D imaging) to be captured in instance such as multi directional curvature along with the ability to fit into narrow spaces on the body such as the armpit and crouch. Associated software allows layering and alteration of imagery to replicate patterns and take precise measurements for alterations and modifications. The state of the art products have inherent interaction with the environment, and other materials in the layering process, such as stretch properties and in motion depending on their surface energy.

This relationship is dependent directly on the limited space required by exterior layers, allowing a spacial representation that provides measurement parameters product designs must fit within.

These images will be used for the pattern prototyping. Providing valuable considerations for padding and abrasion placement and narrowed down the potential materials, based on these size parameters limitations.

FIGURE 73

3D BODY SCAN - SCAN LAYERING SCENARIOS 1 - 3



Note: 3D imaging captured using a Cyberware full body scanner, located at UO Portland Campus's SPD Nucleus Lab

Athlete Product Performance Result Findings

Athlete reviews of the impact mitigation products did afford some unexpected results. Although the testing conditions different drastically from the dry slope conditions and whether that athletes would encounter in off season conditions generalizations arose from interaction with the products.

The feedback results on product comfort highlighted one clear frontrunner, and the only positive overall review, the Burton total impact shorts. The riders also noted that although the product wasn't noticeable in a negative sense they questioned the benefits. One rider experienced bulk and chafing while walking (not strapped into snowboard bindings and snowboard) around the lower buttocks where tailbone placement of padding (Smith, personal communication, 2021). Athletes found discomfort in the fit the jacket and knee pad fit and rigidity of the materials. One piece of feedback referenced the jacket mobility limitation due to the "skiing position" (arms bent at the sides) which was the only position where no strain was experienced on the arms. Any additional movement such as raising the arms proved difficult, and caused rider attention away from riding to the effort they were experiencing by the product (Rescalvo, personal communication, 2021). Both athletes expressed relief after their 90 minute wear testing.

The thermoregulation feedback was relatively neutral its worth noting this experience would likely result in different feedback when worn in the specified climate conditions experienced during the spring, summer, and fall. I suspect that the proximity to the snow in addition to the close to freezing temperatures skewed the product results feedback. In light of this booth athletes provided experienced overheating experienced in the POC jacket and sweat buildup under the padded areas.

The impact protection which was a primary research objective proved difficult to test as injury could not be forced or measured if impact did occur. Although riders were asked to snowboard aggressively neither rider experienced a fall or impact during their 90 min testing session. One of the athletes volunteered to tumble and see if she was able to feel any difference while outfitted with impact protection. During her fall she wasn't able to feel any benefit from the products and re-injured her knee, as it twisted during the roll sequence of the fall. This injury couldn't be placed on the knee pads and the athlete felt that the injury would have occurred without it on. No other impact incidents prevented any further testing insights.

Overall both athletes voiced preference in not wearing any of the impact mitigation products again.

FIGURE 74

ATHLETE RESEARCH FINDINGS- IMPACT MITIGATION RESULTS

Note: The athlete research findings are shown here in this graph. You can see on the right the impact mitigation products that were tested and their rating by the athletes by fit/comfort, thermoregulation, impact mitigation and lastly by any negative effect on their riding. Most surprisingly results were that both riders overall preferred no impact protection due to its bulk, and negative implications on their riding.

Consumer Research Results

The consumer in-depth interviews and athlete google surveys provided the most informative data. Findings provided valuable information that played an imperative role in design ideation and final direction.

In-Depth Interview Findings

The first in-depth interview took place on Wed, January 20th 2021 at 5:25PM PST over zoom with Isaac Gibson, head of Liberty Mountain Snowflex Center ski school and Next Level Development Programs Director and collegiate head coach of Liberty University ski and snowboard teams. The training facility is located in Lynchburg, Virginia and one of only two dry slopes open to the public in the US.

The Snowflex center uses proprietary snowflex material (defined in prior text located in research section I). To reiterate Snowflex is a composite comprised of a sliding component slick, springy, hard wearing monofilament. Layers include a 2 in.–5 cm. shock absorbing layer, an impervious membrane, a geo-textile separating layer, a gravel layer, and a sculpted sub-soil layer (Dissmore, 2020). To function Snowflex requires misting component, the BritonMist system releases a spray onto the slope, it then runs down onto the membrane and back to the piping mechanism to be reused on the slope. The spray reaches 2ft in height but is important to note due to the affects to apparel and equipment that will be mentioned in the below interview findings (Dissmore, 2020).

Some of the most valuable findings included injury information. The most common injury by far is rug burn, aside from that most of the other injuries occur in the park and include broken wrist broken, collarbones (Gibson, personal communication, 2021). The rug burn severity is so common that it's common that every dry slope snowboard rider will experience this injury to their bodies and equipment when riding. For photo references of equipment and injury refer to below Figure 75. Isaac explained that the choice when riding during the Spring, Summer, and early Fall is either too cover all exposed skin and suffer overheating, or ride in shorts and a tee shirt to stay cool while risking severe rug burn injury. Another unexpected injury finding surfaced in Isaac explaining that impact protection is necessary.. He explained riders reluctance to wear any protection due to its bulk and added mobility limitation that experience riders describe. Riders who opt for the cooler option risking rug burn have been known to cut tube socks that act as a barrier between their slope and the skin. The newer riders who could benefit from some protection rarely want to invest in the expensive impact mitigation products in the sport if they are unsure how often they will use it.

FIGURE 75

SNOWFLEX SLOPE RESEARCH PHOTO SUBMISSION

RUG BURN EQUIPMENT + INJURY

Base layer damage, thinning and tearing at knees.

Outerwear pant rear tearing, repaired with duck tape.

Severe thigh rug burn experienced from exposed skin contact with the Snowflex slope material.

Elbow injury from rug burn experienced from exposed skin contact with the Snowflex slope material.

In addition the slope misting machine was mentioned and its affect when riding on boots and lower body apparel. Often times boots are waterlogged and any materials that cant repel water are quickly saturated when riding. This affect can make apparel and equipment uncomfortable and deteriorate at an accelerated rate, in addition to

hosting bacterial buildup that causes odor. Isaac estimated that a pair of new snowboard boots have a lifespan of 2 years or less in these conditions.

The current products worn by coaches and students ranging from 5-25 years of age range drastically. He noted that the older riders tend to shop at goodwill for disposable apparel that can be thrown out at the lowest cost. It's important to note that lynchburg Virginia consumer does not align directly with my target consumer and apparel brand choices/loyalty will be noted but not referred to for consumer market referencing.

The second in-depth interview took place at Wy'East Academy on January 22, 2021 with Dan Tattersfield Brian Sorel, Head snowboard Coach - Big Mountain. Wy'East Mountain Academy (formerly Windells Academy) is a world-class outdoor-oriented, action sports academy designed to develop driven and talented students in the classroom as well as in the outdoors. Wy'East enrolls students ages 12 to 19 who want to combine a rigorous academic setting with skiing, snowboarding, skateboarding, mountain biking and other outdoor recreation sports. Additionally they have summer camps and adult programs for sport specific training. Mary Walsh one of my capstone mentors brought their campus to my attention and connected me with their team. They are located in Oregon at the base of Mt. Hood, minutes away from snow resorts. The campus feature setups change periodically but at any given time features at least three dry slope features, currently they include two down tubes and two boxes (Wy'East Mountain Academy Campus 2021). Their dry slope material is mushroom matting.

This slope material was developed in China in 2012. It has a unique shape with a bulbous head that allows for better edge control for carving. Wy'East was the first and remains the only reported mushroom needle dry slope in the US. Although Wy'East does not currently have a skiable hill it had big construction plans in the works to offer year round training for skiers and snowboarders alike (JF Dry Ski Slope, 2021).

Brandon provided valuable insight specific their slope geographic location and slope material noting that apparel worn on the dry slope matting always gets dirty quickly from the surrounding ground (Sorel, personal communication, 2021). He suggested using a shade of brown or earth tone color fabric and materials to hide the dirt. Also nothing Oregons wet climate the coaches and riders often need rain protection on the dry slope year round, mentioning that current rain-gear is often not breathable and accumulates sweat quickly. Brian also noted that

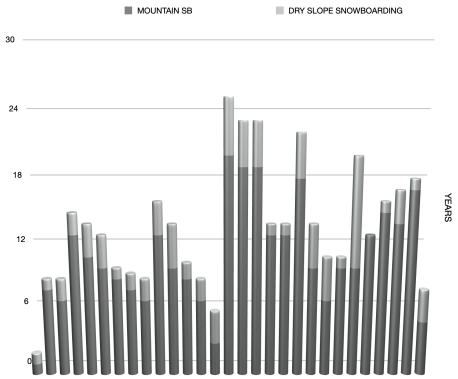
damage to apparel and equipment on the dry slope surface is always expected and refrains from using new or nice apparel when on the slope.

Consumer Online Survey Research Findings

The online consumer Google survey was completed by 30 dry slope snowboarding athletes between the ages of 18-35 with a median age of 22. These athletes had experience as mountain snowboard riders and dry slope snowboarding experience. Experience level relationships are shown in Figure 76 below.

FIGURE 76

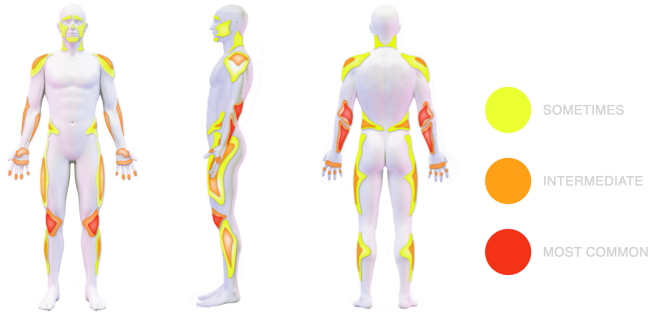
SNOWBOARDING EXPERIENCE COMPARISON



Of the 30 athletes, 100% have experienced injury and 100% have damaged snowboarding apparel while riding on a dry slope. The most common injury was rug burn with 26 out of the 30 participants having experienced rug burn. The body map shown in Figure 77 reflects areas of the body where athletes experienced rug burns. The severity is color coded to reflect the most concentrated and common injuries severity in red, followed by orange, and yellow marking the least common. Other injuries were experienced by one athlete and included sprains, bruises, pulled groin, concussion, and broken bones. Rug burn was the main injury experienced and described by participants.

FIGURE 77

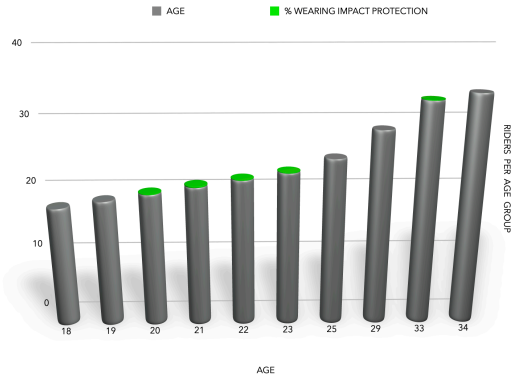
RUG BURN 3D BODY MAP



Participants have rarely worn impact protection mitigation products which is reflected in Figure 78 below.

FIGURE 78

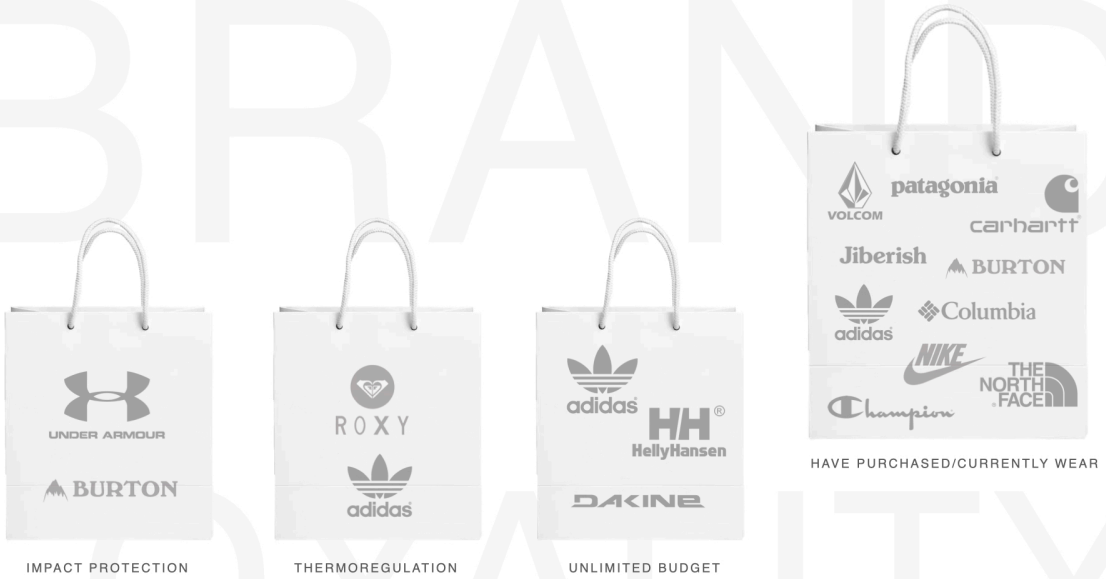
SNOWBOARDING EXPERIENCE COMPARISON



Athletes were asked to identify the brands they wear/have worn for dry slope snowboarding for impact protection and thermoregulation (specifically during the spring, summer, and early fall), brands they currently wear, along with brands they would W from with an unlimited budget. These consumer brands are broken down by category below in Figure 79. The mentioned brands include Burton, Under Armour, Roxy, Adidas, Helly Hansen, Patagonia, Dakine, Champion, Carhartt, The North Face, Nike, Jiberish, and Volcom.

FIGURE 79

CONSUMER RESEARCH BRAND LOYALTY



Note: the athlete subjects do note align directly with this collections intended demographic and consumer shopping and brand loyalty. This insight should not support any design decisions or direction.

IDEATION PLAN

Function

The functional ideation phase started by identifying the specific products that will be designed for the thesis project. First, state of the art products were identified within their respective product category. Each product was individually analyzed by breaking down every component and part. Using data results from research testing any weaknesses were identified. Ideation began by exploring any solution that could fix, or resolve the weakness was noted for further exploration.

