A Collection of Winter Apparel for Chinese Male Couriers

Including a Hard Shell Jacket, a Insulated Layer, and a Cargo Pants

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Abstract

At present, the vast majority of couriers work with equipment that uses cheap materials with simple production processes under cost pressure. Their most important use is perhaps only to indicate the brand of the courier company. The equipment mostly lacks a human touch for the couriers. Furthermore, they show that the hirers have neglected to invest in the company's branding in a far-sighted way. So in this project, I will focus on improving the silhouette, visual elements, and functional integration of existing products. The goal is for the kit to enhance the courier experience and allow the courier company to convey a more professional corporate image to the end-user and the potential audience. It is worth mentioning that numbers of Chinese logistics companies in recent years have good performance; there are enough funds to support staff uniforms upgrade, which makes the feasibility of my project has a reasonable foundation.

With that being considered, this project is designed specifically for experienced male couriers who aged from 20 to 40 and work in 1st to 3rd tier cities in China. It is a collection of garments include a hardshell jacket and pant that provides the wearer with an improved weather-adaptive feature, an ergonomic fit, and an optimized pockets layout. It comes with a modular insulated layer that has a body mapped heat/ventilation zone. This will ultimately improve the couriers' well being and professionalism.

Historical Review

China is one of the earliest countries in the world to establish organizations for sending messages.

As early as the Xia and Shang dynasties, there was already an express delivery limited to transportation and mostly relied on human piggybacking, which was a way of life for some folks. Pieces of evidence from the oracle bones excavated from the Yin ruins confirm that in the Shang dynasty, more than 3,000 years ago, China already had a horse-transmission system similar to the express delivery system (Zhiziwei, 2019). At that time, those who deliver with carts were called "Ri" or "Chuan," and the ones delivered with horses were called "Di" or "Yi" (Zhiziwei, 2019). Meanwhile, express had no privacy at all, nor any means of regulatory.

By the Western Zhou Dynasty, the government found that express could improve efficiency, so it set up numbers of relevant official positions. According to the "Zhouli - Qiuguan" records, the Zhou Dynasty officials then set up in charge of the post, logistics officer "Walker" (Zhiziwei, 2019) . Its duty requirement is "no matter how hard the job is, it needs to be delivered in time" (Zhiziwei, 2019). Compared to the early horse-dispatch system, the courier industry at this point became more regulated because of the imperial court's participation. It was divided into "Tu Xuan" and "Chuan Xuan," which were mainly used to transmit political decrees and military information (Zhiziwei, 2019) . The former was on foot while the latter was by mail carts. However, it was not widely used by people.

In the Spring and Autumn Period, with the demand for express increased, the express industry's development vigorously speeds up. Then there was the horse, which instead of foot power—short distance orders delivered by a light rider and long-distance ones provided by relay. Therefore, the post station was born with the name not unified. It was called "Ju," "You," or "Zhi," the earliest post station system that every twenty miles to set up a station for courier and horse to rest (Zhiziwei, 2019). The establishment of the post station significantly accelerated the transfer of documents and military orders by ship, but at the same time, its security and confidentiality were still not guaranteed.

By the Qin Dynasty, after the country was unified, the express industry has more transparent provisions. The common goods did not indicate a specific due time to reach the general distribution. Couriers will deliver an urgent labeled package at a speed of 300 miles per day (Zhiziwei, 2019). After they arrived at one post station, couriers do not even have time for resting and immediately changed horses before setting out on their journey, which could reach a speed of 500 miles per day (Zhiziwei, 2019).

At that time, the courier costumes also got an absolute uniformity. The Qin dynasty used water and virtue as its motto; black color and six are preferred. The car with the rail were all six feet in width, and the horses used for courier business is better in six; the dress of the superior courier are black (Zhiziwei, 2019). In the Han Dynasty, black was not popular anymore, while couriers wore red uniforms. They also carried a red and white bag, a special mail bag. While in the Wei and Jin dynasties, Chen Qun of

Wei wrote the first postal regulations in China's history (Zhiziwei, 2019). Since then, the "express industry" has developed at high speed, increasingly standardized.

During the Tang Dynasty, frequent international exchanges. Ambassadors and officials increased the number of business trips. The court changed the post station for the post to highlight its ushering and sending the "guesthouse" function, equivalent to today's guest houses. There were 1643 posts and more than 200 water posts in the heyday (Zhiziwei, 2019). More than 20,000 people engaged in stagecoach work. The government called up 80% of them to serve in shifts of farmers (Zhiziwei, 2019).

Although the "express industry" developed rapidly in the Tang Dynasty, the "official express" was mostly for the royal family and dignitaries, and was rarely used by the private sector. However, there was also a demand from the private sector, and so the Biaoju was born. They mainly transported bulky goods, secured by a Biaoju, and escorted by a personal Biao-protector. As the business developed, there were also letter Biao, silver Biao, goods Biao, check Biao, food Biao, and personal Biao (Zhiziwei, 2019). It shows that compared to "official courier," the scope of a Biaoju is much broader, and the safety of the "goods" is more important, similar to today's "transportation insurance system" (Zhiziwei, 2019).

In the Song Dynasty, the government set up a delivery store to deliver documents, which was more like a post office nowadays. However, there was one-word difference between it and "express." Compared with the post office, the courier store had three strengths: first, short distance, more institutions; second, round-the-clock, relay transmission; third, penetrating the interior, with an extensive, accessible communication network (Zhiziwei, 2019). At that time, the basic organizational

principles of the "express" is to complete the delivery in the required time quickly. The time limit can be divided into three kinds: walking delivery, horse delivery, and dash delivery (Zhiziwei, 2019). The specific choice of which depends on the customer's requirements.

The "Jin Yu Xin Shu" formulated during the Song dynasty is a collection of the two Song dynasties' laws and regulations (Zhiziwei, 2019). It was collected in the "Yong Le Da Dian" and is by far one of the complete communication regulations in ancient China (Zhiziwei, 2019). Documented by the Shanghai Almanac, during the Yongle period in Ming Dynasty, Minxin Bureau, also known as the Bureau of Letters, was founded (Zhiziwei, 2019). Xiexingchang in Shanghai County and other letter bureaus possibly be the predecessor of today's post office (Zhiziwei, 2019). By the Qing Dynasty, the postal delivery system was more perfected. All different post stations are collectively known as Post. The express speed can reach 600 miles a day. The number of National Post reached 2000, couriers came 70000, and post stations surpassed 14000 (Zhiziwei, 2019).

Later on, the modern courier industry emerged in the West after World War II. With the advent of peacetime, world trade began to grow, and the global courier industry entered a period of booming growth. In 1979, China Foreign Trade Transportation Corporation (CFTC) signed an express delivery agency agreement with Japan Overseas News & Spread Corporation (OCS), becoming the first company to act as an agent for the international express delivery business. Immediately after that, in 1980, China Post started the international postal express delivery business (Wang, 2018). In the 1990s, the early private courier companies took shape, and they delivered

goods, including customs declarations, commercial contracts, etc. The post office takes half a month to deliver these documents, deals, and high timeliness requirements. It is this demand that appeared, giving birth to the initial private courier enterprises (Wang, 2018).

Activity Environment

Usually at most of the time, couriers work in outdoor environment. It means that they are exposed to all kinds of climates and temperatures while operating. If we took Shanghai as the representative city in China, its visualized annual climate distribution of the different season.

Shanghai summers are uncomfortably hot, humid, and mostly cloudy, while winters are cold, windy, and partly cloudy. Temperatures usually vary between 1°C and 32°C during the year, rarely falling below -3°C or above 36°C. The temperature in Shanghai is hot, muggy, humid, and mostly cloudy in the summer.

The hot season lasts 3.0 months, from June 16 to September 14, with an average daily high temperature of more than 27°C. The hottest day of the year is July 27, with an average high temperature of 32°C and average low temperature of 26°C (Average Weather in Shanghai, n.d.). The cool season lasts 3.2 months, from December 4 to March 12, with average daily high temperatures below 12°C. The coldest day of the year is January 20, with an average low temperature of 1°C and an average high temperature of 7°C. The coolest day of the year is January 20, with an average low

temperature of 1°C and an average high temperature of 7°C. (Fig.1,2) (Average Weather in Shanghai, n.d.).

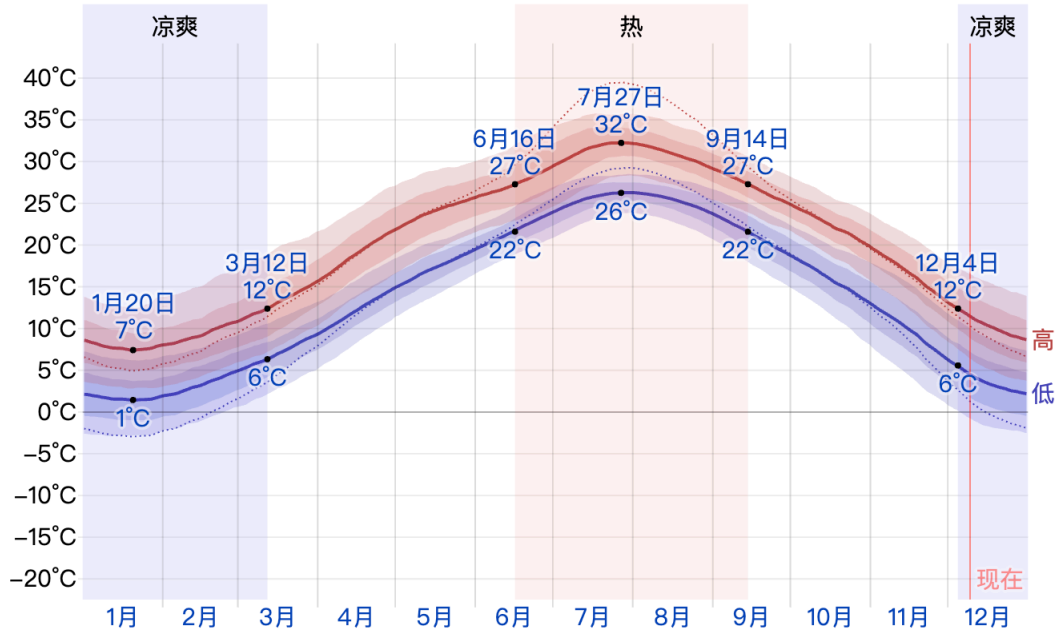


Fig.1 Average high and low temperature

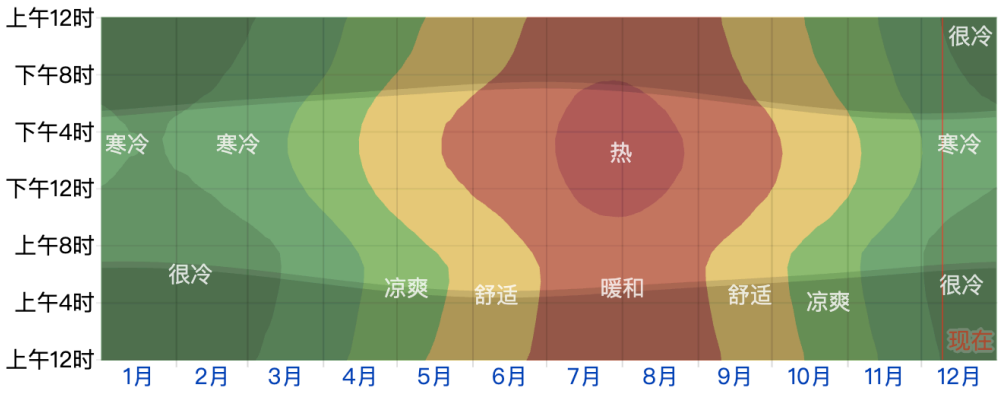


Fig.2 Average hourly temperature

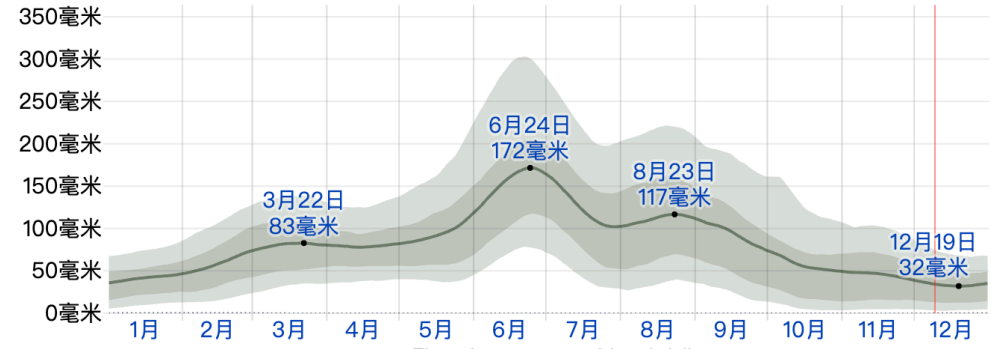


Fig.3 Average monthly rainfall

Shanghai receives the most rainfall during a 31-day period centered on June 24, with an average total cumulative rainfall of 172 mm (Average Weather in Shanghai, n.d.). The least rainy dates were around December 19, with an average total cumulative rainfall of 32 mm (Fig. 3) (Average Weather in Shanghai, n.d.).

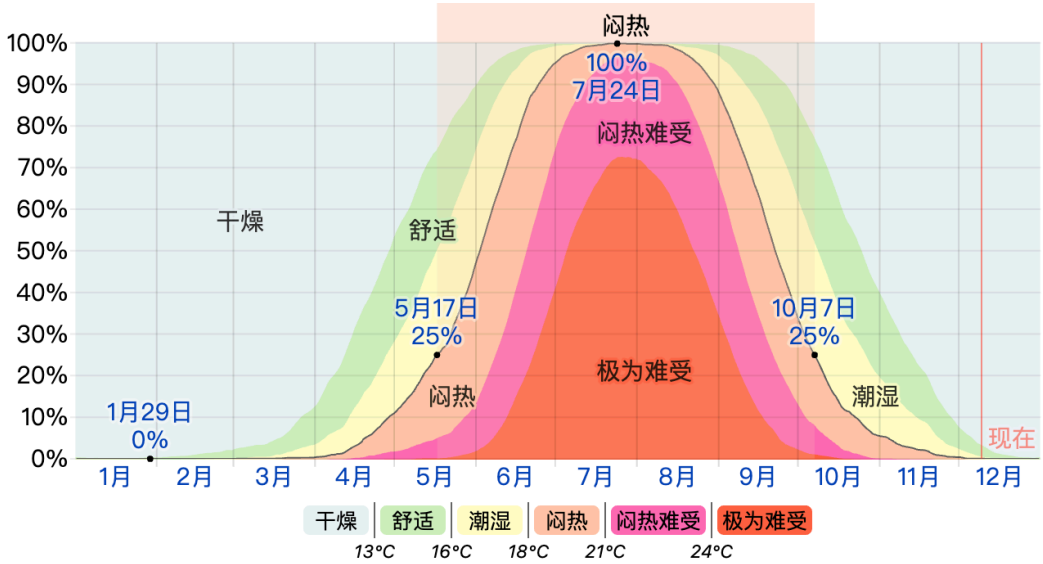


Fig.4 Humidity Comfort Level

Perceived humidity in Shanghai varies greatly seasonally. The hotter phase of the year lasts 4.7 months, from May 17 to October 7, during which the comfort level is hot, oppressive, or uncomfortable at least 25% of the time. The most stifling day of the year is July 24, with stifling conditions occurring 100% of the time. The least stifling day of the year is January 29th, when stifling conditions are almost never heard of (Fig.4) (Average Weather in Shanghai, n.d.).

