

foxtrot

Mil-Spec Footwear Innovation
by Max Brazo

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Foxtrot Footwear: Mil-Spec Footwear Innovation for the Everyday Soldier

Military innovation in footwear, specifically COTS (Commercial Off-the-Shelf), has seen significant progress in both development and manufacture over a short period of time: "Many soldiers reported choosing combat boots from the commercial market because the COTS (Commercial Off-The-Shelf) boots are lighter, more flexible, require less break-in time, and feel more like athletic shoes than traditional combat boots or work boots," said Anita Perkins, RDECOM Soldier Center footwear research engineer and technical lead for the Army Combat Boot Improvement effort. "Unfortunately, these characteristics often come at the cost of durability and protection."[1] Military personnel have adopted COTS (Commercial Off-The-Shelf) footwear options over standard issue in increasing numbers in recent years. Coinciding with numerous sports industry brands releasing performance combat boot designs for various environments and tactical situations, the modern combat boot can be purchased from many online dealers, however, must be an authorized brand and model specific to military outfit.

Army developers have also made advances in boot technology beyond the general issue boot, with substantial work in hot weather, or jungle, boots. Until a posting nearly four years ago, there had been little to no change in Army jungle boot design and materials since the end of the Vietnam War. Major advances in design thinking as well as solider/athlete optimization,

[1] South, T. (2019, January 14). Hundreds of soldiers to test new Army combat boot, first major change in nearly a decade. Retrieved December 5, 2019, from https://www.armytimes.com/news/your-army/2019/01/14/hundreds-of-soldiers-to-test-new-army-combat-boot-first-major-change-in-nearly-a-decade/.

with emphasis on performance and function, have shifted focused to possible innovative solutions.

The opportunities regulation boot solutions continue to arise, specifically, within the areas of training, to extreme cold weather and hot/temperate/jungle conditions. It is clear that “Standard-Issue Footwear” options lack innovation in certain sectors and that to rely on COTS for innovative technologies for our modern soldiers is not practical. The standard issue shoe options that will be designed for are as follows: Athletic trainer (low-top silhouette) for issue during Boot Camp and PT, an extreme cold weather boot for northern arctic conditions (previous issued boots commonly referred to as “bunny boots/mickey mouse boots”), as well as a temperate/warm climate adaptable issued boot for both arid and jungle conditions. With in-depth analysis of these various conditions and applicable adaptable materials as well as possible future scenarios/innovations, this thesis aims to introduce innovative solutions in US Army issued combat boots for both our servicemen and women.

The phrase "an army marches on its stomach"[2] has been attributed to both the Emperor Napoleon and Prussia's Frederick the Great – but regardless of who said it, many soldiers in the field would argue the importance of effective military boots. Infantry regiments of the US military were equipped with calf-high boots in the War of 1812. From the 1820’s, until before the American Civil War, soldiers were issued ankle-high boots, which were made on straight lasts. There was no "left" or "right" boot; instead, they shaped themselves to the wearer's feet over time. As a result, these boots were very uncomfortable until broken in and often resulted

[2] Suciu, P. (2017, September 19). Evolution of combat boots: From bootees to modern tactical boots. Retrieved December 5, 2019, from https://www.foxnews.com/tech/evolution-of-combat-boots-from-bootees-to-modern-tactical-boots.

in blisters. They were replaced in 1858 with an improved version generally known as Jeff Davis boots after Jefferson Davis, the Secretary of War who re-equipped the army in the 1850s. These were used until the 1880s.

The 1917 Trench Boot was an adaptation of the boots American manufacturers were selling to the French and Belgian armies at the beginning of World War I. In American service, it replaced the Russet Marching Shoe. The boot was made of tanned cowhide with a half middle sole covered by a full sole. Iron plates were fixed to the heel. It was a great improvement, however it lacked waterproofing. It soon evolved into the 1918 Trench Boot, also called the Pershing Boot after General John Pershing, who oversaw its creation. The boot used heavier leather in its construction, and had several minor changes from the 1917 Boot.[3]



WWII Combat Boot
(National Museum of American History, 2019)



Hot Temperate Combat Boot
(National Museum of American History, 2019)

The first true modern combat boots (pictured left, M-1943 Combat Service Boots)[4] in the US Army, officially titled "Boots, Combat Service", were introduced in conjunction with the M-1943 Uniform Ensemble during World War II. They were modified service shoes, with an

[3] National Museum of American History . (n.d.). Combat Boots. Retrieved December 5, 2019, from https://americanhistory.si.edu/collections/search/object/nmah_1358110.
[4] National Museum of American History . (n.d.). Combat Boots. Retrieved December 5, 2019, from https://americanhistory.si.edu/collections/search/object/nmah_1358110.

extended, rough-out or, more commonly, a smooth leather high-top cuff added. The cuff was closed using two buckles, allowing the boots to replace the existing service shoes and leggings worn by most soldiers with a more convenient and practical solution. The boots, and the service shoes from which they were made, had a one-piece sole and heel, made from molded synthetic or reclaimed rubber. These "double buckle" boots were worn through the Korean War as a substitute for the Boots, Russet, Leather Lace Up introduced in 1948. The first type of Combat Boots, or Combat Tropical boots were based on the "buckle boot" design and worn during the early parts of the Vietnam War.

"The boots that soldiers have worn have improved dramatically over the past several hundred years."[5] The current Army Combat Boot (Temperate Weather) is used in conjunction with the Army Combat Uniform and is far more practical and a whole lot less "spit and polish" than the boots worn by Napoleon's or even Patton's troops. The ACB (TW) is a tan-colored, temperate weather boot that features moisture-resistant, rough-side-out cattle hide leather with a nylon duck cloth upper. This makes the boots both somewhat waterproof but still breathable, and unlike the old leather boots the polyether polyurethane midsole provides cushion. There is also a slip-resistant rubber outsole that soldiers of the past would have envied.

US Army Combat Boot (ACB) Codification[6]: "For the general-purpose boot, advances in synthetic materials and rapid prototyping may build a boot with the same protection, support

[5] Suciu, P. (2017, September 19). Evolution of combat boots: From bootees to modern tactical boots. Retrieved December 5, 2019, from https://www.foxnews.com/tech/evolution-of-combat-boots-from-bootees-to-modern-tactical-boots.
[6] *Wearing Army Combat Boots in Cold Weather*. (n.d.). Retrieved from https://cascom.army.mil/s_staff/safety/Army Combat Boot Facts.pdf

and durability of current Army boots, but lighter and more comfortable. The Army's current inventory of boots includes seven different styles designed for different environments and climates. The boots issued initially to recruits are the Hot Weather (HW) and Temperate Weather (TW) Army Combat Boots (ACB)."[7]



JCB (Jungle Combat Boot)
(Lopez, 2017)



Jungle Combat Scenario
(Lopez,2017)

Jungle Combat Boot (JCB): Traditional issue footwear works well in sand, asphalt and high heat, but falls short in humid, wet conditions, which can lead to trench foot, according to the US Army. And, soldiers on the ground in jungle-like conditions are subjected to obstacles such as vines, which can snag their boots, and sharp objects, that can sideline foot patrols. The Army Jungle Combat Boot, now under development, features a low-height heel to prevent snags on things like vines in a jungle environment; additional drainage holes to let water out if it becomes completely soaked, speed laces so that soldiers can "don and doff" the boots more quickly, a redesigned upper to make the boots less tight when they are new, an insert that helps improve water drainage, a lining that helps the boot breathe better and dry faster; a ballistic fabric-like layer under a soldier's foot to help prevent punctures, and a foam layer

[7] What the New AR 670-1 Regulations Mean For Your Army Authorized Boots. (2017, September 2). Retrieved December 5, 2019, from https://comfortingfootwear.com/what-the-new-ar-670-1-regulations-mean-for-your-army-authorized-boots/.

between the rubber sole and the upper to provide greater shock absorbing capability. The boot will initially be issued to two full brigade combat teams in Hawaii, part of the 25th Infantry Division, for evaluation.[8]

Hot Weather (HW): The ACB (Army Combat Boot) (HW) is constructed from tan-colored water resistant/breathable, flesh side out cattle hide leather and nylon uppers. It contains a combination speed lace and eyelet lacing system, drainage eyelets for water removal, a padded comfort collar and a non-marking, oil & flame resistant, shock attenuating soling system for durability and injury reduction. The ACB (HW) is an unacceptable choice for personnel exposed to the cold for any period of time.



Hot Temperate Combat Boot (South, 2017)



Hot/Dry Conditions (South, 2017)

Temperate Weather (TW): The ACB (Army Combat Boot) (TW) is constructed from tan-colored water resistant/breathable tan flesh side out cattle hide leather and Cordura nylon uppers. It contains a waterproof-breathable membrane package with durable wicking fabric inner lining, a combination speed lace and eyelet lacing system, a leather comfort collar with leather pull tab for ease of donning, and a non-marking, oil & flame resistant, shock attenuating

[8] Lopez, T. (n.d.). Jungle Boot. Retrieved December 5, 2019, from https://www.dla.mil/News/Images/igphoto/2001707085/mediaid/1765877/.

soling system for durability and injury reduction.[9] The ACB (TW) contains integrated flame and conductive heat resistance features and is currently authorized for US Army flight and Combat





Vehicle Crewman use. The ACB (TW) is acceptable until the temperature drops below 32° F.

Intermediate Cold-Wet Boot (ICWB) - Extreme Cold Weather Boot (ECWB): The tan Intermediate Cold-Wet Boot with Removable Liner (ICWB) is made of waterproof, breathable leather and has removable liners. The tan ICWB is similar to the black ICWB and has the same temperature specifications (14°F to 68°F). It is designed for use in cold, wet weather environments. The Extreme Cold Weather boot (ECWB) is constructed with insulation consisting of three layers of needle punched polyester foam hermetically sealed within an outer and inner layer of rubber. The boot is provided with a pressure release valve to adjust internal air pressure in the boot during high altitude operations. When the temperature is 14°F to -60°F, ECWB boots should be worn.[10]

[9] What the New AR 670-1 Regulations Mean For Your Army Authorized Boots. (2017, September 2). Retrieved December 5, 2019, from https://comfortingfootwear.com/what-the-new-ar-670-1-regulations-mean-for-your-army-authorized-boots/.

[10] What the New AR 670-1 Regulations Mean For Your Army Authorized Boots. (2017, September 2). Retrieved December 5, 2019, from https://comfortingfootwear.com/what-the-new-ar-670-1-regulations-mean-for-your-army-authorized-boots/.

AR 670-1 Optional Footwear Requirements (Army Regulations):

(Boots Must Be 8 to 10 Inches High): To ensure that soldiers get the best protection when deep in action, the AR 670-1 requires all authorized footwear to be between 8 to 10" in height. This ensures adequate coverage in any terrain as well as retained flexibility.

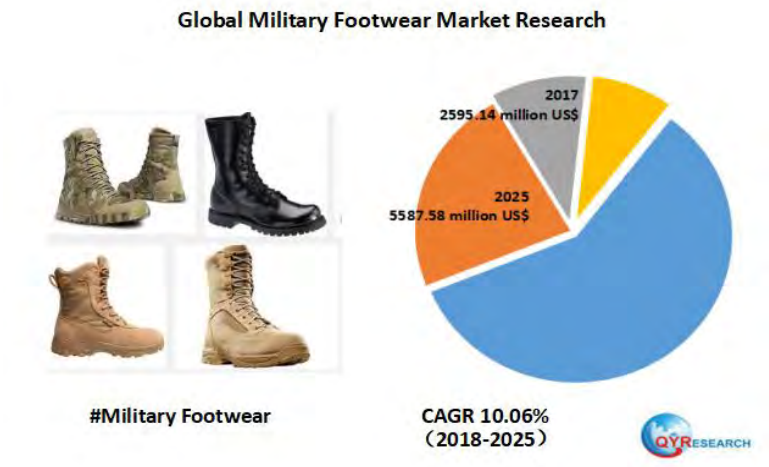
(Boots Must Be Made of Tan Cattle Hide Leather): While there are a lot of other leather types such as pigskin, none of them really meet the criteria of tough cattle hide. These cattle hide types of leather are not only far more durable than other types of leathers, but it also provides superior performance. For the exterior, the AR 670-1 requires authorized boots to be made of all leather material or a combo of leather and some non-mesh fabrics.

(Plain Toe and Matching Sole): US Army authorized boots are required to have a plain toe as well as a soling system that matches the color of the tan materials. From the bottom, the outsole should not extend all the way up the heel or over the toe. Similarly, soling materials that exceed about 2" in height will not be permitted.

(Authorized Outsole Materials): According to the AR 670-1, polyether polyurethane and rubber are currently the only outsole materials allowed on US Army boots. That's because in addition to these materials being the only few that meet a need for extra durability levels, they have the strongest traction and resistance in all environments, conditions and temperature ranges.

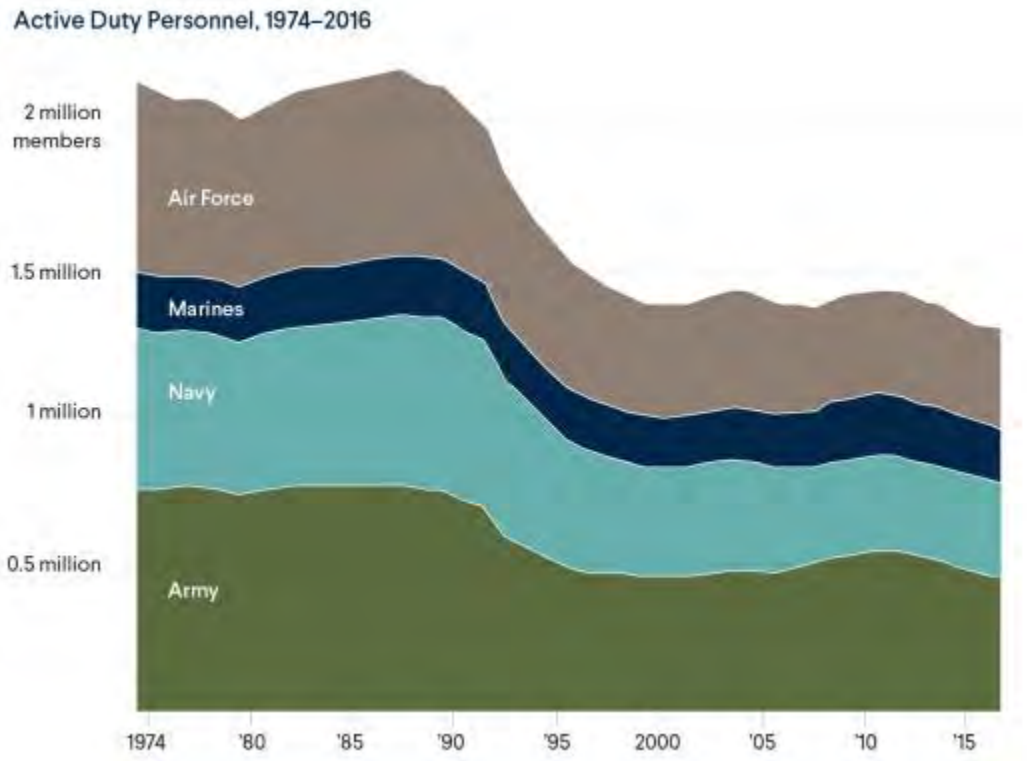
The Global Military footwear market was 2595.14 million USD in 2017 and is projected to reach USD 5587.58 million USD by 2025, at a CAGR (Compounded Annual Growth Rate) of

10.06% between 2017 and 2025. The market is driven by military and civilian use. The key players are Belleville Boot, Wolverine Worldwide, Iturri, Haix, McRae Industries, Rocky Brands, New Balance, Weinbrenner Shoe, LOWA, Meindl Boots, BTK Group, Butex, Altama and so on. Global military footwear is showing a steady growth at present owing to the rapid expansion of the footwear industry coupled with increasing focus on military footwear. Due to the intensification of military activities and the increasing number of enthusiasts of military footwear, the market for military footwear presents a good and steady growth. The influx of new and innovative designs coupled with increasing consumer awareness about trendy and characteristic military footwear are among the major factors fueling the growth of the market. Moreover, consumer's changing lifestyles, preference, increasing demand, comfort, and stylish products further boosting the market of military footwear. Breaking into this market has proven difficult due to the numerous variables and obstacles. These obstacles include, but are not limited to: (i) product development costs; (ii) capital requirements; (iii) intellectual property rights; (iv) regulatory requirement; and (v) unfair methods of competition.[11]



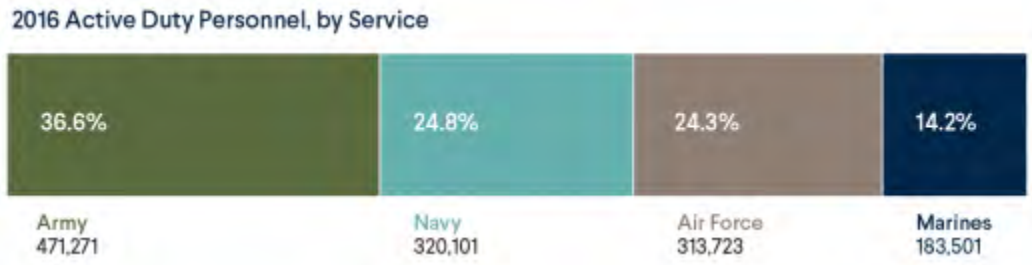
[11] Trepup. (2018, October 29). Global Military Footwear market research by QYResearch. Retrieved December 5, 2019, from https://www.trepup.com/qyresearch/news/global-military-footwear-market-research/1393333.

The United States ended the draft for military service in 1973, transitioning to the all-volunteer force that exists today. At the time, the active component of the military comprised 2.2 million men and women. Now, this group comprises just under 1.29 million, or less than 0.5 percent of the U.S. population[12]:



Active Duty Personnel
(CNA, 2016)

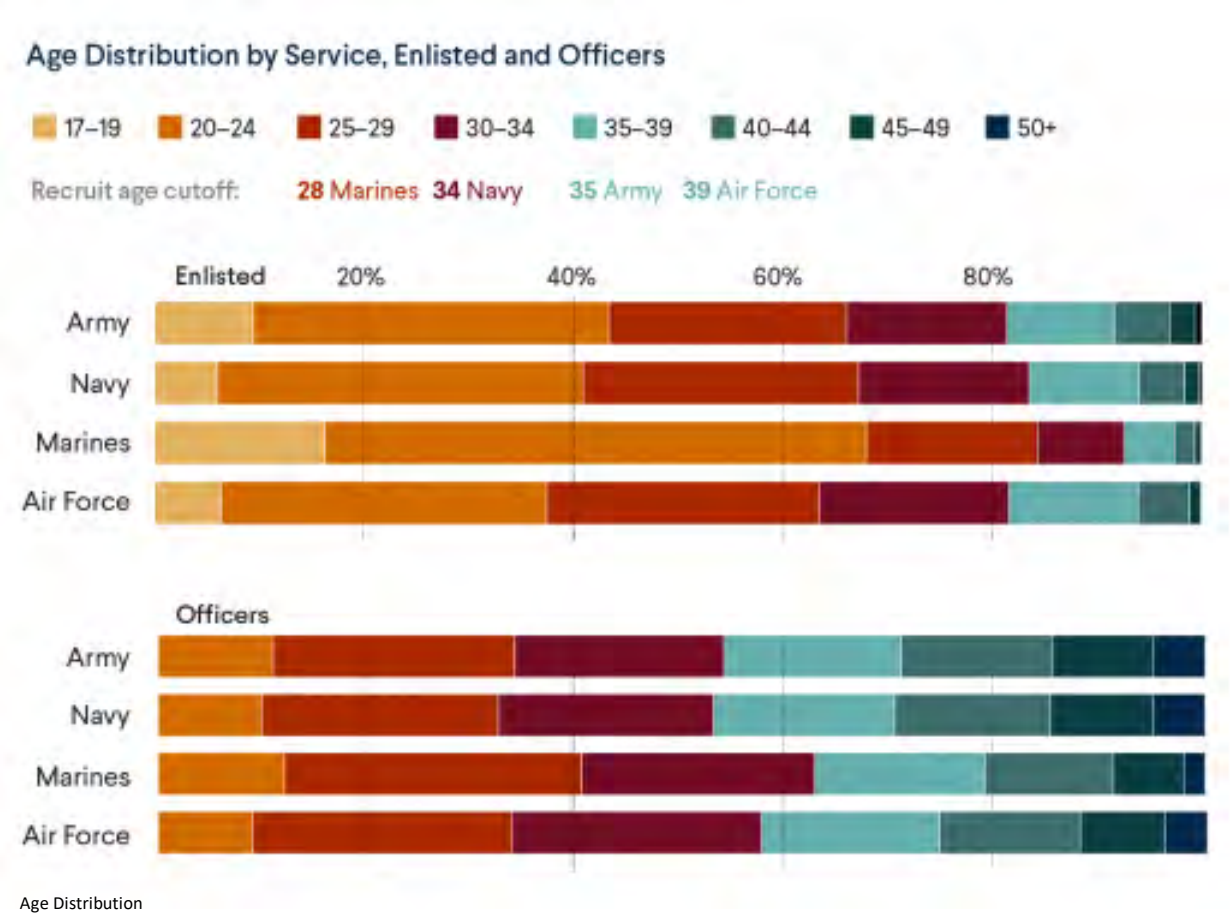
There are four branches of the U.S. military: The Army, Marine Corps, Navy, and Air Force. With nearly half a million members, the army is the largest service.



Active Duty Personnel by Service
(CNA, 2016)

[12] CNA. (2016). Demographics of the U.S. Military. Retrieved December 15, 2019, from https://www.cfr.org/article/demographics-us-military.

The armed forces, which have strict age limits, are younger than the civilian population, but the numbers differ significantly by service. The air force tends to have older recruits, while the marines skew younger. Eighty-four percent of marines recruits are age twenty or younger.

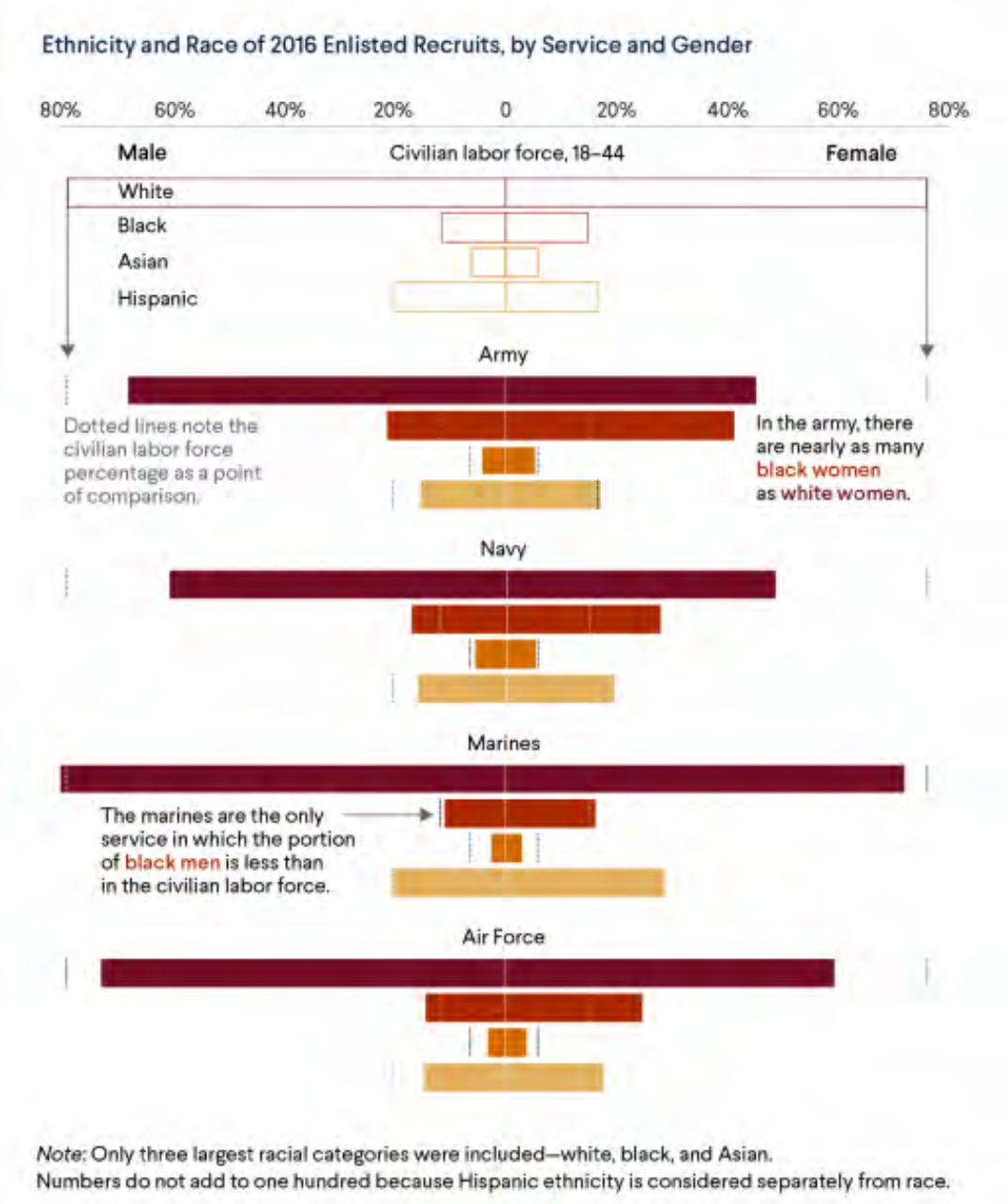


Age Distribution
(CNA, 2016)

Federal agencies categorize race into five groups—white, black or African American, American Indian or Alaska Native, Asian, and Native Hawaiian or other Pacific Islander. [13]Ethnicity, which the government considers distinct from race, is divided into two categories: Hispanic or Latino, and not Hispanic or Latino. Among enlisted recruits, 43 percent of men and

[13] CNA. (2016). Demographics of the U.S. Military. Retrieved December 15, 2019, from https://www.cfr.org/article/demographics-us-military.