FIGURE 80

PRODUCT: OUTERWEAR: JACKET - ARC'TERYX, RUSH JACKET REBIRD - MEN'S

PART:	*STA DESCRIPTION:*	*WEAKNESSES:*	*IDEATION PATH:*
SHELL FABRIC	- *GORE-TEX Pro fabric*	- *Fabric is ideal for cold weather conditions but lacks breathability and ventilation necessary in warmer temperatures*	- *Multi fabric shell to provide better air ventilation* - *Additional back shoulder vent* - *Laser cut/welded underarm grommets*
VENTS	- *WaterTight™ pit zips*	- *Underarm pit zip is difficult to open with small zipper pull* - *Zipper placement can cause underarm friction when walking*	- *Bigger zippers gauge* - *Add additional vents* - *Larger zipper pulls* - *Laser cut and welded underarm vents add ventilation*
ZIPPER VENTS	- *WaterTight zips on external pockets*	- *Hard to access with hand protection (gloves/mittens)*	- *Alternative larger zipper pull*
CENTER FRONT ZIPPER	- *WaterTight VISLON® front zip*	- *Any jacket trim with volume can catch on the dry slope material and rip* - *Accessory zippers pulls are too small and hard to operate with hand protection*	- *Pull over* - *New outerwear layered underneath the bibs* - *One piece step in jump suit* - *Waterproof CF Zipper*
HOOD	- *Helmet-compatible StormHood™ provides additional coverage with minimal impact on vision*	- *Helmet-compatible StormHood™ - rarely used overtop of helmets* - *Collects precipitation when not in use* - *Fixed hood is not removable when not in use*	- *Remove hood* - *Redesign packable underhelmet hood* - *Add chin guard* - *Peaked hood with elasticated drawcord for adjustability*
CUFFS	- *Die-cut laminated cuff tabs*	- *Trim design can snag on dry slope*	- *Remove cuff adjusters* - *Laser-cut bonded sleeve cuffs*
SEAMS	- *Fully taped seams* - *Micro-seam allowance (1.6mm) reduces bulk and weight*	- *No visible weaknesses*	- *No changes necessary*
ARTICULATED ELBOWS	- *Articulated elbows and 3-dimensional articulated patterning promote mobility on hikes and descents*	- *Articulated elbow doesn't provide full range of motion*	- *Increase articulation for elbows* - *Reinforced elbow patches* - *Removable padding pocket*
POCKETS	- *2 hand pockets;* - *1 sleeve pocket* - *1 internal mesh dump pocket* - *1 internal laminated zippered pocket;*	- *-Pocket size can not accommodate large phone models.* - *Lacking RFID resort season/day pass*	- *Add RFID specific pass pocket to outer left forearm* - *Pocket size to accommodate Japan cell phone models* - *Elbow pad pockets - removable padding*
GRAPHICS/ PRINT	- *Dark color*	- *Dark colors draw heat, not ideal for warm weather temperatures*	- *Use earth tones* - *Naturally sustainable garment dye* - *Use solar charged fabric for increased visibility and night riding*
POWDER SKIRT	- *Integrated powder skirt with stretch panel and gripper elastic*	- *Powder skirt is bulky and not widely utilized by snowboarders*	*- Remove powder skirt*

SLIDE 'N LOC™	- *Slide 'n Loc™ attachment (fits compatible pants)*	- *Attachment fits compatible pants to keep in body heat and keep out participation*	- *Unnecessary, remove altogether*
SILHOUETTE	- *No-lift gusseted underarms* - *Slim fit*	- *Long sleeve silhouette restricts thermoregulation* - *Loose Fit*	- *Short sleeve/three quarter sleeve shape alternatives* - *Pattern modification to afford extended underarm panelling for mobility* - *Zip off sleeves*
RECCO® REFLECTOR	- *Embedded RECCO® reflector*	- *Uses radio signals for search-and-rescue detectors in avalanches, unnecessary for warm climates*	- *Remove RECCO reflector*
SIZE LABEL	- *Heat transfer size label center back interior collar* - *Woven content label*	- *Woven labels look messy*	- *Heat transfer label* - *Reflective finish* - *Smart label with tracking capability* - *Digital trigger (QR code)* - *RFID tag* - *Matrix code (matrix code: a companion QR code that could connect consumers' garments to the Infinite Play app irrespective of where the garment)*
CARE LABEL	- *Woven care label wearers right interior side seam*	- *Woven labels look messy*	- *Heat transfer label* - *Reflective finish* - *Smart label with tracking capability*

ADDITIONAL CHANGES

- Padding
  - 3D printed
  - Laser cut
  - Removable padding
  - Individual padding sleeves for various parts on the body worn underneath the outer layer
- EPA-approved, odorless repellent
- Tighter more durability mesh on interior zipper pockets
- Dual-zippered structure creates a v-shape for added breathability

FIGURE 81

PPRODUCT: OUTERWEAR: BIBS - ARC'TERYX, FALL RUSH PANT - MEN'S

PART:	*STA DESCRIPTION:*	*WEAKNESSES:*	*IDEATION PATH:*
SHELL FABRIC	- *Four way stretch softshell* - *Waterproof* - *Windproof*	- *Fabric is ideal for cold weather conditions but lacks breathability and ventilation necessary in warmer temperatures*	- *Multi fabric shell to provide better air ventilation* - *Additional back shoulder vent* - *Laser cut/welded underarm grommets*
MESH	- *No mesh present*	- *Could keep vent openings from splaying* - *Could prevent pant fabric from catching on dry slope material*	- *3D printed* - *Laser cut* - *Removable padding* - *Body mapped padding* - *Mesh back bib upper*
VENTS	- *Two side vents - right side vent can be fully opened and vented with three way slider*	- *Placement can cause friction when walking*	- *Larger zipper pulls will allow easier access* - *Increase zipper gauge*
ZIPPER	- *Center front zipper with snap closure*	- *Unnecessary with hight bib height*	- *Add zip off pant leg* - *Bathroom access zippers on left and right side seams*
FLY	- *Fly with snaps; removable, adjustable belt*	- *Snaps require removal of hand protection*	- *Replace with zipper fly with*
SUSPENDERS	- *Removable suspenders*	- *Can fall down during riding*	- *Added chin guard can protect riders chin*
POCKETS	- *One zip pocket with key leash* - *Zip pocket - left thigh* - *Flap pocket - right thigh*	- *Pocket can be too specific and can overwhelm users which are user specific*	- *Limit the number of pockets and specific uses* - *Additional waterproof CF bib zip pocket* - *RFID specific pass pocket* - *Removable front pocket (clipped or worn as a bag)* - *Center front flap pocket with hidden hoodie hand pocket underneath*
SILOUETTE	- *Trim fit – cut slim to the body through chest, waist, hip and thigh for a low profile fit*	- *Articulated construction provides mobility on up-tracks and descents*	- *Three quarter pant length* - *Short pant length* - *Extended bib fornt*
CROTCH GUSSET	- *Gusseted crotch - articulated pattern*	- *When fully unzipped fabric can catch on dry slope material*	- *Closed gussets design*
SEAMS	- *Fully taped seams guard against driving rain and snow; micro-seam allowance (1.6mm) reduces bulk and weight*	- *No visible weaknesses*	- *Create a pattern with minimal pattern pieces* - *Fully Taped* - *Reinforced seams*
GRAPHICS/ PRINT	- *Dark color*	- *Dark colors will not be practical for hot weather climates*	- *Lighter main body color* - *Natural dyes* - *Reflective graphics*

RECCO® REFLECTOR	- *Embedded RECCO® reflector*	- *Uses radio signals for search-and-rescue detectors in avalanches, unnecessary for warm climates*	- *Remove RECCO reflector* - *Heat transfer silhouette outline* - *Solar charged main body fabric*
INSTEP PATCH	- *Keprotec™ instep patch*	- *Patch reduces edge cuts*	- *Increase size and height*
SIZE LABEL\CONTENT LABEL	- *Heat transfer size label center back interior collar* - *Woven content label*	- *Woven labels look messy*	- *Heat transfer label* - *Reflective finish* - *Smart label with tracking capability* - *Digital trigger (QR code)* - *RFID tag* - *Matrix code (matrix code: a companion QR code that could connect consumers' garments to the Infinite Play app irrespective of where the garment)*
CARE	- Woven care label wearers right interior side seam	- Woven labels look messy	- Heat transfer label - Reflective finish - Smart label with tracking capability

ADDITIONAL CHANGES

- Padding
  - 3D printed
  - Laser cut
  - Removable padding
  - Individual padding sleeves for various parts on the body worn underneath the outer layer
- Reinforced knees and seat
- Drawcords at the pant leg cuffs
- Expandable cuffs
- Water resistant boot gaiter
- Insect shield
- Elasticated underarms for a comfort fit

Aesthetic

Overarching design aesthetic is centered around circular design. Through the unlikely assimilation showcasing fashion's past, present, and future in a balanced juxtaposition found in circular fashion practices. Design elements are recycled, paying homage to traditional sustainability practices and reused in new applications and paired alongside technology though innovative development. The circular theme will play an inherent role in a multitude of applications ranging from materials, prints and graphics, and silhouette. Historical sustainability will utilize and celebrate artists, innovations, and cultures that resonate with sN0s Japanese target demographic. Pushing the boundaries of collaboration and the ideal circular lifecycle.

The style DNA developed to align with street culture and high fashion, questioning the normcore expectations associated with functional sportswear performance apparel. That goal pushes the mainstream style of design ideals, a barrier that has long focused on functionality and performance iconic to outdoor adventure apparel offer-

ings. This collection has the potential to create a new and unique niche market segment appealing to the future consumer, welcoming a new demographic to join the outdoor adventure. This individualistic style will aim to offer the highest level of functionality that aligns with high fashion aesthetic that can appeal to the consumer style not yet catered by the current sportswear market. Consumers unique style identity has the potential for inclusivity and engagement providing the freedom of self expression and identity that allows the functionality and technicality necessary for sport participation.

SN0's brand aesthetic is depicted in detail though the brands style guide, which include font and logo, along with the seasonal color pallet and mood-boards. Visual representation imagery is used as a visual storyboard to define the brand and collection. It is simplified in all categories including fabrication, materiality, print, graphics, and silhouette.

FIGURE 82

FONT PACKAGE

Color Story

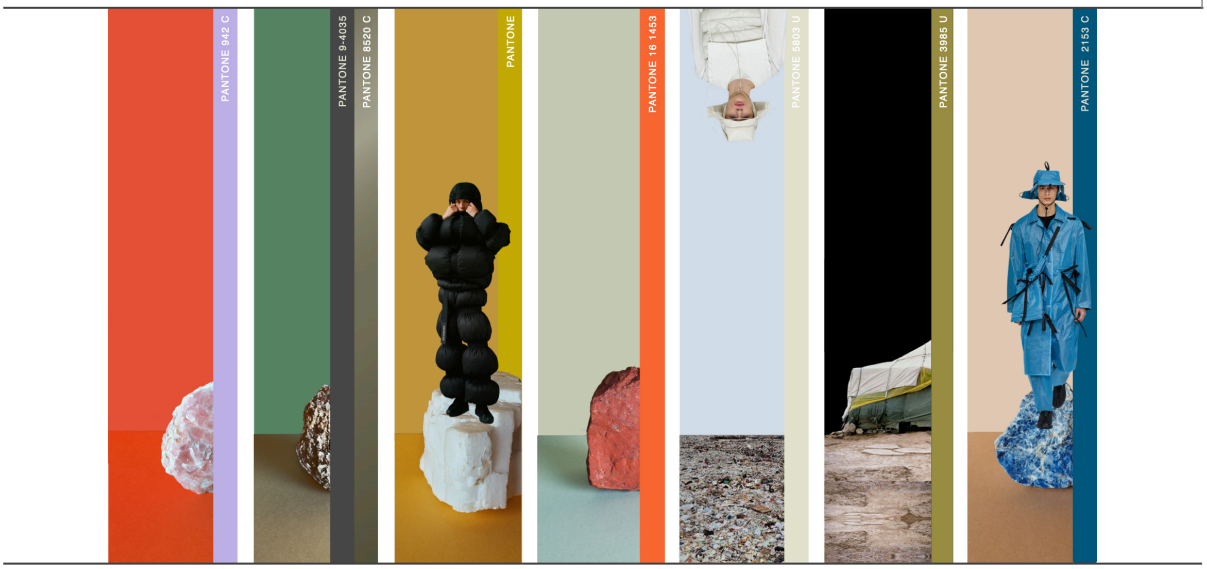
sN0's Spring/Summer 2035 color pallet is derived from nature - celebrating the ancient outdoors evoking ancient color references from Japanese traditional shibiori indigo, shades of greens, and browns; textural palette inspired by the mystery and calm found within the forest (WGSN, 2020). Accents include bright color highlights and shape, shifting metallics (gray's of nickel, pewter and zinc), foreshadowing a digitized future of tomorrows utilitarian modular digitized urban wardrobes

Figure 83

Color story - Pantone information

FIGURE 84

COLOR STORY MOOD BOARD



Mood Board

Aesthetic ideation includes nodes to future looking constructed garments. Simplistic natural elements that coexist together to create a visual identity. Rerooted in nature and the desire for connection can be found in earthy textures, ancient wisdom, and rituals inspire developments in science and technology. This symbiotic relationship requires protection, placing importance of sustainable and regenerative processes. The me-hem and turmoil of global warming will inform design, its presence will transcend the digital world and provide the founding and re-minder amongst the digital chaos. As humanity ventures into the digital world though immersive experiences, an unexplored terrain instills the importance of our relationship to nature, heritage, craft, and community. The roots that renew and sustain us allow continued growth and exploration into the unknown.

FIGURE 85

COLOR STORY MOOD BOARD

Mood Board: Materials

Earthy textures, inspired from ancient artisanal wisdom practices reinvigorate nature's inherent regenerative properties. The use of raw and organic materials, paired with technical innovative materials create a balanced partnership with the ultimate end goal of circular lifecycles and neutral environmental impact within our futures, while reaching science and technology in a continuous push for innovation and possibility. Use of zero-dye fabrics leave fibers in their natural color will allow for production of cleaner products. Alternative use of natural dyes from plants used in traditional Japanese dying techniques are reimagined in additional to dye alternatives found in bacteria growth. Science takes on a bigger industry role introducing biophilic advancements and natural solutions to performance-driven athlete needs. Functionality is hidden in the details of a lighting system, adaptive materials, durable fibres, and elevated thermoregulation. Looking to nature's innovations will continue to inspire textiles, offering sustainable solutions for performance-driven finishes

FIGURE 86

MATERIALS MOOD BOARD

Note:

Mood Board: Graphics + Print

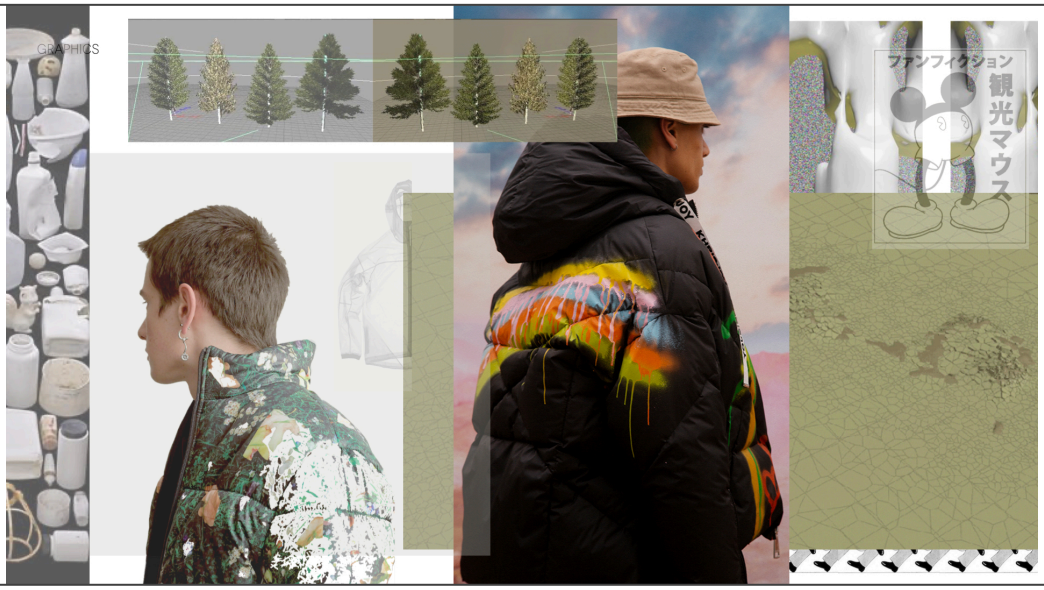
Ancient futures looks to historical references through a futuristic lens to define a new era hovering on a rebellious realm. Prints and graphics reimagine natures influences in pattens, prints, and graphics that are precise and defined. Prints and graphics enhance tactile qualities in redeveloped camouflage where digital realms merge with nature in surfaces textures that inform the origin ties rooted, recycled, and reimagined (Kostiak, 2021). Modern media hides in plain sight emulating iconic, detailed patterns. Digital printing is utilized along with traditional dye techniques using less water and electricity than other methods, and producing vibrant and complicated details.