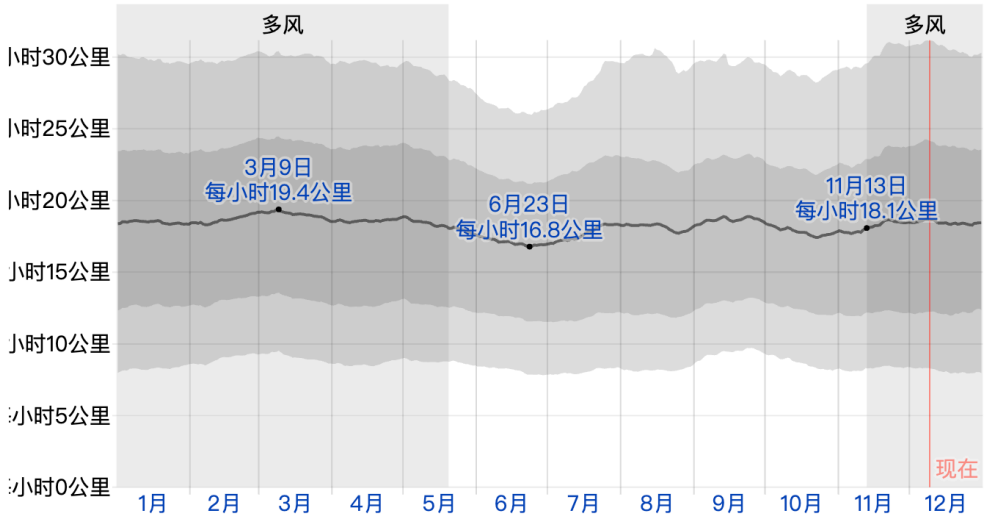


Fig.5 Average wind speed

In Shanghai, the average hourly wind speed undergoes small seasonal variations. The windier part of the year lasted 6.2 months, from November 13 to May 20, when the average wind speed exceeded 18.1 kilometers per hour. The windiest day of the year was March 9 with an average hourly wind speed of 19.4 kilometers per hour. The quieter part of the year lasted 5.8 months, from May 20 to November 13. The calmest day of the year is June 23 with an average hourly wind speed of 16.8 kilometers per hour (Fig.5) (Average Weather in Shanghai, n.d.).

From the above analysis of the year-round climate charts, we can conclude that the average rainfall and the temperature in Shanghai is moderate. Therefore, the priority of the garment aims to water-resistance instead of thermal performance. Thus, the modular insulation allows the jacket to adapt to a more comprehensive temperature range while maintaining its waterproof characteristics.

Activity Regulation and Success Achieving

The goal of a courier's job is to deliver a package to its recipient on time and in perfect condition. But in today's world of vast numbers of parcels and scattered addresses in every corner of the city, it's no easy task to accomplish this simple goal. According to the monitoring data from the Postal Industry Security Supervision and Management Information System, Shanghai's postal and express enterprises handled more than 39.18 million express shipments throughout the day on November 11, 2019, up 16.95% year-on-year, which is three times the daily handling volume since the second quarter (Chen, 2019). The volume of packages received was more than 31.75 million pieces, up 15.14%, and the work of packages delivered was more than 7.43 million pieces, up 25.34%, another record high (Chen, 2019).

The parcels are sorted at each level of the sorting center and arrive at the last receiving network. The couriers in charge of a particular area will deliver all the parcels belonging to that area together (Zhen, 2020). Due to China's advanced e-commerce, competition among courier companies is fierce. Consumers and businesses are becoming more and more demanding of their courier services. This has led courier companies to spare no effort in improving the speed of delivery. However, if they blindly pursue delivery speed, a significant number of parcels are bound to be intentionally or unintentionally damaged during the sorting process. The use of intelligent devices, intelligent packaging, machine image recognition by courier companies is becoming the industry norm. In 2017, the Cainiao Network launched a robot warehouse (Zhen, 2020). Jingdong Logistics also launched the whole process of

intelligent unmanned warehouses (Zhen, 2020). This action significantly improved the efficiency of sorting, reducing the chances of artificial damage to the express.

With modern intelligent sorting systems, couriers only need to ensure that the goods are delivered intact and on time to complete a single delivery successfully. In this process, the new design proposal involved in this project, although not directly affecting the speed of delivery (as this is no longer the only criterion to assess the goodness of the courier service), can reduce the distractions of the couriers during the delivery task (for example, reducing the impact of weather and clothing mobility on the courier's physical state during delivery or improving the courier's ability to carry packages), keep them in good professionality and help maintain the condition of the parcel and its contents. In this way, the professionalism presented in the parcel delivery can enhance customer satisfaction with the service and loyalty to the courier brand.

User Data Analysis

The target users of this project are couriers who live in Tier 1 to Tier 3 cities in China and do deliveries for major courier companies. Their ages range from 20 to 40 years old, and they include both young people who have just entered society and experienced couriers who have been in the industry for many years. More than 90% of them are males (Qiu, Shi, & Zou, 2019). According to the National Post Office's survey, the "post-80s and 90s" constitute the main body of the courier team. The overall youth

of the courier group is one of the effects of the heavy workload of the courier grassroots (Qiu, Shi, & Zou, 2019).

It seems that their task is quite simple: to deliver the parcels to the customers. As a matter of fact, in the highly developed courier industry, they also need to deal with some back-end matters, such as responding to system-assigned tasks after screening and sorting to reduce the error rate, or planning a reasonable delivery route to improve traffic efficiency (Qiu, Shi, & Zou, 2019).

The couriers' primary transportation mode is a custom-made electric bicycle, which is slightly modified to fit a larger load. They usually charge their bikes fully before going to work to stay within a working radius without fail. According to the survey, the electric tricycle is the courier's first choice of transportation, and it isn't easy to have a substitute product (Qiu, Shi, & Zou, 2019). In the first-tier cities, Guangzhou, Beijing Express electric tricycle use rate is high, 87.2% and 84.42% respectively; Shanghai's primary delivery tool for electric bicycles, the use rate of 70% (Qiu, Shi, & Zou, 2019).

Physiological and Biomechanical Needs

Couriers have a few leading states of being at work: commuting on electric bicycles, walking with smaller packages in their hands, walking with larger packages in their hands, and loading large or overweight shipments with hand carts. These activities are all relatively routine behaviors that couriers repeat frequently. With this in mind, when designing equipment for couriers, more thought will be given to how to make them more comfortable and less restrictive in their movements. In other words,

the starting point is to get the couriers to focus more on the task of delivery rather than on avoidable interruptions.

According to the conclusions drawn in the chapter on the active environment, the suit needs to be more flexible in terms of thermal regulation performance in order to adapt to a broader temperature range. Therefore, to optimize the mid layer's warmth, it is also necessary to maximize the thermal map distribution corresponding to the warmth zone, taking into account the user's proprioception.

The thermal sensations elicited by skin surface temperatures are a primary input to our sensing the surrounding environment, and our judging whether we are comfortable (Romanovsky, 2007). The skin's warm and cool sensitivities determine the thermal sensations experienced at different temperatures. They are important for the design of heating and cooling systems, especially those that condition local body parts via radiant beams, jets of air, or by contact with warmed or cooled conductive surfaces. Such systems include sport and protective clothing (Havenith, 2002). They serve both to mitigate thermal discomfort and to induce positive sensations of thermal pleasure through heating or cooling (T. Parkinson, 2016). Designers of such systems would benefit from knowing the sensitivity of different body surface parts to target the more sensitive ones (Maohui Luo, 2020).

A study of High-density thermal sensitivity maps of the human body, aims to describe the distribution of thermal sensitivity across the entire body (assuming that thermal sensitivity is symmetrically distributed over the left and right body halves) at a high enough resolution to be used for locating specific areas of thermal input or extraction (Maohui Luo, 2020). The result clearly shows that there is a large regional

variation in thermal sensitivity for different body parts. In general, the face is highly sensitive. The back of torso and neck is more sensitive than the front (note the darker colours for back than front for both heating and cooling). The abdomen is more sensitive than the chest. The seat is more sensitive than other parts of the trunk. The dorsum of the hand is more sensitive than the palm. The lower extremities are the least sensitive (Maohui Luo, 2020). Table 1 presents the sensitivity magnitude and variation for each body part.

Body part	Cooling		Warming	
	Average	SD	Average	SD
Face	1.89	0.43	1.36	0.53
Neck dorsal	1.73	0.22	1.38	0.44
Neck ventral	1.53	0.4	0.62	0.33
Chest	1.8	0.33	1.28	0.35
Abdomen	1.98	0.16	1.51	0.26
Back	2.02	0.21	1.3	0.37
Upper arm	2.07	0.23	1.3	0.39
Forearm	1.87	0.23	1.14	0.35
Hand palm	1.84	0.32	1.11	0.25
Hand dorsum	2.35	0.24	1.35	0.34
Buttock	2.16	0.48	2.14	0.45
Thigh	1.92	0.13	1.31	0.27
Lower leg	1.5	0.11	0.93	0.18
Sole 5	0.75	0.38	0.45	0.2
Foot dorsum 5	1.1	0.13	0.56	0.17
Sole 7	1.02	0.27	0.43	0.13
Foot dorsum 7	1.08	0.18	0.67	0.15

Table 1. Thermal sensitivity values for each body part.

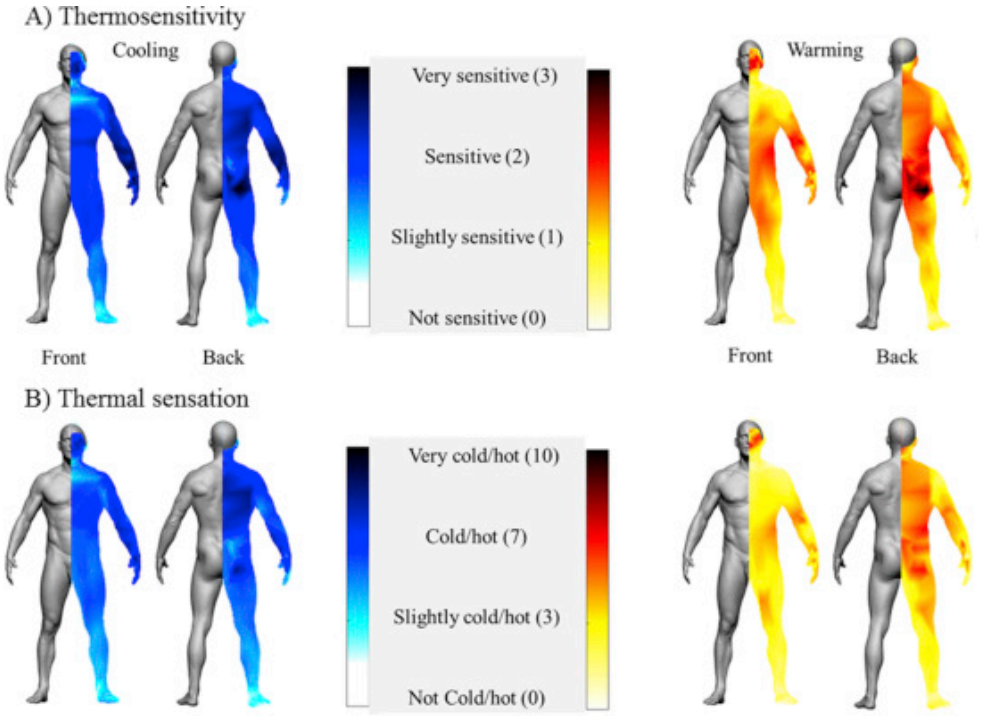


Fig. 6. A) Whole-body thermal sensitivity mapping, within 4 major levels. B) Whole-body thermal sensation mapping. The hair area on the head was not measured due to hair coverage.

Fig. 6A shows the mapping of cool and warm sensitivities across the human body from both front and back views. The values average male and female results. The thermal sensation votes that underlie sensitivity values are mapped in Fig. 6B. Spot thermal sensation values range between 0.5 and 8.6 for cooling, and between 0.3 and 7.1 for warming, across the whole body. This indicates that our heating and cooling stimulus temperatures produce a wide range of responses without extreme sensations. The maps of thermal sensitivity and thermal sensation are very similar, showing the same pattern (Maohui Luo, 2020).

As a result, these body mapping visualized data are the evidence for the layout of quilting or fleece weight distribution when designing garments, since the thermal management based on the body heat map can optimize the insulation efficiency and proprioception of the middle layer.

When the user is riding on a scooter, the clothing's mobility and windproof performance in the riding position needed to be considered. Further, the planning of garment storage areas needs to take into account accessibility in the riding position.

A study of motorcycle riding posture prediction using DHM (Digital Human Modeling) software or algorithms offers an estimation of human joint angles for a

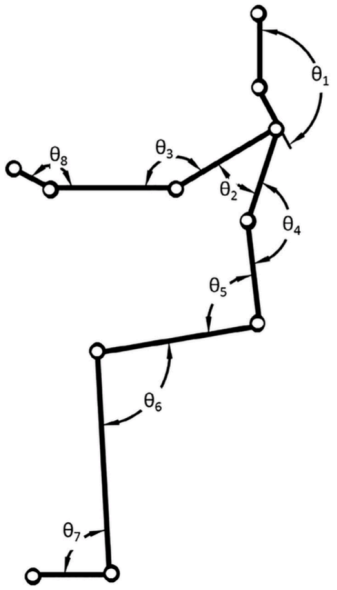


Fig.7 Joint angles studied by the researchers during posture evaluation of motorcyclists

defined posture (Abdel-Malek, Yu, & Jaber, 2001). In DHM software platforms, posture analysis can be performed by defining comfort range of joint angles within the total range of motion (ROM) (Muthiah, Mondal, Singh, & Karmakar, 2018). Similar to ROM, motorcyclist's perceived comfort joint angle (CJA) for various countries have been presented in Table 4 (Muthiah, Mondal, Singh, & Karmakar, 2018). Generally, the researchers for defining the rider*s posture (Fig. 7) consider eight relative joint angles (Muthiah, Mondal, Singh, & Karmakar, 2018). Researchers have used goniometer and faro-arm to measure the joint angles during motorcyclist's perceived comfort/discomfort (Lawrence, 2013), Since the motorcyclists and motorcycles are

apparently different from each other, results of motorcyclist's CJA reported by various researchers differ by about 10-degree (Table 2) (Muthiah, Mondal, Singh, & Karmakar, 2018).