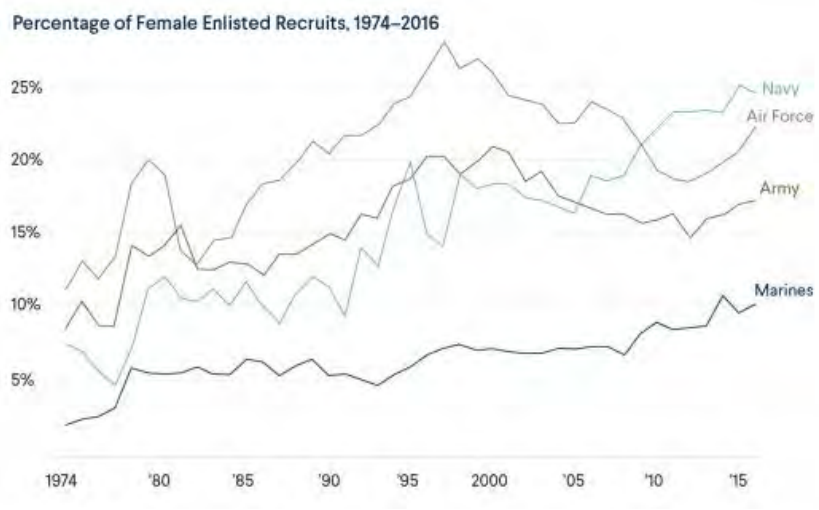
56 percent of women are Hispanic or a racial minority. Female recruits are consistently more diverse than the civilian population; they are also more diverse than male recruits.[14]



Ethnicity & Race Service Members
(CNA, 2016)

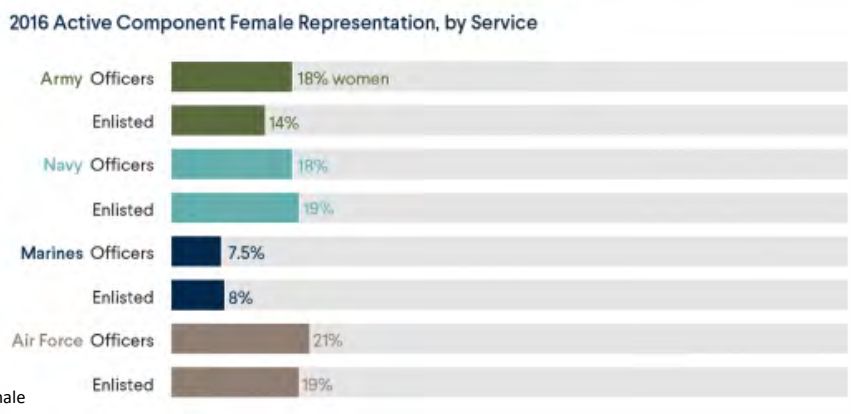
[14] CNA. (2016). Demographics of the U.S. Military. Retrieved December 15, 2019, from https://www.cfr.org/article/demographics-us-military.

When the draft ended in 1973, women represented just 2 percent of the enlisted forces and 8 percent of the officer corps. Today, those numbers are 16 percent and 18 percent respectively, a significant increase.



Percentage of Female Enlisted
(CNA, 2016)

Historically, the air force has had the highest percentage of enlisted and officer women; however, by 2016, the navy had nearly caught up. In both services, approximately one in five enlisted members and officers are women. In 2016, the Defense Department lifted all restrictions on the role's women can perform in the military.



Active Component Female
Representation
(CNA, 2016)

Since 1980, the U.S. Army has assessed physical aptitude through the Army Physical Fitness Test, or APFT. Commonly known as the "PT Test," Soldiers are required to complete three events: two-minutes of push-ups, two-minutes of sit-ups, and a two-mile run: "Today's PT test does not adequately measure components of strength, endurance, or mobility. The events have a low correlation to the performance of warrior tasks and battle drills and are not strong predictors of successful physical performance on the battlefield or in full spectrum operation."[15] Newly revised PT Testing developed by numerous experts in collaboration with the US Army, institutes a new standard named “Army Combat Fitness Test.” Both revisions being the future standard of military personnel in the US Army, athletic performance is determined upon entrance, the necessity of completion in the time allotted being the bare minimum athletic experience required by the US Army. Therefore, a good baseline for activity and performance in military specific footwear across the gamut of options.

A look at the Army's new and old PT test

The chart below is a basic comparison of the Army's current Army Physical Fitness Test, which has been used for nearly four decades, and the proposed Army Combat Fitness Test, which service officials said will be implemented by October 2020.

	Current test	New test
Name:	Army Physical Fitness Test	Army Combat Fitness Test
Number of events:	3	6
Events:	Pushups, situps, 2-mile run	Strength deadlift; standing power throw; hand-release pushup; sprint, drag, carry; leg tuck; 2-mile run
Standards:	Based on gender and age	Will be age and gender neutral, likely to be based on job and/or unit
Rest time between events:	10-20 minutes	2 minutes between first five events and 5 minutes before 2-mile run
Maximum time to complete test:	2 hours	50 minutes
Maximum score:	300 (each event is worth 100 points)	To be determined
Minimum score to pass:	180 (60 on each test)	To be determined

SOURCE: Compiled from information provided by the Army

NOGA AMI-RAV/Stars and Stripes

Event	Components Assessed		
	Strength	Endurance	Mobility
400-Meter Run w/WPN	Upper-Body Muscular Endurance & Anaerobic Power		Coordination Speed Stability
Individual Movement Techniques	Upper-and Lower-Body Muscular Endurance		Agility Balance Coordination Speed Stability
Ammo Can Shuttle Sprint	Total-Body Muscular Strength & Endurance		Agility Coordination Speed Stability Power
Casualty Drag	Total-Body Muscular Strength & Endurance		Agility Coordination Speed Stability Power
Agility Sprint	Lower-Body Anaerobic Power		Speed Power

Basic PT Structure
(US Army News, 2019)

[15] US Army. (n.d.). TRADOC revises Army Physical Fitness Test. Retrieved December 5, 2019, from https://www.army.mil/article/52548/tradoc_revises_army_physical_fitness_test.

The following is a further description of the events and experience necessary in order to meet the physical requirements of the US Army[16]:

- *Strength deadlift:* Soldiers will perform three repetitions of deadlift at the heaviest weight they are capable of between 120 and 420 pounds. The deadlift replicates picking up heavy equipment or a wounded comrade in combat.
- *Standing power throw:* Soldiers will throw a 10-pound medicine ball backward as far as they can. The exercise tests muscular explosive power, replicating aiding a fellow soldier over an obstacle or moving rapidly across uneven terrain.
- *Hand-release push-up:* Soldiers will perform as many hand-release push-ups as possible in two minutes. In a hand-release push-up, soldiers lift their hands and arms from the ground at the bottom of the push-up.
- *Sprint, drag, carry:* Soldiers will twice sprint up and down a 25-meter lane, drag a 90-pound sled up and down the lane, and carry two 40-pound kettlebell weights up and down the lane. The exercises are meant to simulate pulling a soldier to safety, moving quickly to cover or carrying gear.
- *Leg tuck:* Hanging from a pull-up bar, soldiers will lift their legs up and down touching their knees or thighs to their elbows as many times as possible during two minutes. The exercise strengthens core muscles, requiring more strength than traditional sit-ups.

[16] Dickstein, C. (2018, July 10). Army unveils new, six-event physical fitness test to help ready troops for combat. Retrieved December 5, 2019, from https://www.stripes.com/news/army-unveils-new-six-event-physical-fitness-test-to-help-ready-troops-for-combat-1.536807.

- *Two-mile run:* Soldiers will complete the test with a two-mile run, as they must in the APFT. However, Frost said, soldiers will have only five minutes of rest between the leg tuck and the run, which will likely slow their times by 45 seconds to two minutes compared to the current test.

Physiological and biomechanical needs of soldiers as well as all military personnel encompass the basics of standing posture, as well as movement/running with varying load capacities, all made increasingly complex while wearing vast amounts of equipment, gear, and specialized equipment when deployed and in training scenarios. Musculoskeletal injury is a persistent and major health concern for individuals who are responsible for the medical care of military personnel. According to the Armed Forces Epidemiological Board (AFEB), injuries "impose a greater ongoing negative impact on the health and the readiness of U.S. armed forces than any other category of medical complaint during peacetime and combat."[17] More casualties have been caused among U.S. troops by noncombat injuries and disease than by combat. Data presented to the AFEB's Injury Control Work Group by scientists from Navy and Army research organizations, and published military and civilian epidemiologic studies has revealed that the most common types of injuries seen in military populations are unintentional musculoskeletal overuse injuries. A review of the medical treatment records in a group of 298 male infantry soldiers showed that musculoskeletal injuries were very common; musculoskeletal pain was the most common diagnosis followed by strains. Also, a higher

[17] Sell, T. C., Chu, Y., Abt, J. P., Nagai, T., Deluzio, J., Mcgrail, M. A., … Lephart, S. M. (2010). Minimal Additional Weight of Combat Equipment Alters Air Assault Soldiers' Landing Biomechanics. *Military Medicine*, *175*(1), 41–47. doi: 10.7205/milmed-d-09-00066

cumulative incidence of soldiers with musculoskeletal injuries was associated with reduced physical fitness (2-mile run and sit-ups). A study of data in an Army data-base of all hospital admissions (caused by an external injury) for active duty personnel showed that during a 6-year period, 11% (13,861) of the patients had injuries sustained during sports or physical training. Of these, musculoskeletal injuries were very common (fractures, 33%; sprains/strains, 29%; and dislocations, 15%). Sports and Army physical training injuries accounted for a significant amount of lost duty time. An analysis of the Navy Physical Evaluation Board data showed that the most common diagnostic categories of cases were musculoskeletal disorders (43%) and injuries and poisonings (15%).[18] Recently, a survey by Sanders et al. Among military personnel involved in Operations Iraqi Freedom and Enduring Freedom revealed that 34.7% of soldiers reported noncombat injuries. Musculoskeletal conditions and injuries are the leading causes of hospitalization in the U.S. Army, accounting for 31% of all hospitalizations in 1992. Orthopedic and musculoskeletal issues accounted for 53% of all U.S. Army injury cases that were reviewed by the disability evaluation process of the physical evaluation board in 1994. Similarly, 58% of such cases in 2005 in the U.S. Navy were caused by musculoskeletal conditions and injuries. The high rate of overuse injuries adversely affects military training, resulting in lost days and increased medical costs. The annual cost of injury-related disability in the military had exceeded $750 million in the mid-1990s, 1,9 and the annual expenditure of the U.S. Department of Defense to treat musculoskeletal injuries had been $600–750 million before 2001. Such injuries will have long-term consequences even after individuals have left active duty: “Among the

[18] Sell, T. C., Chu, Y., Abt, J. P., Nagai, T., Deluzio, J., Mcgrail, M. A., … Lephart, S. M. (2010). Minimal Additional Weight of Combat Equipment Alters Air Assault Soldiers’ Landing Biomechanics. *Military Medicine*, *175*(1), 41–47. doi: 10.7205/milmed-d-09-00066

veterans returning from Iraq and Afghanistan who have sought Veterans Administration health care between 2002 and 2006, 42% were related to musculoskeletal issues such as joint and back disorders. The knee is one of the most common sites of musculoskeletal injury in the military, accounting for 10–34% of all injuries among different military groups from Army infantry to naval special warfare trainees."[19] The mechanism responsible for knee injuries in the military has not been clearly outlined, but they are hypothesized to be similar to the mechanism responsible for knee injuries in athletes. Most traumatic noncontact knee injuries occur during demanding athletic tasks that include sudden deceleration, landing, and pivoting maneuvers, which are all prevalent in military training, tactical operations, and sports activities. Among these tasks, landing from a raised platform may be one of the most critical and the most common. Landing is involved widely in infantry soldiers' training and operations, such as jumping off the back of a vehicle, traversing a ditch, and landing after a climb over a wall or other obstacle.

Various areas of injury result from inadequate footwear. Ankle and foot injuries (AFI) are a major cause of Active-Duty Army (ADA) soldiers' time lost from training and combat operations. The interactions between active military and their footwear has a direct impact on physical well-being, everyday life, and furthermore, the health and vitality of our soldiers in arms. Biomechanics research into military footwear is limited to conventional combat boots, with ample room to inform the military community on the impact of correct footwear for the

Injury Classification Codes (Sell, 2010)

TABLE I. ICD-9 Codes Used to Classify AFI

Barell Anatomy Classification	Fracture	Stress Fracture	Dislocation	Sprains/Strains	Contusion/Superficial	Crush
Ankle	824	NA	837	845.0	924.10, 924.21	928.10, 928.21
Foot and Toes	825-826	733.94	838	845.1	917, 924.3, 924.20	928.3, 928.20

[19] Sell, T. C., Chu, Y., Abt, J. P., Nagai, T., Deluzio, J., Mcgrail, M. A., … Lephart, S. M. (2010). Minimal Additional Weight of Combat Equipment Alters Air Assault Soldiers' Landing Biomechanics. *Military Medicine*, *175*(1), 41–47. doi: 10.7205/milmed-d-09-00066

correct situation, both in training and in combat. Biomechanical corrective implementations allow for re-positioning of the foot into a more natural stride and foot-strike, many innovations in orthotics have stemmed from this topic thus far.

"Soldiers live in their boots and many will tell you that there is no piece of equipment more important to their lethality and readiness…a bad pair of boots will ruin a Soldier's day and possibly result in injuries."[20]

The standard issue combat boot most Soldiers wear today — the one most commonly worn in Iraq and Afghanistan — is great for sandy dunes, hot dry weather, and asphalt. But it's proven not so good in hot and wet environments. So, the Army has developed a new jungle boot that some Soldiers will see this year. Right now, the new jungle boot the Army developed will be for Soldiers with the 25th ID in Hawaii — primarily because there are actually jungles in Hawaii that Soldiers there must contend with. The new boots look remarkably similar to the current boots Soldiers wear. They are the same color, for instance. And the boots, which Bryan said are called the "Army Jungle Combat Boot" (JCB), sport a variety of features drawn from both the legacy M1966 Vietnam-era jungle boot and modern technology. The M1966 Jungle Boot, which featured a green cotton fabric upper with a black leather toe that could be polished, had a solid rubber sole that Soldiers reportedly said had no shock-absorbing capability. The new boot uses a similar tread, or "outsole," as the M1966 "Panama style" - to shed mud and provide great traction, but the added midsole makes it more comfortable and

[20] US Army. (n.d.). Soldier Center tests new Army combat boot prototypes. Retrieved December 5, 2019, from https://www.army.mil/article/215893/soldier_center_tests_new_army_combat_boot_prototypes.

shock absorbing, according to Albert Adams, who works at the Army Natick Soldier Research, Development, and Engineering Center. The outsole of the new boot is connected to the leather upper via "direct attach." That's a process where a kind of liquid foam is poured between the rubber outsole and leather boot upper: "'[It's] a lot like an injection molding process,' he said. The foam layer between the rubber sole and the upper portion of the boot not only provides greater shock absorbing capability, but it also keeps out microbes in hot, wet environments that in the past have been shown to eat away at the glues that held older boots together."[21] So, the new boots won't separate at the soles, it provides a high level of durability, and it also adds cushioning.

Also, part of the new boot is a textile layer that prevents foreign items from puncturing the sole of the boot and hurting a Soldier's foot, Adams said. The M1966 boot accomplished that with a steel plate. The new boot has a ballistic fabric-like layer instead. The new JCB also features a heel with a lower height than the M1966 model to prevent snags on things like vines in a jungle environment. That prevents tripping and twisted ankles. The boot also has additional drainage holes to let water out if it becomes completely soaked, speed laces so that Soldiers can don and doff the boots more quickly, a redesigned upper to make the boots less tight when they are new, an insert that helps improve water drainage, and a lining that provides for better ventilation and faster drying than the old boot.

Not only has there been inroads to new footwear innovations in tropical boot design for soldiers, but also for extreme cold weather in arctic conditions as well. The Army put out

[21] Lopez, T. (2107, March 3). New Army Jungle Wear Gives 'Trench Foot' the Boot. Retrieved December 5, 2019, from https://www.dsiac.org/resources/news/new-army-jungle-wear-gives-'trench-foot'-boot.

notices to the industry last year looking for a new extreme cold weather boot to replace a rubberized boot known affectionately as the “Mickey Mouse” boot or the “Bunny Boot”: “That piece of footwear has remained virtually unchanged since the 1960s.”[22] The boot was developed during the Korean War to combat the extreme cold weather soldiers and Marines faced in fierce fighting during that war. These large, bulbous waterproof rubber boots are worn only in extremely cold weather (-20°F to -60°F), with the liner-free interior retaining warmth by sandwiching up to one inch of wool and felt insulation between two vacuum-tight layers of rubber; this vacuum layer insulates the wearer's feet similar to a Thermos flask. These boots were originally developed at the Navy Clothing and Textile Research Center in Natick, Massachusetts, for use during the Korean War. Minor modifications occurred early in its development, including an air valve being added in the 1960s for use in high altitudes, whether on mountainsides or in aircraft. An opportunity for current innovation extreme cold temperature boot.

Sneakers are becoming standard-issue for the first time across the Defense Department services following a provision in the 2017 defense budget requiring the military to provide American-made athletic shoes free of charge.[23] Previously, throughout the years, a variety of arrangements were reached to get troops their go-fasters: services would issue the shoes individuals, or let troops buy them with a provided allowance or their own money. A 2016 legislative fight erupted over bill language that would limit the service's footwear options to New Balance sneakers. The limitation was the result of wording that required all components of

[22] South, T. (2018, July 27). The Army wants to replace the 'Mickey Mouse' cold weather boots. Retrieved December 5, 2019, from https://www.armytimes.com/news/your-army/2018/07/26/the-army-wants-to-replace-the-mickey-mouse-cold-weather-boots/.
[23] US Army. (n.d.). Soldier Center tests new Army combat boot prototypes. Retrieved December 5, 2019, from https://www.army.mil/article/215893/soldier_center_tests_new_army_combat_boot_prototypes.

the shoes to be domestically made, a stipulation that it appeared only the Boston-based New Balance met. On average, the shoes, black with slightly different style features, cost just over $90 per pair. The cushion/neutral variant is designed for troops with high arches; the stability shoe variant accommodates medium arches and moderate pronation; and the motion-control variant is best for those with low arches. It is evident athletic training sneaker are just now being adopted for military training and use, and that opportunities for innovative standard issue rather than other more suitable and innovative brands.[24]

Surveys conducted by the Soldier Center report Soldier satisfaction with ACBs is lower than that with Commercial Off-The-Shelf boots, leading many Soldiers to purchase and wear COTS boots: “"The survey of over 14,000 Soldiers world-wide discovered that almost 50% choose to wear COTS combat boots instead of Army-issued boots…many Soldiers reported choosing combat boots from the commercial market because the COTS boots are lighter, more flexible, require less break-in time, and feel more like athletic shoes than traditional combat boots or work boots.”[25] The Soldier Center's Footwear Performance team believes new technologies can bridge the gap between the lightweight, comfortable, COTS boots and the durable, protective, Army boots. Recent advancements in synthetic materials and rapid prototyping can produce a boot with potentially the same protection, support, and durability of current Army boots, but lighter and more comfortable out of the box. To reach this goal, the

[24] Sharp, D. (2019, January 27). Military recruits getting Made-in-the-USA athletic trainers. Retrieved December 15, 2019, from https://www.militarytimes.com/news/your-military/2019/01/27/military-recruits-getting-made-in-the-usa-athletic-trainers/.
[25] US Army. (n.d.). Soldier Center tests new Army combat boot prototypes. Retrieved December 5, 2019, from https://www.army.mil/article/215893/soldier_center_tests_new_army_combat_boot_prototypes.

Soldier Center is evaluating new types of leather and even some man-made materials which are much more flexible than the heavy-duty, cattle hide leather used in the current boots.

The key manufacturers in the military footwear industry include: Belleville Boot, Wolverine Worldwide, Iturri, Haix, McRae Industries, Rocky Brands, New Balance, Weinbrenner Shoe, LOWA, Meindl Boots, BTK Group, Butex, Altama,Rahman Group, Noga Einat Shoe Industries, Danner, Nike, Under Armour, Oakley, Liberty Shoes , J.H. 3514 Military Boots, J.H. 3515 Military Boots, and J.H. 3513 Military Boots to name a few.[26] State of the art manufacturing methods for current products in the military footwear marketplace include basic/traditional techniques and operations through industrial solutions. Various methods of manufacture include but are not limit to basic patterning through assembly as well as similar implemented SOP's to the athletic footwear industry as a whole in terms of optimization and machine learning aided manufacturing, however, with a much more defined focus on orthotics and foot support. Built-in insoles joined to uppers during the manufacturing process, e.g. structural insoles; Insoles glued to shoes during the manufacturing process multilayered.[27]

Garmont T8 Bifida 8" Tactical Boot

Popular with the active military, the Garmont T8 has everything you need to perform your best in any terrain or conditions.

- Backward-sweeping design provides a snug fit that prevents blisters
- Roller bearing hookless rigging-proof hardware
- Tapered nylon woven footboard provides stability and shock absorption
- Innovative heel retention technology supports your whole body
- Zero optical refraction hardware

[26] Military Footwear Market 2018 Global Analysis, Opportunities and Forecast to 2025. (2018, October 23). Retrieved December 5, 2019, from https://www.marketwatch.com/press-release/military-footwear-market-2018-global-analysis-opportunities-and-forecast-to-2025-2018-10-23.

[27] Cavanagh, P. R., Hurley, T. B., Tierney, J. J., & Gillespie, J. W. (2015). *US20140298682A1*. Retrieved December 15, 2019, from https://patents.google.com/patent/US20140298682A1/en?q=military&q=footwear&oq=military+footwear.

- Available in wide widths

Compliance

- Army AR670-1
- USAF Multicam

Oakley Light Assault 8” Boot

If you want to be confident that you can move quickly and with agility in any situation, the Oakley Light Assault is ready to provide lightweight and superior protection.

- Built with mobility and protection in mind
- Superior stability in unstable terrain
- Durable laces are made from 100% braided nylon
- Metal Speed Loop Lacing System Coated with Anti-IR

Compliance:

- Army AR670-1
- USAF Multicam

Rocky S2V Special Ops 8” Boot

Designed for the most challenging demands, the Rocky S2V are built to provide superior protection in rough terrain and to keep you comfortable through it all.

- Roll-Stop Ankle Stability for superior ankle protection
- PTFE coating for optimal flame-resistance
- Flash and water resistant
- Inner lining with Aegis Microbe Shield for reliable wicking
- Fiberglass 8” shank
- Available in wide widths

Compliance:

- Army AR670-1
- USAF Multicam
- Navy Working Uniform NWU Type III
- Berry (Made in USA)

Belleville One Xero Ultra Light 8” Assault Boot

As one of the lightest combat footwear options available anywhere, the Belleville One Xero are surprisingly light and portable even though they don't sacrifice protection or comfort, especially in hot climates.