FIGURE 87

COLOR STORY MOOD BOARD

FIGURE 88

COLOR STORY MOOD BOARD



Silhouette

Future forms concept emerges from the desire to escape the day-to-day leads us to a fantasy world that blurs the boundaries between digital creations and reality. Personal identities and forms are shape-shifting and modular to all fluid freedom in movement. Genderless silhouettes take on architectural shapes and surreal disproportions that push the boundaries between functionality and high fashion. This is a continuous experiment to challenge

norms and exaggerated proportions inspired by natures beauty found in ammonite shell. Design has the ability drive the future innovation using technology and science data progression to provide the unimaginable for sport performance.

FIGURE 89

SILHOUETTE MOOD BOARD - OUTERWEAR JACKET

FIGURE 90

SILHOUETTE MOOD BOARD - OUTERWEAR BIBS

Material Selection and Sourcing

Naturally derived color will play a key role in this collection as part of the responsible product strategies.

FIGURE 91

FOCUS: COLOR + DYE

CONCEPT	*PERFORMANCE GOALS*	*SOURCING IDEAS*
UNDYED	- *Sustainability* - *Natural undid textiles*	- *Undyed polyester* - *Undyed and unrefined cotton*

BOTANICALS	- *Non-toxic source*
	- *and alternative to petroleum-based aniline dyes (hypoallergenic qualities).*
		- *Botanical dyes derived from:*
		  - *fruits*
		  - *spices (turmeric)*
		  - *Leaves and*
		  - *Roots*
		- *Botanical printing technique that involves pressing and dyeing plants and leaves to natural textiles*

INDIGO	- *Extracted from the Indigofera tinctoria plant (long and technical process carried out by masters in the craft, natural indigo dyeing was widely used across the globe until being largely replaced by synthetic dyes in the early 20th century)*	- *Working with the brand*
BACTERIA PIGMENTS	- *Next-generation technology*	- *Faber Futures* - *Post Carbon Lab* - *Colorifix*

As active materials will consciously adapt with a centralized focus on sustainability and circularity. Materials will look to enhance our experiences through performance or sensory care, while prepping us with the resilience in strength. Recycling and chemical-free innovations will set the guidelines for sustainable developments. Looking to nature's innovations will continue to inspire textiles, offering sustainable solutions for performance-driven finishes.

FIGURE 92

FOCUS: FINISHING

CONCEPT	*BENNIFITS*	*SOURCING IDEAS*
SHEER STRENGTH	- *Sheer and lightweight materials*	- *Dyneema* - *Kevlar* - *Graphene*
CHEMICAL-FREE PERFORMANCE	- *Alteration of construction to provide performance*	- *Create weaves that block mosquitos, using miracle fibres such as graphene* - *Use weaving to provide SPF*
RECLAIMED & RECYCLED	- *Recycling/reclaimed product (opportunity for unique one-off designs)*	- *Upcycled designs* - *Recycled materials*
LIQUID HOLOGRAPHICS	- *Reflective holographics*	- *Finished that adapt to light/enviornment*

Using stretch to create a snug fit, shape retention and ease of movement to our entire wardrobe, answering the product needs including fashion, performance, and sustainability.

FIGURE 93

FOCUS: STRETCH

CONCEPT	*BENNIFITS*	*SOURCING IDEAS*
Active & Outdoorwear	- *Eco alternatives*	- *Laytex free innovations* - *DuPont Sorona* - *Unifi Repreve fibres*

The next generation seeks protective performance in their clothing. This report outlines how to build functional, weather-ready innovation into outdoor-wear.

FIGURE 94

FOCUS: FINISHING

CONCEPT	*BENNIFITS*	*SOURCING IDEAS*
WEATHER-PROOFED	- *Performance value* - *Packability* - *Protection from elements*	- *Two-layer waterproof Tetra nylon (four-way stretch in the outer layer and the inner is an antibacterial sweat-wicking mesh with four-way stretch)* - *Recycled yarns – Aquafil, Econyl (Newlife), Unifil (Repreve), Santanderina (Seaqual).* - *Bio-based – Dyntex Biosynthetics (Terryl), Dupont x Tate & Lyle (Susterra).*
SUN-SHIELDING	- *Sun defence* - *UPF +40–50 ratings either block or absorb UV-A and UV-B rays that cause skin burning, ageing and cancer.*	- *Hyosung TNC's Aqua-X nylon teams UV-blocking, sweat-absorbing and quick-dry performance* - *Daehans' moisture-managing, cooling, soft Shelron fibre embeds UV function into fibre via nanotechnology* - *Use of titanium dioxide, zinc oxide, Ciba (Tinosorb FD and FR) Sundriven (PrioriTec) high-density weaves* - ***Key innovators:*** *SkinSafe, M-Shield, Daehan (Shelron), Creora (Mipan Aqua X), Schoeller Textil AG (Coldblack)*
EXTREME PROTECTION	- *personal safety guarantees against the dangers of erratic climates*	- ***Key ingredients and technologies:*** *DSM (Dyneema), Dupont (Kevlar), Invista (Cordura), Nomex, Technora, Twaron, Spectra, Armalith, Gore-Tex Pro, Sang Fang (Pashron)* - ***Key innovators:*** *outdoor – Schoeller, Teijin Frontier Co, Chia Her, Everest Textile Co, Kipas, Evertex, Climashield, Concordia. Denim – Cone Denim, Artistic Milliners, Arvind*

IDEATION PLANS

Ideation calendars were developed for the remaining half of winter 2021 term to assure proof of concept for each of product designing within the thesis collection. Proof of concept involves rounds of design ideation and sketching and prototyping. This experimental process affords a timeframe to experiment and explore potential designs parts that make up each product. Each product design should require a full week to develop. This calendar will act as a grading rubric in order to complete the tasks necessary to fully explore each product.

Figure 95

Ideation Calendar 688 SPD Winter Term Design Studio

February

Sunday	*Monday*	*Tuesday*	*Wednesday*	*Thursday*	*Friday*	*Saturday*
	1	*2*	*3*	*4*	*5* *+ Midterm prep*	*6* *+ Midrm Prep*
7 *+ Midterm Prep*	*8* *+ Class* *Midterm Preview* *+ 3:00 Gore meeting*	*9* *+ Midterm revisions for final presentation*	*10* *+ Midterm review*	*11*	*12* *+ Print off tears for silhouettes: 1 hr* *+ Prep supplies for studio production: 1 hr*	*13* *+ Update calendar with deliverables*
14 *+ Update mood boards with new images* *+ Detail flat images of bib silhouette Illustrator*	*15* *+ Class* *+ Revisit calendar deadlines and adjust deliverables* *+ Review fabric chart master with Susan*	*16* *+ Bib detail sketching br details (20 ideas): 2 hr* *+ Refine sketches:* *+ Bib detail sketching - pockets, suspenders (20 ideas each): 2 hr* *+ Bib detail making, br detail*	*17* *+ Class* *+ Bib detail making - pockets, suspenders (5 each): 5 hr*	*18* *+ Jacket outerwear material selection: 1.5 hr* *+ Jacket detail sketching - removable parts, vents (20 ideas each): 3.5 hr*	*19* *+ Jacket detail making - removable parts, vents (5 each): 3 hr* *+ Jacket detail sketching - Jacket detail sketching - ventilation, padding (20 ideas each): 3 hr*	*20* *+ Jacket detail making - ventilation, padding (10 ideas each): 5 hr*
21 *+ Take photo photos of all work completed thus far: 1 hr* *+ Refine sketches and develop deck: 4 hr*	*22* *+ Class* *+ Jacket Clo/Illustrator flat: 5 hr*	*23* *+ Final mini silhouette proto (2 total): 3 hr* *+ Final sketching cleanup: 2hr*	*24* *+ Class* *+ Jacket request to purchase order for fabric and trims: 1.5 hr*	*25* *+ Base layer sketching (35 ideas): 3 hr* *+ Base layer material selection: 1.5 hr*	*26* *+ Base layer detail sketching - bathroom details (20 ideas): 2 hr* *+ Base layer detail making - bathroom details (10 ideas total): 3hr*	*27* *+ Base layer mini silhouette proto making (2 total): 4 hr* *+ Clean up sketches: 1 hr*
28 *+ Base layer CLO/ Illustrator flat: 5 hr*						

March

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	1 + Class + Redo calendar for remaining 10 days of term + Bib and create final pattern	2 + Storyboard presentation + Make patten for jacket	3 + Class + Define jacket details on mockup (zipper, elbow abrasion resistance)	4 + Add in details for final jacket + Add bib zipper to connect jacket and bib	5 + Take photos and sketch for final presentation	6 + Refine final trims needed on jacket and bibs + Make sure all fabrics are ordered
7 + Presentation finalization + Write copy for final presentation	8 + Class - Final review run-through + Fine tune pattern and	9 + Make any changes/updates: 2 hr + Practice presentations (3 times total - timed): 1 hr	10 + Class - Final Review			

MIDTERM PRESENTATION REVIEW

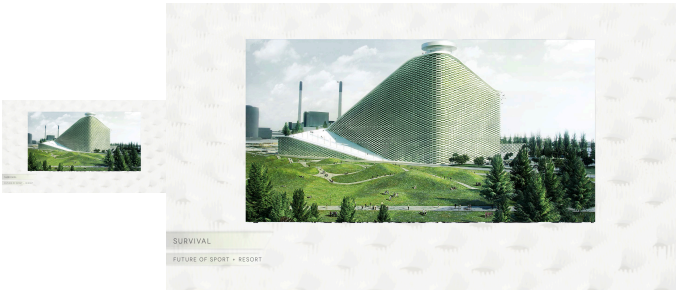
FIGURE 96

MIDTERM PRESENTATION THUMBNAILS

Sports enthusiast, player more than watcher - began my athletic career in on the bunny hill age of 2. Last 10 years working in the fashion industry, primarily in mens design prior to enrollment here at SPD at the UO. I applied to SMD further develop my design aesthetic and knowledge in science, functionality, and technology. Interest reside in High fashion, high function design + sustainability. My Capstone collection circles back to the start of my athletic career on the ski slope

My love of snow sports is facing its end due climate change + global warming. Skiing and snowboarding may eventually become extinct. Industry facing changes already. One of my mentors Scientist Dr. Donal O'Leary helped grasp what lies ahead for the specific sport of snowboarding. . Temp expected to increase by1.8 degrees F (1degree Celsius) over the course of the next 20 years. More extremes, radically divergent weather patterns, and irregular seasons. The lowest altitude resorts will suffer the effects faster than others.

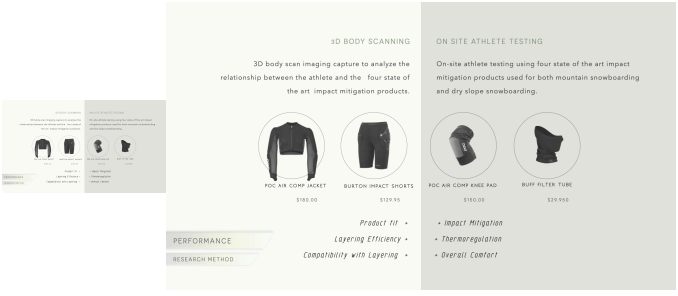
Grim future - implementing methods to become more sustainable lessening their effects that are adding to the diminishing ski seasons. They have also instituted practices such as snow making that acts as a short term bandaid for extending skiable runs and open days an example shown here in the background photo of a ski resort struggling to facilitate an open route down their mountain face. Not to mention that the majority of snowmaking exasperates energy consumption and adds emissions that is the very cause of the shortening their ski season. These resorts are looking for ways to stay afloat and compete against a new competitor in the market, the indoor ski slope. Essentially a huge refrigerator, this 'attraction' adds a substantial amount to global warming and will aid in the progressions ultimate end. (More images of ski resorts)



Not talking about potential to save resorts + the snow sports industry collectively. . Artificial or man made slopes 1927 (Vienna). Located in Europe or unaccessible areas to mountain resorts. Plastic materials mimic real snow. Not dependent on snow - function 365 days/year in any temperature. Installed in any location (indoors/or outdoors on top of buildings, or directly on top of existing ski slopes). Term I coined - dry slope snowboarding.

Difference between snowboarding on snow + dry slope. Everyone to stand up - hip distance apart, toes pointed slightly outward, squat position, heel + toes. Same basic rules; sequences of turns
Same equipment: snowboard, bindings.
Main difference slower coefficient on sry slopes - slower Edging, ability to carve is limited by the depth of the slope surface which will not support a riders weight, if their lean exceeds out beyond their edge.

Difficulty without access to dry slopes - Covid 19, 2 location in the US. 2 Research plans - performance and consumer



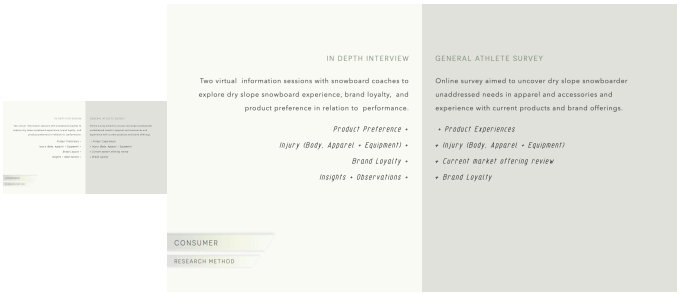
v Selected four products that were used for snowboarding impact protection
Performance research using four our state of the art impact mitigation products t

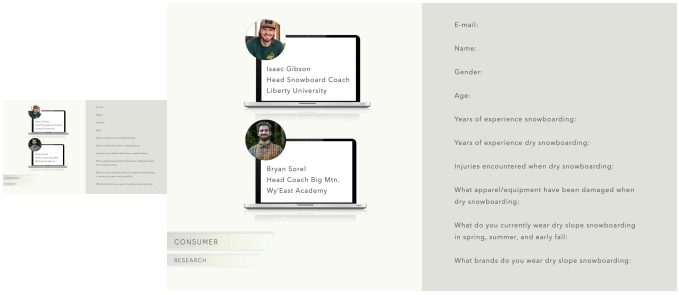
1) *Burton, Total Impact Short, Protected by G-Form™ - women's sz. M,*
2) *POC, Joint VPD Joint Knee System - men's sz. S,*
3) *POC, VPD Air Comp Jacket - men's sz. S, and the Buff,*
4) *Filter Tube - unisex sz. S/M.*

3D body scans. cyberwar scanner. Cyescan software 3D images were assembled and analyzed by layering (better than using body measurement data). Visual relationship between the athlete's body, the impact mitigation products, and the additional layers needed when snowboarding.

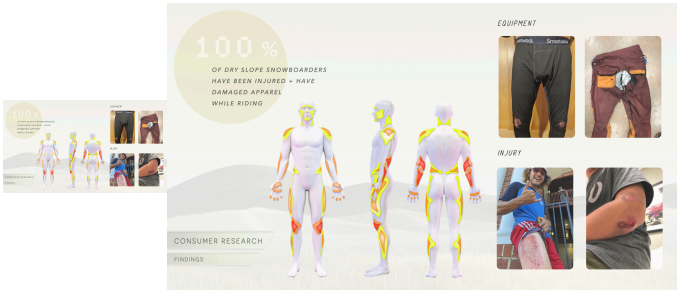
Trial lasted a total of 90 min - aggressively snowboard. Removed protection to compare and contrast their experience. Following day each athlete was interviewed via zoom to discuss their experience and feedback with the impact mitigation equipment.