Comparison of motorcyclist's perceived comfort joint angles for different countries.

	Barone and Curcio (2004) [95] (n = 4)	Chou and Hsiao, (2005) [96] (n = 60)	Lawrence, (2013) [17] (n = 120)	Stefano Barone and giovanni Lo Iacono (2015) [97]
Population	Italy	Taiwan	Nigeria	Italy
Θ_1	–	159.3	159.5	–
Θ_2	50	39.7	40	50
Θ_3	140	140.2	139.3	128
Θ_4	160	169.8	169.9	–
Θ_5	110	103.4	103.8	101
Θ_6	–	78.2	79.0	121
Θ_7	–	–	–	93
Θ_8	155	–	–	–

*All dimensions in the tables are in degree.

Table.2

The courier's leading work equipment is an intelligent device terminal that integrates information collection, query, communication, and multi-platform compatible docking (Li, 2018). It is roughly the size of a 6.5-inch smartphone. In addition, the courier will also carry some personal belongings, such as cell phones, wallets, keys, and other small-sized sundries (Li, 2018). Some experienced couriers also carry several envelopes and hand-filled sheets to distribute to customers who send frequently (Li, 2018). If there are too many items, they have to use a shoulder bag to carry them around (Li, 2018). This makes the hands' pickup line too long. Properly planning the space of the uniform will effectively increase its efficiency.

With the result from further studies, all data will be collected to output a comfortable/uncomfortable riding position for a specific area. This will give you detailed garment fit data that can be used to design clothing to fit that riding position.

Pertinent Apparel Market Size

According to the "2019 Annual Express Market Supervision Report" released by the State Post Bureau, the scale and quality continued to improve in 2019. The volume of express business exceeded 60 billion pieces, and the incremental volume exceeded 10 billion pieces again, contributing more than 50% to the growth of the world express industry (Zhao, 2020). The income of express business exceeded 700 billion RMB, accounting for 7.6‰ of GDP (Zhao, 2020). The income growth rate was four times the GDP growth rate, making positive contributions to steady growth (Zhao, 2020). More than 3 million employees in the courier industry, more than 200,000 new social workers provide essential stable employment support (Zhao, 2020).

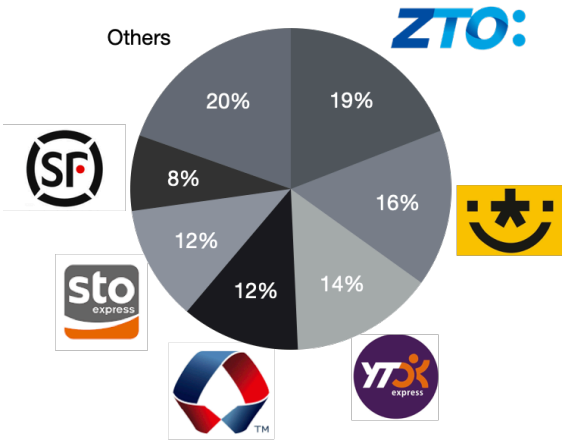


Chart.1 Top 6 Companies 2019 Market Share

Product Landscape

BRAND: Nike/SF Express

MODEL: Nike Shield Jacket

RETAIL PRICE: Approx. $200

FEATURE: NikeShield technology

BENEFIT: Excellent water resistance

BRAND: Yunda Express

MODEL: Winter Jacket

RETAIL PRICE: Approx. $20

FEATURE: Water-repellent shell fabric

BENEFIT: Good water resistance

BRAND: Acronym

MODEL: J87-WS

RETAIL PRICE: € 1,413

FEATURE: The back construction is pleated.

BENEFIT: It helps maintain the lowest of profiles when vacant, but generously expands when worn over most small to mid-sized daypacks.

BRAND: Supreme/ The North Face

MODEL: RTG Jacket

RETAIL PRICE: $698

FEATURE: Detachable utility vest

BENEFIT: Additional storage add-on and modularity for multiple situation.

BRAND: Filson

MODEL: Ridgeway Fleece Jacket

RETAIL PRICE: $130

FEATURE: Polartec fleece

BENEFIT: Highly breathable, lightweight and fast-drying

BRAND: Nike ACG

MODEL: ACG Microfleece Jacket

RETAIL PRICE: $150

FEATURE: Sherpa fleece

BENEFIT: Excellent hand feel

BRAND: The North Face

MODEL: Thermoball™ Eco Jacket

RETAIL PRICE: $199

FEATURE: ThermoBall™ eco insulation

BENEFIT: Keep warm even when wet

BRAND: Chrome Industry

MODEL: Bedford Insulated Jacket

RETAIL PRICE: $130

FEATURE: Quilted poly with DWR finish

BENEFIT: Water/wind resistance

BRAND: SF Express

MODEL: Work Pants

RETAIL PRICE: $10

FEATURE: Standard cargo pockets

BENEFIT: Extra storage

BRAND: Dickie’s

MODEL: DuraTech Ranger Ripstop Cargo Pants

RETAIL PRICE: $49.99

FEATURE: Flexible ripstop fabric and RepelPro finish

BENEFIT: Durable yet flexible, water and oil repellency

BRAND: Arc’teryx LEAF

MODEL: Alpha Pants Gen 2 Men’s

RETAIL PRICE: $599

FEATURE: Premium fabric and trims, big cargo pockets

BENEFIT: Excellent waterproof performance and extra storage

BRAND: 5.11 Tactical

MODEL: XPRT® Waterproof Pant

RETAIL PRICE: $374.99

FEATURE: Half-length side zipper entrance

BENEFIT: Can be worn over XPRT® pant

Product Anatomy

Typically, a hard shell jacket is made of waterproof fabric. Traditional waterproof materials are cotton canvas or twill impregnated with wax. Modern waterproof fabrics are mainly made of synthetic fabrics laminated with a waterproof and breathable membrane made of EPTFE. Simultaneously, the various types of waterproof zippers and seams tapes can ensure the garment's watertight effect. Most jackets are also designed to adjust the hood's fit to enhance further waterproof and windproof. The usual solution is to use elastic cords with snaps at the hood and hem, while individual styles may use Velcro or snap fasteners or thicker laces. Velcro or snap buttons are used at the cuffs. As for the insulated layer, typically, there are three ways to execute: synthetic filler, down filler, and fleece fabrics. The synthetic filler and down filler usually covered by a woven shell that has a better windproof property while fleece fabrics provides a comfortable proprioception. Some 2-in-1 system allows the insulation layer to be attached to the shell layer inside with fastening like zippers or cord-buttons.

Manufacturing

The garments in this system will use waterproof fabrics and waterproof accessories to meet the design proposal's requirements. So this part of the research is about the information about waterproof jacket production.

The process of garment production begins with cutting pieces. With advancements in technology, there have been improvements in fabric techniques like Automated, Numerically Controlled cutting systems, which have Automatic blade

cutting, Laser cutting, Water jet cutting, Die-cutting, etc (TextileSchool, 2018). The first two are widely used in garment production. The automated blade cutting machine is the most highly developed and widely used computerized cutting system, and numerically controlled knives cut multiple plies with great accuracy and speed (TextileSchool, 2018). Although an automated cutting system requires a substantial initial investment, it is considered the most effective investment for large-scale cutting production (TextileSchool, 2018).

The next step in the garment production process is the sewing process, which serves to join the garment pieces. Different sewing processes correspond to specific functional requirements. In the sewn garments' production process with waterproof function, the watertight seal needs to be laminated after sewing the garment pieces together. This process requires a special laminating machine to cover the garment's seams with a waterproof seal and laminate it at high temperatures. This way, the garment will not allow water from the fabric's outer surface to penetrate inside the garment because of the tiny pinholes in the seams.

There are three terms to discuss when examining the topic of seam sealing: fully taped seams, critically taped seams, and welded seams (Triple F.A.T. Goose, 2018). Each is distinct from one another, yet they all serve the same purpose, to keep water out.

The first type of seam saling is Fully Taped Seams. This type of sealing involves a process where the waterproof tape is glued and/or heat bonded to each seam - almost as if it is welded to the jacket, which completely covers the holes left by the sewing

needle (Triple F.A.T. Goose, 2018). Through this process, the seals become completely secure and make the garment at least as water-resistant as the fabric itself.

Almost like fully taped seams, Welded Seam technique utilizes heat and pressure in order to bond the garment seams (Triple F.A.T. Goose, 2018). It implies that there are no stitch holes, no straggling threads, no seam tapes, and no sewing machines. This type of sealing does not work with all materials, but most thermoplastics are weldable. Polyurethane is one such material and is commonly used by outerwear companies in their layering/sealing processes (Triple F.A.T. Goose, 2018). This is why you may come across the term “plastic welding” when examining the label of your jacket. The plastic itself is the bonding agent, and once heated, holds the seam tightly together (Triple F.A.T. Goose, 2018).

In Critically Taping process, only the critical seams are taped (areas that are most prone to cause water seepage). In most cases, these sealed seams are found commonly in the hood, around the neck and over the shoulders (areas where rain would most likely penetrate the exterior of the jacket) (Triple F.A.T. Goose, 2018).

In insulated layer manufacturing process, making a woven based garment is different from making a fleece one in terms of sewing works. A woven based garment will be handled with a technique called quilting. It is the process of sewing two or more layers of fabric together to make a thicker padded material, usually to create a quilt or quilted garment (The Craft Atlas, 2018). Typically, quilting is done with three layers: the top fabric or quilt top, batting or insulating material and backing material, but many different styles are adopted (The Craft Atlas, 2018).

The process of quilting uses a needle and thread to join two or more layers of material to make a quilt (The Craft Atlas, 2018). The quilter's hand or sewing machine passes the needle and thread through all layers and then brings the needle back up (The Craft Atlas, 2018). The process is repeated across the entire area where quilting is wanted. Rocking, straight or running stitches are commonly used with these stitches being purely functional or decorative (The Craft Atlas, 2018). Quilting is done to create bed spreads, art quilt wall hangings, clothing, and a variety of textile products (The Craft Atlas, 2018). Quilting can make a project thick, or with dense quilting, can raise one area so that another stands out (The Craft Atlas, 2018).

Materials

Production of waterproof and windproof jackets, the first consideration is the choice of waterproof fabrics. In modern times, several more common synthetic waterproof fabrics are Vinyl, Polyurethane, laminated or coated fabrics, natural waterproof materials such as animal fur, such as wool, sheepskin. Plant-based materials, such as natural rubber, latex, mixed materials such as wax, or oil-impregnated cotton. The majority selection of modern waterproof and windproof jacket production is synthetic materials from the waterproof effect, safety performance, and service life factors.

Laminates and coatings need added protection against abrasion and contamination from dirt. Therefore waterproof/breathable technologies are characterized as 2-layer, 2.5-layer, and 3-layer. Found on less technical jackets, 2-

layer construction bonds a waterproof/breathable membrane to the underside of an outer fabric with a hanging liner protects the membrane on the inside (REI, 2018). Found on the best (and most expensive) jackets, 3-layer construction is similar to 2-layer in that the waterproof/breathable membrane is bonded to the underside of an outer shell fabric. On the inside, though, another fabric layer is also bonded to the membrane to protect it. This construction (though it sounds counterintuitive) allows a 3-layer jacket to be much lighter than a 2-layer jacket because it doesn't include the weight of the hanging liner (REI, 2018). 2.5-layer construction starts with a waterproof/breathable coating on the underside of an outer shell fabric and then adds a thin protective veneer—the half layer—to protect that coating. A 2.5-layer jacket will typically be less breathable than either a 2-layer or 3-layer jacket, but it will also be less expensive. Because no inner fabric is required, some ultralight jackets might also have a 2.5-layer construction (REI, 2018).

Thermal insulation can broadly be defined as the process of insulation against transmission of heat. In the context of thermal insulation for outerwear, there are two types – down insulation, which is made from goose or duck plumage; and synthetic insulation, or polyfill as its often referred, is comprised of polyester fibers (Thermore, 2012).

Synthetic fibers are versatile options for outerwear insulation. Synthetic thermal insulation is much more resistant to moisture compared to animal-derived products, and in some cases can outperform natural fibers such as cotton, which is slow to dry after getting wet. It's essential to consider synthetic insulation for thermal insulation for outerwear (Thermore, 2012).

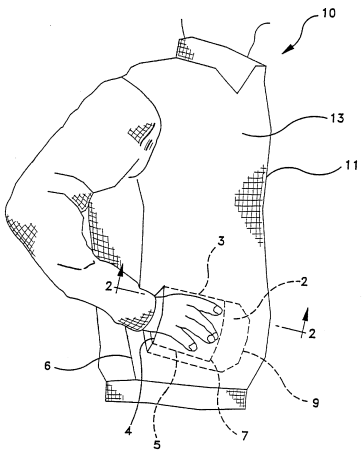
An alternative fabric for insulation layer is fleece. Fleece is a man-made wonder product, if there is such a thing. Despite being named after the ‘fleece’ coat on a sheep, it’s 100% synthetic and derived from plastic rather than a fluffy sheep’s coat – despite being fuzzy to the touch (Luka, 2018). The super soft, warm and breathable nature of this magic material makes it perfect for outerwear and all things cozy (Luka, 2018). Typically, this fabric is created from polyester (which comes from plastic). The fibres of polyester are woven into a light fabric which is brushed to help the fibers increase in volume (Luka, 2018). Occasionally other natural fibers are incorporated into the fleece such as wool, hemp or rayon to create a certain texture or vibrancy of the fabric (Luka, 2018). It can also be made from recycled plastics such as plastic water bottles, giving it an eco-friendly edge whilst being inexpensive (Luka, 2018).

For polyester fleece, the polyester fibres needs to be made first. This is created using a chemical reaction involving petroleum and petroleum derivatives (Luka, 2018). The chemicals are heated until they form a thick syrup, which then hardens and is spun to form threads (Luka, 2018). Because of the structure of the fibres, fleece is extremely warm and breathable and allows air to flow through it easily (Luka, 2018).

The characteristics of this fabric make it incredibly useful for keeping warm, particularly whilst being active. Fleece has a pile surface on both sides of the fabric, meaning each side has a layer of cut fibres (Luka, 2018). Air pockets can sit between the threads in this pile surface, meaning the material can hold in that bit more warmth (Luka, 2018). Not only is polyester fleece warm and durable, but it is moisture resistant making it ideal for extreme weather conditions or for sportswear which it became

popular for in the 1990s, due to it being warmer than wool and much lighter to wear (Luka, 2018).