- Ultralight at only 40oz per pair
- Medial and lateral air vents make it highly breathable and ideal for hot climates
- Rubber sole and Vibram Incisor lug design for maximum traction
- Shock absorbent padding and a single density molded insole
- Available in wide widths

Compliance:

- Army AR670-1
- USAF Multicam



Reviews of Top Rated Military Footwear
(Best of Amazon, 2019)

Military Boots Comparison Chart (Highest Consumer Rated)

PRODUCT	PRICE	SIZE	Compliance
Garmont T8 Bifida 8" Tactical Boot	$$	Regular / Wide	Army AR670-1 USAF Multicam
Oakley Light Assault 8" Boot	$$	Regular	Army AR670-1 USAF Multicam

PRODUCT	PRICE	SIZE	Compliance
Rocky S2V Special Ops 8” Boot	$$$	Regular / Wide	Army AR670-1 USAF Multicam Navy Working Uniform NWU Type III Berry
Belleville One Xero Ultra-Light 8” Assault Boot	$$	Regular / Wide	Army AR670-1 USAF Multicam Berry
Danner Tachyon 8" Boot	$	Regular / Wide	Army AR670-1 USAF Multicam
Reebok Hyper Velocity 8" Boot	$	Regular / Wide	Army AR670-1 USAF Multicam
Danner Tanicus 8" Hot Duty Boot	$$	Regular / Wide	Army AR670-1 USAF Multicam
Rocky C4T 8” Military and Tactical Training Boot	$	Regular / Wide	USAF Multicam (in Sage Green)
Reebok Dauntless 8" Composite Toe Tactical Boot (Side Zip)	$	Regular / Wide	USAF Multicam (in Sage Green)


Future Graphics/Color
(Pinterest, 2019)



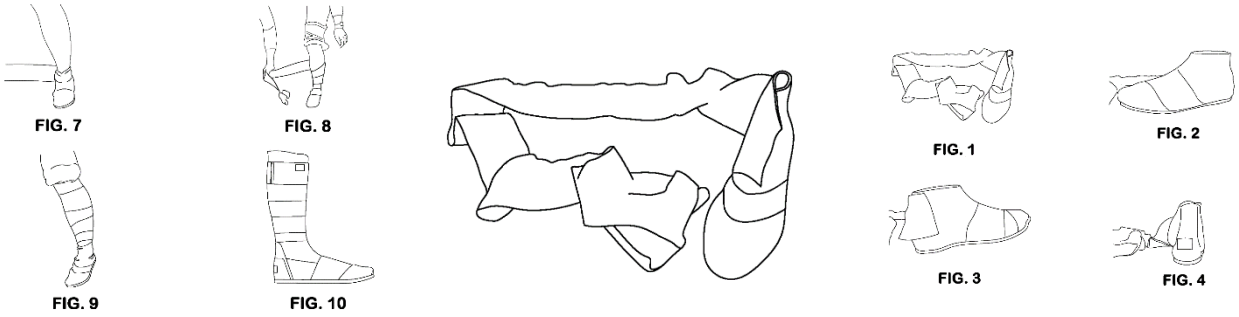
Graphic/Colors
(Pinterest, 2019)


Flexible Camo Military
(Pinterest, 2019)

Utility patent landscape and or protection of the products intellectual property would be determined by the applications of the product direction. Currently, the scope of the project

aims to tackle three various iterations of military issue footwear from extreme cold weather to temperate and hot weather conditions, applications so far have been underdeveloped and thus, the patent landscape is minimal. Current patents are heavily focused on protection from bomb ordinance or internal supportive orthotics for posture and mobility.

However, when looking into extreme temperatures and environments coupled with military footwear, there are patents that could be adapted to fit interesting yet unresolved needs, for instance, the wrap boot: “A wrap boot for a wearer's foot comprising a shoe member and a legging. In use, the legging is wrapped a plurality of times around the lower part of the wearer's leg. The wrap boot may be manufactured from any conventional materials and the legging may be permanently or detachably affixed to the shoe-member. The legging may comprise a fastening means to prevent the wrap boot from unraveling.”[28]

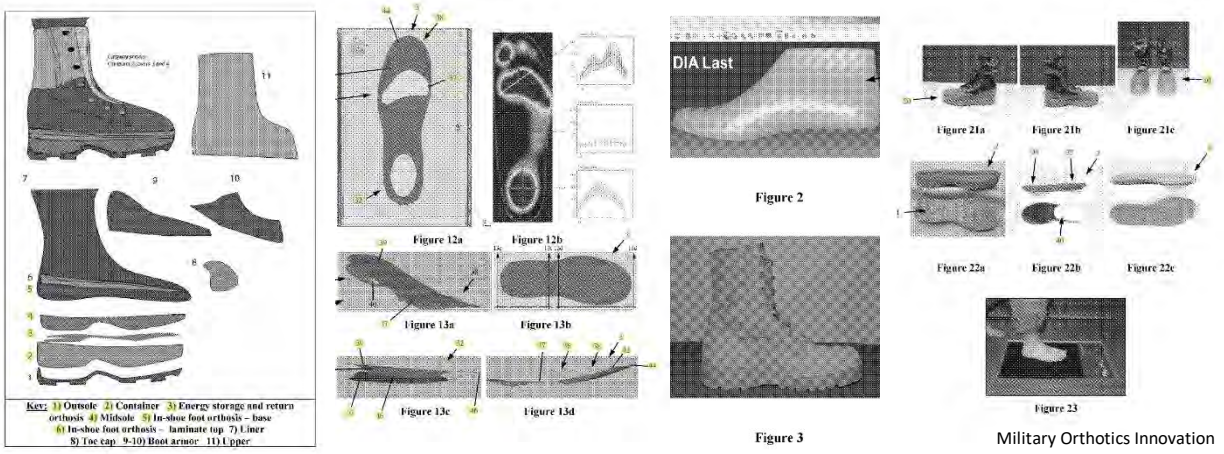


Wrap Boot Design Patent
(Mycoskie, 2015)

Furthermore, patents with emphasis on military orthotics as well as overall support for injury prevention and increased load capacity are predominant within military footwear categorization. The improved footwear system of the present application uses composite materials in the design of an advanced modular in-shoe foot orthosis and a new container

[28] Mycoskie, B. (2015). *US20090183394A1.* Retrieved December 5, 2019, from https://patents.google.com/patent/US20090183394.

assembly which includes a high-performance energy storage and return element orthosis. The footwear system uses a method of manufacture incorporating a new last model: "The advantages of the footwear system over standard issue combat boots include lower weight, improved treatment of lower extremity overuse injuries and reduction of the occurrence of such overuse injuries by protecting at-risk feet with advanced footwear which can be customized to meet the biomechanical needs as well as the specific activities of the wearer."[29]



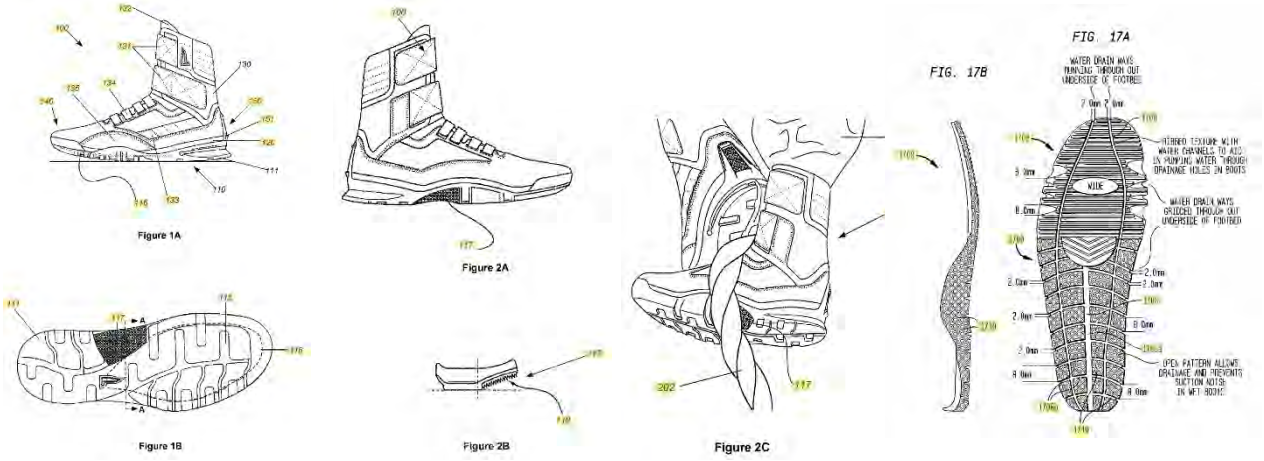
Military Orthotics Innovation (Cavanagh, 2015)

Indeed, what is evidently important for military footwear in its ability to be both reliable and desirable is adaptability and multi-functionality. Described are embodiments of multi-functional footwear. In one example, an article of footwear includes a climbing arch configured to receive at least a portion of a climbing surface. The climbing arch also includes a plurality of engagement members extending from the arch and configured to engage a climbing surface. The article of footwear may also include a protective plate, a plurality of outwardly extending

[29] Cavanagh, P. R., Hurley, T. B., Tierney, J. J., & Gillespie, J. W. (2015). *US20140298682A1.* Retrieved December 15, 2019, from https://patents.google.com/patent/US20140298682A1/en?q=military&q=footwear&oq=military+footwear.

protrusions that form a receiving area configured to receive a portion of a second body, a drainage system configured to drain liquid from within the article of footwear, and/or an anti-rope burn upper. The described, multi-functional footwear may be designed with significantly less mass than known footwear.[30] With adaptability and multi-function comes necessities for extreme situations and environments not yet seen or not yet adopted. Extreme scenarios and environments including hazardous conditions, temperatures, etc. There is a need for increased protection, patent design and application reflect this need: "This footwear includes protective coverings that may be proof, puncture proof, fire retardant or water repelling. Drainage holes can be positioned in the toe region and along the outsole to enable a wearer to quickly drain water from the article of footwear. Single use or replaceable drainage plugs may cover the holes to prevent entry of water into the boot or other article of footwear. Removable and/or replaceable footbeds may be employed, and such footbeds may provide adjustable sizing of the article of footwear using interchangeable cartridges. A support saddle may be employed with the footbed to enhance foot support under heavy loads. These and other features herein are suited for use in a wide variety of footwear.[31] In particular, the present invention relates to a shoe sole which can be attached to the heel so as to fulfill a damping function and to prevent the ingress of water into the boot in case of bad weather and with a section of the water in ventilation and sealing applied to the front of the heel for good ventilation and to further improve the shock absorption.

[30] Roberti, N. (2009). *US8296973B2.* Retrieved December 15, 2019, from https://patents.google.com/patent/US8296973B2/en?q=military&q=footwear&oq=military+footwear&page=1.
[31] Clark, D. (2006). *US7762008B1.* Retrieved December 15, 2019, from https://patents.google.com/patent/US7762008B1/en?q=military&q=footwear&oq=military+footwear&page=2.



Training Footwear Innovation
(Clark, 2006)

As noted, and outlined in previous sections, military footwear, specifically that of individual service branches such as the US Army, implement strict guidelines as far as color and graphics of footwear specific to environment and uniform. Regulation informs every colorway, usually camouflage patterning and earth tones, as per military indoctrination, all color and graphics are meant to portray professionalism and practicality[32]:



Color and Graphic Authorization
(Cavanaugh, 2015)

[32] Cavanagh, P. R., Hurley, T. B., Tierney, J. J., & Gillespie, J. W. (2015). *US20140298682A1*. Retrieved December 15, 2019, from https://patents.google.com/patent/US20140298682A1/en?q=military&q=footwear&oq=military+footwear.

The color scheme of the Army Combat Uniform is composed of tan (officially named Desert Sand 500), gray (Urban Gray 501), and sage green (Foliage Green 502). The pattern is notable for its elimination of the color black. For general design characteristics of U.S. Army Organizational Colors, information is presented as follows by arm or corps of service: Background Color, Fringe Color, Outline Color of Scrolls, Color of Numerals and Letters on Scrolls. All information concerning the flags and colors of the U.S. Army is drawn from Army Regulation 840-10, Flags, Guidons, Tabards, and Automobile and Aircraft Plates

	Background Color	Fringe Color	Outline Color of Scrolls	Color of Numerals and Letters on Scrolls
Adjutant General's Corps	Dark Blue	Scarlet	Scarlet	Dark Blue
Air Defense Artillery and Field Artillery	Scarlet	Yellow	Yellow	Scarlet
Armor and Cavalry	Yellow	Yellow	Scarlet	Scarlet
Army Medical Department	Maroon	White	Yellow	Maroon
Aviation	Ultramarine Blue	Golden Orange	Golden Orange	Ultramarine Blue
Chemical Corps	Cobalt Blue	Golden Yellow	Golden Yellow	Cobalt Blue
Corps of Engineers	Scarlet	White	Yellow	Scarlet
Infantry	Dark Blue	Yellow	Yellow	Dark Blue
Judge Advocate General's Corps	Dark Blue	White	Yellow	Dark Blue
Maintenance	Crimson	Light Blue	Yellow	Crimson
Military Intelligence	Oriental Blue	Silver Gray	Golden Yellow	Oriental Blue
Military Police Corps	Green	Yellow	Yellow	Green
Ordnance Corps	Crimson	Yellow	Yellow	Crimson
Quartermaster Corps	Buff	Light Blue	Light Blue	Light Blue
Signal Corps	Orange	White	White	Orange
Special Forces	Jungle Green	Silver Gray	Yellow	Jungle Green
Supply	Buff	Ultramarine Blue	Ultramarine Blue	Ultramarine Blue
Supply and Service	Buff	Yellow	Dark Blue	Dark Blue
Supply and Transport	Buff	Brick Red	Brick Red	Brick Red
Support	Buff	Scarlet	Scarlet	Scarlet
Transportation Corps	Brick Red	Golden Yellow	Golden Yellow	Brick Red

Training (Boot Camp/Basic PT): Just now is the US Army developing solutions for training footwear for Basic PT and everyday solider life, for too long have soldiers been forced to utilize footwear options that increase chance of injury and everyday strain. US Army has recently allowed use of running shoes for training, specifically New Balance models that are authorized.

- Strengths: The current landscape of products provide solutions for many multi-variable problem-sets for soldiers and military personnel. With significant progress in comfort and durability of combat boot design the strengths of current market products resides in reliability over performances. Training footwear specific to military, is an emerging area for innovation over even the last few years,
- Weaknesses: The sheer number of various combat boots for specific needs is staggering. Part of being a solider is adapting to survive, to overcome. There is a clear need for a combat boot that can cover the basic needs of performance, durability, and protection that doesn't come at the cost of functionality and adaptability.
- Opportunities: Training footwear is a very under-developed area for the military, especially for specific PT and Boot Camp activities.
- Threats: COTS options for enlisted military personnel currently is the more favorable option over standard issue options. US Army has opted to instead authorize use of specific New Balance models and other assorted brands. This is a new development and adds to the current trend of Commercial Off-The-Shelf adoption.

Tropical/Hot & Temperate Weather: Avenues of innovation in tropical combat boot design and functionality has seen increased movements as well in recent years with US Army

specifically innovating solutions for soldiers in jungle and tropical conditions. Increased slip-resistance and ventilation for quick dry adaptability.

- Strengths: Current innovation adoption have resulted in numerous patented applications for jungle conditions. The US Army has allocated resources in increasing numbers towards developing solutions for these soldiers, specifically through the Solider Center in Natick, Massachusetts.
- Weaknesses: Even though inroads and various innovations were made into JCB innovation, it was recently reported The US Army has shelved their plans to introduce their own standard issue design, due to reasons not yet resolved. Jungle Combat School in Hawaii was the testing ground for the specific standard issue model.
- Opportunities: There is opportunities to further adopt solutions not only for JCB conditions and environment, but also coupled with Extreme Hot Weather adaptability. Transition for tropical to hot, dry conditions could be interesting path to innovation for further JCB and standard issue boot design.
- Threats: Current problem areas to possible solutions for a combined tropical and ry hot weather combat boot are quite possibly many. Solutions will heavily rely on material innovation as well as combined technical and future product design methodologies. Weight, durability, traction, and performance are just a few areas in which problems will be clear to arise.

Artic/Intermediate & Extreme Cold Weather: Northern arctic and extreme cold weather conditions, specifically the aptly nicknames “Bunny Boot”, is the decades old solution to extreme cold weather for military use. Innovation is heavily lacking and has been emphasized

just the past two years with calls for new product innovation and design for our military personnel.

- Strengths: Designed for use in even more extreme cold weather, and is rated all the way down to −65 °F (−53.8 °C). The Type II was created to encompass the "worst case scenario" need to field soldiers in the coldest conditions in which any military force could reasonably attempt to conduct operations (including Alaska, Siberia and both Arctic poles). For comparison, the average winter temperature at the South Pole in Antarctica is roughly -56°F. The boot is slightly bigger and heavier (~8 oz. (0.22 kg) more per boot) than the black Type I because of the extra insulation. Strengths rely in material choice and overall functionality and effectiveness, even if outdated in design.
- Weaknesses: The design of the product is clearly outdated, calls for innovation in this product specific space have been numerous especially in the last year or so. The overall design is very cumbersome and clunky. It weighs a ton and lacks versatility that is necessary in extreme cold weather conditions. Material choice also lacks sustainable options.
- Opportunities: It is clear that is the most apparent option for innovation in the space of military footwear design. Solutions have not been optimal for standard issue options and the need is there when use of a design from the 1960's is preferred over modern-day designs and options.
- Threats: Product design and options in the space will require in depth evaluation of materials and effectiveness of design, coupled with critical testing in extreme cold.

Necessary components for versatility and compliance with military authorization and various necessary attachments (snow-shoes, skis, etc.) is necessary.

In order to successfully introduce solutions to the problem of underdeveloped combat boots for multiple extreme climates, there is a need for delve further into the history and pragmatic solutions that have propelled these designs to the forefront of adoption. Put simply, figure out why soldiers wear the boots that they wear, and introduce solutions that change the conventional understanding of a combat boot. What does a combat boot look like in 2020? Does it have to adopt traditional standards? Or completely re-introduce the concept for the modern age?

Military footwear, specifically the combat boot, requires a complete technical understanding of both the product and the user and the many variable requirements set by the US Armed Forces. This becomes readily apparent when delving into codifications and specific requirements for military footwear even in slightly different temperate zones. This project, and its many functionalities will provide an all-encompassing challenge that includes both footwear design innovation and material/textile science, coupled with issues of durability, performance, and functionality. There is a reason these boots haven't seen major innovations in recent years. The problems are complex and not easily resolved. It is important, as a product innovator, to challenge not only yourself, but attempt to solve problems that require time, patience, and constant failure.

As a designer and product innovator, Max has shown his skill and technical aptitude for learning new processes and design tools quickly and efficiently. His strengths lay in adapting to

any given situation and problem-set and being able to find different and interesting connections through storytelling that would perhaps be lost in the background otherwise. Attention to detail and a willingness to set high standards for himself that are at times unreachable, have brought Max to where he is today in his professional design career. Furthermore, Max's unique ability to connect with those around him on a mutual level of understanding and respect, has propelled him to be able to open up to new perspectives and avenues of thinking that has defined his life thus far. The necessity for discipline and thorough research and problem identification will implore Max to be able to successfully innovate and create. The ability to innovate and design within readily defined constraints, is essential for this project topic.

While Max's aptitude as a designer is clear, it is evident that in order to support new innovation for this collection of military footwear solutions he needs to push his boundaries to pursue truly innovative solutions that have not been seen as of yet. His strengths remain very much grounded in realistic problem solving and a balanced "common-sense" mentality. While this may seem like a strength, it tends to get in the way of innovative or "revolutionary" concepts. There is, however, strength in awareness. This collection of hopefully innovative footwear solutions for our military personnel will provide enough clarity necessary for Max to adapt to the challenges that are forthcoming.

This body of work could have the potential to propel Max into a future career as either a footwear designer or industrial designer at any of the top sports and outdoors brands in the Greater Portland, Oregon area, the potential is there. Footwear design, specifically, provides an outlet to showcase a multitude of design skills encompassing technical strengths that are not

out of reach. The key, for this final thesis project, will be to bring all the different elements together in a cohesive, informative, and innovative direction that will disrupt conventional/common sense thinking; innovation is the promise of the future now, and now is the time.

Primarily for research into this project and problem scope my method(s) for both collecting data and connecting with experts remained simple and very straight forward. For initial research and wear testing of baseline standard issue footwear models, (this includes the New Balance 950v2, Vietnam Era Jungle Combat Boot, and the Air-Boss VB Boot Type II) I designated three distinct environments for testing and wear. These areas being suitable for all conditions these boots were categorized for by military services for proper combat needs.

For cold weather conditions I focused on mountainous area with heavy snowfall and a trail with multi-variable elevation. I travelled to Mt. Hood National Forest in Oregon to Trillium Lake Snowshoe Trailhead with an approximate hike of around 10 miles being completed in the duration of around 5-6 hours. Wearing the extreme cold weather boots known as the “bunny boots” was a very tough task, especially on a trek like this in relatively cold but nowhere near extremely freezing temperatures. As such, hiking felt extremely arduous as each boot weighs 5 approximately five pounds apiece. It was clear after the first hour of the trek that these boots are very much outdated and very uncomfortable for wearing longer than 30 mins. The boot itself is over-built for these conditions, only in desperately freezing temperatures will these boots prove effective, mainly from avoiding frostbite. Furthermore, this boot has various other issues as far as weight, traction (slippage) from lack of traction where needed, as well as

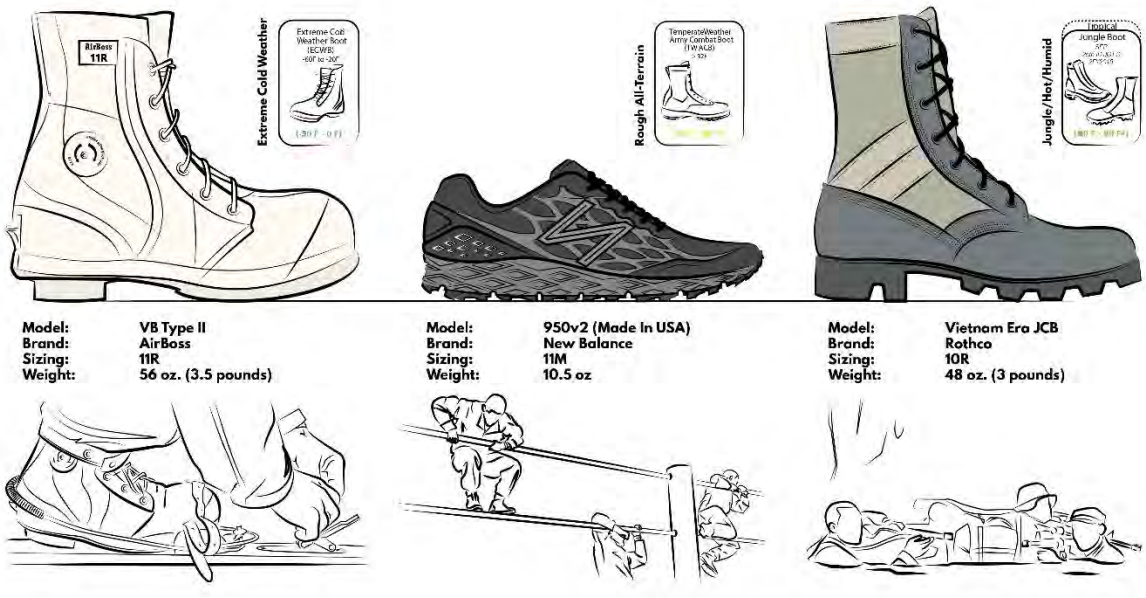
fastening when lacing up. The laces barely budge due to the thickness of rubber upper pattern layering, it is only effective at the top two laces to avoid snow and vapor from entering. Overall, these boots are in desperate need of improvements and various alterations in design.

In order to test the jungle boots effectively, it was decided to explore the surroundings of Portland for damp, wet, and muddy conditions appropriate for wear testing of the Vietnam Era Jungle Combat Boot. Trailheads primarily for hiking provided extreme elevation deficits as well as unreliable and unstable footing when wear testing. It was wet, slippery, and just warm enough to provide proper insights into actual training and operations when wearing these boots. Overall, the boots are very simple and are lacking quality, the upper doesn't provide enough flexibility and support to enable proper feedback and return. Immediately I experienced blistering all over the heels of both feet as well as strain on the bottom of the heel due to poor cushioning of the rubber midsole. Lack of insole as well as proper support (padding, flexible materials) really effected and hampered overall performance while wear-testing. Some positives include superior traction especially in muddy unstable ground conditions, as well as in and around sources of water such as streams, rivers, etc. However, the boot remained bulky around the midsole as patterning ensures full grain leather toe and heel counters as a form of the upper patterning. These are very stiff and uncomfortable and do not provide flexibility and support where needed and doesn't provide a locked-in feel. Materials used in this design are very outdated, clearly, as the model mimics the design of jungle boots used in Vietnam, where functionality was basic and innovation as far as these conditions was not yet fully understood. Thus, materials are very basic and minimal and do not reflect possibilities in the current

marketplace. This is an observation that is easily made, as just looking at these boots it is clear these are from a different era of combat and warfare.