The athlete research findings are shown here in this graph. You can see on the right the impact mitigation products that were tested and their rating by the athletes by fit/comfort, thermoregulation, impact mitigation and lastly by any negative effect on their riding. Most surprisingly results were that both riders overall preferred no impact protection due to its bulk, and negative implications on their riding.





Consumer research In-depth interviews two coaches + athlete consumer survey.Experience with dry slopes, Common apparel and equipment worn in the Spring, Summer, and early Fall, temperatures, maintaining thermoregulation and when raining, impact mitigation equipment apparel used, injury patterns, additional needs of dry slope snowboarders, and any additional comments/feedback. In the second research method was conducted using google survey and sent out to 30 dry slope snowboard athletes at both Liberty University and Wy'East. 30 respondents answered similar questions to that of the in-depth interview .

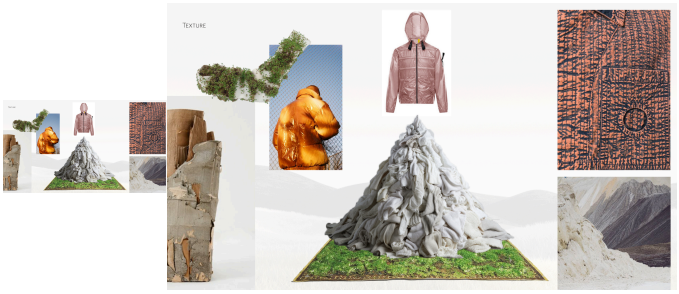


Better than athlete testing - lack of dry slope access . Body map shows rug burns. Most surprising revelations Impact mitigation isn't necessary! Currently wear products from goodwill - throw away . Unmet needs - rung burn, ventilation for hot temperatures.

2035 (affects of climate change) . Japan - worlds most popular ski destination "power Mecca" upwards of 600 in. Per year and 500 ski resorts + 2 winter olympic games. Strong snow sport culture + fashion capital (recreational GORP-CORE subculture movement). Unisex symbolic for both inclusion and diversity and progressive leadership of fashion expression. Fashion focused + environmentally conscious, Heritage brand loyalty.

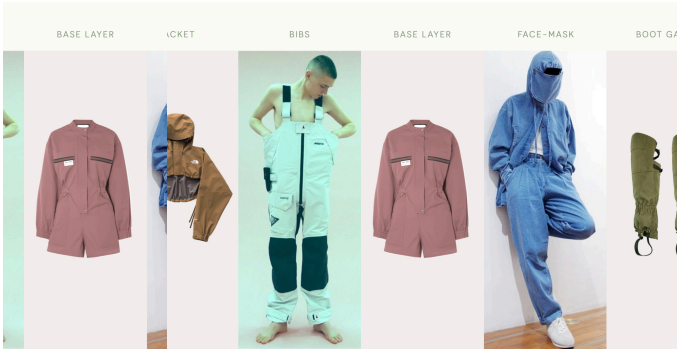
Circular design/ideation overarching theme (not just sustainability, but celebrate graphics, and artists who defined the culture of snowboarding). An aim to celebrate + recycle paired with new inspiration from innovation + technology. Video games and virtual reality recent influence ranging from: CGI, virtual models to fashion brands have started making virtual clothes was a major influence in sNO's design aesthetic along with Japanese comics and hype beast artist.

Aesthetic ideation. Earth tones, nodes to future looking constructed garments. Simplistic natural elements that coexist together to create a visual identity.



Materials will again fall inline sustainability theme. Use of zero-dye fabrics - leaving fibers in their natural color, and will allow for production of cleaner products with all the performance characteristics. Or natural dyes - food waste, plants, bacteria, and traditional Japanese dying techniques. Looking to nature's innovations will continue to inspire textiles, offering sustainable solutions for performance-driven finishes.

Color pallet is derived from nature - evoke themes of the ancient outdoors in a mysteriously and calm primordial landscape . Tamed and muted textural tones contrast with digitized visions relative for the consumers in an urban environment. Color highlights will act as accents to the utilitarian needs tomorrow's modular wardrobes - include a node to vintage Japanese indigo in addition to the versatile, shape-shifting greys of nickel, pewter and zinc. This color pallet lends itself to outdoor utility, and material patchwork that will define the practice of modern upcycling.



No products currently on the market specific to dry slope snowboarding. Design collection will feature 5 products. Vastly different climate conditions (Spring, summer, and early fall) - breathable, ventilation details, thermoregulation support. Abrasion resistance - prevent rug burns. Revision silhouettes future facing - challenge the 'norm' apparel shapes static in snowboarding.

Capstone catalysts - build a new kind of home in the mountains Introduce alternative snowboard style in high fashion (inclusive) Bring awareness to sustainability Build industry connections Ultimately find a job in the fashion outwear space following graduation.

Design Sizing Identification

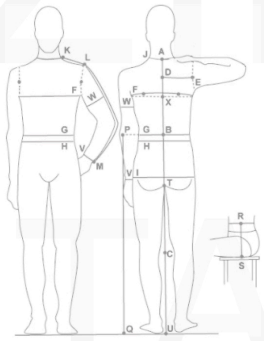
FIGURE 97

MANNEQUIN AND FIT MODEL SIZING MEASUREMENTS

SIZING DETAILS

Professional Male Full Body
Dress Form Size: 36

- CHEST
- WAIST
- HIP
- NECK
- BACK WIDTH (WIDEST PART)
- FRONT LENGTH (NECK BASE TO WAIST)
- BACK LENGTH (NECK TO BASE WAIST)
- CROTCH (FRONT WAIST TO BACK WAIST)
- THIGH (CIRC. WIDEST PART)



Male Fit Model
Mens Size: M

HEIGHT	71
CHEST	35
WAIST	30
PANT WAIST	29
HIP	31
INSEAM	30.5
PANT SIZE	31
TOP SIZE	M

Final Midterm Presentation

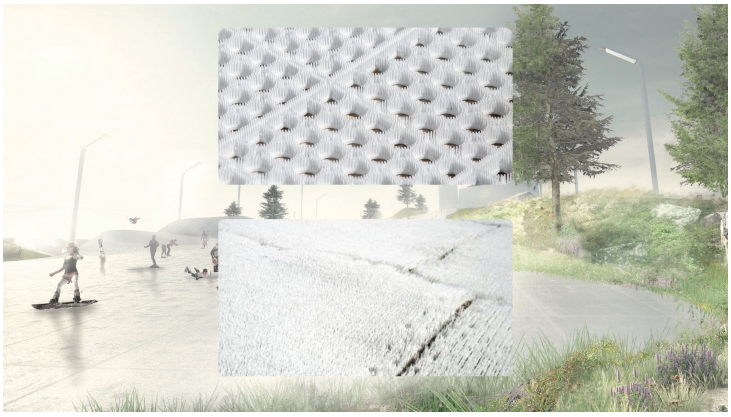
FIGURE 98

FINAL PRESENTATION THUMBNAILS + COPY

Introducing sN0 a dry slope snowboarding collection by Eva Vaughan.

"HOW CAN WE DESIGN INNOVATIVE, LUXURY FASHION, DRY SLOPE SNOWBOARDING APPAREL THAT PROPERLY ADDRESS ABRASION RESISTANCE, MOBILITY, AND THERMOREGULATION NEEDS NECESSARY FOR OFF-SEASON CLIMATE CONDITIONS."

A research plan was developed to better understand mobility, thermoregulation limitation, and overall effectiveness of state of the art impact mitigation injury protection products to define unmet needs of dry slope snowboarders apparel and equipment.



Difference between snowboarding on snow + dry slope. Same basic rules; sequences of turns + Same equipment: snowboard, bindings. Main difference slower coefficient on sry slopes - slower Edging, ability to carve is limited by the depth of the slope surface which will not support a riders weight, if their lean exceeds out beyond their edge. Indoors out-doors - Done 365 days a year - in any weather The slope surface -

My love of snow sports is facing its end due climate change + global warming. Skiing and snowboarding may eventually become extinct. Industry facing changes already. One of my mentors Scientist Dr. Donal O'Leary helped grasp what lies ahead for the specific sport of snowboarding. Temp expected to increase by1.8 degrees F (1degree Celsius) over the course of the next 20 years. More extremes, radically divergent weather patterns, and irregular seasons. The lowest altitude resorts will suffer the effects faster than others. Since the 1950's we've lost 600 reported ski resorts alone. A bad snow season effects more than resorts, in 2019 the US economy alone lost $20.3 billion. Resorts are aware of the grim future and have begun implementing methods to become more sustainable, lessening their effects that are adding to the diminishing ski seasons. They have also instituted practices such as snow making that acts as a short term bandaid for extending skiable runs and open days an example shown here in the background photo of a ski resort struggling to facilitate an open route down their mountain face. Not to mention that the majority of snowmaking exasperates energy consumption and adds emissions that is the very cause of the shortening their ski season. These re-sorts are looking for ways to stay afloat and compete against a new competitor in the market, the indoor ski slope. Essentially a huge refrigerator, this 'attraction' adds a substantial amount to global warming and will aid in the progressions ultimate end.

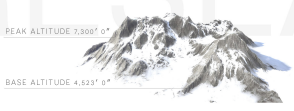
RESEARCH

3D BODY SCAN

3D body scans using Cyberwar scanner software were assembled and analyzed by layering (better than using body measurement data). Visual relationship between the athlete's body, the impact mitigation products, and the additional layers needed when snowboarding.

RESEARCH

Mt. Hood Meadows Ski Resort

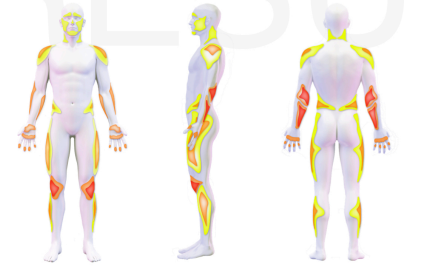


Date: 01.15.2021
Location: Mt Hood, OR
Temperature: High 37 - Low 10 degrees
Weather: scattered snow/rain 30 %
Athlete: 2 Female

Each athlete was asked to snowboard aggressively wearing 3 state of the art products for a total of 90 min. The following day athletes will meet virtually to discuss each product.

January 15th, 2021 weather; high of 37 low of 10 scattered snow/precipitation of 30%. 2 female in this study participated in testing trials each test lasted a total of 90 min. Athletes were asked to snowboard aggressively to maximize the potential need for impact protection products during the trial. Athletes were asked to snowboard a - aggressively snowboard Removed protection to compare and contrast their experience Following day each athlete was interviewed via zoom to discuss their ex

RESULTS



EQUIPMENT

INJURY

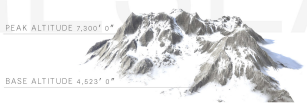
100% OF DRY SLOPE SNOWBOARDERS EXPERIENCED INJURED WHEN RIDING

100% OF DRY SLOPE SNOWBOARDERS HAVE DAMAGED APPAREL WHEN RIDING

Consumer in-depth interviews and online surveys proved more valuable than the lather testing. On January 14th I met with Isaac Gibson Head snowboard coach at Liberty University where they have one of the only two public dry slopes in the United States via zoom. A separate interview was conducted in person with Bryan Sorel head coach - Big Mountain at Wy'East Academy where he has trained olympic level athletes. Wy'East has three dry slope installations that are used for snowboarders to train. Over the course of both interviews we discussed their experience with dry slopes, common apparel and equipment worn in the Spring, Summer, and early Fall, temperatures, maintaining thermoregulation and when raining, impact mitigation equipment apparel used, injury patterns, additional needs of dry slope snowboarders, and any additional comments/feedback. In the second research method was conducted using google survey and sent out to 30 dry slope snowboard athletes at both Liberty University and Wy'East. 30 respondents answered similar questions to that of the in-depth interview . Body map shows rug burns. Most surprising revelations Impact mitigation isn't necessary! Currently wear products from goodwill - throw away . Unmet needs - rung burn, ventilation for hot temperatures.

RESEARCH

Mt. Hood Meadows Ski Resort



Date: 01.15.2021
Location: Mt Hood, OR
Temperature: High 37 - Low 10 degrees
Weather: scattered snow/rain 30 %
Athlete: 2 Female

Each athlete was asked to snowboard aggressively wearing 3 state of the art products for a total of 90 min. The following day athletes will meet virtually to discuss each product.

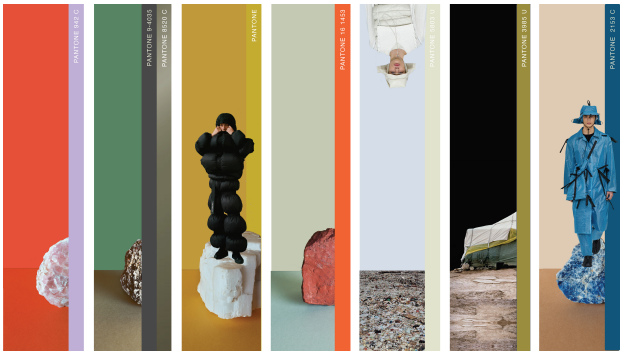
On site athlete testing was conducted on January 15th, 2021 at Mt. Hood Meadows Ski resort. The temperature: high of 37 low of 10 degrees Fahrenheit, with scattered snow/precipitation of 30%. 1 female and 1 male subject were used in this study. Each trial lasted a total of 90 min in which they athletes were asked to snowboard aggressively using all four impact mitigation products. After 90 min the athletes removed the impact protection and continued cool down runs to compare/contrast between their experience with and without the products. The following day each athlete was interviewed via zoom to discuss their experience and feedback with the impact mitigation equipment.

GOALS

Ideation goals for designing.

Remain High fashion without forfeiting functionality. Aesthetic ideation includes earth tones, nodes to future looking constructed garments and simplistic natural elements that coexist together to create a sustainable visual identity.

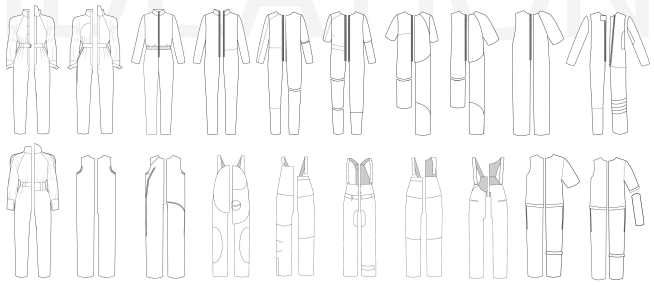
Materials will again fall inline sustainability and circular design. Looking to nature's innovations will continue to inspire textiles, offering sustainable solutions for performance-driven finishes while graphics prints will celebrate the target consumers Japanese heritage, paying homage to historical cultural design along with current streetwear cultural.



Color pallet evokes themes of the ancient outdoors in a mysteriously and calm primordial landscape. Tamed and muted textural tones contrast with digitized visions relative for the consumers in an urban environment.

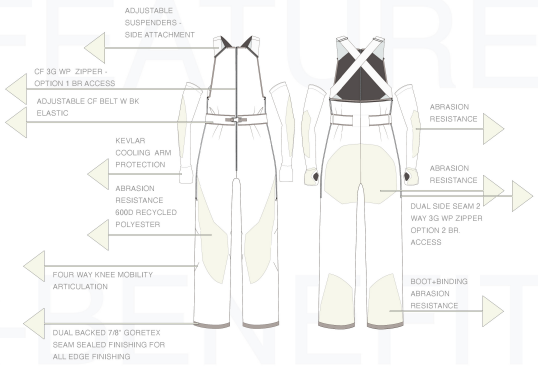
No products currently on the market specific to dry slope snowboarding. Design collection will feature two products for vastly different climate conditions (spring, summer, and early fall). Making breathable, ventilation details, thermoregulation support imperative along with abrasion resistance to prevent rug burn injury. Revised silhouettes will be future facing and challenge the 'norm' apparel shapes static in snowboarding.