Patent landscape

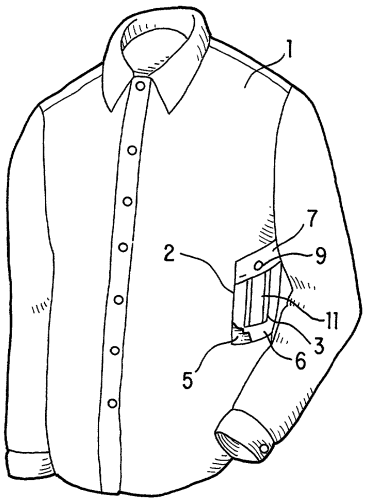


US5555566A

Method of enhancing posture using garment pocket structure

Inventor: Louis Kuhn

A method of enhancing posture by using a garment having an improved pocket structure which includes a restraining pocket configured such that, upon placing ones hands into the restraining pockets, the posture of the person wearing the garment is enhanced providing improved appearance. The positioning of the restraining pocket on the garment, as well as the pocket depth tend to improve posture by naturally forcing the shoulders back and pulling the stomach in.



US20020157170A1

Security pocket assembly

Inventor: Bernard Lipscher

An improved security pocket assembly is disclosed for the secure storage of conventional items such as a cellular phone, a personal data assistant and different forms of currency and identification. The pocket assembly includes a front panel attached to a rear panel to form a pocket for retaining items and optionally may include a flap with a closure or a pleated pocket for additional storage. Furthermore, the flap contains a pocket on the underside for the storage of identification. Finally, a slit may be cut into the garment and flap for storage of a writing instrument.

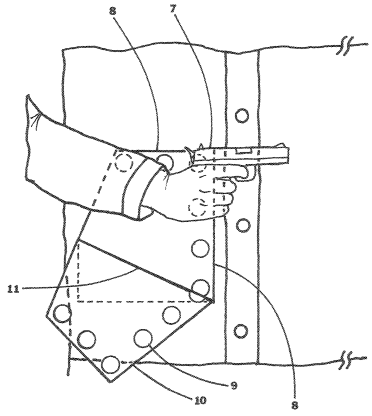


Fig. 2

US9009870B1

Garment pocket for rapid extraction and deployment of a concealed weapon

Inventor: William Joseph Connick, Jr.

A novel garment pocket, and method for making said pocket, for the rapid extraction and deployment of a weapon concealed therein. One or more edges of the pocket are reversibly attached to the garment proper by means of quick release, easily disengaged, readily releasable, or break away fasteners. Said

edge or edges being located and positioned to permit said weapon to be extracted from said pocket by means of a substantially forward thrust of the hand grasping the weapon through said edge or edges attached by said fasteners. Said hand being the one on the arm that is on the same side of the body as said garment pocket.

The pocket of the present embodiments enables the weapon to be extracted from the pocket with a reduced chance of snagging and danger to the garment wearer.

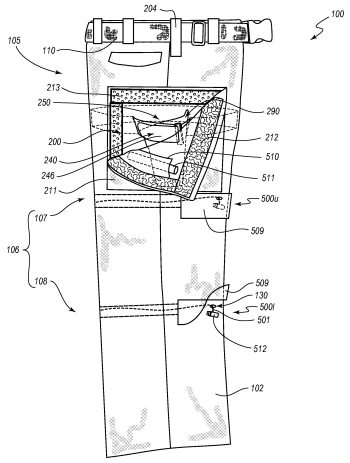


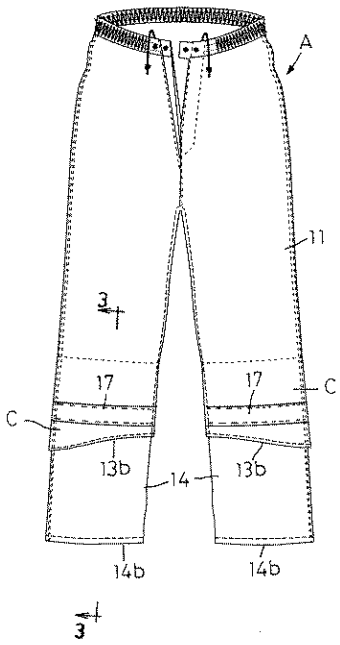
FIG. 2

US20120158041A1

Tactical pants

Inventor: Richard Gene Craig

Tactical pants can include one or more features for retaining a utility object, such as a firearm, for protecting against ballistic projectiles, or for reducing the effects of leg wounds. Various pants can include one or more of a weight distribution system, an anti-ballistic shield, or one or more tourniquets.



JP3202339U

Waterproof work pants

Inventor: 康二 松倉

[PROBLEMS] To provide waterproof work trousers that are effective when worn together with boots on various outdoor work that is easily contaminated by agriculture, horticulture, fishing, car washing, and other water and mud. The trouser body 11 and the trouser skirt 14 inserted into the boots B are separated from each other, and the upper end 14a of the trouser hem is brought into a midway position H higher than the lower end 13b of the trouser body. The band from the attached midway position H to the lower end 13b of the trouser body is determined to function as a cover C that surrounds the vicinity of the entrance portion of the boots from the outside.

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Graphic and Color Application

In order to highlight elements of corporate visual identity, such as brand color palettes and brand logos, their uniforms usually use corresponding colors. And these colors are, to a large extent, more conspicuous and recognizable. Brand logos and brand statements, etc., will make a visual representation of the uniform. Therefore, a lot of graphic design will revolve around these two points.

COLOR: Hi-Vis / Vivid Tone

GRAPHIC: Delicate Text / Indicative

LOGO: Badge / Functional Element

COLOR: Monochrome / Dark

GRAPHIC: Brand Driven / Indicative

LOGO: Badge / Functional Element

Current Competitor SWOT Analysis

Product	Strength	Weakness	Opportunities	Threats
	-Excellent fabric -Drop tail design	-Relatively high price	-Endorsements from partnerships with a famous brand	-Various cheap alternatives
	-Clear brand identity -Appropriate padding	-Limited functionality -Lacks durability	-Competitive price	-Saturated market -Various peer competitors
	-Premium fabric -Ergonomic fit -Expandable backpack storage	-Half zipper entrance makes wearability inconvenient -High retail price	-Lack of equivalent competitors	-Various cheap alternatives
	-Excellent fabric -Modular utility vest	-High retail price -Heavy weight	-Lack of equivalent competitors -Reasonable upgrading of existing product	-Various cheap alternatives

	-Nice fabric -Multiple storage	-Potential static electricity	-Better fleece application than regular products	-Saturated market -Various peer competitors
	-Nice fabric -Multiple storage	-Potential static electricity -Baggie fit -Heavy weight	-Better fleece application than regular products	-Overly fashionable silhouette
	-Excellent textile performance -Lightweight materials	-Insufficient storage	-Better technology matrix -Configurability	-Saturated market -Various peer competitors
	-Multiple storage -Lightweight materials	-Collar less -Horizontal chest pocket limits accessibility	-Configurability -Classic silhouette	-Saturated market -Various peer competitors
	-Clear brand identity -Multiple storage	-Excess decoration -Lacks durability	-Competitive price	-Saturated market -Various peer competitors

	-Reasonable cost -Waterproof, stainproof finish	-Finish will decay -	-Appropriate price and technology matrix	-Saturated market -Various peer competitors
	-Premium fabric -Articulated silhouette -Configurable	-High retail price	-Lack of equivalent competitors -Excellent material and notions' matrix	-Various cheap alternatives
	-Premium fabric -Articulated silhouette -Configurable	-High retail price -Horizontal side pockets limits accessibility	-Lack of equivalent competitors -Excellent material and notions' matrix	-Various cheap alternatives

Project SWOT Analysis

Strength:

The system will be considered with pioneering design, superior performance materials, and manufacturing processes. The pockets' arrangement, and the ergonomic fit will be considered and validated to achieve an outstanding experience. The configurable insulation layer ensures the outer jacket a wider range of temperature adaption. The cargo pants can be paired with the jacket to create the best overall

waterproof performance and ergonomic advantage when riding the scooter. As an outfit, such an array of products will provide the purchaser with an overall solution.

Weakness:

Since waterproof fabrics will be used as the primary material, this collection may make the wearer feel hot in warmer weather conditions, even if the fabric boasts excellent waterproof and breathable features. The premium materials and possibly more complicated manufacturing processes may result in higher production cost. This is a potential disadvantage in project bidding.

Opportunities:

The market mainly lacks professional delivery apparel developed for couriers and is filled with simple products containing only essential functions. However, as China's e-commerce business grows year by year, major courier companies' business is also rising. They will have enough profit to upgrade and replace their existing obsolete equipment. The deployment of a revolutionary solution can also give courier companies a significant boost to their professional image. It's an investment worth considering for their brand building.

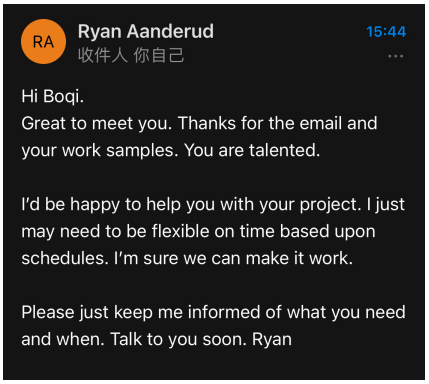
Threats:

Although there is no dedicated competitive program out there, the core of this product array: the apparel equipment in China, which has many apparel companies, is still easily overwhelmed by various manufacturers who are good at cost control. Because even if these major courier companies have sufficient budgets, the sheer number of couriers can make the apportioned cost of each set of equipment seem

overstretched. Therefore, every detail must be carefully considered in the trade-offs of mass production to balance function and price.

Mentor Mapping

Ryan Aanderud: VP of design & marketing at Hua Feng Textile Group. (Confirmed)



Personal Innovator Strengths Application

Below are my strengths per “Strength Finder”:

- Adaptability - People exceptionally talented in the Adaptability theme prefer to go with the flow. They tend to be "now" people who take things as they come and discover the future one day at a time.
- Maximizer - People exceptionally talented in the Maximizer theme focus on strengths as a way to stimulate personal and group excellence. They seek to transform something strong into something superb.
- Harmony - People exceptionally talented in the Harmony theme look for consensus. They don't enjoy conflict; rather, they seek areas of agreement.

- Includer - People exceptionally talented in the Includer theme accept others. They show awareness of those who feel left out and make an effort to include them.
- Deliberative - People exceptionally talented in the Deliberative theme are best described by the serious care they take in making decisions or choices. They anticipate obstacles.

My capstone project is to design a set of advanced delivery equipment for Chinese couriers. First of all, this is a relative niche project. Few people pay attention to this silent yet profoundly impactful people in our daily lives. This is a reflection of my Inclusive strength. I want to improve these hard-working people's work experience so that they will have a greater sense of faith and responsibility for their work. And because of my Deliberative strength, I was able to plan this line-up correctly. It's a full category of apparel, footwear, and loading systems that need to have functional requirements based on a total solution and a complete set of visual elements. I am confident about this.

Career Goal Support for Desired Role

The selection of a garment, footwear, and equipment as my capstone project can examine whether I had progressed in multiple directions in the SPD program. Covering a more comprehensive product line with one idea requires overall thinking and appropriate research of the problem. Therefore, this project's experience will

potentially test my capacity in the workflow that I mentioned in order to review and evaluate myself in the following performance: the understanding of the needs, the research for solutions, the overall aesthetic, and prototype fabrication.

In the future, I hope that I can be a principal designer that can solve a specific need with multiple approaches. It starts from various perspectives before assigning appropriate design direction to team members, and come back to numerous feasible solutions after divergent thinking and research. I think this is the form of work I am looking forward to.

Strategic Product Development

- **Detailed Baseline SWOT Analysis**

How Could We… Statement

How could we improve the garments' overall ergonomic and weather resistance, as well as the storage accessibility, for Chinese couriers?

Parts of Improvement

i. Jacket: Hood / Body / Pockets / Hem / Sleeves / Cuffs
ii. Insulation: Collar / Body / Pockets / Hem / Cuffs / Sleeves
iii. Pant: Waistband / Pockets / Legs / Cuffs / Crotch

Areas of Improvement

i. Jacket: Mobility / Water resistance / Positioning
ii. Insulation: Mobility / Comfort / Thickness
iii. Pant: Mobility / Water resistance / Positioning

Query Path

Jacket

	Strengths	Weakness	Opportunities	Threats
Hood + Mobility	Allow head moving inside	Potentially block sights	Add volume to be helmet compatible	Complex construction
	Strengths	Weakness	Opportunities	Threats

Hood + Water resistance	Seam sealing tape provides good water resistance	Stuffy after long time coverage	Apply more breathable membrane	Higher cost
Body + Mobility	Strengths	Weakness	Opportunities	Threats
	Decent overall fit for most performance	Insufficient room at rear panel	Folding at shoulder and back	Thicker back panels and less breathability
Body + Water resistance	Strengths	Weakness	Opportunities	Threats
	Seam sealing tape provides good water resistance	Stuffy after long time coverage	Apply more breathable membrane	Higher cost
Pockets + Water resistance	Strengths	Weakness	Opportunities	Threats
	Seam sealing tape provides good water resistance	Stuffy after long time coverage	Apply more breathable membrane	Higher cost
Pockets + Positioning	Strengths	Weakness	Opportunities	Threats
	Traditional layout fits most user preference	Lacking easier or quicker access to specific storage	Longer entrance and reposition some pockets	Excess pockets can get lost
	Strengths	Weakness	Opportunities	Threats

Hem + Mobility	Elastic draw cord provides adjustability	Excessively long hem makes sitting uncomfortable	Zipped side slit	Potentially sacrifice the waterproof property
Sleeves + Mobility	Strengths	Weakness	Opportunities	Threats
	Slightly loose fit provides appropriate mobility	Lacking articulated construction to fit a riding posture	Add ergonomic features to meet the adaptable	Potentially produces more offcut
Sleeves + Water resistance	Strengths	Weakness	Opportunities	Threats
	Seam sealing tape provides good water resistance	Stuffy after long time coverage	Apply more breathable membrane	Higher cost
Sleeves + Positioning	Strengths	Weakness	Opportunities	Threats
	At side of the body panels, easy to move forward and backward	Potentially limit the movement when riding	Move sleeves slightly forward toward chest	Allow less chest movement
Cuffs + Mobility	Strengths	Weakness	Opportunities	Threats
	Adjustable cuff opening fits most scenarios	Lack of elasticity when fixing the cuff	Velcro or snap button adjustment around the cuff	Excess thickness at cuff