As far as the trainer category is concerned, there is not enough innovation in focused design specifically for the needs of soldiers in boot camp and physical training exercises. The New Balance 950v2, while a new innovative model as far as domestic manufacturing under the Berry Amendment is concerned, is no more than a standard running sneaker. During boot camp, soldiers have been issued this model shoe since this past year in October of 2019 according to numerous news articles and related information regarding its overall design and sourced manufacturing of assembly here in the United States. Even for a running shoe, this model lacks overall support that is needed around the ankle, especially for soldiers who experience much more strain from exercise. Running is not the only activity these soldiers endure during boot camp, this includes obstacle courses, rigorous training regimens, where these shoes would clearly not perform daily let alone throughout a single day.

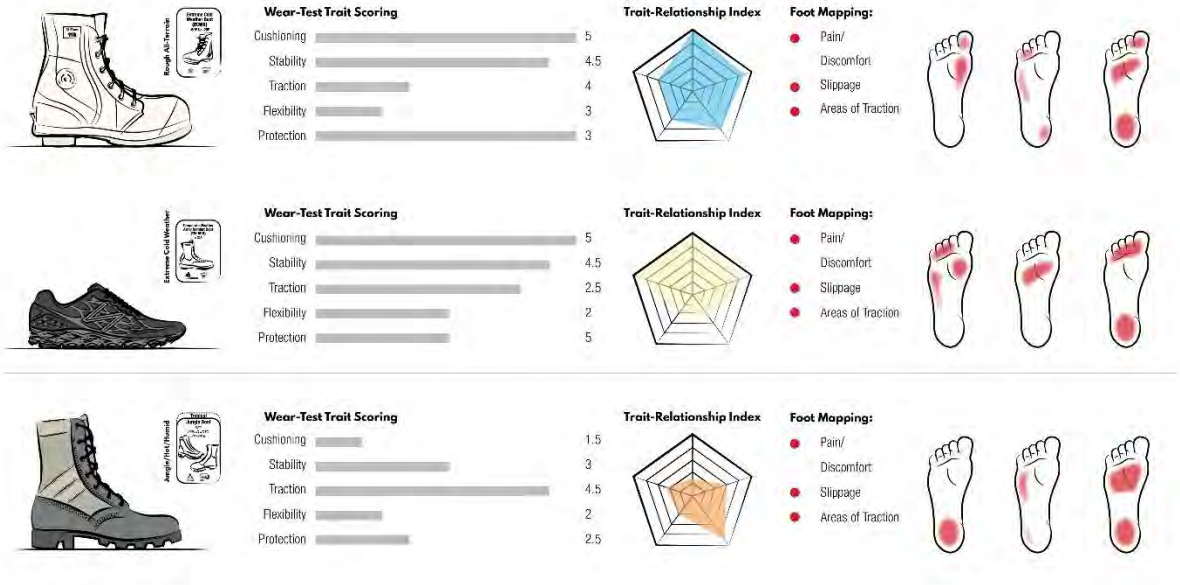
Product Identification & Activity Analysis
(Three Footwear Models)



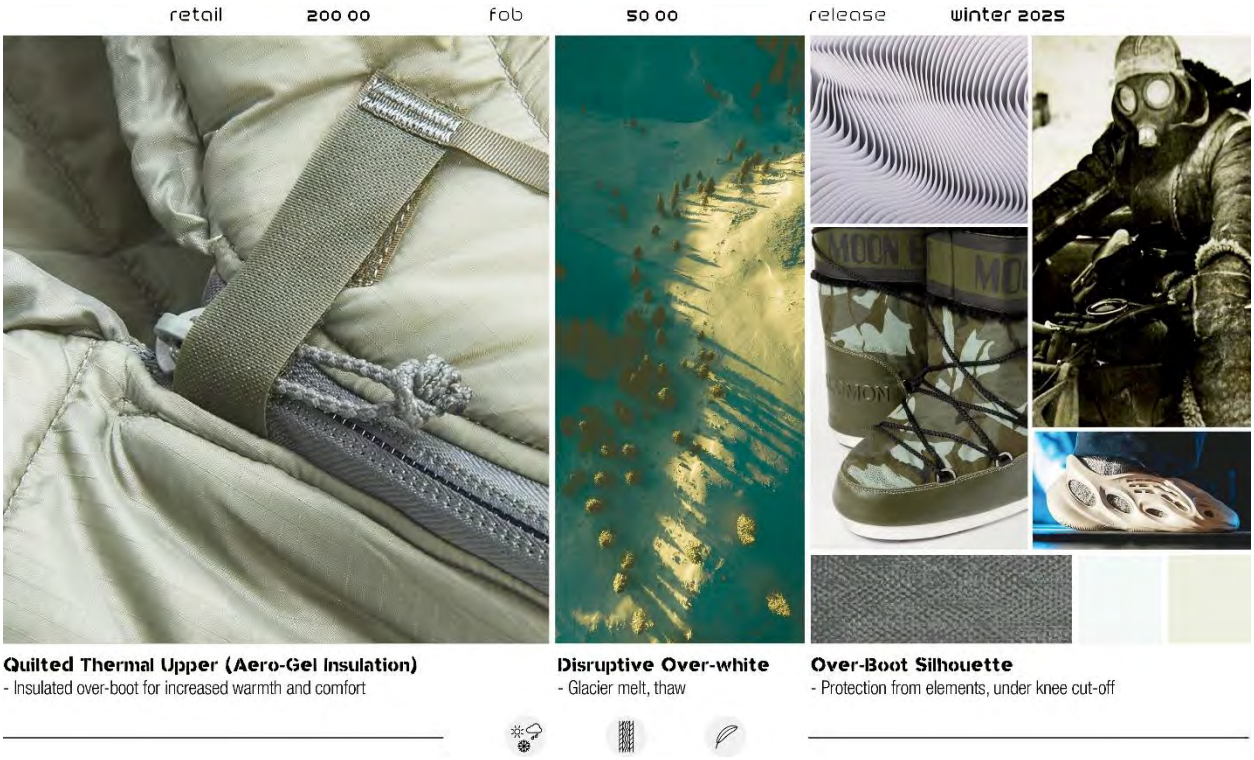
From the numerous testing of all three models of footwear chose for targeting, the hands-on wear-testing provided clear instructions for avenues of improvement. As already previously mentioned, all three footwear models are extremely outdated if not ineffective in all three given terrain and climate environments in various ways. It is easily identified that these models are outdated in both overall design and performance. Being as many of the models were not even design and manufactured in this decade, they are still used for the most part by solider and civilians alike, for reasons that are not clear. Materials are going to be a primary focus for updated overall design, as materials used are not highly effective in providing necessary support and comfort. Weight is an issue for materials as well for all three footwear models, even the New Balance running shoe. The materials used for the cold weather boot are mainly thick layers of wool surrounded by vacuum sealed rubber to seal in heat and trap it in the wool layers to protect against the extreme cold. This material choice, while highly effective in the conditions used for, is highly ineffective in any conditions but. Shoes are not easily packed and only provide resilience in conditions that are rarely seen even in the Arctic. Thus, the opportunity for innovation remains very much open to new possibilities including new categories with defined temperature ranges that reflect the future warming climate. For further development, I spoke with former US Army footwear scientist Jay and Jared who informed me they both worked on the possibility of an over-boot category specifically targeting through water design for over and through river operations in cold environments where a vapor barrier was still needed, but flexibility, lightweight, and packability were very much the intended focus and scope of the design. Various other categories have been defined through research but were never developed, this includes the Alpine Combat Boot and Cold Weather Combat Boot.

Numerous variables were tested for upon initial wear-testing and field research. These included areas on the foot of pain and discomfort highlighted in the below table per corresponding boot and sneaker. As well as focus on overall traction which included slippage and areas of highlighted grip to provide an analysis of areas where traction and grip could possibly be improved. These areas were mapped on the foot to provide of visual path towards improvement for all three aforementioned areas. Furthermore, initial wear testing of each footwear model provides important information and data in categories of cushioning, stability, traction, flexibility, and protection. All three footwear models were very different with observational results. VB boot performed well in cushioning, as it should being a very protective boot with many layers of padding. New Balance also shared a high cushioning score as is customary with all New Balance footwear design. It is optimal for comfort and support for walking and running, not meant for flexibility and overall protection, which it did not do well in.

Wear-Testing
(Baseline Boot Models)

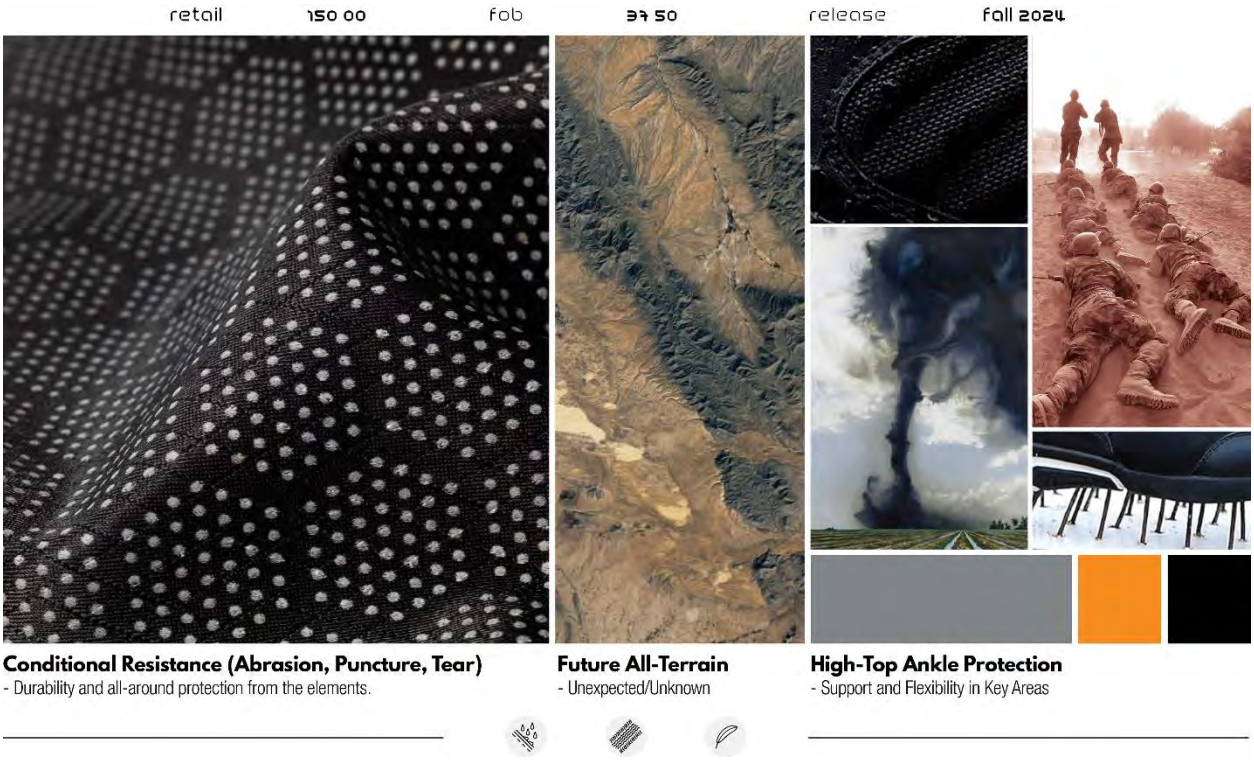


Standard-Issue Cold Weather Over-Boot (Vapor Barrier)



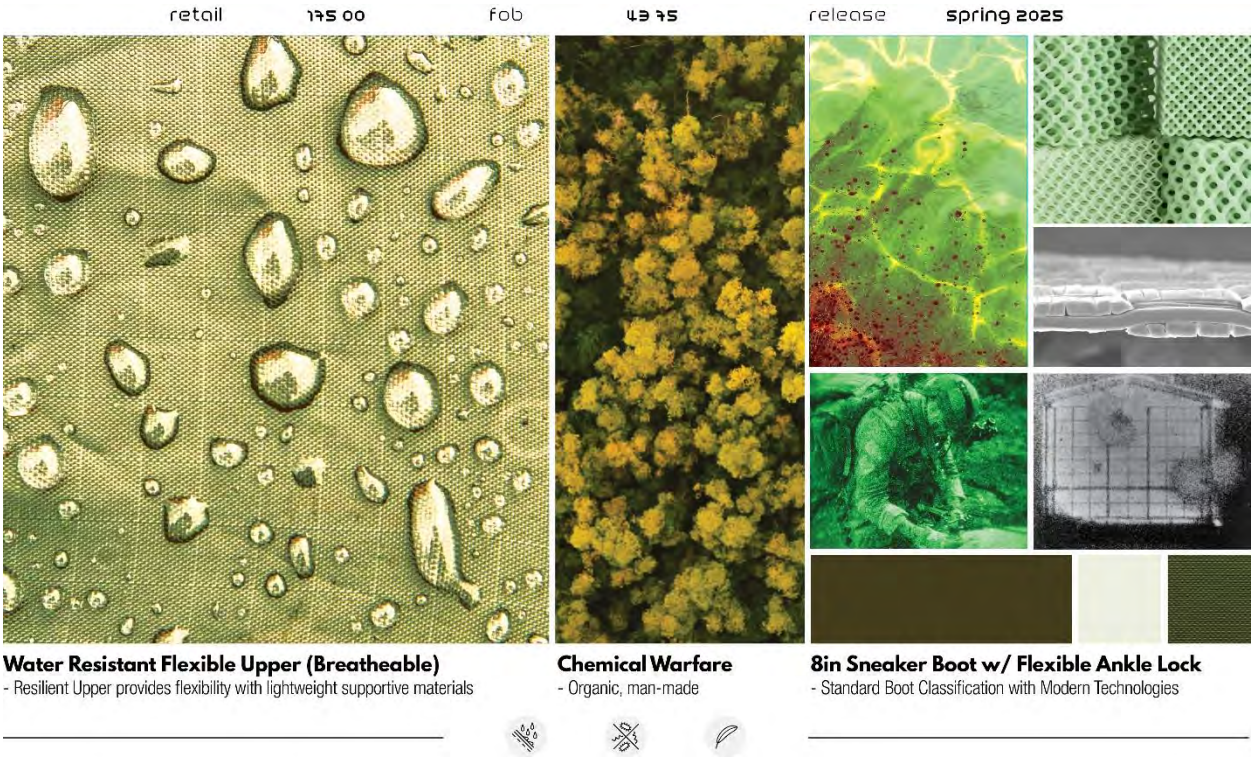
Design priorities for the Cold Weather Over-boot includes All-Weather Resistance. Insulation, and Lightweight. Priorities for the cold weather over-boot include a quilted thermal upper utilizing an areo-gel insulation layer where needed, thus enhancing insulation without sacrificing for increased overall weight. Furthermore, quilted upper panels utilizing a quilted insulation membrane combined with an inward facing breathable water-resistant layer for added protection and warmth. The overall look and feel of the boot will highlight a disruptive over-white mood and direction to reflect melting glaciers and a warming arctic. The silhouette mimics the functionality, an over-boot that fits over current basic boot design and provides protection up to under the knee, protecting from snow and providing vapor barrier. This over-boot maintains lightweight and is effective in numerous specified terrain conditions.

Standard-Issue Boot Camp Trainer (All-Terrain)



Design priorities for the Trainer includes Water Resistance. Traction, and Lightweight. Focus of priorities for the all-terrain sneaker for boot camp and physical training highlights all around conditional resistance, this includes abrasion resistance, puncture and tear, and overall durability into the midsole and upper. Ceramic coating where need around the toe box and ankle means increased protection and flexibility while maintaining lightweight. Future all-terrain mood and direction to emphasize a shoe that can tackle any obstacle and any terrain conditions, including future unexpected environments. Mainly for training, this focuses on all activities that a soldier will endure during training, not just running. Furthermore, a high-top ankle silhouette provides enhance protection and support that is critical for soldiers not only in difficult training circumstances, but in active duty as well.

Standard-Issue Hot Weather Jungle Combat Boot



Design priorities for the Hot/Humid/Wet Weather Boot includes Water-Resistance. Antibacterial, and Lightweight. Focus on upper design to propel the Lightweight overall design, the design will feature a water-resistant flexible upper that is breathable as well. This will allow for increased resistance to specified conditions. This is the boot that will always be wet, so to provide a water-proof feature doesn't seem applicable in order to work with the conditions rather than fight them. Chemical warfare inspires the mood and direction of this designed boot, organic materials and man-made will be combined in all aspects of design. Looking into anti-bacterial flexible PLA to print midsole and toe and heel counter iterations will provide innovation where needed. The overall silhouette being the classic eight-inch regulation boot with flexible ankle lock that provides increased support for enhanced fit and lightweight.

Initial steps toward ideation started with examination of overall silhouette to really focus in on shape and function. Early on it was clear that the extreme cold weather boot was not the avenue in which to focus on in terms of innovation. Thus, it was decided to explore a new category in cold weather conditions and temperature, as discussed with mentors, to identify an over-boot silhouette as the right choice. As far as silhouette and fit of the over-boot I drew inspiration from the waterproof over-boot made by Air-Boss, same company that produces the extreme cold weather vapor barrier boot as well. This allows for a fully closed upper without need for zippers are attachments and can be easily adjusted with implementation of straps or fasteners to tighten fit. The fit of these over-boots however only went up to mid-calf and was not effective in protecting the full leg, thus I brought the silhouette up to cut right below the knee to allow for greater flexibility and ease of movement. This produced the overall final silhouette direction moving forwards and provided clear path towards solving for other problem areas.

Initial Ideation
(Silhouette and Form)



Further ideation produced effective results in refining the concept and looking into midsole and internal toe and heel counters as well to provide support and flexibility where needed when wearing over a boot. Final Ideation Direction was conducted to focus in on silhouette, fit, as well as upper patterning and outsole shape. Pursuit of custom leg last is initiated as there are not many examples of such to design over-boot (3D scan of leg/boot).

Ideation Direction
(Over-Boot/Lightweight)



Final Ideation Direction
(Mood & inspiration)



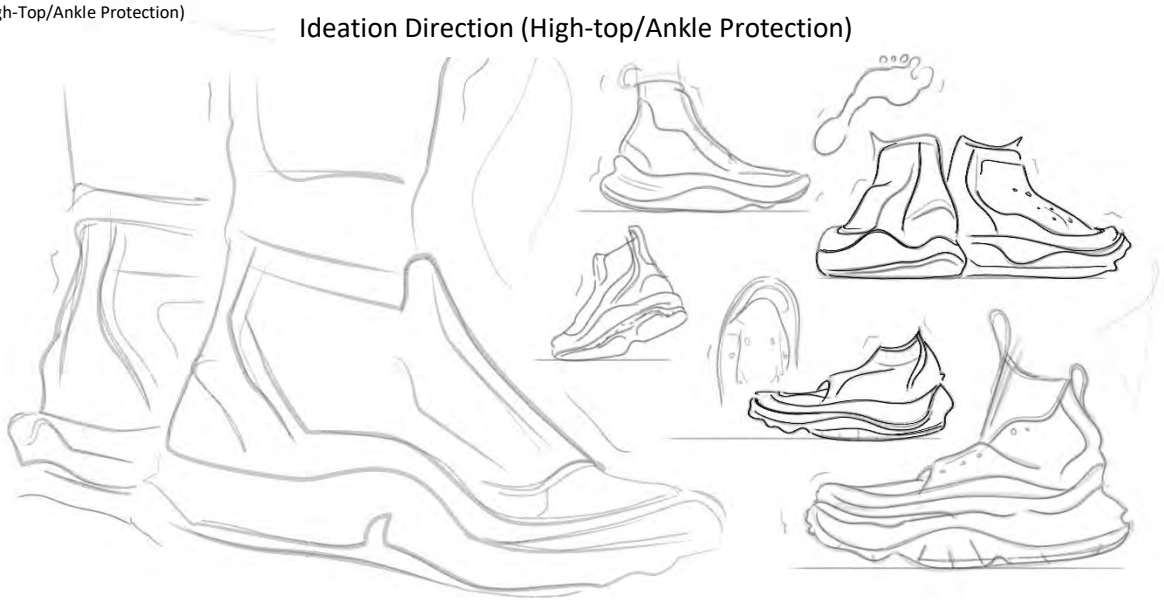
Ideation into the all-terrain training shoe was the most difficult as it was redesigning a basic running shoe to reflect needs and wants of soldiers in physical training exercises during boot camp deployment. Initial ideation towards silhouette made the most sense to add ankle protection with a high-top silhouette. The overall focus on this trainer is to be able to traverse unstable and rocky terrain, thus a chunky midsole/outsole was ideated to provide both stability and proper cushioning and protection from whatever you may encounter under your foot. It seemed necessary to provide protection to the toes and sides of foot most importantly, based on initial wear-testing review and analysis. A more dynamic heel counter to provide increased locked-in feel was also pursued for possibilities in terms of both form and overall shaping around the foot. Initially, the thought was to increase flexibility and support where needed, however necessary rigidity remained an issue when ideating the uppers, being able to provide enough resistance but also allow for flexibility was not an easy solve and needed to be expanded upon with further ideation down the line. Initial ideation to solve for silhouette and form proved to be extremely difficult, however there were a few forms that I chose to pursue.

Initial Ideation
(Silhouette and Form)



Further ideation into high-top ankle protection provided a defined silhouette for further refinement. The chunky oversized outsole was decided as a key solve for pursuit into the all-terrain trainer which really helped define the overall design direction of this footwear model especially. Final ideation direction mirrored ideation direction in various ways, further developed inspiration provided good feedback for next steps and materials for use.

Ideation Direction
(High-Top/Ankle Protection)



Final Ideation Direction
(Mood & Inspiration)



Initial ideation into the third and final footwear model, being the hot/humid/wet jungle conditions boot to directly target to Vietnam Era Jungle Combat Boot for enhanced updated design. The classic eight-inch boot silhouette was used as initial silhouette direction to provide reliability and support around the leg for arduous and strenuous activities that are commonplace for solider in these jungle conditions. A wrapped toe counter and heel counter that are flexible remain a theme across the collection and was implemented for this boot more aggressively to provide enhanced flexible and performance. An ankle cuff that was more cushioned and flexible with softer materials was also explored as the previous model was very stiff and tough to break in. Further ideation into overall fit with included toe and heel counters was a key solve and explored further in next steps of ideation. A more rugged and aggressive midsole and outsole was an easy solve as traction was not an issue and improvements were minor to enhance for the project problem scope and specific future environments that would include harsher, more difficult to traverse elevated terrains.

Initial Ideation
(Silhouette and Form)

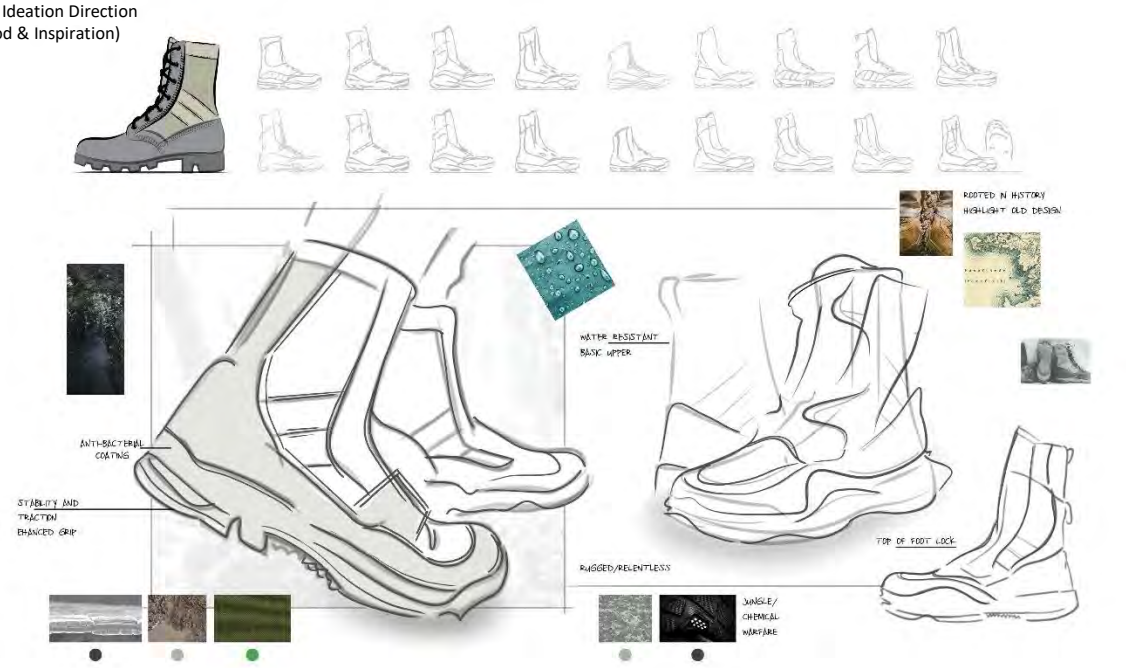


Ideation direction provided more clues towards silhouette and form/fit. A more streamlined, curved design was designated for this model to reflect the environment in which it would be found. Final direction reflects these key-solves and possible inspiration and materials and colors choices for further refinement into the validation and proof of concept phases of design.