IDEATION

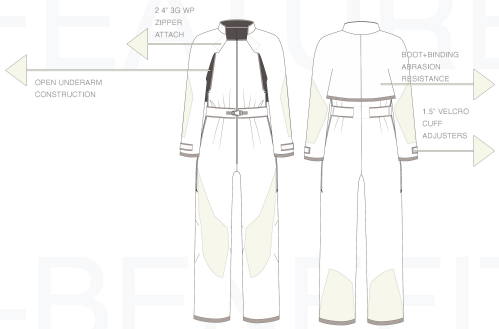


IDEATION

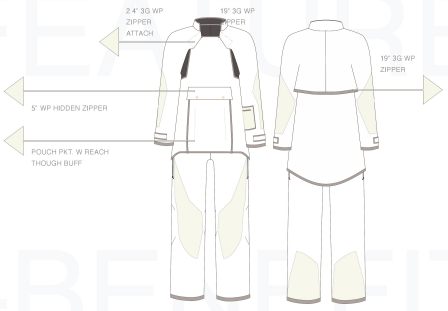
IDEATION



vAesthetic ideation. Earth tones, nodes to future looking constructed garments. Simplistic natural elements that coexist together to create a visual identity.

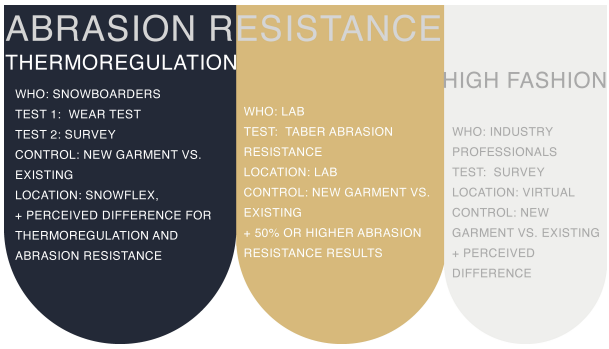


vMaterials will again fall inline sustainability theme. Use of zero-dye fabrics - leaving fibers in their natural color, and will allow for production of cleaner products with all the performance characteristics. Or natural dyes - food waste, plants, bacteria, and traditional Japanese dying techniques. Looking to nature's innovations will continue to inspire textiles, offering sustainable solutions for performance-driven finishes.



v Color pallet is derived from nature - evoke themes of the ancient outdoors in a mysteriously and calm primordial landscape . Tamed and muted textural tones contrast with digitized visions relative for the consumers in an urban environment. Color highlights will act as accents to the utilitarian needs tomorrow's modular wardrobes - include a node to vintage Japanese indigo in addition to the versatile, shape-shifting greys of nickel, pewter and zinc. This color pallet lends itself to outdoor utility, and material patchwork that will define the practice of modern upcycling.

v No products currently on the market specific to dry slope snowboarding. Design collection will feature 5 products. Vastly different climate conditions (Spring, summer, and early fall) - breathable, ventilation details, thermoregulation support. Abrasion resistance - prevent rug burns. Revision silhouettes future facing - challenge the 'norm' apparel shapes static in snowboarding.



The performance goals of the new tech with anticipated metrics and how it will be validated to prove it is better than the benchmark (high-level summary). Validated against the state of the art benchmark product.

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SECTION III

PROOF ON CONCEPT FINAL VALIDATION TESTING

Final testing methods were determined to collect data to validate final design performance. Testing plans focused on three areas: abrasion resistance, thermoregulation limitation, and fashion alignment. These three areas of focus were defined to measure key improvement areas that address unmet needs of current dry slope snowboarding apparel available on the market. Data results and findings should support substantial improvements of the final design when compared and contrasted against current market offerings.

Test methods were subject to considerable limitations due to the lockdown restrictions associated with COVID-19 and altered accordingly to comply with COVID-19 regulations.

OBJECTIVES:

Proof of Design Concept:

1. Abrasion resistance - Material testing
2. Thermoregulation - Athlete testing
3. Fashion alignment - Perception testing

Final Validation and Proof of Concept Testing Method Plan

Three final proof of concept testing methodology plans are outlined below. The final testing methods were devised to collect final garment performance data metrics that support the design intent to provide dry slope snowboarders innovative, luxury fashion dry slope snowboarding apparel that properly addresses abrasion resistance and thermoregulation needs necessary for off-season climate conditions. Testing methods include three separate tests areas: abrasion resistance testing, athlete thermoregulation performance testing, and fashion industry insight and feedback perception.

Abrasion Resistance Final Validation Product Performance Testing Plan

1A. SPECIFIC AIMS/STUDY OBJECTIVES, INCLUDE TO PROVE:

The testing will attempt to show the improved abrasion resistance offered by the garment materials and design. The final design's three primary fabrics used were tested against four of the most common materials/fabrics worn by dry slope snowboard athletes. This testing method plan was modeled to mimic recognized industry protocols used to measure abrasion/wear. Materials were subjected to extensive abrasive stressors until the material structure is no longer considered functional (also referred to as 'to destruction'). Time to destruction of new materials and existing industry standards should offer data measurements that show substantial abrasion resistance improvement - setting new expectations for dry slope snowboarding apparel life expectancy standards .

1B. METHODOLOGY

Location of Study:

- The testing will take place at the University of Oregon Portland Campus (70 NW Couch St, Portland, OR 97209).

Date:

- Tuesday August 9th, 2021

Experiment Supplies:

- Scotch-Brite 3M Paint and Rust Stripper (5in/po/plug) Disc
- Heavy Duty Staple Gun + Staples
- C-Clamps
- Plywood Board
- 2" Gorilla Tape
- Drill

New Fabrics (Materials):

A. Mainbody Fabric (3 Ply SWB-Tex) + abrasion resistance (WeatherMAX 65 Polyester)

B. Mainbody Fabric (3 Ply SWB-Tex)

C. Abrasion Resistance (WeatherMAX 65 Polyester)

Existing DSS Fabrics (Materials):

D. Lt. Weight Chino Khaki

E. Windbreaker

F. Tube Socks

FIGURE 99

1C ABRASION RESISTANCE TESTING

PHASE OF STUDY	PROCEDURE	DATA COLLECTED	TIMING
PRE EXPERIMENT	*Supplies assembled*	*None*	*N/A*
PRE EXPERIMENT	*Cut 7 new and existing fabrics into 12x12 in. sample squares. Edge stitch abrasion resistance and main body fabric swatch together using 1/2" (11-12 spi) sn topstitch. Place 6 samples onto plywood board. Staple fabrics at corners and midpoints to plywood board. Cut gorilla tape and cover edges of fabric to prevent movement during abrasion stressor exposure. Final sample square is reserved as a control.*	*None*	*30 minutes*
PHOTO ASSETS COLLECTION	*Photos of fabric pre-experiment taken to compare to post-experiment sample photos.*	*Photo Assets*	*10 minutes*
DATA COLLECTION	*Scoctch-Brite disc attached to drill. Two additional subjects use stopwatch timers to record time to destruction of materials and record data.*	*Cyescan software computes SCAN 1 full body scan.*	*5 minutes*
	Round 1: Drill placed on each fabric. Timer and drilling stared simultaneously. Even downward pressure is applied to the fabric with the drill disc face. When fabric reaches destruction (hole that reaches over 1" in diameter) the timer and experiment are stopped and data is recorded.	*First experiment round - time to destruction of fabric samples 1-6. Time to destruction recorded in seconds.*	*30 minutes*
	Round 2: The experiment is repeated in reverse of the material testing order followed in Round 1. Repeating the steps in the first experiment the drill is placed on each fabric. Timer and drilling started simultaneously. Even downward pressure is applied to the fabric with the drill disc face. When fabric reaches destruction (hole that reaches over 1" in diameter) the timer and experiment are stopped and data is recorded.	*Second experiment round - time to destruction of fabric samples 1-6 in reverse order. Time to destruciton recorded in seconds.*	*30 minutes*
PHOTO ASSETS COLLECTION	*Photos of fabric sample post-experiment taken to use to compare to pre-experiment sample photos.*	*Photo Assets*	*10 minutes*
DATA CALCULATED	*Data is averaged and calculated from both experiment rounds.*	*Final averaged data*	*10 minutes*
TOTAL EXPERIMENT TIME			*2 hours 5 minutes*

Thermoregulation Final Validation Product Performance Testing Plan

2A. AIMS/OBJECTIVES, INCLUDE TO PROVE:

The testing will attempt to collect data to show improved thermoregulation properties characteristics offered in final design apparel products.

2B. METHODOLOGY

Athletes will participate in performance experimentation where data on perception of mobility and fashion/ design aesthetic personal style alignment will be collected via interview. The testers will be asked to compare the final designs against their existing snowboard apparel outfits.

Location of Study:

- The testing will take place at Mt. Tabor Park; SE 60th Ave &, SE Salmon St, Portland, OR 97215.

Date:

- Tuesday August 15th, 2021 at 11:00 am - 3:20 pm.

Athlete Subjects:

- Snowboard athletes meeting final design sample size parameters were sourced as test subject participants.

Supplies:

- Voice record and transcription mobile App Otter.
- Cell phone

FIGURE 101

2C THERMOREGULATION TESTING

PHASE OF STUDY	PROCEDURE	DATA COLLECTED	TIMING
PRE EXPERIMENT	*Athletes scheduled in time slots for experiment and data collection.*	*None*	*N/A*
ATHLETE 1 PERFORMANCE EXERCISES IN EXISTING SNOWBOARD OUTFIT	*Athlete 1 changes into their existing snowboard apparel. The first experiment sequence begins. Athletes climb and ascend 1 flight of stairs for 5 consecutive min. 3 min rest in shade. Athletes complete 20 squat dips, 20 pushups, and 20 lunges.*	*None*	*30 minutes*
ATHLETE 1 REST, REHYDRATE, AND DATA COLLECTION	*Athlete 1 removes outfit for rest, rehydrate, and data collection. Otter used to transcribe athlete perception feedback from the following survey questions: Using a Likert scale athletes asked to rate current outfit for thermoregulation properties on a scale from 1-10, mobility properties on a scale from 1-10, and design/fashion alignment on a scale from 1-10. Athletes are free to offer any additional comments and feedback.*	*Perception comments and Likert scale ratings.*	*30 minutes*
ATHLETE 1 PERFORMANCE EXERCISES IN SN0 FINAL GARMENT SAMPLE	*Athlete 1 changes into SN0 final apparel sample. The first experiment is repeated. Athletes climb and ascend 1 flight of stairs for 5 consecutive min. 3 min rest in shade. Athletes complete 20 squat dips, 20 pushups, and 20 lunges.*	*None*	*30 minutes*
ATHLETE 1 REST, REHYDRATE, AND DATA COLLECTION	*Athlete 1 removes outfit for rest, rehydrate, and data collection. Otter used to transcribe athlete perception feedback from the following survey questions. Using a Likert scale athletes asked to rate current outfit for thermoregulation properties on a scale from 1-10, mobility properties on a scale from 1-10, and design/fashion alignment on a scale from 1-10. Athletes are free to offer any additional comments and feedback.*	*Perception comments and Likert scale ratings.*	*30 minutes*
ATHLETE 2 PERFORMANCE EXERCISES IN EXISTING SNOWBOARD OUTFIT	*Athlete 2 changes into their existing snowboard apparel. The first experiment sequence begins. Athletes climb and ascend 1 flight of stairs for 5 consecutive min. 3 min rest in shade. Athletes complete 20 squat dips, 20 pushups, and 20 lunges.*	*None*	*30 minutes*
ATHLETE 2 REST, REHYDRATE, AND DATA COLLECTION	*Athlete 2 removes outfit for rest, rehydrate, and data collection. Otter used to transcribe athlete perception feedback from the following survey questions. Using a Likert scale athletes asked to rate current outfit for thermoregulation properties on a scale from 1-10, mobility properties on a scale from 1-10, and design/fashion alignment on a scale from 1-10. Athletes are free to offer any additional comments and feedback.*	*Perception comments and Likert scale ratings.*	*30 minutes*
ATHLETE 2 PERFORMANCE EXERCISES IN SN0 FINAL GARMENT SAMPLE	*Athlete 2 changes into SN0 final apparel sample. The first experiment is repeated. Athletes climb and ascend 1 flight of stairs for 5 consecutive min. 3 min rest in shade. Athletes complete 20 squat dips, 20 pushups, and 20 lunges.*	*None*	*30 minutes*

ATHLETE 2 REST, RE-HYDRATE, AND DATA COLLECTION	*Athlete 1 removes outfit for rest, rehydrate, and data collection. Otter used to transcribe athlete perception feedback from the following survey questions. Using a Likert scale athletes asked to rate current outfit for thermoregulation properties on a scale from 1-10, mobility properties on a scale from 1-10, and design/fashion alignment on a scale from 1-10. Athletes are free to offer any additional comments and feedback.*	*Perception comments and Likert scale ratings.*	*30 minutes*
DATA CALCULATION AND QUOTE SELECTION	*Data averaged from athletes' Likert scale data. Otter transcription scripts are reviewed to select quotes the offer valid insight and support data hypothesis.*	*Final data, top athlete quotes.*	*20 minutes*
TOTAL EXPERIMENT TIME			*4 hours 20 minutes*

Fashion Alignment Final Validation Product Performance Testing Plan

3A. AIMS/OBJECTIVES, INCLUDE TO PROVE:

The testing will attempt to collect proof of fashion alignment offering to a higher fashion forward consumer market.

3B. METHODOLOGY

Fashion industry professionals virtual meeting and design reviews to assess the current design alignment against current snowboard market apparel.

Location of Study:

- Meetings took place virtually over Zoom to accommodate work schedules.

Subjects:

- Three total fashion industry professionals were interviewed.