Insulation

Collar + Mobility	Strengths	Weakness	Opportunities	Threats
	Appropriate collar opening allows most neck movement	Large obstruction when swinging the neck back and forth	Reconsider the height difference between the front and back of the collar	Potentially sacrifice the thermoregulation
Collar + Comfort	Strengths	Weakness	Opportunities	Threats
	Standing collar prevent heat loss	Inner side of the fabric does not have sweat wicking	Use next to skin material for collar lining	Fabric shrinkage may various
Body + Mobility	Strengths	Weakness	Opportunities	Threats
	Regular fit and fleece fabric allows most movement	Straight body pattern potentially limits the shoulder movement	Wider chest width	Excess wrinkles at back
Body + Comfort	Strengths	Weakness	Opportunities	Threats
	Excellent thermal regulation and breathability	No sweat wicking property	Add next to skin liner	Thicken overall

Body + Thickness	Strengths	Weakness	Opportunities	Threats
	Consistent fabric thickness prevents heat loss	Body sweat zone potentially feels stuffy	Lighter fabric at body sweat zones	Fabric shrinkage may various
Seams + Comfort	Strengths	Weakness	Opportunities	Threats
	Overlock stitching reduce seam thickness	Rough touch at the stitching	Chain stitching with woven fabrics	Require liner
Pockets + Comfort	Strengths	Weakness	Opportunities	Threats
	Stretch nylon pocket shell with wrap knit liner provide excellent skin touch and warmth	No entrance security	Zipped pocket entrance	The zipper may scratch hands
Hem + Mobility	Strengths	Weakness	Opportunities	Threats
	Elastic draw cord allows the hem to be secured	The exposed cord stopper potentially be hooked	Elastic binding at hem	Not adjustable
	Strengths	Weakness	Opportunities	Threats

Hem + Comfort	Elastic draw cord allows the hem to be secured	Draw cord is too thin to be comfort	Thicker draw cord at hem	Stiffer hem
Cuffs + Mobility	Strengths	Weakness	Opportunities	Threats
	Stretch woven with elastic band secure wrist properly	Elastic band is too wide for the wrist	Elastic binding at cuffs	Less security
Cuffs + Comfort	Strengths	Weakness	Opportunities	Threats
	Stretch woven with elastic band secure wrist properly	The woven does not provide good skin touch	Sweat wicking liner inside the cuff	Fabric shrinkage may various
Sleeves + Mobility	Strengths	Weakness	Opportunities	Threats
	Set-in sleeve and raglan sleeve mix provide good shoulder movement	Lacking articulated elbow construction to fit a riding posture	Add ergonomic features to meet the adaptability	Potentially produces more offcut
Sleeves + Comfort	Strengths	Weakness	Opportunities	Threats
	Sherpa fleece provide excellent skin touch and warmth	Not sweat wicking	Add sweat wicking liner	Thicken overall

	Strengths	Weakness	Opportunities	Threats
Sleeves + Thickness	Consistent fabric thickness prevents heat loss	Arm sweat zone potentially feels stuffy	Lighter fabric at arm sweat zones	Fabric shrinkage may various

Pant

	Strengths	Weakness	Opportunities	Threats
Waistband + Mobility	Waistband with beltloops fits most body shape	Belt required	Integrated waist adjustment and elastic band	Complex construction
	Strengths	Weakness	Opportunities	Threats
Pockets + Water resistance	Pocket flap prevents droplets	Poor water resistance in shell fabric	DWR finish for the shell fabric	Finish may potentially fade away
	Strengths	Weakness	Opportunities	Threats
Pockets + Positioning	Traditional layout fits most user preference	Lacking cargo pockets for extra storage	Reposition some pockets and entrances	Excess pockets can get lost
	Strengths	Weakness	Opportunities	Threats

Legs + Mobility	Slightly loose fit provides appropriate mobility	Lacking articulated construction to fit a riding posture	Add ergonomic features to meet the adaptable	Potentially produces more offcut
Legs + Water resistance	Strengths	Weakness	Opportunities	Threats
	Durable cotton ripstop	Poor water resistance	DWR finish for the shell fabric	Finish may potentially fade away
Cuffs + Mobility	Strengths	Weakness	Opportunities	Threats
	Regular cuff opening fits most scenarios	Not adjustable for different conditions	Velcro or snap button adjustment around the cuff	Excess thickness at cuff
Cuffs + Positioning	Strengths	Weakness	Opportunities	Threats
	Horizontal opening has great visual balance	Front opening will rise when riding	Longer front opening	Visually imbalanced
Crotch + Mobility	Strengths	Weakness	Opportunities	Threats
	Less crotch wrinkles	Limited crotch movement	Add crotch gusset	Excess wrinkles

- **Baseline Testing Plan**

Mobility Test

Phase of Study	Procedure	Data Collected	Timing
Subject Recruitment	Sent invitation to SPD classmates via emails or verbal invitation	None	N/A
Subject Sign-Up	Subjects contact me via emails or verbal confirmation	Name, height	1 min
Data Collection (at White Stag)	Subjects wear next-to-skin apparel, and will be measured to acquire lengths of limbs and trunk	Pictures of subject's frontal and lateral view Length of upper arm, length of forearm, shoulder width, trunk length, thigh length, calf length	5 mins /subject
	Subjects wear baseline products, and sit on the scooter and maintain riding position	Elbow angle, upper arm rise angle, hip angle, and knee angle	5 mins /subject
	Subjects stay on the scooter, and I'll take photos of baseline's sleeves, body, hip, and legs to capture wrinkles and bunches	Pictures of baseline's sleeve, body, hip, and legs	2 mins /subject

Materials Required

Scooter, baseline jacket, baseline insulation, baseline pant, data collecting form, camera

Water Resistance Test

Phase of Study	Procedure	Data Collected	Timing
Subject Recruitment	Sent invitation to SPD classmates via emails or verbal invitation	None	N/A
Subject Sign-Up	Subjects contact me via emails or verbal confirmation	Name	1 min
Data Collection (by Walking)	Subjects wear a cotton pullover under the baseline jacket, and walk around where it rains for 10 minutes	None	10 mins /subject
	Subjects take off the baseline jacket before I check the pullover's water marks	Pictures of the pullover's frontal view, rear view, sleeves	5 mins /subject
Data Collection (by Riding)	Subjects wear a cotton pullover under the baseline jacket, and ride the scooter where it rains for 10 minutes	None	10 mins /subject
	Subjects take off the baseline jacket before I check the pullover's water marks	Pictures of the pullover's frontal view, rear view, sleeves	5 mins /subject

Materials Required

Scooter, baseline jacket, baseline pant, camera

Thermal Regulation Test

Phase of Study	Procedure	Data Collected	Timing
Subject Recruitment	Sent invitation to SPD classmates via emails or verbal invitation	None	N/A
Subject Sign-Up	Subjects contact me via emails or verbal confirmation	Name	1 min
Data Collection (at Outdoor)	Subjects wear the baseline insulation only, and walk around where the temperature is around 50°F for 10 minutes. During this period, subjects grade the perception of heat loss base on the body map	Grades of collar heat loss, body heat loss, sleeve heat loss, hem heat loss, and cuff heat loss	10 mins /subject
	Subjects wear the baseline insulation under the baseline jacket, and walk around where the temperature is around 50°F for 10 minutes. During this period, subjects grade the perception of heat loss base on the body map	Grades of hood heat loss, body heat loss, sleeve heat loss, hem heat loss, and cuff heat loss	10 mins /subject
Data Collection (at Indoor)	Subjects wear the baseline insulation only, and walk around where the temperature is around 40°F with a wind speed of 17mi/h for 10 minutes. During this period, subjects grade the perception of heat loss base on the body map	Grades of collar heat loss, body heat loss, sleeve heat loss, hem heat loss, and cuff heat loss	10 mins /subject
	Subjects wear the baseline insulation under the baseline jacket, and walk around where the temperature is around 40°F with a wind speed of 17mi/h for 10 minutes. During this period, subjects grade the perception of heat loss base on the body map	Grades of hood heat loss, body heat loss, sleeve heat loss, hem heat loss, and cuff heat loss	10 mins /subject
Data Collection (at Indoor)	Subjects wear a light-colored cotton shirt under the baseline jacket, and run a treadmill test for 10 minutes	None	10 mins /subject

	Subjects take off the baseline insulation before I check the shirt's sweat marks	Pictures of the shirt's frontal view and rear view	1 min /subject

Materials Required

Baseline jacket, baseline insulation, baseline pant, light-colored cotton shirt, perception grading form, treadmill

Storage Test

Phase of Study	Procedure	Data Collected	Timing
Subject Recruitment	Sent invitation to SPD classmates via emails or verbal invitation	None	N/A
Subject Sign-Up	Subjects contact me via emails or verbal confirmation	Name	1 min
Subject Preparation	I measure the baseline products, 10 regular envelops, 10 package bags, a roll of packaging tape, a smart terminal model, a smartphone, a wallet, a bundle of keys, a pair of gloves, a water bottle, some snacks, a pen, a pack of napkin, a pack of cigarette, and a lighter	Dimension and weight of the envelops, package bags, packaging tape, smart terminal model, smartphone, wallet, keys, gloves, water bottle, snacks, pen, napkin, cigarette, and lighter	20 mins
Data Collection	Subjects wear all the baseline products, try to put everything into the pockets that all baselines have in a reasonable distribution, then take pictures	Pictures of gearing up frontal view, lateral view, and rear view Footage of the testing process	5 min /subject
	I use the marking tape to highlight the pockets that need to be enlarged, re-positioned, and added, then take pictures	Pictures of marked frontal view, lateral view, and rear view	15 mins /subject

Materials Required

Baseline jacket, baseline insulation, baseline pant, 10 regular envelops, 10 package bags, tape, smart terminal model, smartphone, wallet, a bundle of keys, a pair of gloves, water bottle, 3 packs of snack, pen, cigarette, lighter, marking tape, camera

- **Consumer Testing Plan**

This research will target the experience pain points of current Chinese couriers' garments to conduct an anatomical analysis and synthesize the relationship between the data from the performance research to develop improvement strategies.

Test subject: 10 Chinese couriers from different companies

Questionnaire

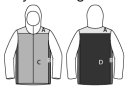
About mobility

1. Please grade the restrain level of area A to C of the sleeves when you riding on the scooter from -2 to 2.

-2 means too tight
0 means comfort
2 means too loose

2. Please grade the restrain level of area A to D of the body when you riding on the scooter from -2 to 2.

-2 means too tight
0 means comfort
2 means too loose



3. Please grade the restrain level of area A, B, and C of the hood when you riding on the scooter from -2 to 2.

-2 means too tight
0 means comfort
2 means too loose

4. Please grade the restrain level of area A to F of the pant when you riding on the scooter from -2 to 2.

-2 means too tight
0 means comfort
2 means too loose

About water resistance

1. Please grade the body's water resistance from 1-5.

2. Please grade the front flap's water resistance from 1-5.

3. Please grade the cuffs' sealing performance from 1-5.

4. Please grade the hem's sealing performance from 1-5.

5. Please grade the hood edge's sealing performance from 1-5.

About thermal regulation

1. Please grade the front body's thermal regulation from 1-5.

2. Please grade the front body's breathability from 1-5.

3. Please grade the rear body's thermal regulation from 1-5.

4. Please grade the rear body's breathability from 1-5.

5. Please grade the sleeves' thermal regulation from 1-5.

6. Please grade the sleeves' breathability from 1-5.

7. Please grade the collar's thermal regulation from 1-5.

8. Please grade the collar's breathability from 1-5.

About storage

1. Please grade the sufficiency of the pocket space from 1-5.

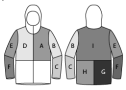
2. Please grade the accessibility of the pocket entrance from 1-5.

3. Please grade the number of the pockets you need more from 1-5.

4. Do you prefer pockets for specificate items?

5. Do you have familiar storage habits?

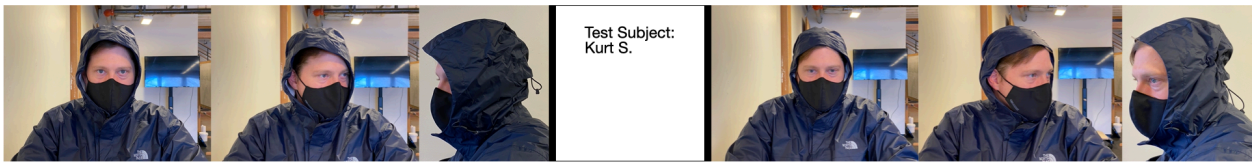
6. Please identify the areas from A to I that you want to add pockets.

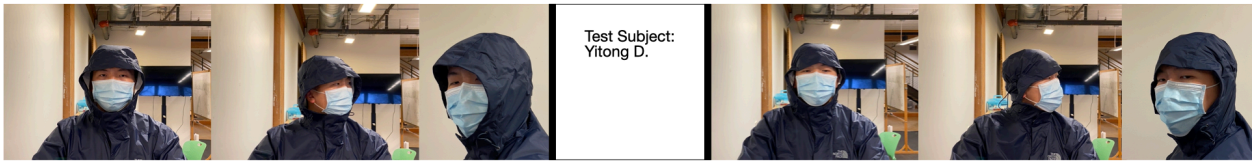


- **Baseline Testing Result**

MOBILITY TEST

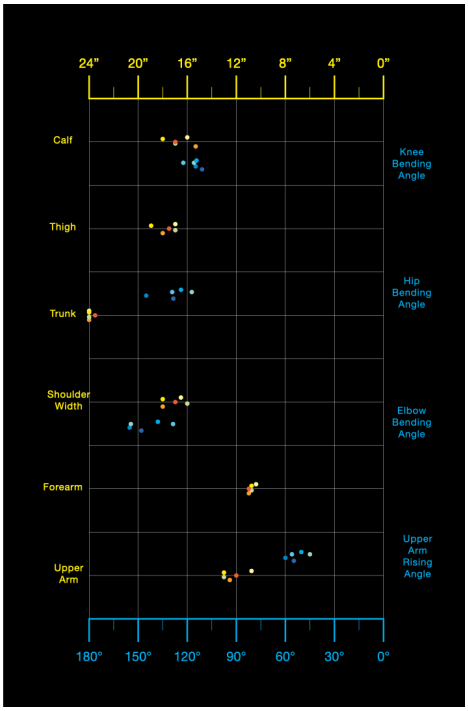
| Hood Mobility Test |





MOBILITY TEST

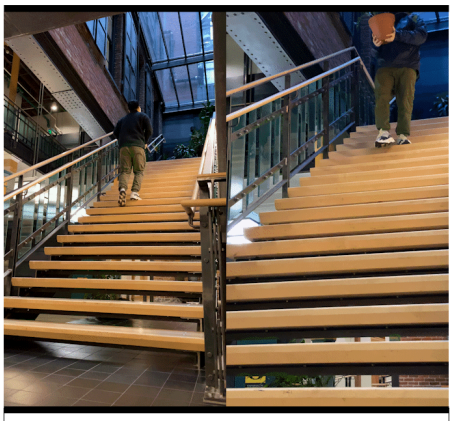
| Anthropometric Data Analysis |



THERMAL REGULATION TEST

| Outdoor & Indoor Field Test |

Outdoor Test
Subject: Yitong D.