Ideation Direction
(Flexible/Lightweight)



Final Ideation Direction
(Mood & Inspiration)

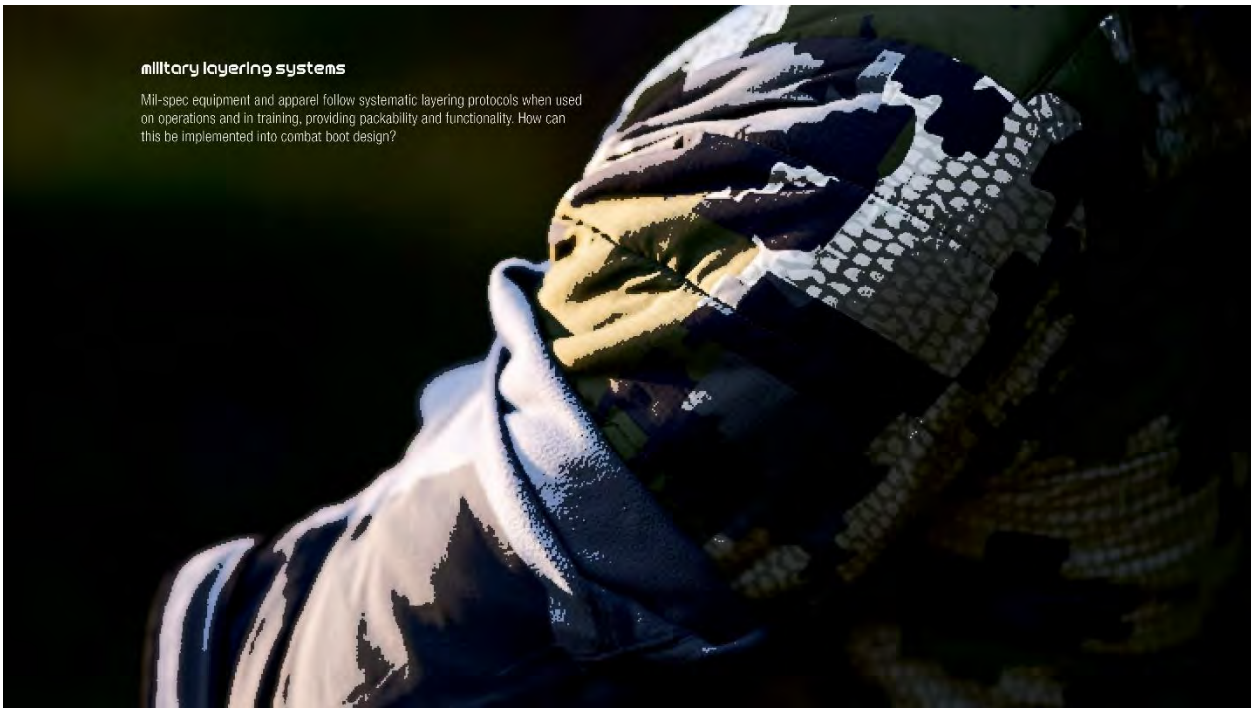


Ideation conducted reflected good progress into silhouette and overall form for all three boot models, however it felt as though an overall concept was lacking as all three boots are completely different and didn't emphasize a collection with a unified target. Thus, introduced after final ideation direction, it was chosen to pursue a system that would unify the collection behind a common intersection that felt very appropriate given the project scope. Military equipment and apparel systems highlight use of layering as a completely functional and optimal way to stay "comfortably cool." Being able to have a packable system that allows for versatility when needed to enhance a soldier's optimal comfort. These systems include layered insulation that can easily be adjusted by removing an outer or inner layer. As well as equipment such as backpacks intended for quick and easy attachment of additional storage and allows the soldier to fully customize their own system to fit their specific needs.

Military layering systems as an intersection has provided a unified concept to allow for a soldier to alternate between shoe models if needed using a basic boot as the sub-structure in which can be built upon, whether that be strapping the jungle midsole on when increased traction is needed or attachment of over-boot upper to provide insulation and protection. This system provides reliability and versatility in the field and is based around the idea that a soldier should be able to traverse the entire climate landscape from cold weather through all terrain and jungle conditions, and that this system which is much easier to pack and lightweight will allow the soldier to do such that. The entire system will allow packability into one bag for all three operations models if needed. This will provide an enhanced redesign of most of the entire organizational matrix the military utilizes to assign boots to their soldiers as well as target various temperature categories.

Military spec equipment and apparel follow systematic layering protocols when used on operations and training, providing packability and functionality. How can this be implemented into combat boot design? The concept of such a fit-lock cage system mimics and was inspired by various removable midsole/outsole designs for sneakers, but specifically the safety over toe shoe that is used by many construction sites and safety zones for those without safety boots. This system allows for easy transport and ease of use when in the field, especially for soldiers, this could be the difference between life and death. With the ability to layer upon a base model, this system could provide clear avenues for innovation in the future as well. Problem areas with such a concept are focused in fit. As this is a multi-layered system, the necessary and exact fit is key to providing proof of reliability and features aforementioned pertaining to the system itself. Further ideation into this concept was necessary to further understanding possibilities into this modular/layered system.

Intersection:
Military Layering Systems



Ideation into this implemented intersection of military layering systems proved effective in framing a solution for a whole concept to encompass this family of footwear models. A cage-lock fit system would allow a basic combat boot, everyday wear, to hook into a more effective jungle midsole, and attach straps and fasteners to further lock into the upper as well. Furthermore, the basic boot, while the over-boot wouldn't necessarily require, would fit and lock into the cage which would be situated inside the shoe stitched are glued into the midsole. Flexibility is a key solve for this concept, but overall packability is the focus and direction which encompasses the other features of this possible concept. Inspired by not only certain footwear models which explore removable midsoles, but more importantly safety shoes which fit around current user's shoes to provide increased protection and durability. Below is the exploration into this concept and possibilities for adaption to various environments a soldier would encounter. Being able to fit all these options in one pack would be validation of this concept.

Intersection Ideation
(Modular Midsole/Cage-Lock)



Cage-Lock (Section View)

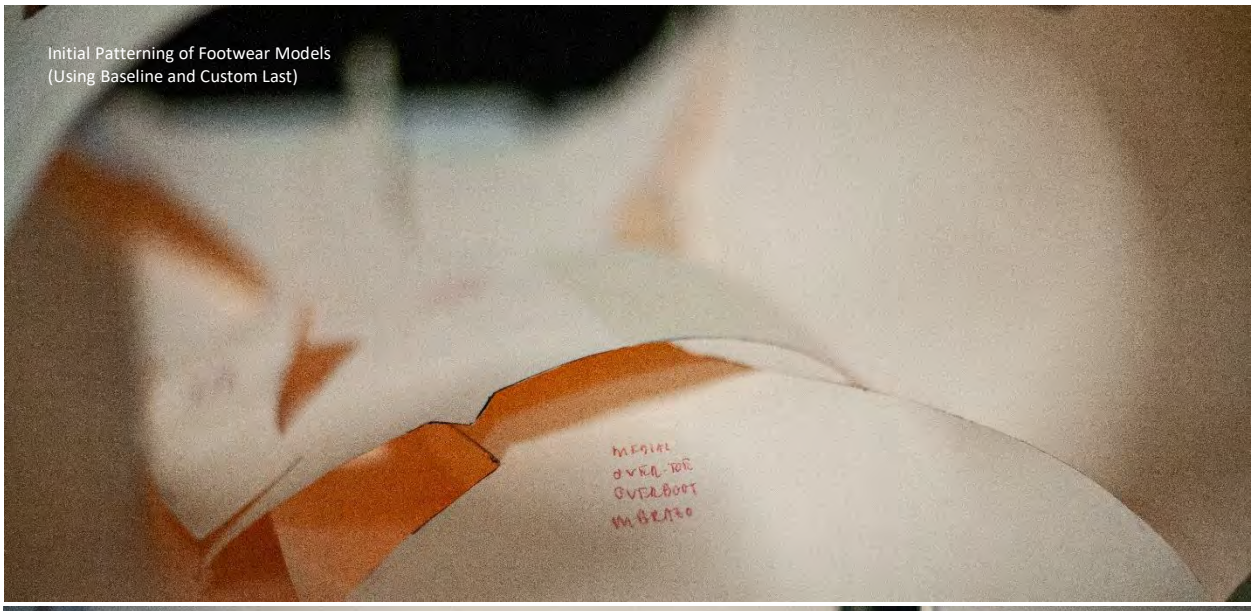
Final intersection ideation direction really helped defined this project as a whole and provide a clear avenue for innovation across all categories of military footwear for our shared climate future and those implications. Successfully allowed for two separate categories of models, based on conversations with soldiers based on basic questions, it was clear the trainer was something that was more important to have as an option for training and day to day wear, not use during operations. Thus, a separate operations category was adopted for the cage-lock system and concept to be included in each model. These will be the models that really reflect valid proof of concept down the line. Below is the illustrated collection, as well as how the cage lock system is included and how the basic boot would fit into each system. Proof of concept will focus on the cage-lock system as well as overall fit/comfort of each model including basic upper design and functionality. Further exploration into traction/tread will be explored during validation testing during Spring Term Capstone. 3D printing will be adopted for use to prove the concept further than possibly with ordinary methods.

Final Intersection ideation Direction
(Basic Boot/Cage-Lock/Training vs. Operations)



Trainer Basic Boot Jungle Midsole Over-Boot

Development of upper patterning and basic patterns from lasts available and baseline products allowed for initial steps towards silhouette and form matching as well as material identification for use. Started with over-boot as a last wasn't available thus patterning was back engineered from baseline over-boot product identified during ideation.



Initial Patterning of Footwear Models
(Using Baseline and Custom Last)



Upper Patterning of Basic-Boot
(Focus on Material Layering Thickness and Elastic Supoort)

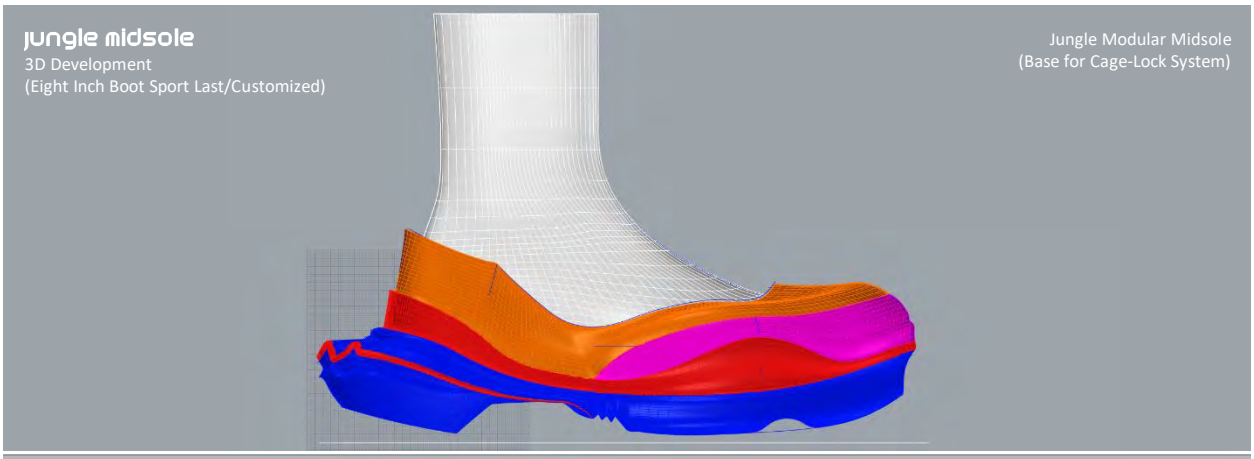
Development of upper patterning and basic patterns from lasts available and baseline products allowed for initial steps towards silhouette and form matching as well as material identification for use. Started with over-boot as a last wasn't available thus patterning was back engineered from baseline over-boot product identified during ideation. Patterning took a lot of the focus away initially from further developing the collection a really focusing in on a unified concept. As all the uppers for the footwear models do not feature clear proofs of concepts, it didn't make sense to continue to waste time that could be served towards a proof of concept. The designs of each upper maintains a very minimalistic and simplistic design. Material uses of layering are simple in the over-boot to the extent that it requires less than ten patterns to assemble. The real innovation and concept are focused on the midsole and the connection between the Basic Boot and the Cage-Lock systems.

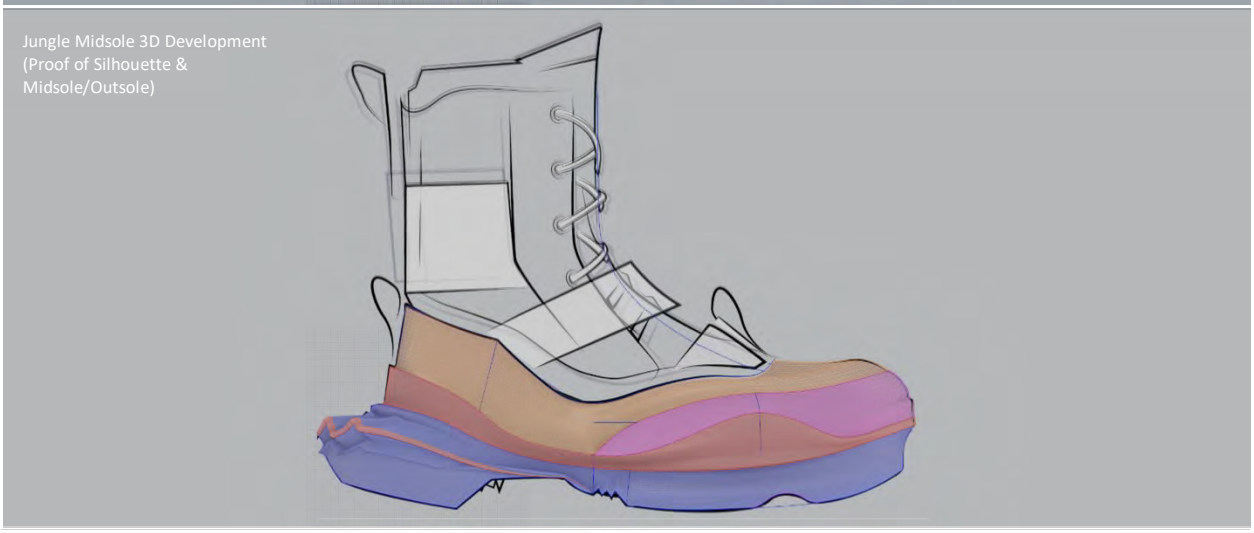
Initial patterning was accomplished for the Over-Boot and significant progress has been done on the Basic Boot upper, as it follows somewhat closely to overall look and feel of current military uppers with various improvements. The implementation of a single thick elastic strap attached to the lace vamp to allow for increased support and resistance when laces are fastened, almost acting like a resistance strap around the back of the ankle which is a weak point for movement within these lightweight uppers. Lacing structure mimics standard combat boots with the first two lacing positions being embedded withing the toe vamp/tongue gusset. This allows for a better flex region, furthermore a more refined layered flexible toe heel counter like the jungle midsole will be implemented to reduce weight while maintain flexibility and structure overall boot upper. These uppers are still in development and will completed week one and week two of Spring Term Capstone SPD 689.

Initial development of 3D Basic Boot was the first step towards proof of fit and functionality of the cage lock system as this is the base for being built upon and layered. Last was made using customized sport properties to provide increase responsiveness and fit. Surfacing the basic boot midsole allowed for proof that it would fit into the jungle midsole cage.

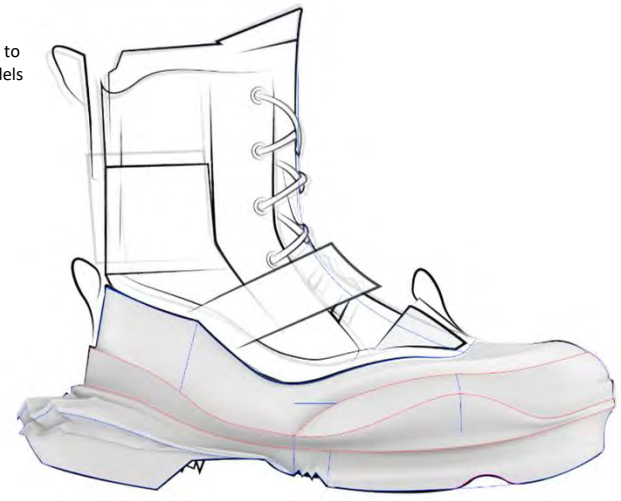


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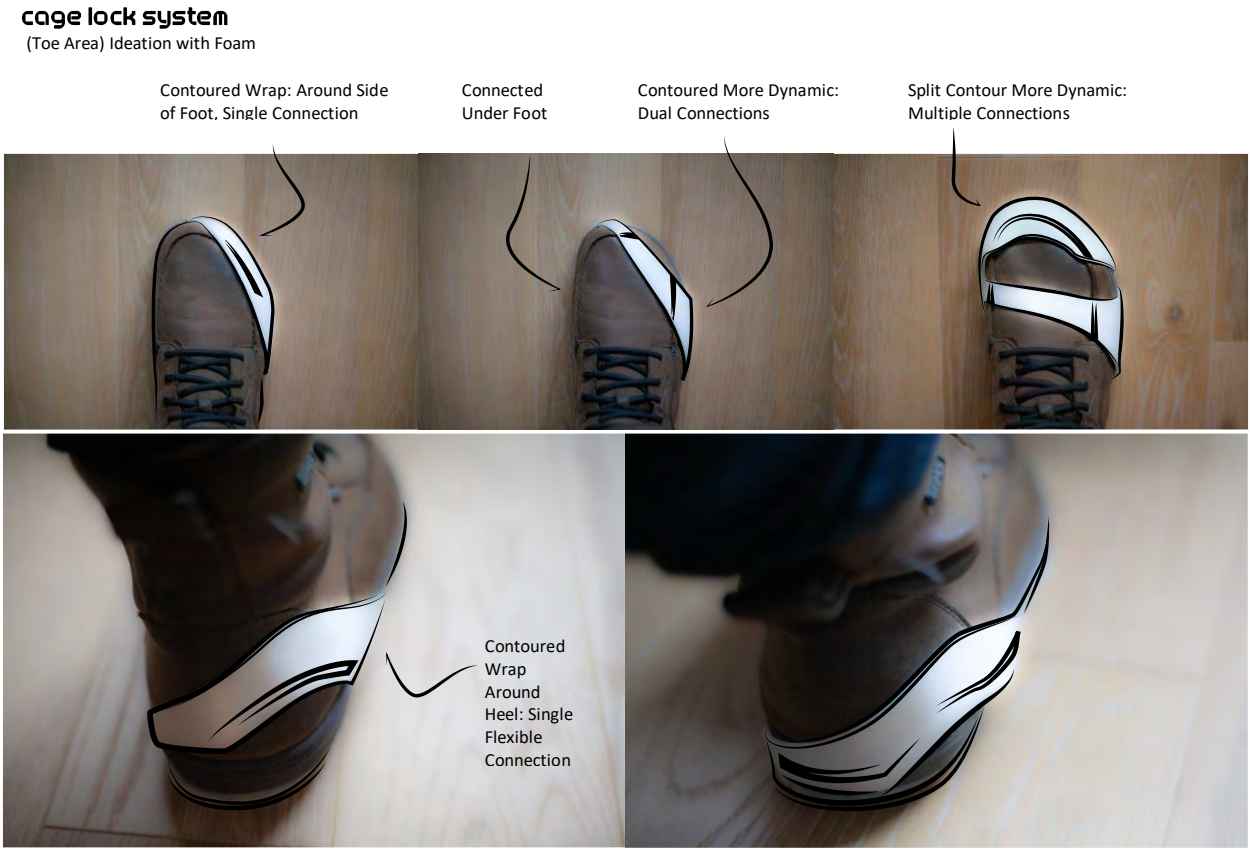




Jungle Midsole 3D Development
(Proof of Fit Around Basic Boot Prior to Design of Cage-Lock Using Both Models As Boundary Surfaces)



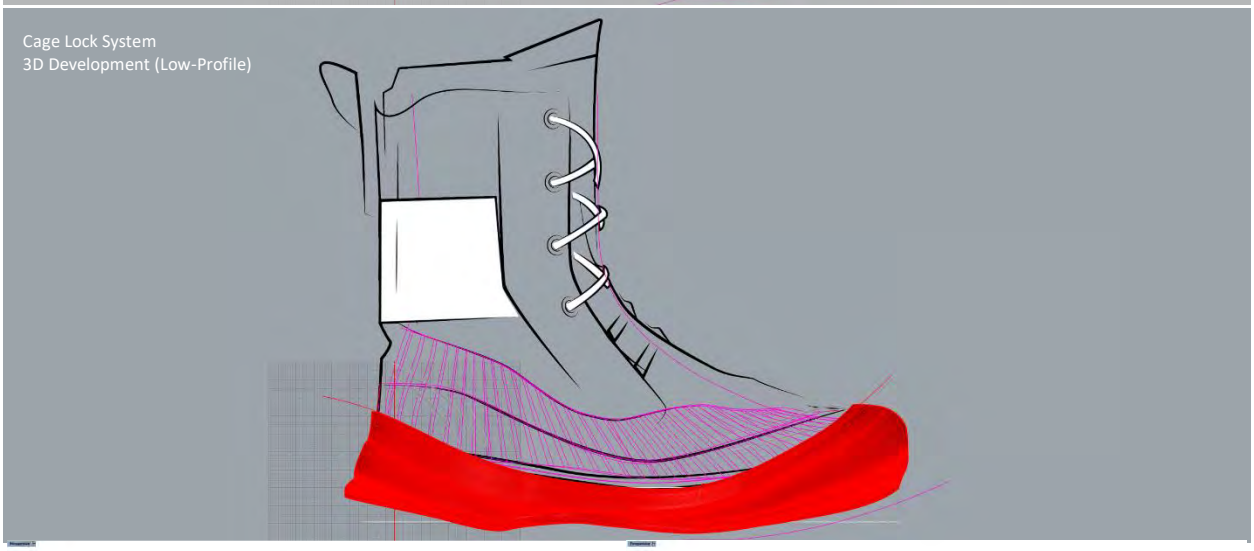
Next steps for 3D development included targeting the proof of concept for the cage-lock system that will fit each shoe model. The cage-lock system needs to contour the foot at both possible locking points at the heel and toe. First thing after sketch ideation was to make some physical models in which a flexible flat pattern would wrap the foot, and at what areas the basic boot would connect into the cage-lock system.



While this method of modelling to achieve the desire form proved to be educational in areas of flex and reflexivity, it did not provide the full shape that I need to make sense of how the connections would work, so I decided to move into 3D to develop a fully formed cage-lock wrap for the boot, layered with thickness in areas of connection. Foam/paper models didn't allow for clear and distinct surfacing direction for further 3D development but using Rhino to achieve the desired shaping around the basic boot 3D model made much more sense.

3D ideation provided substantial advances in form and placement of connection areas on the heel and toe of the outer surface of the basic boot. It provided easy shaping and necessary look into various shapes and flat patterns for assembly as well. Being able to project curves onto the surface of the already develop basic boot in rhino, it was very easy to connect.