Supplies:

- Voice record and transcription desktop app Otter.
- Computer with videocamera
- Zoom software

FIGURE 102

3C FASHION ALIGNMENT TESTING

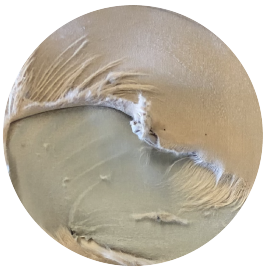
PHASE OF STUDY	PROCEDURE	DATA COLLECTED	TIMING
PRE EXPERIMENT	*Appointments with fashion industry professionals requested and scheduled.*	*None*	*15 minutes*
ZOOM MEETING INTERVIEW WITH FASHION INDUSTRY PROFESSIONAL 1	*Fashion industry professionals took place over Zoom and scheduled for 40 min. SN0 project overview and final apparel sample show and tell lasted 15 minutes. Professionals asked to ask questions and give feedback, suggestions.*		*40 minutes*
INSIGHT REVIEW AND COLLECTION	*Otter transcription scripts are reviewed to select quotes the offer valid insight and support data hypothesis.*	*Most prevalent fashion industry professional insights werereviewed and collected.*	*20 minutes*
ZOOM MEETING INTERVIEW WITH FASHION INDUSTRY PROFESSIONAL 2	*Fashion industry professionals took place over Zoom and scheduled for 40 min. SN0 project overview and final apparel sample show and tell lated 15 minutes. Professionals asked to ask questions and give feedback, suggestions.*		*40 minutes*
INSIGHT REVIEW AND COLLECTION	*Otter transcription scripts are reviewed to select quotes the offer valid insight and support data hypothesis.*	*Most prevalent fashion industry professional insights were reviewed and collected.*	*20 minutes*
ZOOM MEETING INTERVIEW WITH FASHION INDUSTRY PROFESSIONAL 3	*Fashion industry professionals took place over Zoom and scheduled for 40 min. SN0 project overview and final apparel sample show and tell lated 15 minutes. Professionals asked to ask questions and give feedback, suggestions.*		*40 minutes*
INSIGHT REVIEW AND COLLECTION	*Otter transcription scripts are reviewed to select quotes the offer valid insight and support data hypothesis.*	*Most prevalent fashion industry professional insights were reviewed and collected.*	*20 minutes*
TOTAL EXPERIMENT TIME			*3 hours 5 minutes*

Final Validation and Proof of Concept Result Findings

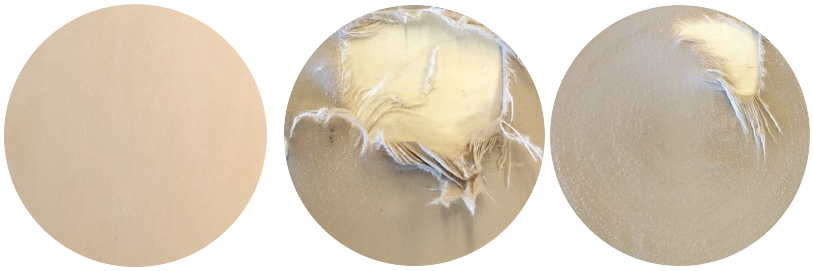
ABRASION RESISTANCE RESULTS

FIGURE 103

1D. ABRASION RESISTANCE TESTING RESULTS

	-	1	2
1	MAIN-BODY: THREE-PLY FABRIC (PTFE) CONTENT: SYNTHETIC POLYMER + ABRASION RESISTANCE: WEATHERMAX 65 CONTENT: 100% SOLUTION DYED POLYESTER AVERAGE TIME TO DESTRUCTION: 27.49 SECONDS			

2 MAIN-BODY: THREE-PLY FABRIC WITH MICRO-POROUS TEFLON (PTFE)
AVERAGE TIME TO DESTRUCTION: 20.63 SECONDS

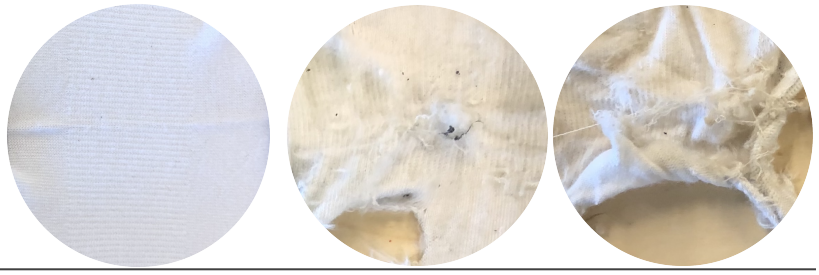


3 ABRASION RESISTANCE: WEATHERMAX 65
CONTENT: 100% SOLUTION DYED POLYESTER
AVERAGE TIME TO DESTRUCTION: 21.43 SECONDS

4 LT. WT CHINO
CONTENT: 100% POLYESTER
BRAND: COMUBMIA SPORTSWEAR
AVERAGE TIME TO DESTRUCTION: 5.55 SECONDS

5 WINDBREAKER
CONTENT: 100% NYLON
BRAND: HELLY HANSEN
AVERAGE TIME TO DESTRUCTION: 4.76 SECONDS

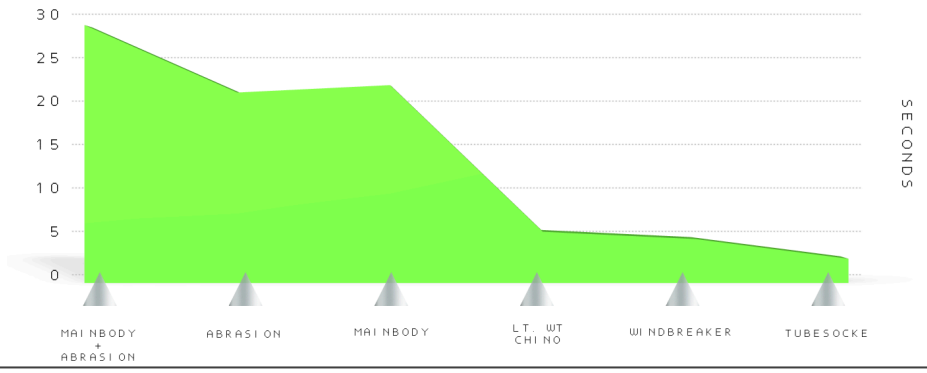
6 TUBE SOCKS
CONTENT: 97% POLYESTER, 2% SPANDEX, 1% OTHER FIBER
BRAND: HANES
AVERAGE TIME TO DESTRUCTION: 2.63 SECONDS



1D. ABRASION RESISTANCE FINDINGS

FIGURE 104

1E. ABRASION RESISTANCE TESTING DATA FINDINGS



Both rounds of material trials were averaged individually and then separated into two groups: 3 new materials and 3 existing materials. Each group was averaged. The final percentage was calculated; the data results indicate an increase in new material abrasion resistance of 578%, adding substantial durability and overall product life span compared to the current dry slope snowboarding materials. These findings will be used for prototyping to provide valuable insight for abrasion resistance.

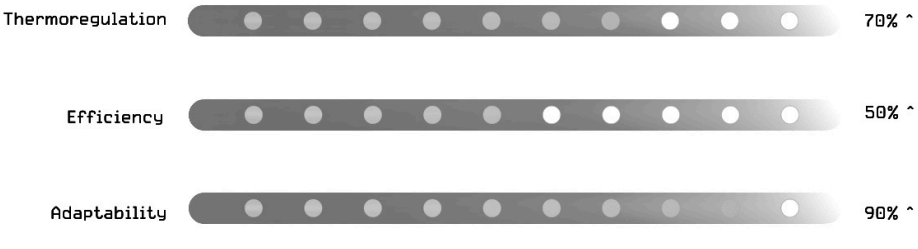
Thermoregulation Athlete Performance Perception Test Results

2D. THERMOREGULATION FINDINGS

A 10-point Likert scale was used to to translate athlete perception into measurable numeric data shown in the figure 105 below. A rating of 1 being low/not functional and a rating of 10 indicating high/peak performance.

FIGURE 105

2D THERMOREGULATION ATHLETE PERFORMANCE TEST RESULTS



Note: The Likert scale was used as an approach to scale survey questionnaire responses into measurable data.

The athletes rated Thermoregulation as a 7 out of 10, Efficiency 5 out of 10, and Adaptability 9 out of 10.

Additionally, athletes provided additional insight into the final designs' functionality and sport application. The most notable comments were selected and are relayed verbatim below:

1. "I like all of the reinforced features on the garments to protect against abrasion on frequent falling zones."
2. "The outwear pieces were breathable and light in comparison to the mountain gear I have right now. I think for warmer seasons the modularity, cooling fabric feel, and venting features will be very helpful in staying cool while snowboarding."
3. "I felt really comfortable and fashionable in the sleek garments especially with the versatile configuration they can be worn in. I don't see many silhouettes like these on the market and they were more flattering than my current outerwear setup."
4. "The crop top I could see fitting into a future fashion wardrobe."
5. "The placement of the suspenders on the shoulders felt way less restricting (because they're not positioned straight over your traps like a normal suspenders). It makes the fit feel more mobile overall - they not in the way of anything."
6. "I think these pieces offer unlimited versatility. I would wear these bibs during the winter, and can see myself wearing them as regular clothing as well."

3D. FASHION ALIGNMENT TESTING RESULTS

Fashion industry professionals comments were transcribed verbatim and reviewed to select several of the most insightful pieces of feedback and insights which are copied below.

1. "By removing the need for extensive layering systems you've enhanced the creative style elements that can be used as outward expression that aligns with riders personal style (Walsh, personal communication, August 25, 2021)."
2. This kind of unisex outerwear affords much broader gender expression possibility than previous styles relegated to men's or women's specific design (Walsh, personal communication, August 25, 2021)."

3. “It’s design visually looks breathable yet tough in a utilitarian kind of way (Sampey, personal communication, August 10, 2021).”

4. “There's something that does feel a little like apocalyptic about it - protected from the elements but also looking badass (Sampey, personal communication, August 10, 2021).”

5. “The innovation and attention to detail paired with its design it what separates it from the current brands (Marshall, personal communication, August 8, 2021).”

6. “This proliferation of style diversity and non-normative style expression allows accessibility to reach a broader range of style alignment (Walsh, personal communication, August 25, 2021).”

7. “ I think there's also something about how wearable but clearly unique in that its fashion forward (Sampey, personal communication, August 10, 2021).”

8. “ I like the overall aesthetic and the functionality serves (Marshall, personal communication, August 8, 2021).”

9. “Unlimited versatility and outfit configurations to accommodate a wide range of gender style preferences (Walsh, personal communication, August 25, 2021).”

10. “You've hit even a really nice sweet spot between this like avant-garde and Japanese-like sculptural (Sampey, personal communication, August 10, 2021).”

11. “These unisex pieces have a certain gender fluidity fashion offering that allows riders personal street style expression to apply seamlessly to their snowboarding style (Walsh, personal communication, August 25, 2021).”

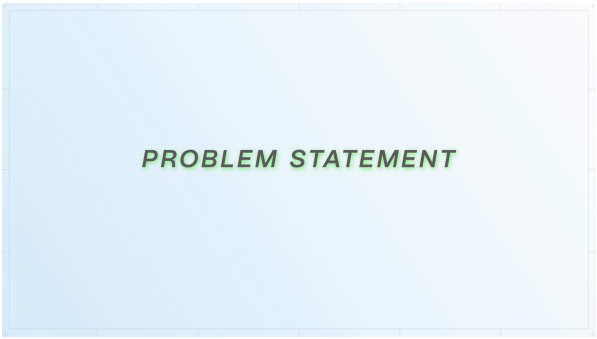
PROOF OF CONCEPT TEST RESULT FINDINGS

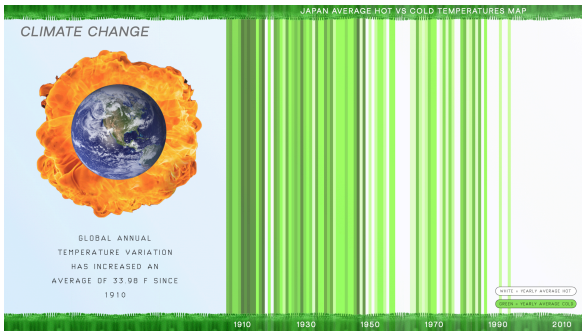
Testing results and insights validated proof of concept with substantial improvement in all three areas tested: abrasion resistance, thermoregulation, and fashion alignment. Additionally, each individual area of focus showed substantial improvement over dry slope snowboarding apparel outfit preferences in addition to apparel offers within the current retail market.

PROCESS BOOK

FIGURE 104

PROCESS BOOK THUMBNAILS





DRY SLOPE SNOWBOARDING

MARKET OPPORTUNITY

TARGET DEMOGRAPHIC

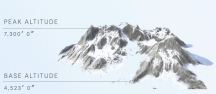
INITIAL TESTING

ABRASION + TESTING

POC AIR COMP JACKET
$180.00

BURTON IMPACT SHORTS
$129.95

POC AIR COMP KNEE PAD
$150.00



LOCATION: MT HOOD, OR

DATE: 01.15.2021

TEMPERATURE: HIGH 37 - LOW 10 DEGREES

WEATHER: SCATTERED SNOW/RAIN 30%

PROTOCOL: SNOWBOARD AGGRESSIVELY WEARING 3 STATE OF THE ART PRODUCTS FOR A TOTAL OF 90 MIN. THE FOLLOWING DAY ATHLETES WILL MEET VIRTUALLY TO DISCUSS EACH PRODUCT.

THERMOREGULATION + ALIGNMENT TESTING

E-MAIL:

NAME:

GENDER:

AGE:

YEARS OF EXPERIENCE SNOWBOARDING:

YEARS OF EXPERIENCE DRY SNOWBOARDING:

INJURIES ENCOUNTERED WHEN DRY SNOWBOARDING:

WHAT APPAREL/EQUIPMENT HAVE BEEN DAMAGED WHEN DRY SNOWBOARDING:

WHAT DO YOU CURRENTLY WEAR DRY SLOPE SNOWBOARDING IN SPRING, SUMMER, AND EARLY FALL:

WHAT BRANDS DO YOU WEAR DRY SLOPE SNOWBOARDING:

INITIAL TESTING FINDINGS

100%
OF DRY SLOPE SNOWBOARDERS HAVE BEEN INJURED + HAVE DAMAGED APPAREL WHILE RIDING

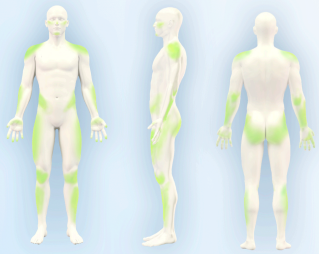
MOST WORN PRODUCTS ARE FROM GOODWILL
+ LT. WEIGHT KHAKIS
+ WINDBREAKERS
+ TUBE SOCKS

MOST SURPRISING REVELATIONS
IMPACT MITIGATION ISNT NECESSARY!