Indoor Test
Subject: Yitong D.

Feedback:
Fleece jacket has good next-to-skin performance

Collar is too tight to ventilate

Cuff material is durable but poor at sweat wicking

Great overall warmth but feels stuffy when working indoor

WATER RESISTANCE TEST

| Walking & Riding Field Test |

highlight setup

Walking Test
Subject: Yitong D.

Feedback:
Jacket has great water resistance

Pants get wet easily

Riding Test
Subject: Yitong D.

Feedback:
Water may splash in from the hood

Pants suffer a worse condition

THERMAL REGULATION TEST

| Breathability Test on Hard Shell Jacket |

Subject: Charbel H.

Subject: Charbel H.

Feedback: Very poor breathability

STORAGE TEST

| Layout Preference Mark Up |

Test_1
Subject: Kurt S.

Layout_1 | Front View | Right View | Left View | Rear View

Test_2
Subject: Daniel C.

Layout_2 | Front View | Right View | Left View | Rear View

- **Function Ideation Plan**

Hard Shell Jacket	
Hood	
SWOT opportunities: Adjustable volume	_Velcro at back _Multiple dimension drawcord _Expandable room with zipper
Benchmark opportunities: Waterproof	_Longer brim _Foldable brim _Expandable brim _Wider brim
Benchmark opportunities: Visibility	_PVC at hood lateral edges _Notch at hood lateral edges
Consumer opportunities: Comfort	_Next-to-skin liner _Fleece liner _Better membrane
Consumer opportunities: Windproof	_Detachable fleece brim _Brim draw cords _Higher collar
Body	
SWOT opportunities: Waterproof	_Shoulder covers
Benchmark opportunities: Riding posture adaptive	_Lateral slits _Lateral folds _Lateral zippers _Shoulder back accordion _Wider upper back panel _Elastic material at shoulder back
Benchmark opportunities: Breathability	_Better membrane _Back ventilation
Consumer opportunities: Windproof	_Lateral migrate front entrance _Double front flap _Waist drawcord
Pockets	

SWOT opportunities: Waterproof	_Entrance flap _Folded entrance
Benchmark opportunities: Larger capacity	_Enlarge pocket bag _Pocket bag darts _Pocket bag accordion _Enlarge quantity
Benchmark opportunities: Item specific layout	_Lower pockets for heavy items _Back pockets for big and flat items _Higher pockets for light items _Sleeve pockets for small items _Inner pockets for small items
Consumer opportunities: Accessibility	_Longer entrance _Tunnel to inside jacket's pocket _Ergonomic positioning
Hem	
SWOT opportunities: Wind-sealing	_Inner wind skirt _Longer tail
Benchmark opportunities: Droplet protection	_Layered tail _Drop tail
Sleeves	
SWOT opportunities: Mobility	_Articulated elbow cutlines _Elbow darts _Elbow folds _Underarm gusset
Benchmark opportunities: Breathability	_Better membrane _Underarm ventilation
Cuffs	
Benchmark opportunities: Waterproof	_Expanded cuff cover _Higher Velcro strap position
Consumer opportunities: Windproof	_Inner elastic cuff

Insulation

Collar	
SWOT opportunities: Modularity	_Zip to attach to hard shell jacket _Loop to attach to hard shell jacket _Velcro to attach to hard shell jacket
Benchmark opportunities: Breathability	_Wider opening _Sweat wicking liner _Shorter collar height _Detachable collar module
Consumer opportunities: Comfort	_Next-to-skin liner _Fleece liner
Consumer opportunities: Windproof	_Detachable fleece gaitor _Foldable gaitor
Body	
SWOT opportunities: Windproof	_Woven material with padding
Benchmark opportunities: Breathability	_Lighter material at central back _Lighter material at upper chest
Pockets	
SWOT opportunities: Security	_Zipped entrance _Velcro entrance _Snap button entrance
SWOT opportunities: Larger capacity	_Enlarge pocket bag _Enlarge quantity
Benchmark opportunities: Accessibility	_Ergonomic positioning _Longer entrance
Hem	
SWOT opportunities: Comfort	_Body material _Inner drawcord
Benchmark opportunities: Security	_Elastic binding _Elastic band
Sleeves	

SWOT opportunities: Mobility	_Articulated elbow cutlines _Elbow darts _Underarm gusset
SWOT opportunities: Modularity	_Loop to attach to hard shell jacket _Velcro to attach to hard shell jacket
Benchmark opportunities: Breathability	_Underarm venting hole _Mesh at elbow pit
Cuffs	
SWOT opportunities: Comfort	_Bound cuff _Narrower elastic band _Sweat-wicking cuff liner _Elastic material cuff

Pant	
Waistband	
SWOT opportunities: Adjustability	_Partial elastic band _Velcro tabs _Snap button tabs
Consumer opportunities: Comfort	_Ergonomic patten _More belt loops
Pockets	
SWOT opportunities: Security	_Zipped entrance _Velcro entrance _Snap button entrance
SWOT opportunities: Larger capacity	_Enlarge pocket bag _Inner key pocket
Consumer opportunities: Breathability	_Mesh pocket bag
Legs	
SWOT opportunities: Mobility	_Knee darts _Knee folds _Articulated cutline

Benchmark opportunities: Riding posture adaptive	_Tapered fit _Enlarged hip volume
Consumer opportunities: Comfort	_Sweat-wicking liner _Fleece liner
Cuffs	
SWOT opportunities: Adjustable	_Expandable width with zipper
Consumer opportunities: Durability	_Reinforced panel
Crotch	
SWOT opportunities: Mobility	_Add crotch panel _Higher crotch _Elastic material
Consumer opportunities: Durability	_2-layer crotch _Durable material

- **Aesthetic Ideation Plan**

FONT PACKAGE

TITLE: **DIN Cond-Bold 48pt**

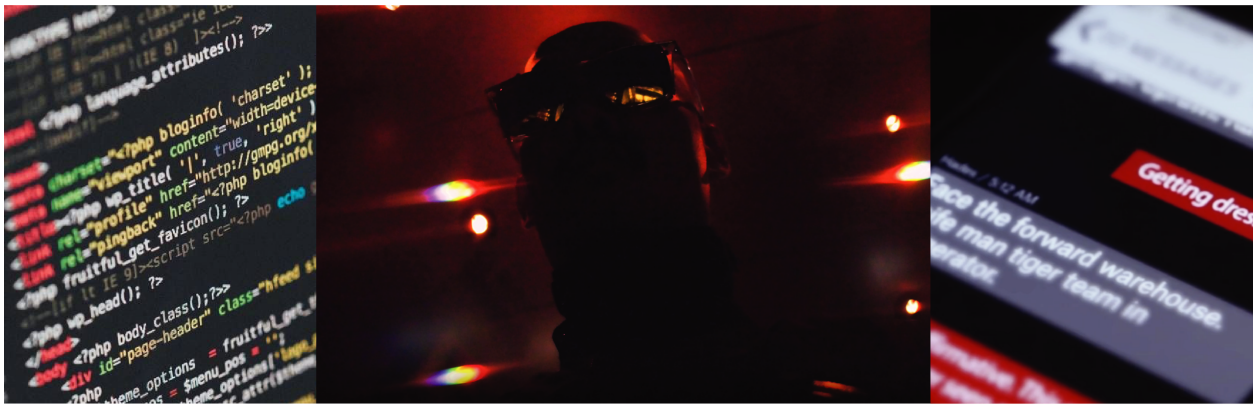
SUBTITLE: DIN Cond-Regular 48pt

HEADING: **Helvetica Neue-Bold 36pt**

BODY: Helvetica Neue-Medium 20pt

COLOR PALETTE

| Majority darktone with vivid accent for visual communication |
| Tonal individuals with highlighted modules for products |



| VISUAL |

BLACK CYAN MAGENTA YELLOW GREEN RED

| PRODUCT |

PANTONE 19-4007 TCX
PANTONE 18-5105 TCX
PANTONE 14-4500 TCX
PANTONE 19-2024 TCX
PANTONE 17-1563 TCX

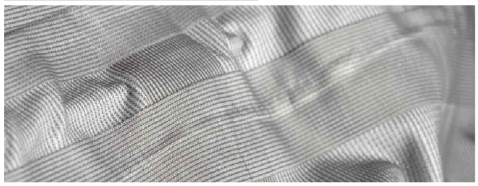
MOOD BOARD CONCEPT

| Futuristic urbanism |
| Metalic finish |
| Mobility with protection |







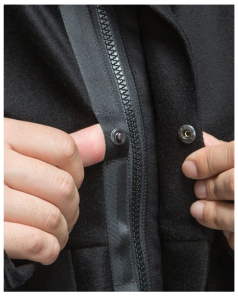
MOOD BOARD HARD SHELL

| Functional hood features |
| Modularity |
| Organized storage |







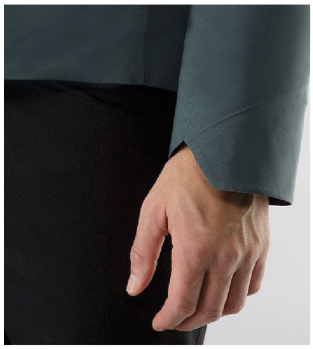




MOOD BOARD | HARD SHELL

| Large volume storage |
| Mobility with considered hidden details |
| Extended cuff protection |

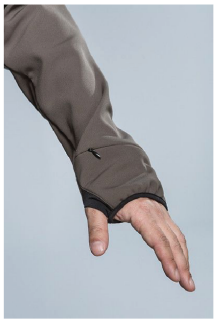







MOOD BOARD | INSULATION

| Elastic cuff |
| Modularity |
| Zoned thermal area |




MOOD BOARD | PANTS

| Adjustable fit |
| Articulated knee |
| Large volume utility pockets |







MOOD BOARD | SILHOUETTE

| Mid long outerwear with articulated construction |
| Short collar or collarless insulation |
| Tapered pant with articulated construction |







- **Resourcing Plan**

Hard Shell Jacket			
Materials	Performance goals	Where it will be applied	Where to source
Poly/Nylon 3L fabric	-Waterproof -Breathability -Durability	-Full body	-Look under studio table -www.seatlefabrics.com -www.rockywoods.com -Mill End store -www.taobao.com
Sealing tape	-Waterproof	-Full body	Obtained
Waterproof zipper	-Waterproof -Pocket entrance secure -Opening secure	-Center front -Hand warmer pockets -Utility pockets -Side slit -Underarm vent	Obtained
Reversed coil zipper	-Pocket entrance secure	-Hidden pockets -Inside pockets	Obtained
Molded resin zipper	-Insulated jacket secure -Pocket entrance secure	-Facing to attach to insulation -Hand warmer pocket -Utility pockets	-Look in Nucleus Lab containers -www.seatlefabrics.com -www.rockywoods.com -Mill End store -Joann store -www.taobao.com
Velcro	-Pocket entrance secure -Flap secure	-Cuff -Pocket closure -Front flap	Obtained
Elastic cord	-Tightness adjustment	-Hood -Hem	-Look in studio racks -Andy & Bax store -www.seatlefabrics.com -www.rockywoods.com -Mill End store -www.taobao.com
Cord stopper	-Cord secure	-Hood -Hem	Same as above
Eyelet	-Cord tunnel opening	-Hood -Hem	Same as above
Snap button	-Flap secure	-Inside flap closure -Pocket closure	Same as above

Insulated Jacket			
Materials	Performance goals	Where it will be applied	Where to source
Poly or Nylon Plain weave	-Water resistance -Breathability	-Full body shell	-Look under studio table -www.seatlefabrics.com -www.rockywoods.com -Mill End store -www.taobao.com
Poly taffeta or brushed tricot	-Breathability -Next-to-skin comfort	-Full body lining	Same as above
Insulation	-Warm keeping -Fast dry	-Padding	Same as above
Lycra	-Elasticity -Breathability -Sweat wicking	-Arm pit -Elbow pit -Collar -Cuff -Hem	Same as above
Molded resin zipper	-Opening secure -Insulated jacket secure -Pocket entrance secure	-Center front -Hand warmer pockets	-Look in Nucleus Lab containers -www.seatlefabrics.com -www.rockywoods.com -Mill End store -Joann store -www.taobao.com
Reversed coil zipper	-Pocket entrance secure	-Hidden pockets -Inside pockets -Hand warmer pockets	Obtained
Performance rib	-Elasticity -Sweat wicking	-Collar -Cuff -Hem	Obtained
Elastic cord	-Loop to attach shell jacket	-Collar -Cuff	-Look in studio racks -Andy & Bax store -www.seatlefabrics.com -www.rockywoods.com -Mill End store -www.taobao.com
Snap button	-Pocket entrance secure	-Pocket closure	Same as above

Pant			
Materials	Performance goals	Where it will be applied	Where to source
Poly or Nylon 3L fabric	-Waterproof -Breathability -Durability	-Full body shell	-Look under studio table -www.seatlefabrics.com -www.rockywoods.com -Mill End store -www.taobao.com
Cotton/Poly DWR plain weave	-Water resistance -Breathability -Durability	-Alternative full body shell	Same as above
Poly taffeta	-Breathability -Next-to-skin comfort	-Pocket bag	Same as above
Metal zipper	-Opening secure	-Front fly	Obtained
Waterproof zipper	-Waterproof -Pocket entrance secure -Opening secure	-Hand warmer pockets -Cargo pockets -Cuff slit	Obtained
Reversed coil zipper	-Pocket entrance secure -Opening secure	-Hidden pockets -Cargo pockets -Cuff	Obtained
Velcro	-Flap secure -Length adjustment	-Cuff -Waist band	Obtained
Snap button	-Pocket entrance secure -Opening secure	-Pocket closure -Front fly	-Look in studio racks -Andy & Bax store -www.seatlefabrics.com -www.rockywoods.com -Mill End store -www.taobao.com
Poly webbing	-Reinforcement -Durability	-Cuff	Obtained
Elastic band	-Length adjustment	-Waist band	Obtained

- **Calendar**

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Feb.7	***Feb.8*** Midterm Preview	***Feb.9*** Midterm Prep	***Feb.10*** Midterm	***Feb.11*** Midterm	***Feb.12*** Material Selection	***Feb.13*** Hard Shell Jacket: -50 design iterations(-close-up sketches, anatomy sketches, over-all sketches)
Feb.14 Hard Shell Jacket: -Measurement & rough pattern of each part	***Feb.15*** Class Hard Shell Jacket: -5 sleeve mock-ups -1 body mock-up -update pattern	***Feb.16*** Hard Shell Jacket: -5 sleeve mock-ups -1 body mock-up -update pattern	***Feb.17*** Class Hard Shell Jacket: -5 pocket mock-ups -2 hood mock-ups -1 body mock-up -update pattern	***Feb.18*** Hard Shell Jacket: -5 pocket mock-ups -2 hood mock-ups -2 pocket layout mock-ups on body -update pattern	***Feb.19*** Hard Shell Jacket: -1 body mock-up -2 pocket layout mock-ups on body -Final design & pattern	***Feb.20*** Insulation Jacket: -50 design iterations(-close-up sketches, anato-my sketches, overall sketches) -Measurement & rough pattern
Feb.21 Insulation Jacket: -Measurement & rough pattern	***Feb.22*** Class Insulation Jacket: -5 sleeve mock-ups -update pattern	***Feb.23*** Insulation Jacket: -5 sleeve mock-ups -update pattern	***Feb.24*** Class Insulation Jacket: -2 collar mock-ups -update pattern	***Feb.25*** Insulation Jacket: -2 collar mock-ups -1 body mock-up -update pattern	***Feb.26*** Insulation Jacket: -1 body mock-up -2 overall mock-up -Final design and pattern	***Feb.27*** Pant: -50 design iterations(-close-up sketches, anato-my sketches, overall sketches) -Measurement & rough pattern
Feb.28 Pant: -Measurement & rough pattern	***Mar.1*** Class Pant: -5 pocket mock-ups -update pattern	***Mar.2*** Pant: -5 pocket mock-ups -2 waistband mock-ups -update pattern	***Mar.3*** Class Pant: -4 waistband mock-ups -update pattern	***Mar.4*** Pant: -3 leg mock-ups -3 pocket mock-ups on leg -update pattern	***Mar.5*** Pant: -3 leg mock-ups -3 pocket mock-ups on leg -Final design and pattern	***Mar.6*** Photograph organizing
Mar.7 Presentation update	***Mar.8*** **Final Review**	***Mar.9***	***Mar.10*** **Final Review**	***Mar.11***	***Mar.12***	***Mar.13***

- **Stage One Prototype**

Hard Shell Jacket

Testing the overall fit and storm hood’s adjustability

Insulated Jacket

Testing the overall fit with insulation, and functional quilting.