Cage Lock System
Rendered/
Perspective

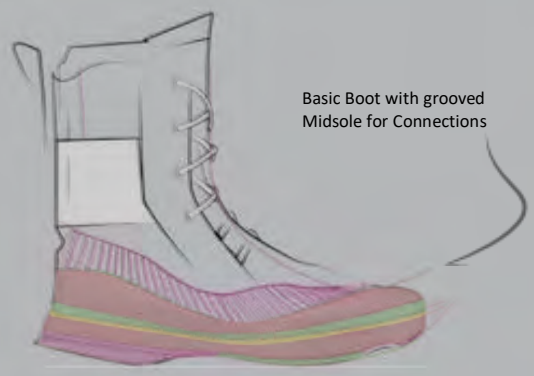


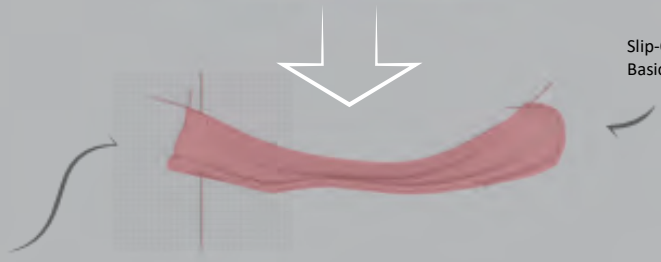


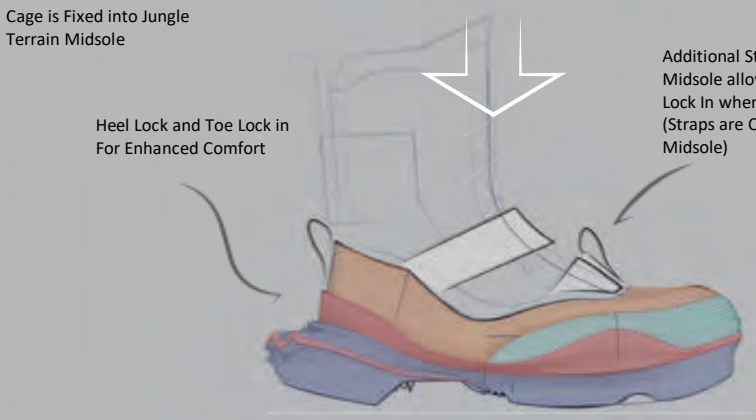
proof of concept

3D Assembly (Basic Boot into Jungle Midsole with Cage Lock System Embedded in Jungle Midsole)

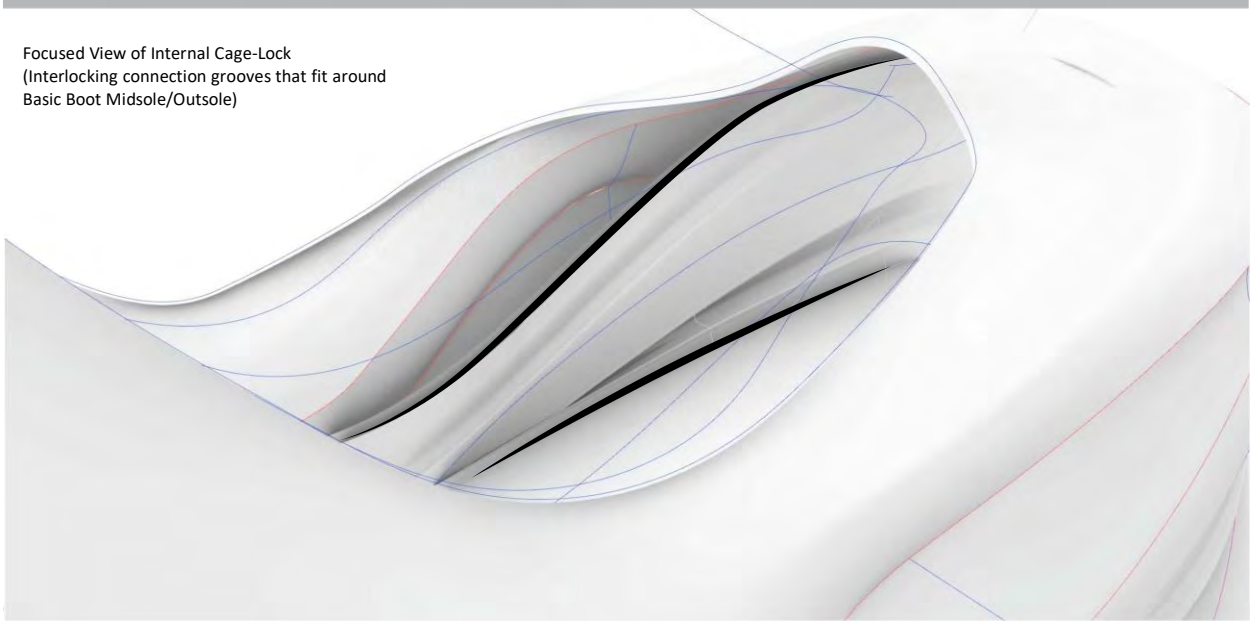
Basic Boot Layering System. Attachment of Jungle midsole using Cage Lock-System







Focused View of Internal Cage-Lock
(Interlocking connection grooves that fit around
Basic Boot Midsole/Outsole)



In order to provide proof of product validation, this project scope commands further development and refinement in several key areas. These include, the cage-lock fit system, further 3D development of this interlocking system needs to be refined for validation that it will provide a more locked-in feel and connects to connectors embedded on the Basic Boot Model. Utilizing 3D printing this will be achieved through 3D development around a printed Basic Boot Midsole and Last to show how the lock system works visually. This system will be the focus of the “operations” line and will be the number one key solve. Furthermore, 3D development into all footwear models in the operations line will need to be refined to confirm and validate fit into this overall system. Flexibility will remain a secondary key solve for this system as well, due to understanding these models need to be responsive and functional for the project scope needs for each environment. 3D printing will be the key to testing all models as well as construction to achieve fully developed footwear models for the full collection. This will allow for validation wear-testing as well down the line with the ability for refinements based on these evaluations.

Furthermore, validation in overall design including uppers, midsole, outsole, as well as the overall system will provide proof of product validation using materials targeting each model key-solves and features. Performance and comfort in all three climate environments will provide proof of product validation, in order to perform this validation all footwear models will need to be made for testing, not necessarily both left and right model but possibly one for wear while wearing another shoe as to provide quick feedback during wear. For final proof of product validation all footwear models will be produced using achievable manufacturing methods as close to high quality/state-of-the-art as possible given the limited resources available for production.

Validation Test Methods: Cage-Lock System (Fit, Functionality) & Tread/Traction (Outsole Plates for Analysis and Testing). A total of two testing methods will be carried out to prove functionality of the overall fit-lock system as well as efficiency and effectiveness of traction for all three footwear operations models as well as the training footwear model conceptualized in the final ideation stage.

The fit-lock cage system will be validated using 3D printing to achieve optimal shape and compatibility with midsoles, as well as ability to lock foot in place at heel and around toe for flexibility without increased rigidity. First and foremost, the basic cage lock design will be 3D printed out of flexible filament to provide the structure needed. Connections on the basic boot will be 3D printed out of more rigid filament to attach to basic boot upper and midsole to provide necessary connection points into the fit-lock cage system. The 3D development should showcase this system and how it would interlock the foot into the midsole, and physical proof will be defined as the cage being able to lock into the boot effectively without adding too much bulk. This system will be implemented in the Basic Boot, Hot/Humid/Wet jungle midsole, as well as in the cold weather over-boot.

Secondary, various tread pattern designs for traction implementation for all footwear models will be developed as 3D print plates for testing on all various climate terrain surfaces to mimic specific environmental conditions. A series of five plates total will be designed with differing tread patterns to utilize across the footwear collection. These plates will mimic those done will in Footwear Studio and done using tools that are available in the Nucleus Lab for data collection. This will allow for vital feedback into which tread/traction pattern to focus in on for each model.

The layout of validation testing of the two methods of testing (cage-lock system for overall comfort/fit and traction/tread) will be conducted using separate methods. As previously mentioned, the cage-lock system will be validated by fit/comfort when wearing by user, thus testing will be conducted on a handful of persons who have the specific foot measurement necessary for sizing into these boot models. Evaluation will be conducted using similar methods to wear-testing having each person evaluate fit and comfort, as well as specific variables such as cushioning and flexibility. Each person who conducts the test will be given a handout of basic questions to enable feedback from wear-testing and overall proof of validation based on key areas and variable that have been solved for. Further validation for overall fit and comfort will be measure by wear by myself in comparison to those models previously analyzed in ideation research. This will allow for clear correlation between proof of solutions in the various problem scopes.

Validation testing for traction/tread will be laid out just as previously identified. A total of five traction/tread plates will be printed and evaluated for overall design and effectiveness. Utilizing 3d printing, and various applicable filament materials, each plate will be printed out of either flexible, semi-flexible, or rigid PLA filaments at 5mm thickness to attach to testing instruments for data collection. Data will be conducted to provide details and analysis into which tread/traction pattern will be proved to be most effective throughout the entire footwear model collection, with various differentiations to provide clear distinctions. Furthermore, implementation of subtle Grasshopper script will allow for easy projection of tread pattern onto surfacing of various midsole and outsole shapes already finished in Rhino. This will allow for refinement and even more detailed tread solutions for each of models.

Work will be marketed using a look-book based upon the presentation deck crated for final winter term presentation and feedback. This process book will highlight all steps of ideation as well as problem scope and research in a visually appealing manner like that already laid out in the presentation deck. This will be a comprehensive look into the whole scope of my project from inception through final design and proof of concept with final physical models. This will allow for easy transition into digital portfolio once it is finalized.

Secondly, I will be making small business cards featuring aspects of this project as a visual image on the side of my card to have for a hand out as well as a small leaflet highlighting the project in a short project scope and summary with final renders and photography highlighting the collection. These marketing materials will be easily printed using online marketplaces and designed by myself utilizing Adobe InDesign and Illustrator skills. The Look book will remain a part of the display unit for final presentation plan and will not be available to be handed out as it will be a more comprehensive book. These materials including the book will rely heavily on final renders and final photography so hoping to get that done with enough time to spare to complete these basic marketing materials for distribution. It will include snapshots of each boot including the features and benefits of each as well as material callouts. On the back will include a comprehensive look at the cage-lock system with callouts for detailed information. Each of these trifold pamphlets will also be included as miniature prints to attach to each shoe along with 3D printed dog tags to highlight the naming and temperature range of each boot for display purposes. This should be a simple process as dog tag files are available online and can easily be manipulated to adding this necessary information. This will be nice addition to display unit and marketing materials as well for those to take with them.

Spring Term Prototyping Plan Calendar
(April-May 2020)

Primary Objectives:
(3D Printing, Upper Development, 3D Midsole/Outsole Development)
Three Uppers, 4 Midsoles/Outsoles, Cage Lock System

april

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
			1 3D Development Over-Boot Last	2 3D Development Over-Boot Last	3 Upper Pattern Basic Boot	4 Upper Pattern Basic Boot
5 Upper Pattern Basic Boot	6 Upper Pattern Basic Boot	7 Upper Pattern Basic Boot	8 3D Development Cage-Lock	9 3D Development Cage Lock	10 3D Development Basic Boot	11 Buffer
12 Buffer	13 3D Printing Basic Boot	14 3D Printing Basic Boot	15 3D Development Jungle Midsole	16 3D Development Jungle Midsole	17 3D Development Jungle Midsole	18 3D Printing Cage-Lock
19 Buffer	20 3D Printing Cage-Lock	21 3D Printing Cage-Lock	22 3D Development Over-Boot	23 3D Development Over-Boot	24 3D Development Over-Boot	25 Upper Over-Boot
26 Buffer	27 Upper Pattern Trainer	28 Upper Pattern Trainer	29 3D Development Trainer	30 3D Development Trainer		

may

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
					1 Pattern Trainer	2 3D Development
3	4 Upper Pattern Over-Boot	5 Upper Pattern Over-Boot	6 Upper Pattern Over-Boot	7 Upper Pattern Trainer	8 Upper Pattern Trainer	9 Buffer
10 Buffer	11 Upper Pattern Basic Boot	12 Upper Pattern Basic - Boot	13 3D Printing Jungle Midsole	14 3D Printing Jungle Midsole	15 3D Printing Over-Boot	16 3D Printing Over-Boot
17 Buffer	18 3D Printing Trainer	19 3D Printing Trainer	20 Assembly Collection	21 Assembly Collection	22 Assembly Collection	23 Assembly Collection
24	25	26	27	28	29	30
31						

Spring Term Validation Plan Calendar
(April-May 2020)

Primary Objectives:
(Cage-Lock System 3D Printed for Comfort/Fit Analysis, Traction/Tread Plate Data Collection)
Cage Lock System and Traction/Tread

april

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19 Buffer	20 3D Printing Cage-Lock	21 3D Printing Cage-Lock	22 System Fit Validation into Jungle Midsole	23 System Fit Validation Basic Boot	24 System Fit Analysis and Refinement	25 System Fit Analysis and Refinement
26 Buffer	27 System Fit Analysis and Refinement	28 System Fit Analysis and Refinement	29 3D Development Cage-Lock	30 3D Printing Cage-Lock		

may

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
					1	2
3	4 3D Develop Traction/Tread	5 3D Develop Traction/Tread	6 3D Development Traction/Tread	7 3D Printing Traction Plates	8 3D Printing Traction	9 Buffer
10 Buffer	11	12	13	14	15	16
17 Buffer	18 Validation Cage-Lock	19 Validation Cage-Lock	20 Validation Comfort/Fit	21 Validation Traction Plates	22 Validation Traction/Tread	23 Buffer
24 Final Analysis	25 Final Analysis	26 Final Deliverables	27 Final Deliverables	28	29	30

Spring Term Presentation Plan Calendar
(May-June 2020)

Primary Objectives:
(Presentation Display, Marketing Materials, Business Cards, Process Book)
Process Book (Illustrated) and Display Dog Tags 3D Printed

may

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17 Buffer	18 Process Book Illustrator	19 Process Book Illustrator	20 Process Book InDesign	21 Process Book InDesign	22 Process Book Review Print	23 Process Book Review Print
24 Display Case Presentation	25 Display Case Presentation	26 Display Case Presentation	27 Marketing Materials	28 3D Printing Display Tags	29 3D Printing Display Tags	30 Process Book Print
31 Process Book						

june

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	1 Assembly Display	2 Assembly Display	3 Final Reviews SPD 689	4 Final Reviews SPD 689	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

Project scope beginning of Spring term saw a major shift in problems solved for as well as problem scope focus. Collection shifted to regulation boot design coupled with over-boot functionality. Focus on pain points of the everyday soldier and gathering sufficient solider survey data to ensure proper direction of focus for problem-solving. Working with my athlete/user to connect problems in current regulation boots to target solutions in materials, construction, and midsole design. Survey conducted of ten soldiers under the command of my athlete, questions ranged from basic pain points to desired features in a combat boot. Results were very beneficial to identifying activities as well as pain points and basic information. In order to properly evaluate avenues for innovation, it was crucial to identify activities, pain points due to these activities, and being able to discern which areas of the foot to target for design implementation.

Results were very straight forward as all responses seemed to be somewhat similar from subject to subject. Soldiers are very knowledgeable about the shortcomings of their equipment as their lives usually depend on what they are wearing and carrying. All survey results are listed below and questions including multiple response are included. Soldiers experience is varied and expertise listed as well. Survey conducted was followed up with athlete testing including fit and feel and activities responsiveness. My athlete, Captain Lindsay Keith, helped facilitate quick and immediate responses to this survey in an efficient manner, and allowed for future validation and testing of the regulation boot as well as the insulated over-boot for both initial acts like prototypes and final prototypes. Without this level of insight and data collection ability, these areas of problem solving would not have been easily identified, the regulation boot focus was the main area of problem solving followed by the over-boot for the updated project direction.

US Army Soldier Survey for Review & Analysis

(Combat Boot Design and Wear Research)

1. Please list your credentials (Rank, Expertise, etc.): *

2. What injuries do you sustain on the foot while wearing your combat boots? *

3. What area of the foot sustains the most injury while wearing your boot? *

- Toes

- Heel (Underfoot)

- Foot Arch (Underfoot)

- Ankle

- Forefoot (Top of Foot)

- Other:

4. Please elaborate on your answer above:

5. What activities are most strenuous while wearing your boot? *

6. What is most important to you when it comes to your boot for daily wear? *

- Lightweight

- Comfort

- Supportive

- Protection

- Durability

- Performance

- Other:

7. In what areas would you improve your current choice of boot? *

- Flexibility

- Weight

- Comfort

- Performance

- Other:

8.Please elaborate to your answer above (i.e. your needs and wants that haven't been met in your current boot):

9. Approximately how long do you wear your boots on any given day? *

- Less than 4 hours

- 4-6 hours

- Longer than 8 hours

10. What do you feel you need the most in your combat boots?

1. Please list your credentials (Rank, Expertise, etc.):

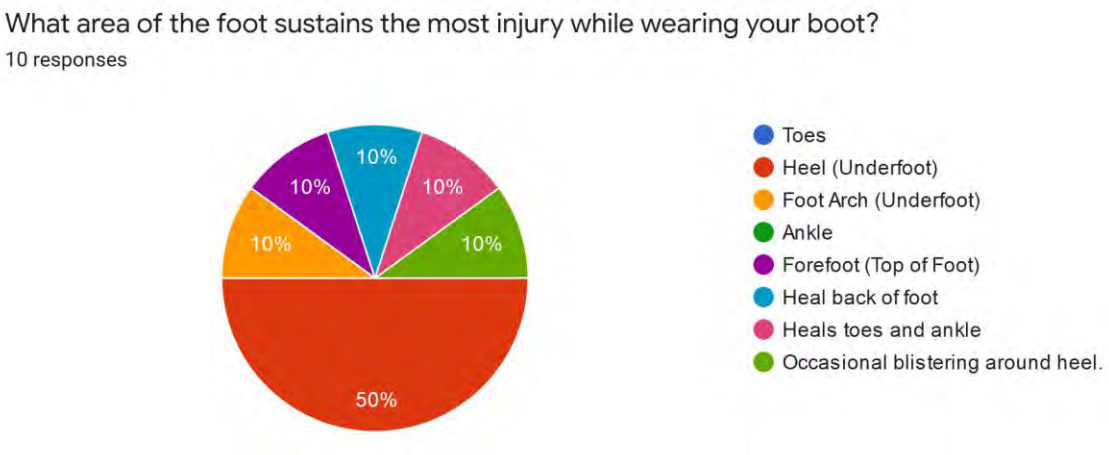
- CPT, Armor Officer, Light Infantry Experience
- CPT, Intelligence
- CPT, BN/BDE staff. Company XO.
- Captain, Infantry Officer, 2 x combat deployments
- I.S. Army, Military Intelligence Officer, CPT, 7 years of service
- 1LT, Active, MI, 5R
- Msg
- CPT, Counterintelligence
- Captain, intelligence Officer, United States Army
- CPT

2. What injuries do you sustain on the foot while wearing your combat boots?

- Hot spots
- Blisters occasionally
- Blisters
- Blisters
- Blisters during ruck marches, narrow foot width of boot causes pain on sides
- Ankle rolls, blistering on fore foot, on back side of heel
- Minor blisters but mostly ankle prone injuries

- Heel blisters / hot spots
- Usually none.
- Blisters during ruck.

3.



4. Please elaborate on your answer above:

- Hot spots on the heel and forefoot on the bottom side towards toes
- I typically get heal blisters
- After extended periods of time or high sweating tasks (rucking) will get blisters on heel
- Long hours of standing and walking generate the most pain to my lower extremities
- When we wear our boots on weekly ruck marches, we are carrying heavy weight for extended mileage. My boots tend to rub the back of my heels a bit, no matter the fit or sock material. These are not new boots; I have had them for 6+ months. I also think

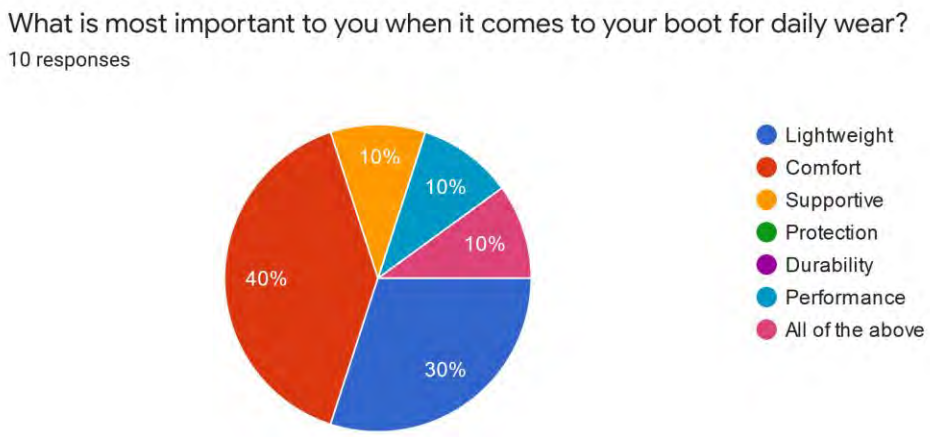
sometimes extended wear can give me cramps in the arch of my foot. On a daily basis, I wear my boots for approximately 10-11 hours a day.

- Blisters. However, ankle rolls are just as prevalent
- Not enough support on most boots with soft durable cushions
- Also, the ball of my foot, towards the center of my foot from my big toe gets hot spots
- Occasional blistering around heal, generally after boots are wet and the duration of the activity is long.
- Large blisters due to the length of ruck.

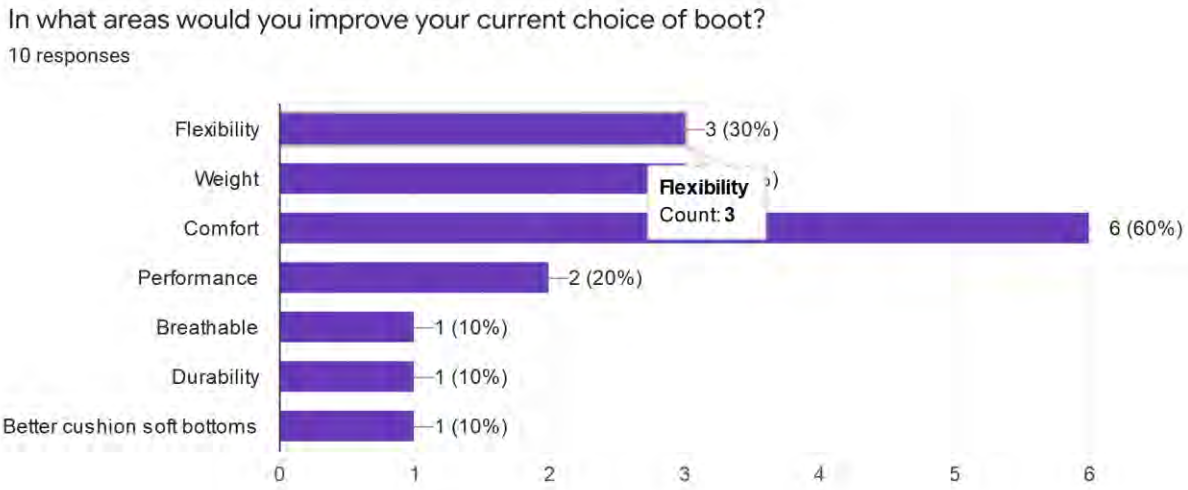
5. What activities are most strenuous while wearing your boot?

- Ruck marching
- Rucking
- Rucking, running.
- Sprinting
- Ruck marches
- Running, quick agility movements
- Walking and foot marches every day.
- Ruck marching
- Running.
- Foot march.

6.



7.

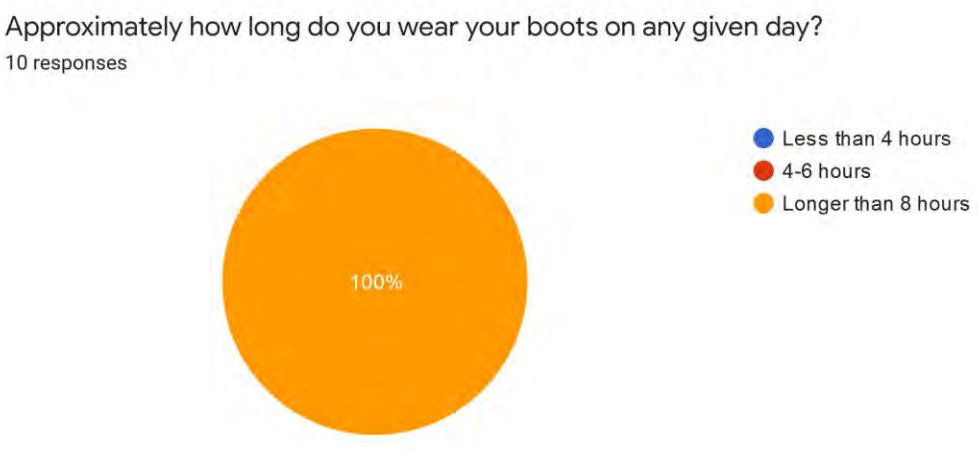


8. Please elaborate to your answer above (i.e. your needs and wants that haven't been met in your current boot):

- My current boots are lightweight and not the most comfortable
- It supports everything except they could be lighter

- I add my own insole to provide comfort. Would change the insole of boot. No air circulation
- Garmont T8s are probably the most durable and comfortable boots on the market but are significantly heavier than the lightweight boots on the market that do not have great tread.
- My boots are pretty light, but don't have great ankle support which is generally okay because I am not conducting daily activity that requires a super supportive boot. I think by the end of my day my feet feel tired, uncomfortable, and hot. It would be useful to incorporate a design that keeps your feet cool.
- More durable material
- See other remarks above
- Lack flexibility for running while rucking
- Boots are mostly stiff and uncomfortable until broken in.

9.



10. What do you feel you need the most in your combat boots?

- Lightweight and comfortable
- Support
- Something that is lightweight, comfortable, and easily breathable.
- Comfort, lightweight, performance and durability
- Something comfortable, that breathes, but doesn't compromise support. I think majority of the time we aren't wearing winter boots, unless you're stationed in Alaska or New York.
- For every day, comfort and breathability
- Better cushions and variety in widths
- The build of an athletic shoe, with the durability of a hiking boot. Salomon boots (not army authorized) are a great example
- Lightweight, breathable, and comfortable.
- Good soles.