UNMET NEEDS
+ RUNG BURN
+ VENTILATION IN HOT TEMPERATURES

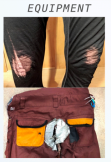
FINDINGS

INITIAL TESTING FINDINGS



BODY MAP

EQUIPMENT



INJURY

100% OF DRY SLOPE SNOWBOARDERS HAVE EXPERIENCED INJURY WHEN RIDING

100% OF DRY SLOPE SNOWBOARDERS HAVE DAMAGED APPAREL WHILE RIDING

DESIGN DIRECTION

LOGO DEVELOPMENT

FINAL LOGO

DEVELOPMENT

AESTHETIC RESEARCH

JAPANESE DRESS • HISTORIC SILHOUETTES • KIMONO • SIMPLICITY • DYE

JAPANESE DRESS • HISTORIC SILHOUETTES • KIMONO • SIMPLICITY • DYE

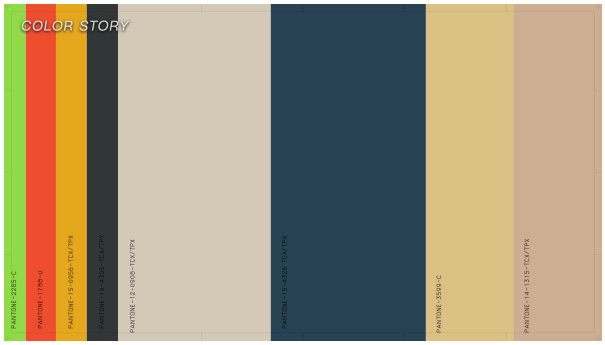
MOOD * AESTHETIC

MOODBOARD

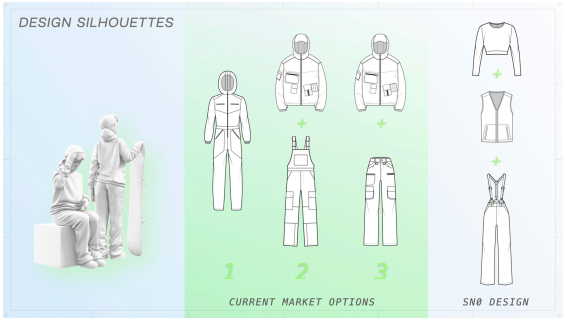

MOOD * MATERIAL + TEXTURE

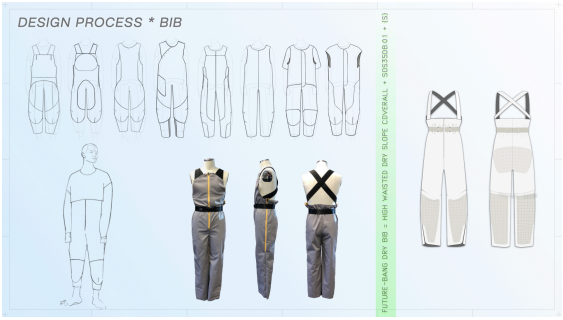

MOOD * GRAPHICS + PRINT


MOOD * SILHOUETTE

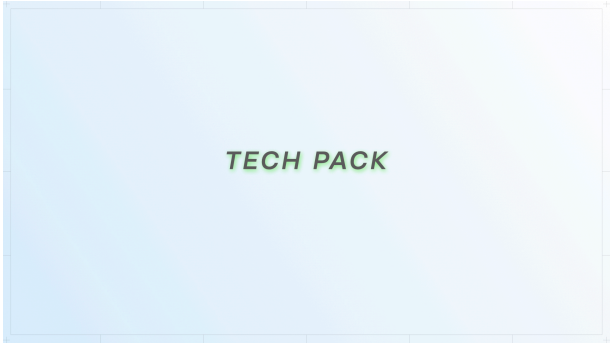

COLOR STORY
PANTONE-2285-C
PANTONE-1795-U
PANTONE-15-0956-TCX/TPX
PANTONE-19-4305-TCX/TPX
PANTONE-12-0960-TCX/TPX
PANTONE-19-4216-TCX/TPX
PANTONE-3590-C
PANTONE-14-1315-TCX/TPX


DESIGN DEVELOPMENT


DESIGN SILHOUETTES
1
2
3
CURRENT MARKET OPTIONS
SN0 DESIGN


DESIGN PROCESS * BIB


DESIGN PROCESS * LONG SLEEVE CROP TOP



BRAND: SNO
DELIVERY: SPRING | SUMMER
SEASON: 2035

DESIGNER: EVA VAUGHAN
ATTN: PRODUCT DEVELOPMENT

PAGE SUBJECT: HEADER INDEX BREAKDOWN
PAGE: 01 | 22

	STYLE NAME:	STYLE NUMBER:	DESCRIPTION:	PG. #
A	FUTURE-BANG DRY BIB	SO33SDB.01	HIGH WAISTED DRY SLOPE COVERALL	01-08
B	WIKBERG MID-PULLOVER	SO33SDO.01	LONG SLEEVE OUTERWEAR PULL OVER CROP	09-13
C	GIBSON SLEEVELESS VEST	SO33SDO.02	OVERSIZED SLEEVELESS DUAL ZIP V-NECK VEST	14-18
D	SNO SHOPPING BAG	-	REUSABLE SHOPPING BAG	19
E	LOGO + HANG TAG + CARE LABEL	-	LOGO, HANG TAG + CARE LABEL	20-22

BRAND: SNO
DELIVERY: SPRING | SUMMER 2035
DESIGNER: EVA VAUGHAN

STYLE NAME: FUTURE-BANG DRY BIB
STYLE NUMBER: SO33SDB.01
SIZE: XS, (S), M, L, XL

PAGE SUBJECT: HEADER
LAST MODIFIED: 09.11.2021

COVER SHEET | HEADER

FRONT

BACK

BRAND: SNO
DELIVERY: SPRING | SUMMER 2035
DESIGNER: EVA VAUGHAN

STYLE NAME: FUTURE-BANG DRY BIB
STYLE NUMBER: SO33SDB.01
SIZE: XS, (S), M, L, XL

PAGE SUBJECT: BILL OF MATERIALS
LAST MODIFIED: 09.11.2021

BILL OF MATERIALS

CODE	PART	DESCRIPTION	QTY/UNIT#	COLOR/FINISH
1	EXTERIOR FABRIC	THREE-PLY FABRIC WITH MICRO-POROUS TEFLON (PTFE)	-	NATURAL
2	ABRASION RESISTANCE PANELING	WEATHERMAX 65. - 100% SOLUTION DYED POLYESTER WITHE HYDROMAX FINISH	-	TOAST
3	REFLECTIVE SUSPENDER LOOP (G-HOOK)	1" 3 M REFLECTIVE TAPE	2	NEON ORANGE
4	G-HOOK	1" X 1.5" X 0.135"	2	POWDER COATED NUDE
5	SUSPENDER ADJUSTER	DIE CASTED ZINC TRIGLIDE 0.75" X 1.75"	3	POWDER COATED NUDE
6	LOOP SLIDE	DIE CASTED ZINC LOOP	2	POWDER COATED NUDE
7	SUSPENDER ELSATIC	1" RECYCLED ELASTIC	-	NUDE
8	ZIPPER	2.5" ANATULON CHEMICALLY RECYCLED VISION - 2-WAY ZIP	2	EARTH NUDE
9	ZIPPER	15" ANATULON CHEMICALLY RECYCLED VISION 8G CF 1	1	EARTH NUDE
10	ZIPPER PULL	NATULON RECYCLED ZIPPER PULL	5	NUDE
11	COUNTRY LABEL OF ORIGIN TAG	RECYCLED POLYESTER	1	NATURAL
12	CARE LABEL	RECYCLED POLYESTER	1	NATURAL
13	LOGO LABEL	RECYCLED POLYESTER	1	NATURAL
14	BIO-CHARGED FABRIC	GLOW IN THE DARK FILM-TPU LUMINOUS FILM OR GLOW	-	CLEAR

BRAND: SNO
DELIVERY: SPRING | SUMMER 2035
DESIGNER: EVA VAUGHAN

STYLE NAME: FUTURE-BANG DRY BIB
STYLE NUMBER: SO33SDB.01
SIZE: XS, (S), M, L, XL

PAGE SUBJECT: CALLOUTS + CONSTUCTION
LAST MODIFIED: 09.11.2021

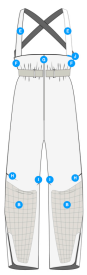
CALLOUTS + CONSTRUCTION

FABRICATION

MAIN BODY: THREE-PLY FABRIC WITH MICRO-POROUS TEFLON (PTFE)

ABRASION RESISTANCE - WEATHERMAX 65. - 100% SOLUTION DYED POLYESTER WITHE HYDROMAX FINISH

FRONT



BACK

A BELT 35"
B ABRASION RESISTANCE PANELING
C ABRASION RESISTANCE PANELING
D ABRASION RESISTANCE PANELING
E SUSPENDERS W/ INT ELASTIC
F (2) S/S 2-WAY OPEN SS ZIPPERS
G (1) CF 1-WAY OPEN ZIPPER
H EXTERIOR LEG DART 5"
I INTERIOR LEG DART 2.25"
J SNO LOGO LABEL
K BACK VENT OPENING B/T TOP + BTTM. PANEL
L

= ULTRASONIC WELDED PATTERN APPLICATION
= USE FOR ALL SEAMS

BRAND: SNO
DELIVERY: SPRING | SUMMER 2035
DESIGNER: EVA VAUGHAN

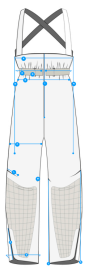
STYLE NAME: GIBSON SLEEVELESS VEST
STYLE NUMBER: SO33SDA.01
SIZE: (S), M, L, T

PAGE SUBJECT: POINTS OF MEASUREMENT SPECIFICATIONS + DIAGRAM
LAST MODIFIED: 09.13.2021

POINTS OF MEASUREMENT SPECIFICATIONS + DIAGRAM

A	"BACK" CIRCUMFERENCE (FRONT + BACK)	36"
B	HIP CIRCUMFERENCE 6" DOWN FROM TOP RISE (FRONT + BACK)	36"
C	THIGH MEASURED 7" DOWN FROM CROTCH POINT (FRONT)	11.5"
D	THIGH MEASURED 7" DOWN FROM CROTCH POINT (BACK)	13.5"
E	LEG OPENING CIRCUMFERENCE 2" UP FROM BTTM CUFF (FRONT + BACK)	19"
F	LEG OPENING CIRCUMFERENCE RIBBED	11"
G	BELT WIDTH	2"
H	BELT CIRCUMFERENCE	43"
I	CF ZIPPER OPENING FROM TOP WAIST TO BOTTOM OPENING	14.25"
J	SIDE SEAM INTERIOR LEG DART MEASURED FROM BTTM. HEM	19"
K	SIDE SEAM EXTERIOR LEG DART MEASURED FROM BTTM. HEM	25"
L	SIDE SEAM INTERIOR DART LENGTH	2.5"
M	SIDE SEAM EXTERIOR LEG DART LENGTH	5"
N	SIDE SEAM ZIPPER LENGTH	25"
O	SUSPENDER LENGTH	43"
P	SUSPENDER WIDTH	1.5"
Q	BOTTOM OUTER SIDE SEAM OPENING	6"

FRONT



BACK

BRAND: SNO
DELIVERY: SPRING | SUMMER 2035
DESIGNER: EVA VAUGHAN

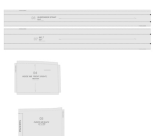
STYLE NAME: FUTURE-BANG DRY BIB
STYLE NUMBER: SO33SDB.01
SIZE: XS, (S), M, L, XL

PAGE SUBJECT: PATERN
LAST MODIFIED: 09.11.2021

PATTERN

* IMAGES BELOW ARE NOT TO SCALE (REFER TO FILE PROVIDED TO FACTORY FOR CORRECT SIZING AND DIMENSIONS)

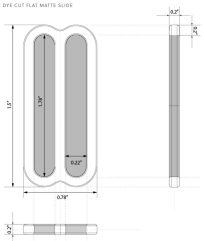
BIB



ABRASION RESISTANCE

* IMAGES BELOW ARE NOT TO SCALE (REFER TO FILE PROVIDED TO FACTORY FOR CORRECT SIZING AND DIMENSIONS)

1.5" DYE CUT FLAT MATTE SLIDE

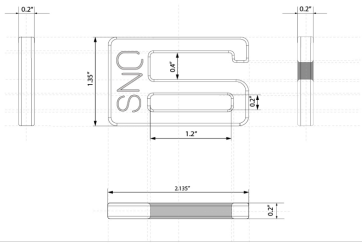


MATERIAL: TITANIUM
FINISH: MATTE
COLOR:

PANTONE
14-0502 TCX
Pumice Stone

* IMAGES BELOW ARE NOT TO SCALE (REFER TO FILE PROVIDED TO FACTORY FOR CORRECT SIZING AND DIMENSIONS)

2.135" POWDER COATED G-HOOK



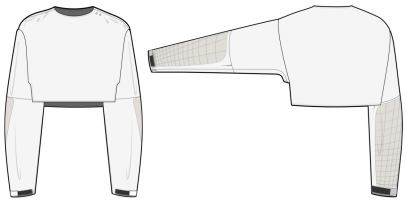
MATERIAL: TITANIUM
FINISH: MATTE
COLOR:

PANTONE
14-0502 TCX
Pumice Stone

COVER SHEET | HEADER

FRONT

BACK



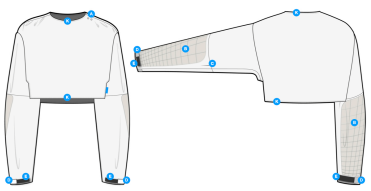
BILL OF MATERIALS

CODE	PART	DESCRIPTION	QTY/UNIT#	COLOR/FINISH
1	EXTERIOR FABRIC	THREE-PLY FABRIC WITH MICRO-POROUS TEFLON (PTFE)	-	NATURAL
2	ABRASION RESISTANCE PANELING	WEATHERMAX 65. - 100% SOLUTION DYED POLYESTER W/THE HYDROMAX FINISH	-	TOAST
3	SNAP (MALE AND FEMALE)	HEAVY DUTY POWDER COATED SNAP	2/E	POWDER COATED NUDE
4	VELCRO HOOK SIDE	1 INCH SEW-ON TAPE FASTENER, HOOK SIDE	-	TAN449
5	VELCRO LOOP SIDE	1 INCH SEW-ON TAPE FASTENER, LOOP SIDE	-	TAN449

CALLOUTS + CONSTRUCTION

FRONT

BACK



A (2) POWDER COATED SNAPS
B ABRASION RESISTANCE PANELING
C ELBOW DART
D (2) CUFF ADJUSTER STRAP WITH VELCRO HOOK
E VELCRO LOOP
F LOGO LABEL
G + ULTRASONIC WELDED SEAMING + APPLICATION PATTERN

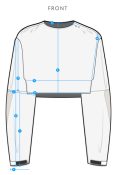
FABRICATION:

MAIN BODY: THREE-PLY FABRIC WITH MICRO-POROUS TEFLON (PTFE)

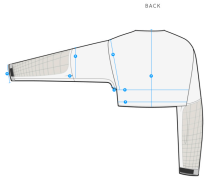
ABRASION RESISTANCE - WEATHERMAX 65. - 100% SOLUTION DYED POLYESTER W/THE HYDROMAX FINISH

POINTS OF MEASUREMENT SPECIFICATIONS + DIAGRAM

		S
A	FRONT LENGTH HPS TO CF HEM	14"
B	BACK LENGTH HPS TO CB HEM	15.5"
C	FRONT PANEL WIDTH (AT UA)	14.75"
D	FRONT HEM WIDTH (AT ITEM)	14.5"
E	BACK PANEL WIDTH (AT UA)	17"
F	BACK HEM WIDTH (AT ITEM)	16.75"
G	SLEEVE LENGTH (TOP SHOULDER SEAM TO CUFF)	27"
H	TOP SLEEVE PANEL (TOP SHOULDER SEAM UPPER SEAM)	10.75"
I	BOTTOM SLEEVE PANEL (UPPER SEAM TO CUFF)	16.25"
J	UPPER ARM CIRCUMFERENCE (AT MID PANEL HEM)	17"
K	CUFF CIRCUMFERENCE	11.5"
L	NECK OPENING (SS TO SS)	8"
M	FRONT SHOULDER DROP	10.25"
N	BACK SHOULDER DROP	11.45"
O	ELBOW DART LENGTH	4.4"
P	CUFF STRAP WIDTH	1.5"
Q	CUFF STRAP HEIGHT	1.45"



FRONT



BACK

PATTERN

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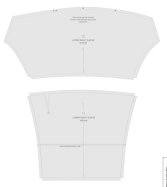
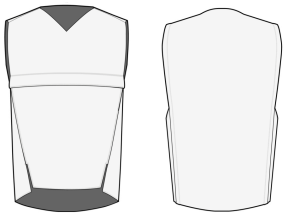
LONG SLEEVE PULL OVER