Cargo Pant

Testing the mobility and cargo pocket execution.

- **Stage Two Prototype**

Testing the venting system and storm collar.

Cargo Pant

Testing the cargo pocket execution.

- **Product Brief**

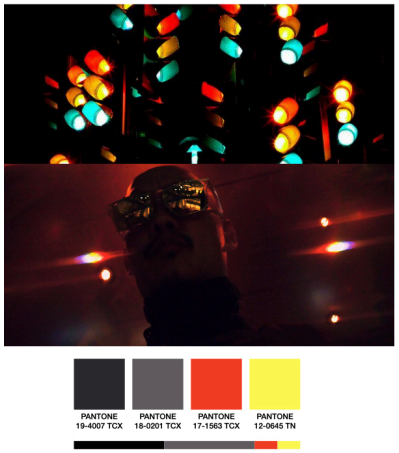
Hard Shell Jacket	
Features	Benefits
Mid-long fit	Larger coverage
Waterproof execution	Keep internal
Detachable hood	Climate adaptability
Articulated sleeves	Improve mobility
Armpit gusset	Improve mobility
Enlarged primary storage	Larger storage capacity
Ventilation	Improve breathability
Hi-Vis details	Improved safety

Insulated Jacket	
Features	Benefits
Regular fit	Multi outerwear adaptability
Windproof execution	Reduce heat dissipation
Articulated sleeves	Improve mobility
Armpit gusset	Improve mobility
Secondary storage	Added storage configuration
Moderate insulation	Climate adaptability

Cargo Pant	
Features	Benefits
Tapered fit	Improve mobility
Articulated legs	Improve mobility
Crotch gusset	Improve mobility
Secondary storage	Added storage configuration
Durable material	Added durability

- **Design Concept**

COLOR BOARD:
Tonal individuals with Hi-Vis details



MOOD BOARD:
Mineral finish
Urban workwear

FUNCTION:
Articulated construction
Enlarged volume storage
Zoned thermal areas

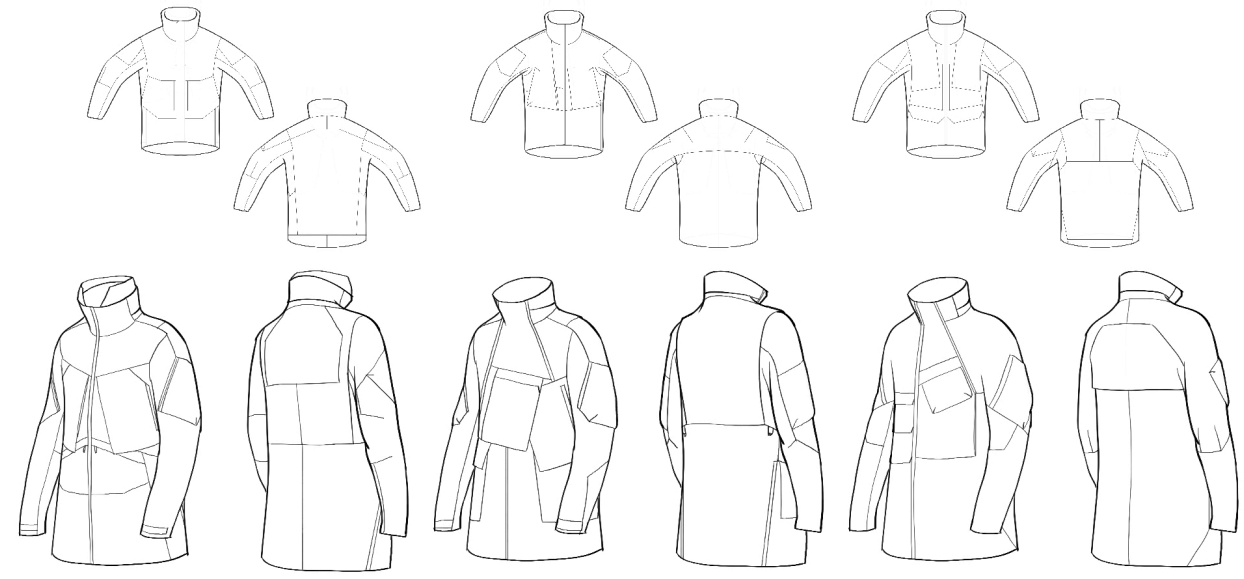
BENEFITS:
Better mobility
Greater storage
Optimized thermoregulation

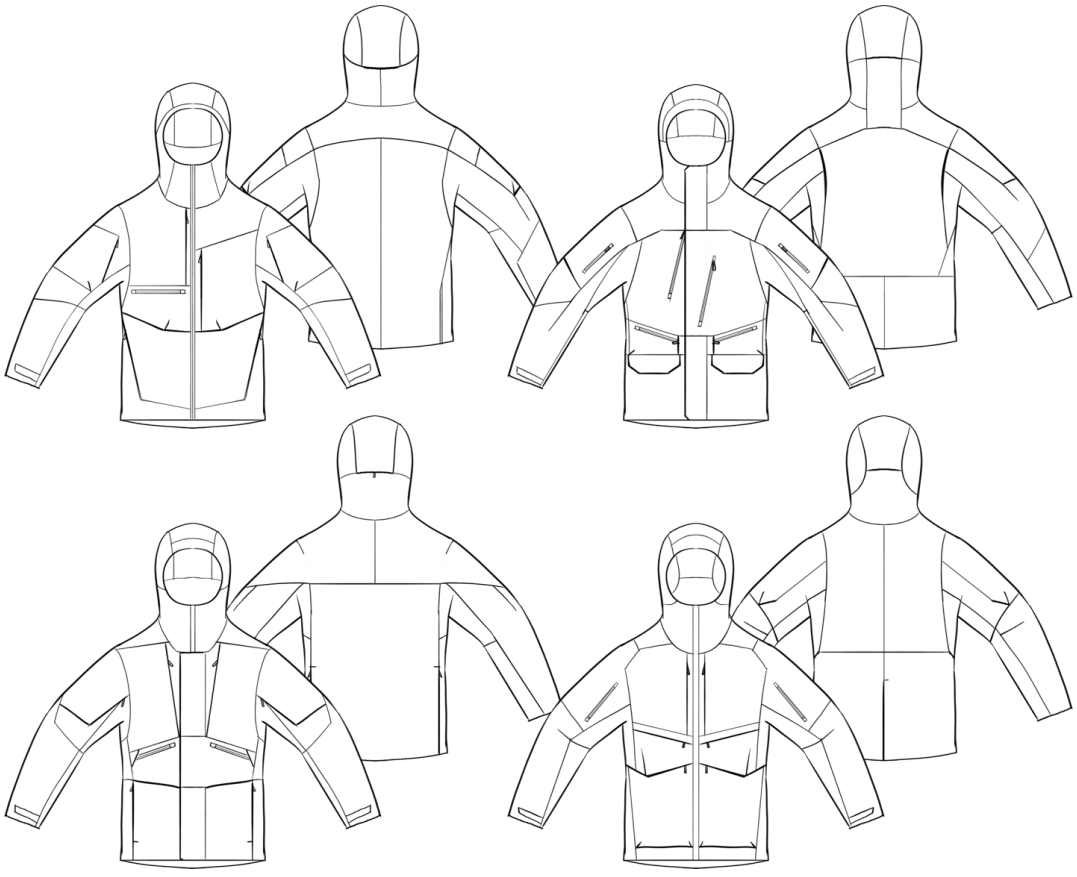
MATERIALS:
Gore-Tex® Pro 3L
Gore-Tex® Infinium™ 2L
Dyneema® Moto Denim