Further validation conducted with athlete post survey results to discern problem solving areas and appropriate activities analysis. Areas of focus included heel pain points as well as injuries such as blistering, hot spots, and foot fatigue. Focused activities are ruck marching (loaded foot march), running/walking, and quick agility exercises. Initial prototyping targeted all feedback received from soldier survey as well as expert sources for cold weather utilized in previous project scope iteration.

Initial prototyping and validation covered in process book utilized expert feedback as well as solutions to survey results in following areas of comfort, lightweight, and flexibility. Targeting areas of pain and discomfort to solve for, starting with upper construction and material selection coupled with overall midsole and silhouette design. Validation methods used for final prototypes included fit and feel testing with athlete on site, as well as perception testing with athlete and experts for necessary feedback moving forward. Material selection for final prototypes was recommended from experts contacted through initial stages of feedback as well. Final designs iterate solutions and problem scoped targeted through survey and athlete and activity analysis.

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U.S.ARMY

EXTREME CONDITIONS (CLIMATE ADAPTABLE) FOOTWEAR COLLECTION: STANDARD ISSUE INNOVATION

Analysis of various conditions and applicable adaptable materials as well as possible future scenarios/ innovations, this thesis aims to introduce innovative solutions in US Army issued combat boots for both our servicemen and women.



CLIMATE ADAPTABLE MILITARY: FOOTWEAR COLLECTION

(PROBLEMS/OPPORTUNITIES)





(US ARMY Standard Issue Extreme Cold Weather "Mickey Mouse"/Bunny Boot circa 1975)

"The opportunities for climate adaptable boot solutions continue to arise, specifically, within the areas of training, extreme cold weather and hot/temperate/jungle conditions: It is clear that "Standard-Issue Footwear" options lack innovation in certain sectors and that to rely on COTS (Commerical Off-The-Shelf) for innovative technologies for our modern soldiers is not practical."

Environments:
- **Physical Training/Boot Camp**
- **Extreme Cold Weather (Arctic)**
- **Hot/Temperate/Jungle (Tropical)**

Footwear Collection:
- **Standard Issue Training Sneaker**
- **(ECW) "Bunny Boot"**
- **(JCB) "Jungle Combat Boot"**

A collection of three different military shoe models that are intended for extreme conditions.Each specifically designed for the modern soldier to enable successful operations in various conditions such as: extreme cold weather, hot temperate jungle conditions, as well as physicial training boot camp conditions.



BOOT CLASSIFICATION MATIRX (ARMY)



INNOVATION TIMELINE

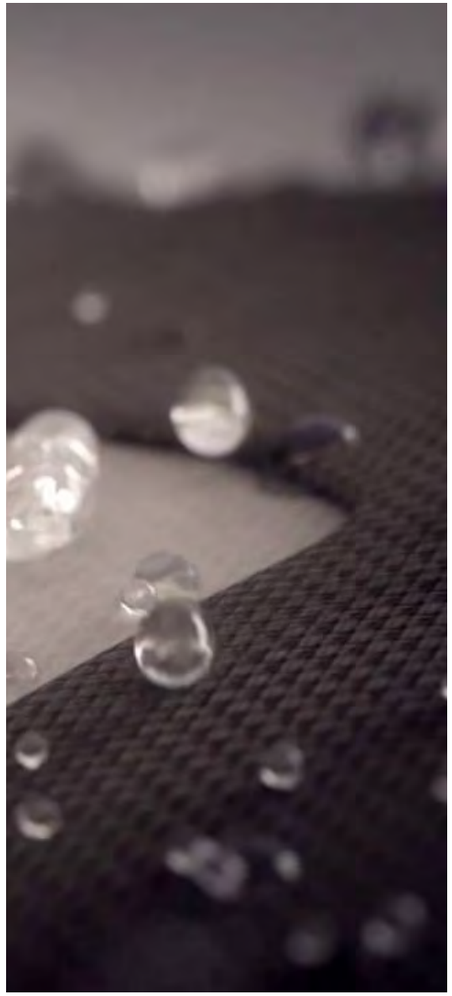


ARMY BOOT REQUIRMENTS & COMPLIANCE: AR 670-1

Research into military combat boot design and classification spans a vast multitude of instances and specifications. Current solutions are tied to historical examples and tradition, however this is chnaging. Military innovation in climate specific footwear shows potential but remains unfufilled.



ATHLETE/USER INSIGHTS



MATERIAL RESEARCH



EXTREME ENVIRONMENTAL CONDITIONS (ANALYSIS)

Neccessary research to further develop solutions for extreme conditions include athlete and user insihgts, this is vital to understanding correct features and the right direction forward. Materials research coupled with further analysis into extreme environmental conditions is paramount for possible innovative solutions.



NETWORKING (MENTORS)



PRODUCT TEAR-DOWN



ON-SITE CLIMATE ANALYSIS/TESTING (ARCTIC/JUNGLE/TRAINING)

The neccessity for further research into current product options (product tear-down to analyze assembly) as well as in context of the various conditions in which these footwear solutions will be applicable.Networking with mentors to further understand possibilities and critique ideas.

HOW WILL FIELD RESEARCH/TRAVEL SUPPORT THE RESEARCH YOU NEED TO CONDUCT?

(MILITARY FOOTWEAR EXTREME CONDITIONS)



PRODUCT VALIDATION



EXPERT/USER INSIGHTS



PRODUCT MARKETPLACE/BENCHMARKING (COTS & STANDARD ISSUE)

Field research and travel will be important to evaluate and gain insights into testing and manufacturing. Testing methods and various benchmarking will allow for a clear path towards innovative solutions for military combat boot design in extreme climate conditions.

TRAVEL PLAN: **(DATES/LOCATION/GOALS/ETC.)**

- (ANME) Army Navy Military Expo, Las Vegas, NV, Rio All-Suites Hotel and Casino (January 19th-21st) (Surplus Footwear/Interviews with Experts)

ANME is a B2B tradeshow that offers goods from the army-navy, tactical & law enforcement, camping & outdoors industries. We pride ourselves in knowing that we offer what other shows can't, an intimate venue where orders can be written.

Goals:
- Product benchmarking (further analysis into Commerical Off-The-Shelf over Standard Issue)
- User insights (Industry experts)

- U.S. Army Combat Capabilities Development Command Soldier Center (CCDC), Natick, Massachusetts (Material & Manufacturing Research/Prototype Validation)

The U.S. Army Combat Capabilities Development Command is the Army's technology leader and largest technology developer. CCDC ensures the dominance of Army capabilities by creating, integrating and delivering technology-enabled solutions to our Soldiers.

Goals:
- Observations of combat boot innovation
- Meet with Design & Prototyping teams to further devlop solutions and validate design

- US Army Jungle Training School Schofield Barracks (East Range Training Complex), Wahiawa, Hawaii (Prototype Validation)

The Jungle Operations Training Course (JOTC) spans 20 (day zero included) days through which students execute a 19 day program of instruction. Subjects focus on jungle mobility training, waterborne operations, combat tracking, jungle tactics, survival training, and situational training.

Goals:
- Enviromental conditions analysis and validation
- Meet with servicemen and women for various interviews

- Northern Warfare Training Center (Cold Weather and Mountain Warfare), Fort Wainwright, Alaska (Prototype Validation)

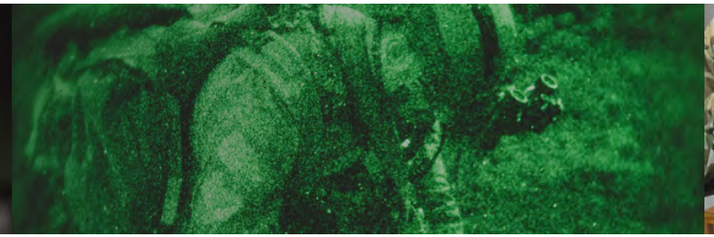
NWTC provides Cold Weather and Mountain Warfare training to US military and designated personnel in order to enhance war-fighting capabilities of US and coalition partners. On order, assists in rescue and recovery operations in the worldwide.

Goals:
- Enviromental conditions analysis and validation
- Meet with servicemen and women for various interviews

- One trip in Winter Term to ANME Surplus Convention to further identify features and benefits that are necessary.
- Trips to combat/training schools and Design Development center for U.S. Armed Forces will take place more than likely in Spring Term.

SUPPLEMENTAL RESEARCH : PRODUCT TEAR DOWN & MATERIALS RESEARCH

(OUTLINE & CALENDAR)




		SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
JANUARY								
JANUARY	Week 2 PROJECT RESEARCH		FIELD WORK FINALIZATION **INDIVIDUAL REVIEWS**	FIELD WORK FINALIZATION **INTITAL RESEARCH STRATETGY**	PROJECT + RESEARCH INVENTORY **PRODUCT INDENTIFICATION FOR PURCHASE**	FIELD WORK FINALIZATION **PURCHASE BASELINE PRODUCTS**	FIELD WORK FINALIZATION **SOLIDER QUESTIONAIRE (ALASKA/HAWAII)**	FIELD WORK FINALIZATION **SOLDIER QUESTIONAIRE (BOOT-CAMP)**
JANUARY	Week 3 PROJECT RESEARCH	FIELD WORK FINALIZATION **MEET WITH EXPERTS**	FIELD WORK FINALIZATION **FIELD/ENVIRONMENT TESTING**	FIELD WORK FINALIZATION **INITIAL ANALYSIS FIT/COMFORT/ETC.**	STUDIO + LAB RESEARCH FINALIZATION **PRODUCT TEAR-DOWN ANALYSIS**	FIELD WORK FINALIZATION **MATERIALS & MANUFACTURING IDENTIFICATION**	FIELD WORK FINALIZATION **TECHNICAL DRAWINGS EXPLODED/LATERAL/ETC.**	FIELD WORK FINALIZATION **FIELD TESTING & PRODUCT ANALYSIS OVERVIEW**
JANUARY	Week 4 PROJECT RESEARCH	FIELD WORK FINALIZATION **MEET WITH EXPERTS**	NO CLASS MLK DAY **INDIVIDUAL REVIEWS**	FIELD WORK FINALIZATION **FINALIZE TEAR-DOWN & MATERIALS ANALYSIS**	RESEARCH REVIEWS **INDIVIDUAL WORK**	FIELD WORK FINALIZATION **INTITAL RESEARCH STRATETGY**	FIELD WORK FINALIZATION **RESEARCH PRESENTATION FINALIZATION**	FIELD WORK FINALIZATION **RESEARCH PRESENTATION FINALIZATION**
FEBRUARY								
FEBRUARY	Week 5 MIDTERM REVIEWS	FIELD WORK FINALIZATION **MEET WITH EXPERTS**	RESEARCH REVIEWS **RESEARCH PRESENTATION FINALIZATION**	---------- **INDIVIDUAL MIDTERM REVIEWS** ----------				
FEBRUARY	Week 6 DESIGN & PROTOTYPE							
FEBRUARY	Week 7 DESIGN & PROTOTYPE							

A collection of three different military shoe models that are intended for extreme conditions.Each specifically designed for the modern soldier to enable successful operations in various conditions such as: extreme cold weather, hot temperate jungle conditions, as well as physicial training boot camp conditions.

RESEARCH UPDATE: PRODUCT SELECTION & MATERIAL IDENTIFICATION

(PRODUCT COLLECTION CATEGORIES)

(US Army Standard Issue Extreme Cold Weather "Mickey Mouse"/Bunny Boot)

Boot Type II

- heavy, bulky, and difficult to pack/carry when conducting dismounted operations, ski/snoeshow
- foot warmth in temperatures down to -60 Fahrenheit



Boot Type I

- oil/diesel resistant rubber, less common, not issued (-20F)



(AR670-1 ARMY Compliant Hot/Temperate & Jungle Combat Boots)

Standard Issue Hot/Temperate Weather & Jungle Combat Boot



The LALO Shadow UCB (Uniform Compliant) AR670-1 combat boot was designed to meet regulation uniform requirements, but more importantly, all day comfort. The Shadow UCB is a durable, lightweight boot purposely made for warm weather environments. It features our signature drainage system to help with as much air circulation as possible to keep your feet as comfortable as they can be.



A new take on an old classic, the LALO Shadow Jungle Combat Boot (JCB) is made for use in land-based operations and wet environments. It features a passive drainage system, which is not designed to keep the water out, but to let it flow in and out of the boot as needed.





(Standard Issue Training/Running Sneaker Boot Camp & Physical Training)

LALO All-Terrain

- Multi-Density EVA Midsole
- Lightweight
- Long and short distances, fast & responsive

The Zodiac Recon All Terrain is an over-sized, rugged running shoe with lightweight component construction and responsive geometry. It provides a quick and responsive ride for off road terrain. The Zodiac Recon AT is suitable for both long and short distance runs, but excels on trails, mixed substrates and road. Due to the construction of the outsole, this is not a shoe for the treadmill.



New Balance 950v2

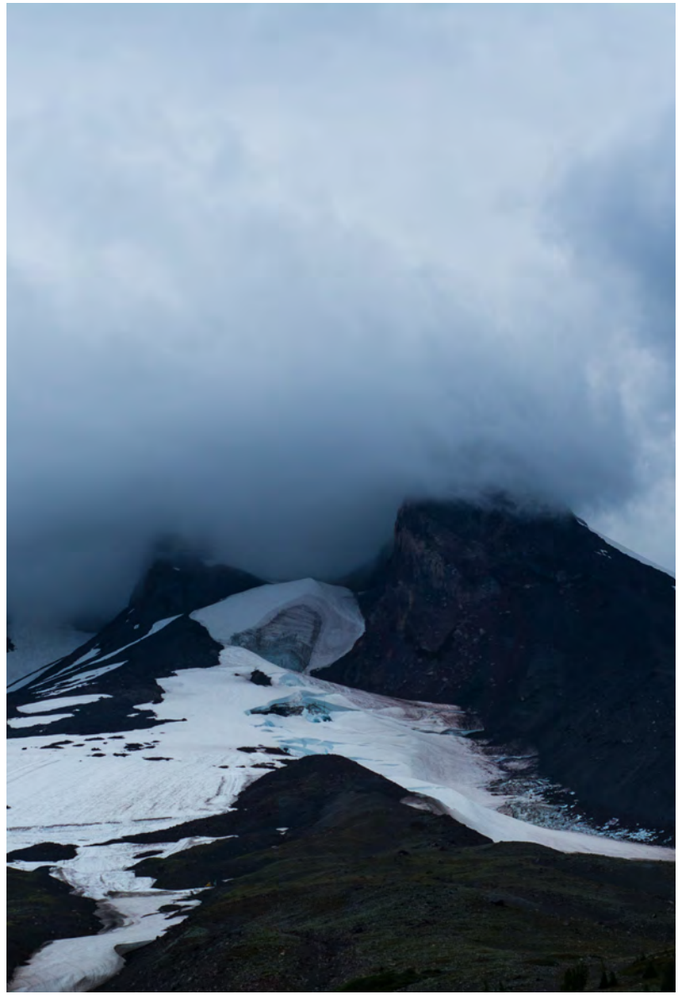
- Contracted shoe design by US military forces for USA Made standard issue for boot camp and training
- 21 Subcontractors needed to make this shoe
- Features and benefits of this design (To be determined)



Product tear down plan: one footwear option from each category designated for initial wear-testing in designated environment as well as complete product tear-down for manufacturing/assembly and materials analysis.
Material identification plan: arrange product tear-down models individually on boards as well as technical drawings for organization (material callouts etc.)

ENVIRONMENT IDENTIFICATION: PRODUCT TESTING & ANALYSIS

(TARGET LOCATIONS)



Extreme Cold Weather (Snow/Ice/etc.)
Mt. Hood



PT (Physical Training)
Portland (All-Conditions)



Standard Issue Boot (Hot/Temperate/Wet/Jungle)
Wildwood Trailhead

Environment field testing plan: inital wear testing for each footwear option in each specific enviromental condition (develop standard report to be able to record and anlayze clear variables and identifiers for further analysis)
Examine conditions to identify various variables that woudl effect the user, product photography and videos etc.

INDUSTRY EXPERTS: BRAND TARGETING

(NETWORKING/MENTORS)



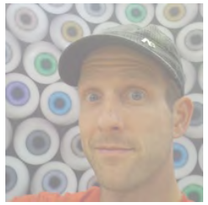
Jared Sapp
Science Advisor to US Army Alaska at U.S. Army Research Development and Engineering Command

- Initial Introduction
- Organize Soliders for Questionaire on Basic Extreme Cold Weather Operations & Conditions
- Schedule visit to Natick Soldier Center for future Validation Testing and Qualititative Research (TBD)



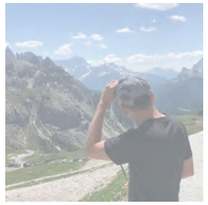
Cameron Kinder
Product Manager at LALO Tactical

- Initial Introduction
- Target Brand for Benchmarking and Materials & Manufacturing
- Meet for Interview (TBD)



Michael Maggs
Director of Innovation at Vibram Group

- Midsole/Outsole Identification
- Environmental Conditions - Basic Questions
- Design Innovation discussion



Johnathan Swegle
Footwear Engineer at W. L. Gore & Associates

- Materials Workshop January 23rd 3-4pm
- Materials Acquisition for Capstone Project
- General questioning and education on military textile options

Meet with Industry experts to discuss innovative solutions for capstone direction and current market options.
Brand targeting for product selection and identification: soldier insights as well as environment specific conditions and insights.

INDUSTRY EXPERTS: NEXT STEPS

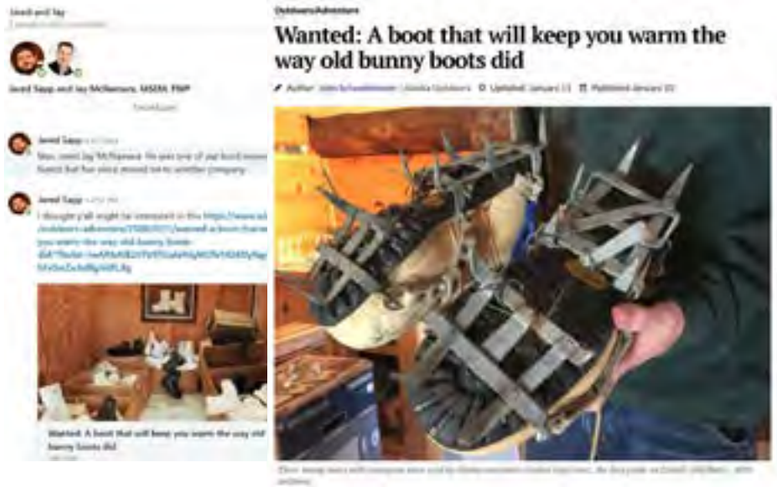
(NETWORKING/MENTORS)



Jared Sapp
Science Advisor to US Army Alaska at
U.S. Army Research Development and Engineering Command
- Organize Soliders for Questionaire on Basic Extreme Cold Weather Operations & Conditions
- Schedule visit to Natick Soldier Center for future Validation Testing and Qualititative Research (TBD)



Jay McNamara
Extremity Protection Project Engineer, Engineering Psychologist
U.S. Army CDCC Soldier Center
- Setting-up interview/phone call for questions into Extreme Cold Weather Boot development
- Connection for possible visit to Natick Solider Center





Cameron Kinder
Product Manager
LALO Tactical
- Discussion on LALO brand and regulation JCB combat boots
- Discuss technologies and innovations within the space (questionnaire)





Michael Maggs
Director of Innovation
Vibram Group
- Environmental Conditions - Basic Outsole Conditions
- Design Innovation discussion



Meet with Industry experts to discuss innovative solutions for capstone direction and current market options.
Brand targeting for product selection and identification: soldier insights as well as environment specific conditions and insights.

CLIMATE ADAPTABLE MILITARY: FOOTWEAR COLLECTION

(SHOE MODEL IDENTIFICATION)

PHYSICAL TRAINING/BOOT CAMP	HOT/TEMPERATE/WET/JUNGLE (JCB)	EXTREME COLD WEATHER (ECWB)
	 	
New Balance 950v2 (Size 11)	ROTHCO Vietnam Era Jungle Boot (Size 10, Runs One Size Large)	BATA "Bunny Boot" Type II (Size 11, Half Size Smaller)
- Contracted shoe design by US military forces for USA Made standard issue for boot camp and training (21 Subcontractors)	- Outdated design from vietnam era warfare, breathable, water resistant, etc. (Vibram Panama Outsole)	- Heavy, bulky, and difficult to pack/carry when conducting dismounted operations, ski/snoeshow
Activities, Operations Performed etc:		
Boot Camp/Physical Training (PT) - Physical Preparation - Reception Battalion (Total Control) - Standing Guard Duty - Weapons and Combat Training - Victory Forge (Final 3 Day Field Journey)	Lightning Academy Jungle Combat Training School - Basic Jungle Survival Skills (Food, Water, Shelter) - Waterborne Operations 	Northern Arctic Warfare Training Center - Basic Arctic Survival Skills (Food, Water, Shelter) - Military Skiing - Military Snowshoeing 
Variable Conditions: - Dry, Temperate - Sand, Concrete, All-Terrain	Variable Conditions: - Muddy, Slippery/Steep Terrain - Wet, Damp - Never Dry	Variable Conditions - Freezing Temperatures (Vapor Barrier) - Snow, Ice, Water

A collection of three different military shoe models that are intended for extreme conditions.Each specifically designed for the modern soldier to enable successful operations in various conditions such as: extreme cold weather, hot temperate jungle conditions, as well as physicial training boot camp conditions.

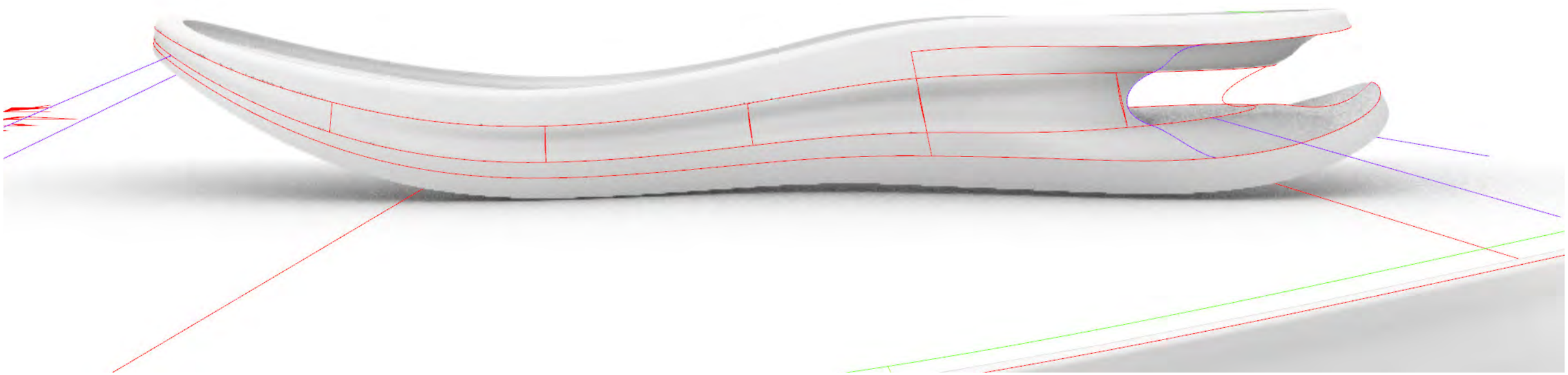
U.S. ARMY CLIMATE FOOTWEAR COLLECTION: MILITARY COMFORT/PERFORMANCE INNOVATION by MAX BRAZO

Analysis of various conditions and applicable materials as well as possible future scenarios/ innovations, this thesis aims to introduce innovative solutions in US Army issued combat boots for both our servicemen and women.



PROJECT ASPIRATIONS: FOOTWEAR/COMPUTATIONAL DESIGN

(PROFESSIONAL ASPIRATIONS)



Footwear Design (Concept Ideation - Prototyping - 3D CAD - Product Rendering - 3D Printing/Scanning - Validation)

- Continue to develop as a designer specifically in the field of footwear design
- Develop of fully formed project from concept through final design that showcases my technical understanding and apptitudes.

Computational Design (Intro)

- Introduction to Grasshopper
- Focus on traction patterning

Continuing to pursue possibilities in footwear design as a profession, this project aspires to showcase my technical understandings and ability to solve complex problems. This will be the accumlation of everything I have learned in Sports Product Design thus far.

Environment field testing plan: inital wear testing for each footwear option in each specific enviromental condition (develop standard report to be able to record and anlayze clear variables and identifiers for further analysis) Examine conditions to identify various variables that woudl effect the user, product photography and videos etc.