ABRASION RESISTANCE

COVER SHEET | HEADER



BRAND: SNO
DELIVERY: SPRING | SUMMER 2035
DESIGNER: EVA VAUGHAN

STYLE NAME: GIBSON SLEEVELESS VEST
STYLE NUMBER: SOS35DO.02
SIZE: XS, (S), M, L, XL

PAGE SUBJECT: BILL OF MATERIALS
LAST MODIFIED: 09.11.2021

BILL OF MATERIALS

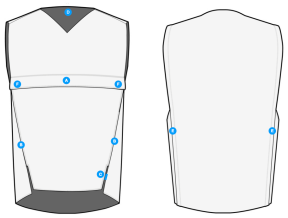
CODE	PART	DESCRIPTION	QTY/UNIT#	COLOR/FINISH
1	EXTERIOR FABRIC	THREE-PLY FABRIC WITH MICRO-POROUS TEFLON (PTFE)	-	NATURAL
2	ZIPPER	9" ANATULON CHEMICALLY RECYCLED VISION 3G CF 1	2	EARTH NUDE
3	ZIPPER PULL	NATULON RECYCLED ZIPPER PULL	3	NUDE
4	HIDDEN MAGNET CLOSURE	MALE + FEMALE	2/E	BLACK
5	COUNTRY LABEL OF ORIGIN TAG	RECYCLED POLYESTER	1	NATURAL
6	CARE LABEL	RECYCLED POLYESTER	1	NATURAL
7	LOGO LABEL	RECYCLED POLYESTER	1	NATURAL
8	BIO-CHARGED FABRIC	GLOW IN THE DARK FILM-TPU LUMINOUS FILM OR GLOW	-	CLEAR

BRAND: SNO
DELIVERY: SPRING | SUMMER 2035
DESIGNER: EVA VAUGHAN

STYLE NAME: GIBSON SLEEVELESS VEST
STYLE NUMBER: SOS35DO.02
SIZE: XS, (S), M, L, XL

PAGE SUBJECT: CALLOUTS + CONSTRUCTION
LAST MODIFIED: 09.11.2021

CALLOUTS + CONSTRUCTION



1. POUCH POCKET FLAP
2. 9" L+R SIDE SEAM ZIPPER
3. LOGO LABEL
4. CARE LABEL
5. R+L HIDDEN LASER CUT BELT LOOP
6. - ULTRASONIC WELDED SEAMING
   - APPLICATION PATTERN

FABRICATION

MAIN BODY: THREE-PLY FABRIC WITH MICRO-POROUS TEFLON (PTFE)

BRAND: SNO
DELIVERY: SPRING | SUMMER 2035
DESIGNER: EVA VAUGHAN

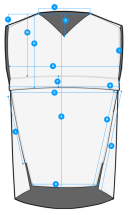
STYLE NAME: GIBSON SLEEVELESS VEST
STYLE NUMBER: SOS35DO.02
SIZE: (S), M, L, T

PAGE SUBJECT: POINTS OF MEASUREMENT SPECIFICATIONS + DIAGRAM
LAST MODIFIED: 09.12.2021

POINTS OF MEASUREMENT SPECIFICATIONS + DIAGRAM

		S
A	FRONT LENGTH HPS TO CF HEM	25.5"
B	BACK LENGTH HPS TO CB HEM	28.25"
C	CHEST WIDTH 1" FROM AH	22"
D	FRONT NECK SWEEP WITH FRONT PANNEL SEAM TO SS	12.125"
E	TOTAL OF BACK PANEL AND SIDE SEAM FROM ELBOW TOP	23"
F	SHOULDER SLOPE	1.75"
G	FRONT CHEST 6 INCHES FROM HPS	15.25"
H	BACK WIDTH 6" INCHES FROM HPS	16.5"
I	FRONT PANEL ARM HOLE FROM TOP SHOULDER TO CA	10"
J	NECK OPENING HPS TO HPS	11.75"
K	NECK PANEL DEPTH FROM HPS	4"
L	RIGHT AND LEFT SIDE SEAM ZIPPER LENGTH	9"
M	FRONT POCKET POSITION FROM HPS	15"
N	L/R UNDER SS FRONT PANNEL LENGTH	13"
O	L/R OUTER SS FRONT PANNEL LENGTH	17.5"
P	FRONT POUCH POCKET TOP FLAP FOLD LENGTH	1.5"
Q	FRONT POUCH POCKET BOTTOM FLAP FOLD WIDTH, CF, RIGHT SS	14.75"
R	FRONT POUCH POCKET PLACEMENT FROM HP FRONT PANNEL SEAM TO FLAP BOTTOM	16.5"

FRONT



BACK

BRAND: SNO
DELIVERY: SPRING | SUMMER 2035
DESIGNER: EVA VAUGHAN

STYLE NAME: WIKBERG MID-PULLOVER
STYLE NUMBER: SO33DO.01
SIZE: XS, (S), M, L, XL

PAGE SUBJECT: CONSTRUCTION
LAST MODIFIED: 09.11.2021

PATTERN

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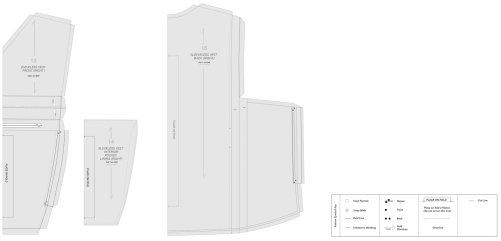
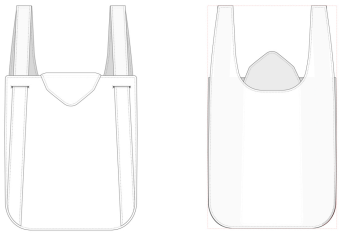


BRAND: SNO
DELIVERY: SPRING | SUMMER 2035
DESIGNER: EVA VAUGHAN

STYLE NAME: REUSABLE SNO SHOPPING BAG
STYLE NUMBER: SOS35DA.01
SIZE: OS

PAGE SUBJECT: HEADER
LAST MODIFIED: 09.11.2021

COVER SHEET | HEADER

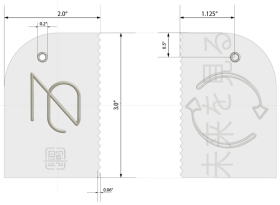


BRAND: SNO
DELIVERY: SPRING | SUMMER 2035
DESIGNER: EVA VAUGHAN

PATTERN
STYLE NUMBER: N/A
SIZE: SAMPLE SIZE S

PATTERN
LAST MODIFIED: 09.01.2021

HANG TAG



SNO HANG TAG

+ GOGGLE/LENSE CLEANER - CLEANS, DRIES + REMOVES FINGERPRINTS AND GREASE FROM GOGGLES
CONSTRUCTION: WOVEN
CONTENT: RECYCLED MICROFIBER: 80% RECYCLED POLYESTER + 20% VIRGIN POLYAMIDE-POST-CONSUMER SOURCED
+ POST-CONSUMER SOURCED
+ CHEMICAL-FREE + HYPOALLERGENIC
+ HIGHLY DURABLE
+ SUPER ABSORBENT
+ WASHABLE
FLAT EDGE
ONE SIZE
DIGITAL PRINT W/ BEMIS OVERLAY
REFER TO ARTWORK HANDOFF FOR SIZING AND COLOR CALLOUTS
COLOR: VARIABLE DUE TO USE OF VARIOUS RECYCLED MATERIALS

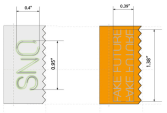
BRAND: SNO
DELIVERY: SPRING | SUMMER 2035
DESIGNER: EVA VAUGHAN

PATTERN
STYLE NUMBER: N/A
SIZE: SAMPLE SIZE S

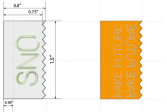
PAGE SUBJECT: LOGO HANGTAG
LAST MODIFIED: 09.07.2021

BRAND LOGO TAG

FRONT (FACE)



BACK (REVERSE)



SNO LOGO LABEL

WOVEN LABEL
MATERIAL: DIUBLE SIDED RECYCLED POLYESTER WITH DWR COATING
LASER CUT
FLAT EDGE
DIGITAL PRINT W/ BEMIS OVERLAY
REFER TO ARTWORK HANDOFF FOR SIZING AND COLOR CALLOUTS

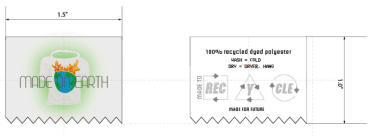
BRAND: SNO
DELIVERY: SPRING | SUMMER 2035
DESIGNER: EVA VAUGHAN

PATTERN
STYLE NUMBER: N/A
SIZE: SAMPLE SIZE S

PAGE SUBJECT: CARE LABEL
LAST MODIFIED: 09.07.2021

* IMAGES BELOW ARE NOT TO SCALE (REFER TO FILE PROVIDED TO FACTORY FOR CORRECT SIZING AND DIMENSIONS).

STANDARD SNO CARE LABEL



WOVEN LABEL
MATERIAL: DIUBLE SIDED RECYCLED POLYESTER WITH DWR COATING
LASER CUT
FLAT EDGE
DIGITAL PRINT W/ BEMIS OVERLAY
REFER TO ARTWORK HANDOFF FOR SIZING AND COLOR AND SPECIFICATIONS

MATERIALS PALETTE

CHARACTERISTICS

MAIN-BODY: THREE-PLY FABRIC WITH MICRO-POROUS TEFLON (PTFE)

CONTENT: SYNTHETIC POLYMER (POLYTETRAFLUOROETHYLENE)
COLOR: NATURAL

- WATERPROOF
- BREATHABLE
- WINDPROOF

ABRASION RESISTANCE: WEATHERMAX 65

CONTENT: 100% SOLUTION DYED POLYESTER
FINISH: THE HYDROMAX FINISH
COLOR: TOAST

- UNSURPASSED WATER REPELLENCY
- MILDEW & OIL RESISTANCE
- ENVIRONMENTALLY FRIENDLY PROCESSES

LINING: SUNSCREEN50™ LIGHTWEIGHT NYLON WOVEN

CONTENT: NYLON
FINISH: WATER REPELLENT FINISH
COLOR: WHITE

- BREATHABLE
- UPF50+
- BREATHABLE
- SOFT, COTTONY HAND

GLOW IN THE DARK FILM

CONTENT: TPU LUMINOUS FILM OR GLOW FILM

- GLOW IN THE DARK
- WEATHER RESIST
- HIGH BRIGHTNESS
- SHORT LIGHT ABSORPTION TIME

FINAL GARMENTS

FUTURE-BANG DRY BIB
SOS3508.01

WIKBERG MID-PULLOVER
SOS3500.01

GIBSON VEST
SOS3508.01

FEATURES AND BENEFITS

FEATURES AND BENEFITS * FUTURE-BANG DRY BIB

FEATURES AND BENEFITS * WIKBERG MID-PULLOVER

FEATURES AND BENEFITS * GIBSON VEST

COLOR-UPS

COLOR-UPS

FUTURE-DIRT

SHIBORI DENIM

DRY GREEN

PROOF OF CONCEPT TESTING

FINAL TESTING VALIDATION

ABRASION

SUBJECT
FABRIC NEW VS. OLD

METHOD
ABRASION SANDING + TIME TO DESTRUCTION

LOCATION
UNIVERSITY OF OREGON PORTLAND

FINDINGS
+ ABRASION RESISTANCE

THERMOREGULATION

SUBJECT
SNOWBOARD ATHLETES

METHOD
ATHLETE PERCEPTION TESTING NEW VS. OLD

LOCATION
MT TABOR PARK

FINDINGS
+ THERMOGRGULATION
+ MOBILITY
+ COMFORT

FASHION ALIGNMENT

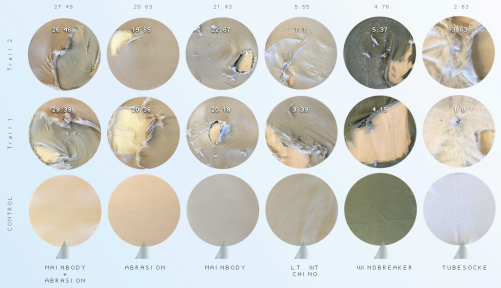
SUBJECT
FASHION INDUSTRY PROFESSIONALS

METHOD
IN-DEPTH INTERVIEW

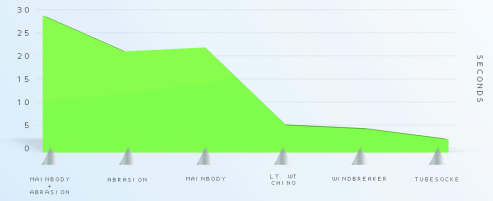
LOCATION
VIRTUAL (GOOGLE SURVEY)

FINDINGS
+ FASHION ALIGNMENT
+ LIKEN SCALE

ABRASION RESULTS



ABRASION VALIDATION



578% LONGER TIME TO DESTRUCTION

THERMOREGULATION VALIDATION

"I like all of the reinforced features on the garments to *protect against abrasion on frequent falling zones.*"

"The outwear pieces were *breathable and light* in comparison to the mountain gear I have right now. I think for *warmer seasons the modularity, cooling fabric feel, and venting features will be very helpful in staying cool while snowboarding.*"

"I felt really *comfortable and fashionable* in the sleek garments especially with the *versatile configuration* they can be worn in. *I don't see many silhouettes like these on the market and they were more flattering than my current outerwear setup.*"

The crop top I feel could see fitting into a future fashion wardrobe.

The placement of the suspenders on the shoulders felt way less restricting (because they're not positioned straight over your traps like a normal suspenders). It makes the fit feel *more mobil overall* - they not in the way of anything.

I think these pieces offer *unlimited versatility.* I would wear these bibs during the winter, and can see myself wearing them as regular clothing as well.

FASHION ALIGNMENT VALIDATION

MARY WALSH
SENIOR EDITOR OF SNOWBOARD MAGAZINE

HALEY SAMPEY
VP OF MERCHANDISING AT VICTORIA'S SECRET

WILLIE MARSHALL
MEN'S KNIT DESIGNER AT RALPH LAUREN

"By removing the need for extensive layering systems you've *enhanced the creative style elements* that can be used as outward expression that aligns with riders personal style."

This kind of unisex outerwear affords much *broader gender expression possibility* then previous styles relegated to men's or women's specific design

"There's something that does feel a little like *apocalyptic* about it - *protected from the elements* but also looking badass."

"This *proliferation of style diversity and non-normative style expression allows accessibility to reach a broader range of style alignment.*"

"You've hit even a really *nice sweet spot between like this like avant-garde* and Japanese like sculptural, you know."

"The *innovation* and *attention to detail* paired with its design it what *separates it from the current brands.*"

" I think there's also something about how *wearable* but clearly unique in that its' *fashion forward.*"

"These unisex pieces have a certain *gender fluidity fashion offering* that allows riders personal street style expression to apply seamlessly to their snowboarding style."

"It's design visually looks *breathable* yet tough in a utilitarian kind of way."

" I like the overall *aesthetic* and the *functionality* serves."

"Unlimited *versatility* and outfit configurations to *accommodate a wide range of gender style preferences.*"

LOOKBOOK

FUTURE CONSIDERATIONS

Future considerations for the project include additional sample development in which construction would reflect tech pack construction and assembly techniques which were omitted as a result of machine access and factory assembly expertise. Factory outsourcing would provide a more accurate design sample and could influence the outcome pertaining to proof of concept test results.

Additionally, expansion of testing validation could provide a more accurate data and insight results, offering an alternative validation of proof of concept and product validation. Alteration of thermoregulation athlete performance test methods could benefit by adding additional number of subjects to participate in testing. Additionally, athlete testing trial location at a dry slope facility at temperatures/wether conditions specific to off season conditions could offer more accurate perception of athlete performance. Fashion alignment insight would similarly benefit by expanding the number of fashion industry professionals surveyed and more diversification in field of expertise, geography, and experience would offer a more nuanced portrayal of fashion alignment viability.

REFERENCES III

(Marshall, W. (2021, August 8). Interview by E. Vaughan. [Video Conference].

Sampey, H. (2021, August 10). Interview by E. Vaughan. [Video Conference].

Walsh, M. (2021, August 25). Interview by E. Vaughan. [Video Conference].