BENEFITS:
Waterproof
Windproof and breathability
Durability and comfort

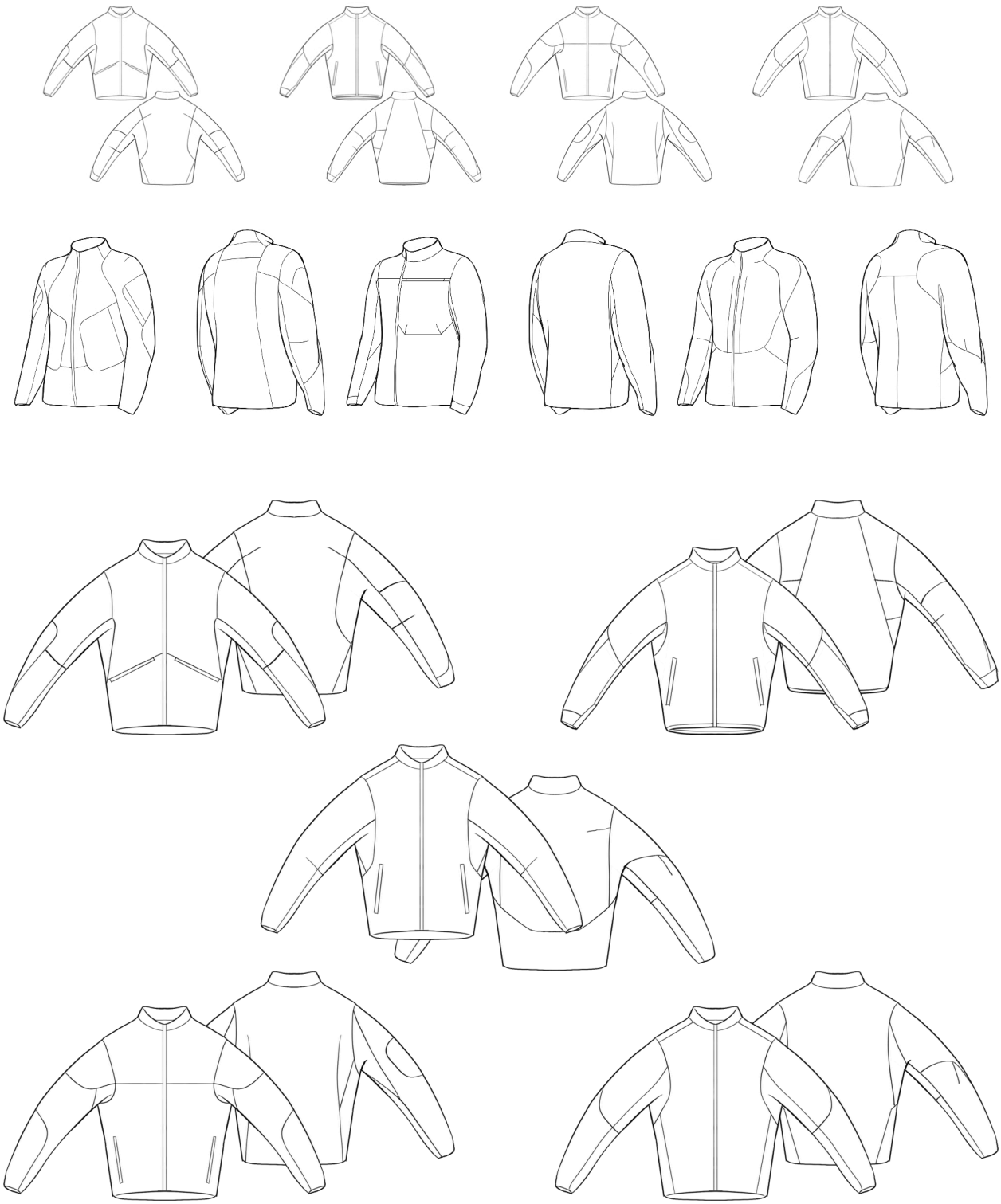
- **Design Ideations**

IDEATION:
Hard-shell JKT

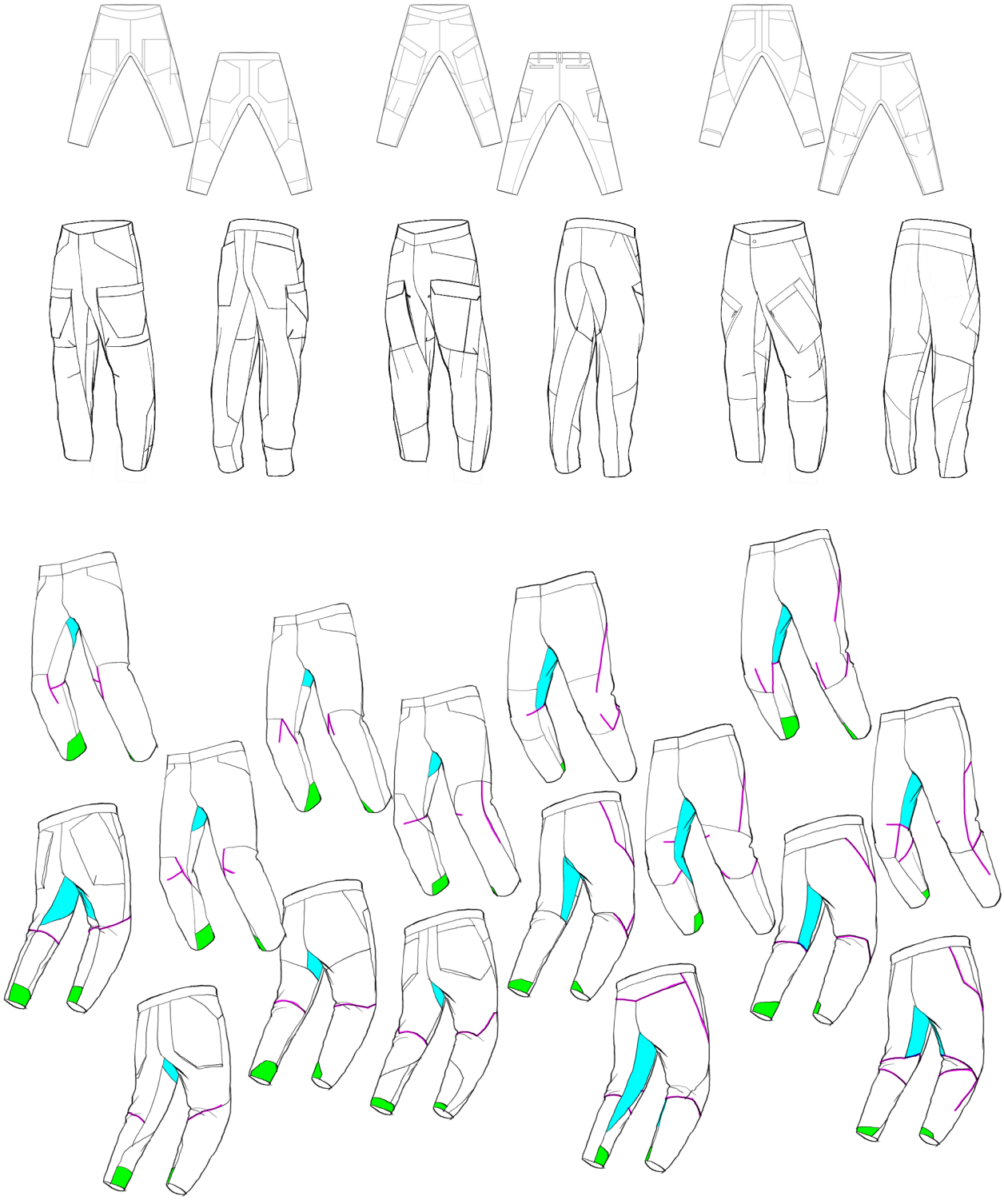




IDEATION:
Insulated JKT

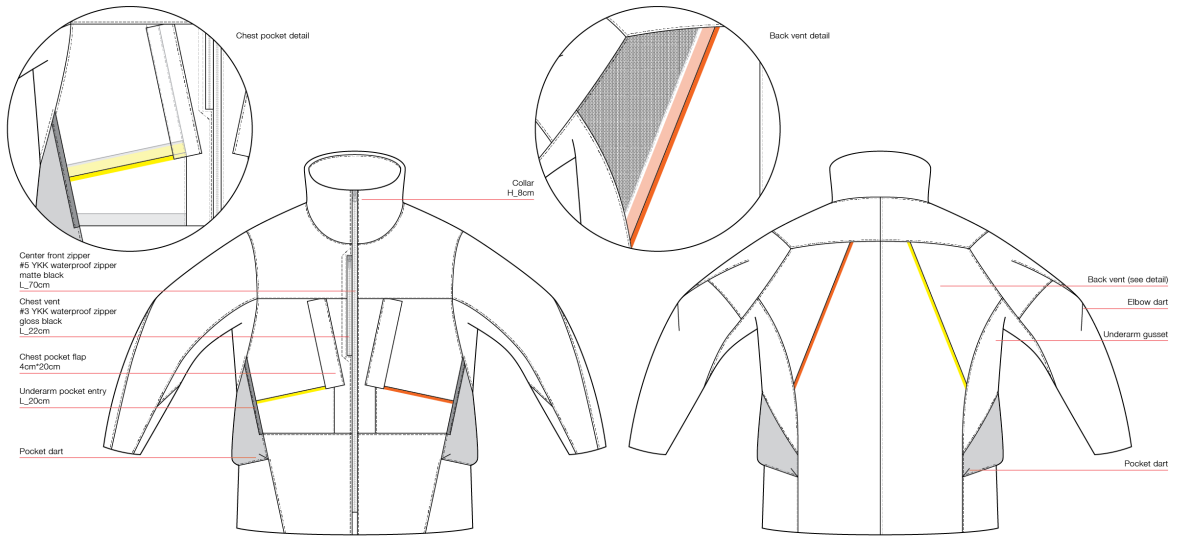


IDEATION:
Cargo pant



- **Final Product**

Hard Shell Jacket

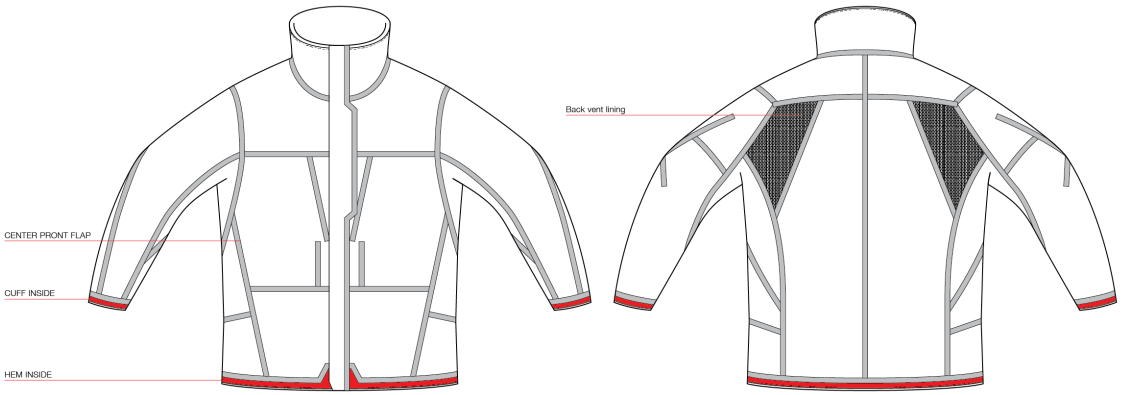


VANGUARD SYSTEM TECH SPEC

Ver: 2021.06.10

FABRIC APPLICATION:

GORE-TEX PRO 3L	3M NEON YELLOW_W 1.5"
HEAVY POLY MESH	3M NEON ORANGE_W 1.5"
NYLON WEBBING_W 1"	POWER MESH_BLACK



INSIDE VIEW

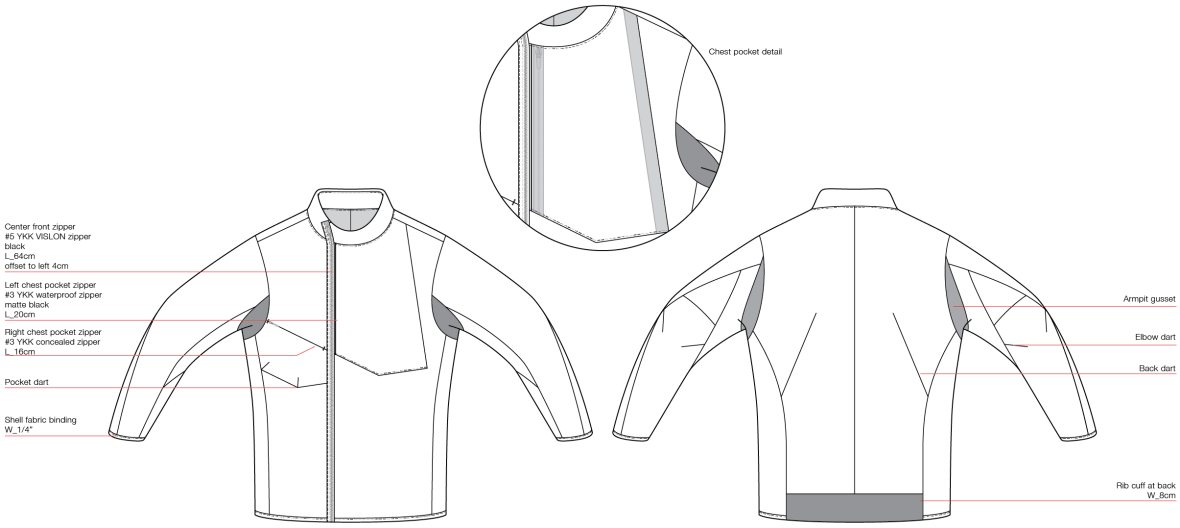
VANGUARD SYSTEM TECH SPEC

Ver: 2021.06.10

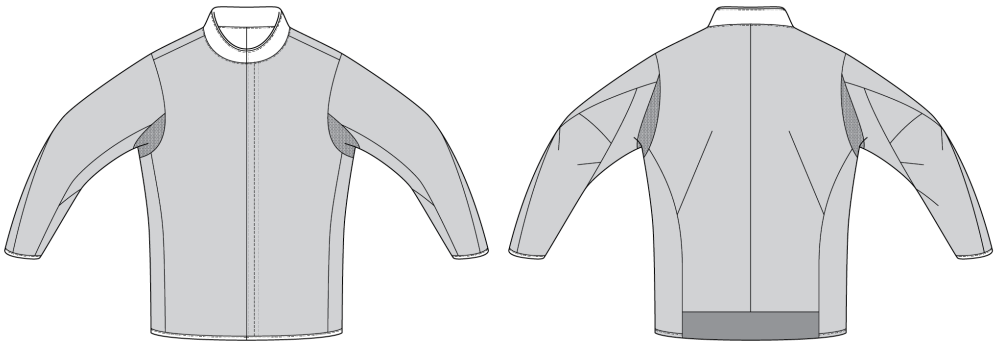
FABRIC APPLICATION:

GORE-TEX PRO 3L	
BONDING TAPE_W 1"	
NYLON RIPSTOP	POWER MESH_BLACK

Insulated Jacket



VANGUARD SYSTEM TECH SPEC	FABRIC APPLICATION:
Ver: 2021.06.10	GORE-TEX INFINIUM 2L
	NYLON RIPSTOP
	SCHOELLER RIB 2*2



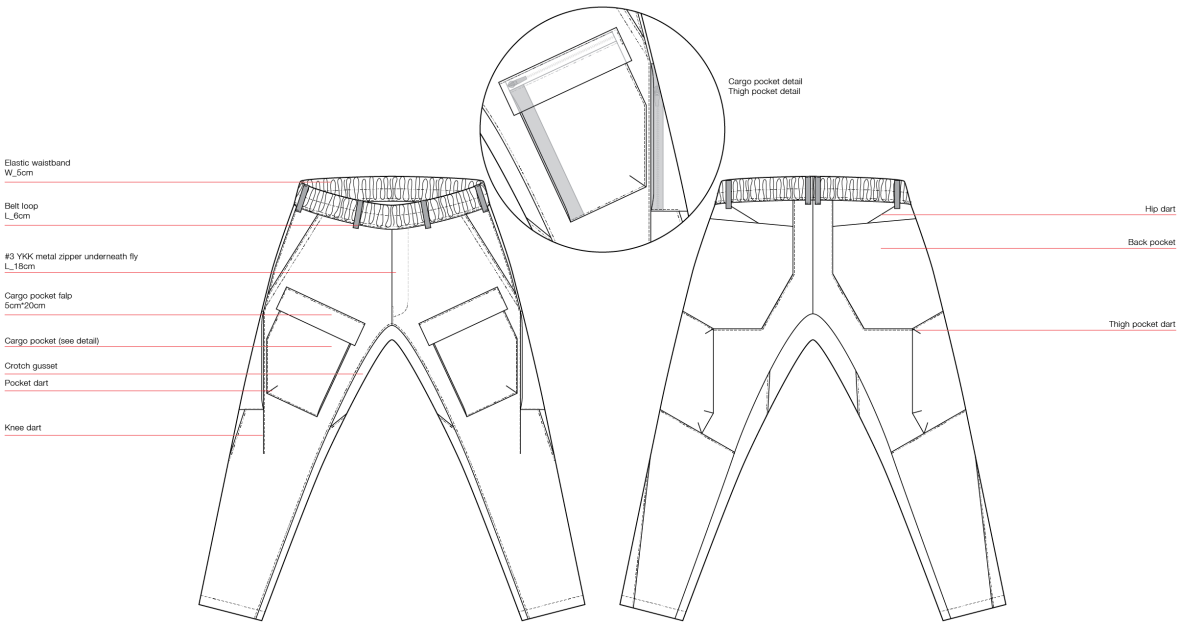
INSIDE VIEW

VANGUARD SYSTEM
TECH SPEC
Ver: 2021.06.10

FABRIC APPLICATION:

- GORE-TEX INFINIUM 2L
- NYLON RIPSTOP
- SCHOELLER RIB 2*2
- POWER MESH_BLACK

Cargo Pant



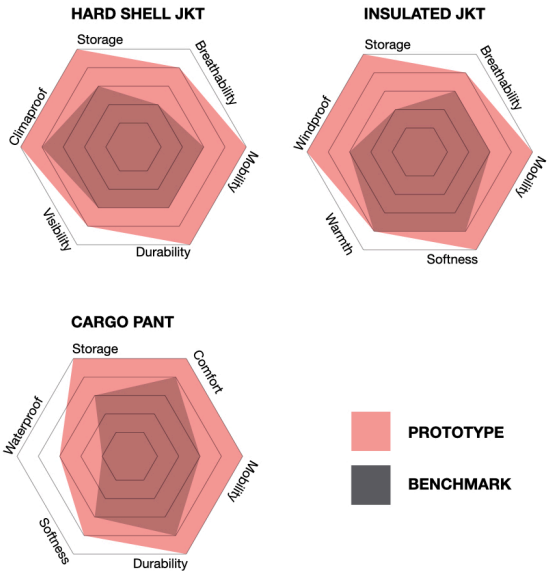
VANGUARD SYSTEM TECH SPEC	FABRIC APPLICATION:
Ver: 2021.06.10	DYNEEMA MOTO DENIM NYLON WEBBING_W 1/4"

- **Testing**

FEEDBACK:
"The hardshell jacket has nice ventilation when riding, but can be a shorter one. Maybe it's because of the stiff fabric.
"Insulated jacket fits me pretty well, fabric is nice and soft.
"Cargo pant generally feels impressive. The denim fabric feels so different from others, kinda soft and stretchy."

- **Performance Rating**

PERFORMANCE RATING:
PROTOTYPES VS BENCHMARKS



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