- Peter Martin Richmond Walton
(Royal Air Force Reserve, Fighter Jet Pilot. Lifelong Pilot and Aviation Expert. Flew jets longer than anyone)



- Bruce Allen Brazo
(US Army Military Police, Served in Japan during WWII Occupation, was 17 years old at the time)



- George Jeffery Keith
(Norwich University, US Army 2nd Lieutenant. 4 Years Schweinfurt, Germany)



- Mark Stillman Keith
(Retired Lieutenant Colonel US Army, served 20+ years. First deployed in Desert Shield at age 23.)



- Lindsay Francis Faith Keith
(US Army Intelligence, rank of Captain. About to begin 3rd deployment to Afghansitan.)

Inspired by family service in the United States Armed Forces and British Royal Air Force, this project aims to combine my understandings and technical knowledge of footwear design and innovation to further develop solutions for our soliders in uniform.

It is clear from that footwear options for our soldiers are completely outdated and inefficient for the modern soldier's needs. Most, if not all of these enlisted servicemen and women have utilized the same combat boot technology as was used in wars as far back as Vietnam.

THE CURRENT MILITARY FOOTWEAR MATRIX: TEMPERATURE

(RESEARCH INSIGHTS)

-60°F | 32°F | 120°F

Extreme Cold | **Cold** | **Temperate** | **Hot / Humid / Wet**

Extreme Cold Weather Boot (ECWB)
-60F to -20F



(-20F to 14F)

Intermediate Cold/Wet Boot w/ removable liner (ICWB)
14F to 32F



Temperate Weather Army Combat Boot (TW ACB)
> 32F



Hot Weather Army Combat Boot (HW ACB)
> 70F



Hot Weather Flame-Resistant Army Combat Boot (HW FR ACB)



KEY

- Wet/Rainy
- Mountainous
- Standard
- Snow
- Hot/Dry
- Hot/Wet/ Humid

Alpine Comabt Boot



Evaluate in AK
FEB-APR 2015

Temperate Weather Mountain Combat Boot (TW MCB)



Hot Weather Mountain Combat Boot (HW MCB)



Tropical Jungle Boot
SEP
25th ID JOTC
2FY2015



The current theater of war in the Middle East over the past decade has seen many advances in hot and temperate weather combat boots as it is very climate specific.Mianly desert environment, thus innovation in other temperature categories has been close to none.







Warming of Arctic Circle (Militarization & Control)

- Warming ice sheets allow for more explorationa nd intervention in the Artic (Land claims and waterways)
- Constant echoes of Cold War, Alaska will be new front lines.
- Combat Boots for this Climate Condition have not been updated since the 1970's

South China Sea (Pacific Trade Routes)

- Increased military intervention withing the South China
- Vital trade routes (artificially constructed islands, jungle conditions)

Berry Amendment

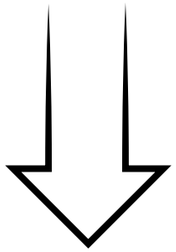
- Made in USA
- Security of domestic design methods and manufacturing

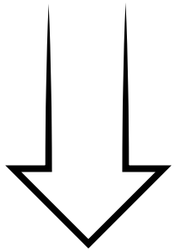
The U.S. Army has been making strides in order to adopt more sought after comabt boot models for standard issue. Currently soldiers are choosing notable footwear brands over Standard Issue because Commercial Off-The-Shelf options are way more comfortable and flexible allowing for ease of use during everyday operations and training.

“Soldiers live in their boots and many will tell you that there is no piece of equipment more important to their lethality and readiness; Most components of these combat boots have not been updated in almost 30 years...”

- Al Adams, TL, Natick Soldier Center

DURABILTY + PROTECTION + COMFORT





Standard Military Issue

C.O.T.S (COMMERICIAL OFF-THE SHELF)

The U.S. Army has been making strides in order to adopt more sought after comabt boot models for standard issue. Currently soldiers are choosing notable footwear brands over Standard Issue because Commercial Off-The-Shelf options are way more comfortable and flexible allowing for ease of use during everyday operations and training.





BERRY AMENDMENT COMPLIANT

USER(S): U.S. ARMY SERVICE PERSONNEL

SPORT: TRAINING/ OPERATIONS/ETC.

The opportunities for innovative boot solutions continue to arise, specifically, within the areas of training, cold weather and hot/ temperate/jungle conditions: It is clear that 'Standard-Issue Footwear' options lack in comfort and performance.

Simply put: today's soldiers dont have the neccessary footwear solutions for their specific wants and needs.Soliders opt to buy Commercial Off-The SHeelf brands because they are more comfortable and flexible and allow for greater range of motion and enhance feel.

ENVIRONMENT IDENTIFICATION: CLIMATE CONDITIONS

(TARGET LOCATIONS)



Rough All-Terrain

Standard Issue Boot Camp - Temperate Weather

- Uneven terrain, rocky & unstable
- Need traction and stability for all-terrain

Over-Snow Mobility

Vapor Barrier - Intermediate Cold/Wet Weather

- Staying dry and warm in freezing temperatures
- Mobility and sustainment

Jungle/Wetlands

Quick Dry - Jungle/Tropical/Hot/Humid

- Always wet, rarely dry
- Steep, slippery terrain, hard to navigate

Moderate
(40°F - 60°F)

Sub-Zero
(-30°F - 0°F)

Hot/Humid
(60°F - 90°F+)

Three climate conditions in which there has been little to no invvoation in the last 30-50 years. These environments are becoming increasingly important, soldiers deployed into these climate specific areas do not have the optimal footwear for neccessary activities and temperatures

ENVIRONMENT IDENTIFICATION: CLIMATE CONDITIONS

(TARGET LOCATIONS)

Rough All-Terrain

Temperate Weather Army Combat Boot (TW ACB)
> 32F



(40 F - 60 F)





Extreme Cold Weather

Extreme Cold Weather Boot (ECWB)
-60F to -20F

(-30 F - 0 F)



Jungle/Hot/Humid

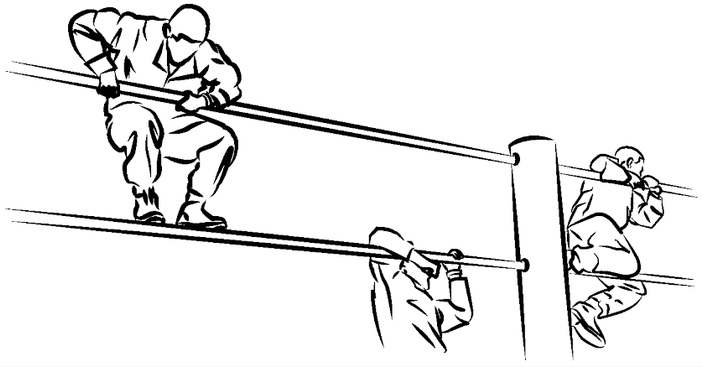
Tropical Jungle Boot
SEP
25th ID JOTC
2FY2015

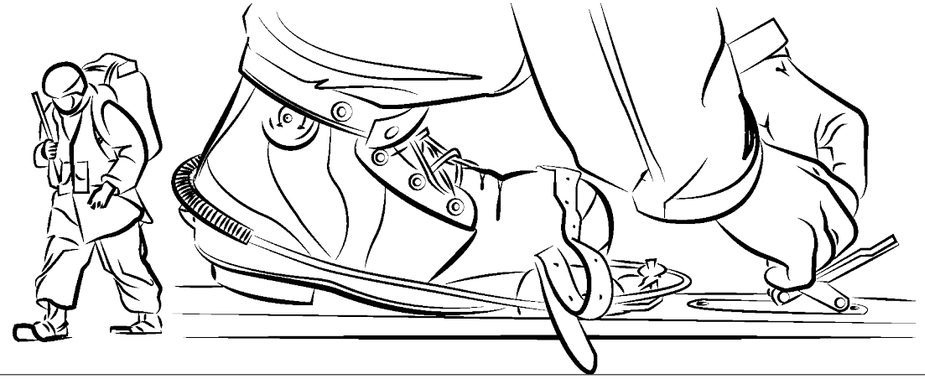
(60 F - 90 F+)

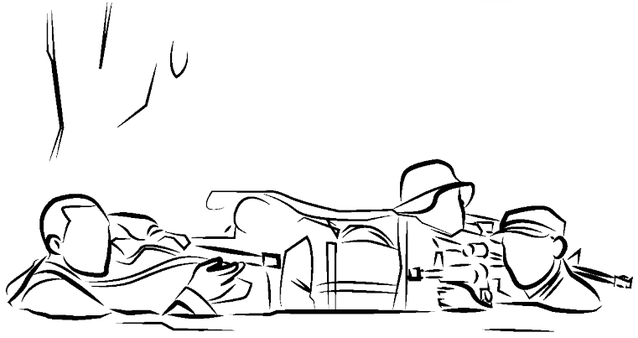
MODEL: 950v2 (Made In USA)
BRAND: New Balance
SIZING: 11M
WEIGHT: 10.5 oz

MODEL: VB Type II
BRAND: AirBoss
SIZING: 11R
WEIGHT: 56 oz. (3.5 pounds)

MODEL: Vietnam Era JCB
BRAND: Rothco
SIZING: 10R
WEIGHT: 48 oz. (3 pounds)







PRODUCT WEAR TESTING: CLIMATE CONDITIONS

(TARGET LOCATIONS)



Rough All-Terrain

- Toe and ankle took some injuries
-Really geared towards running and not other activities
- Not very protective, not any differnent from trainers on the market

Over-Snow Mobility

- Like wearing cement blocks on your feet
- Very comfortable initially, until the 2 hour mark
- In optimal temperatures, this boot is mainly to keep from frost-bite, in temperatures closer to -30 - 0 degrees these boots are not optimal

Jungle Traction & Navigation

- Immediately clear these boots are outdated (materials, construction)
- Steep, slippery terrain, hard to navigate
- Traction was great for such an outdated design
- Do not wear well out-of-box (foot injuries/blisters from stiff material and full-grain leather

Environment field testing: 24 hours in each footwear specific model in each specific temperature climate and conditions. Rough All-Terrain was tested on the streets of Portland between days testing Extreme Cold and Hot/ Humid Temperatures. Trillium Lake Snowshoe Trail and Portland McLeay park Trails were utilized for this testing.

INITIAL PRODUCT WEAR TEST: REVIEW

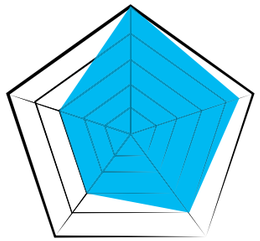
(BASELINE BENCHMARKING)



Wear-Test Trait Scoring



Trait-Relationship Index



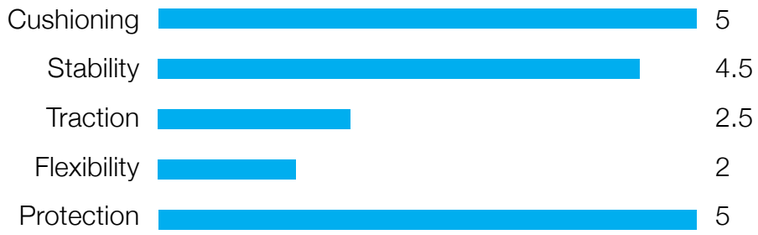
Foot Mapping:

- Pain/ Discomfort
- Slippage
- Areas of Traction

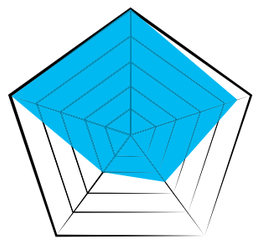




Wear-Test Trait Scoring



Trait-Relationship Index



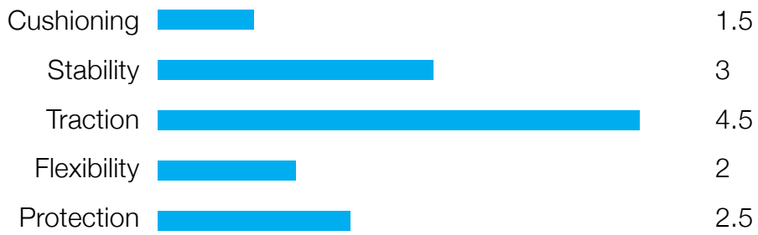
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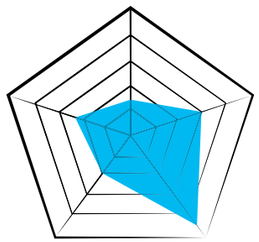




Wear-Test Trait Scoring



Trait-Relationship Index



Foot Mapping:

- Pain/ Discomfort
- Slippage
- Areas of Traction



INDUSTRY EXPERTS: PROOF OF LIFE

(NETWORKING/MENTORS)



Ret. Lieutenant Colonel Mark Keith
U.S. Army (30+ years)
Olympia, Washington

"Preparation is key. Without knowing your environment you cannot function or plan accordingly."


FW: POCs at Northern warfare training center (UNCLASSIFIED)

Keith, Mark S CIV USARMY I CORPS (USA) <mark.s.keith2.civ@mail.mil>
to maxwell.brazo@gmail.com
Wed, Dec 18, 2019, 1:36 PM

CLASSIFICATION: UNCLASSIFIED

Max, I don't have any good contacts for the US Army Natick Soldier Systems specifically the US Army Combat Capability development command Soldier Center which I believe would work boots. Appears they have some form of linkage with Harvard and therefore should have a method by which you could request a visit. Below is a contact (science advisor) for Alaska. He hasn't responded to me yet but appears they would be receptive. Still working Hawaii. Army is on 1/2 schedule for the holidays so very likely I won't get good info until next year.

Mark S. Keith
I Corps G33, DAC
Global Force Management
Comm: (253) 477-1142
DSN: (312) 477-1142



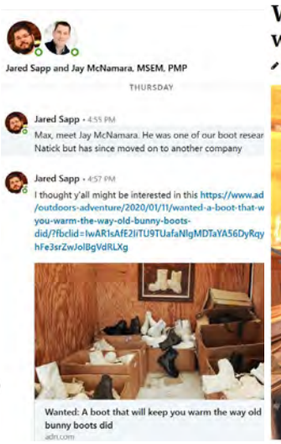
Jared Sapp
Science Advisor to US Army Alaska at
U.S. Army Research Development and Engineering Command

"In terms of energy expenditure or calories burned, 1-pound of weight at the feet is equivalent to 4-pounds in your rucksack."



Jay McNamara
Extremity Protection Project Engineer, Engineering Psychologist
U.S. Army CDCC Soldier Center

"In a poll of 14,000 soldiers, the Army said it found that nearly 50 percent choose comfortable sneaker-like commercial boots..."


Jared Sapp and Jay McNamara, MSEM, PMP

THURSDAY

Jared Sapp • 4:55 PM
Max, meet Jay McNamara. He was one of our boot resear
Natick but has since moved on to another company

Jared Sapp • 4:57 PM
I thought y'all might be interested in this https://www.ad
/outdoors-adventure/2020/01/11/wanted-a-boot-that-w
you-warm-the-way-old-bunny-boots-
did/?fbclid=IwAR1sAfE2liTU9TUafaNlgMDTaYA56DyRqy
hFe3srZwJolBgVdRLXg

Wanted: A boot that will keep you warm the way old bunny boots did
adn.com


Wanted: A boot that will keep you warm the way old bunny boots did

Author: John Schandelmeier | Alaska Outdoors Updated: January 11 Published January 10

These bunny boots with crampons were used by Alaska mountain climber Ray Genet, the first guide on Denali. (Bill Roth / ADN archives)



Cameron Kinder
Product Manager
LALO Tactical

"Jungle conditions are unforgiving, the JCB should be able to allow the soldier to overcome while retaining basic functionality."


Cameron Kinder 1st
Product Manager at LALO Tactical

TUESDAY

Max Brazo • 8:53 AM
My name is Max Brazo and I am a graduate student at UO in Portland studying Sports Product Design. I'm working on my thesis looking into solutions for military footwear in extreme climate conditions (ECWB, JCB, etc.) hoping to possibly connect to ask some general questions about LALO!

Cameron Kinder • 8:56 AM
Sure- shoot me an email or give me a call. Cam@lalo.com
503-560-7072. Available anytime tomorrow.





Johnathan Swegle
Footwear Engineer
W. L. Gore & Associates

"Innovation in insulation and layering of material has shown promise for cutting down weight and adding flexibility."

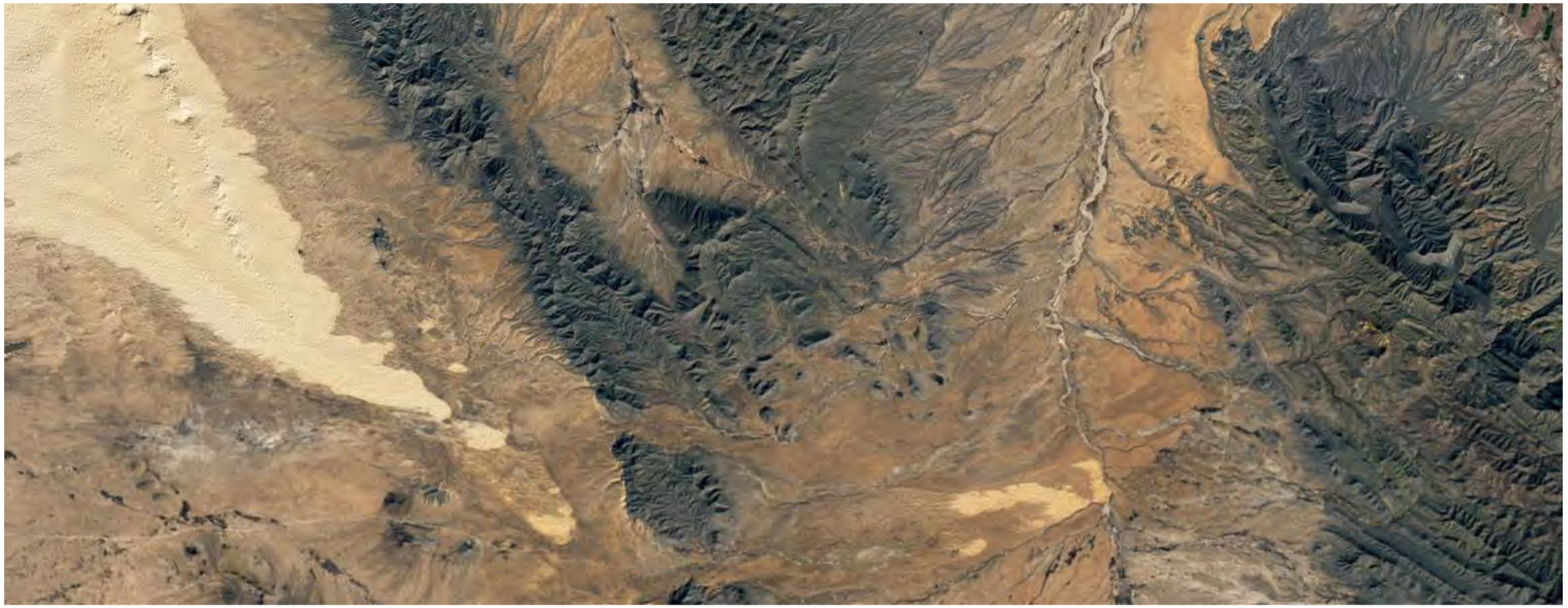


Temperate Weather Army Combat Boot (TW ACB)

> 32F



(40°F - 60°F)



RETAIL:	**$150.00**
FOB:	**$37.50**
RELEASE:	**FALL 2024**

FEATURE(S):

- Lightweight
- Flexible
- Durable All-Terrain Midsole/Outsole
- Vapor Permeable
- Protective Upper
- Supportive Sneaker-Boot Silhouette

BENEFIT(S):

- Weight Ratio
- Performance Driven
- All-Terrain Training Capabilities
- Ankle Support Protection from Injury
- Enhanced Feel & Traction

Physical Training/Boot Camp for US Army Personnel: Redesigned sneaker-boot silhouette to aide in support and comfort while retaining all-terrain attributes sutiable for running, obstacle course training, weight lifting and everday wear and tear of military life.







Multi-Density EVA Injection Molded (Flexible)

- Durable protection/cushioning over uneven terrain
- Flexibility and support where need, toe and heel protection

Standard US Army Colorway

- Army Regulation Colorway (Boot Camp)
- Natural Earth Tones based on training environment

Abrasion/Puncture/UV Resistant

- Protection from elements
- Durable materials that wont tear or puncture from increased physical activity

Standard Military Issue Training Sneaker-boot: Should be able to withstand daily training regimen as required during initial Boot Camp entry, as well as be comfortable and flexible enough to keep you on your feet thourgh everyday wear and tear.

Extreme Cold Weather Boot (ECWB)

-60F to -20F



(-30°F - 0°F)



RETAIL: $200.00

FOB: $50.00

RELEASE: WINTER 2025

FEATURE(S):

- Enhanced Traction (Slippage)
- Vapor Barrier Protection
- Enhanced Lacing for Support
- Updated Silhouette for Comfort
- Over-Boot Functionality

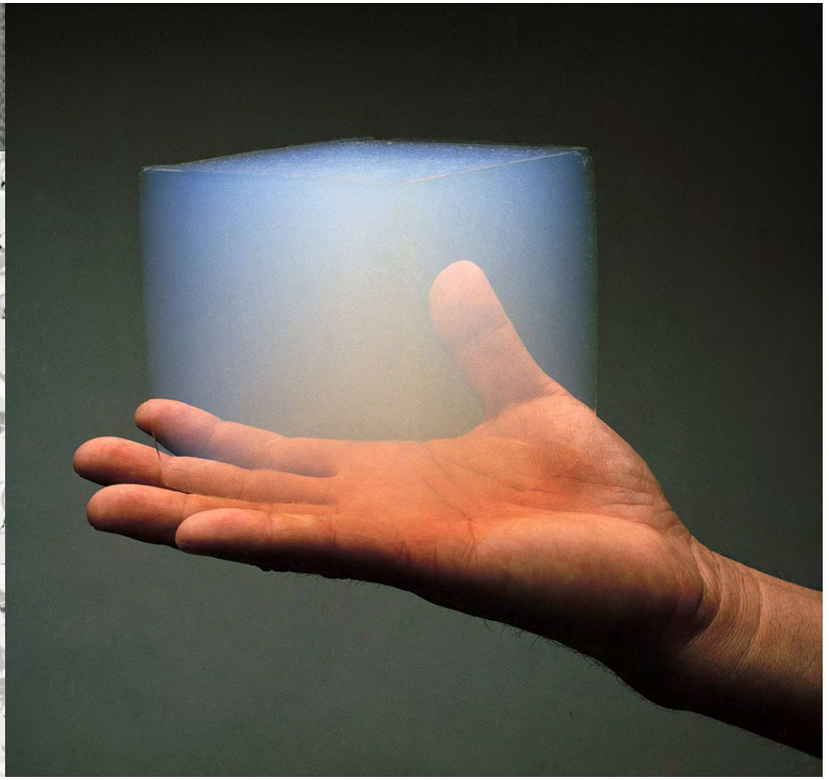
BENEFIT(S):

- Enhanced Over-Snow Mobility
- Protection from Low Temperatures
- Enhanced Feel and Flexibility
- Layered Optimization
- Thermal Weight Ratio

Extreme Cold-Weather Overboot: Over-Snow Mobility and Sustainment, allowing for enhanced adaptability to adjust to fluctuating temperatures. Lightwr weight silhouette and materials allow for ease of wear and utilization.







Heat/Vacuum-Sealed Upper(Vapor Barrier)

- Blocks mositure from getting inside boot (barrier from elements)
- Layered material heat/vacuum sealed for enhance insulation

Disruptive Over-White

- Blending into snowy environment
- Muted Off-White Colors (Disruptive)

Aerogel Thermal Insulation

- Next-Gen Insulation (Weight Ratio and increased Vapor Protection)
- Layered and moldable to allow for slimmer profile with same thermal protection properties

Innovative material adaptability, protection from extreme cold and arctic terrain. Over-boot design will allow for layering system to remain "comfortably cool" even in the most extreme temperatures, and allows for snowshoe and ski attachments. Colorway blends into the surrounding environment.

Tropical
Jungle Boot

SEP
25th ID JOTC
2FY2015



(60°F - 90°F+)



RETAIL: $175.00

FOB: $43.75

RELEASE: SPRING 2025

FEATURE(S):
- Water Drainage/Flow
- Flexible Upper
- Lightweight Midsole
- Enhanced Traction
- Responsive Materials & Construction
- Updated Silhouette/ Lacing System

BENEFIT(S):
- Increased Ventilation/ Drainage/Airflow
- Comfort/Performance Driven
- Injury Prevention
- Ankle Support Protection
- Tighter Fit

Jungle Combat Boot has not seen effective innovation in material choice and overall comfort and fit, outsole traction pattern is similar to what is used today with very minor adjustments. Enhanced traction, comfort and fit will allow for greater ease of use and adaptability in the jungle environment.



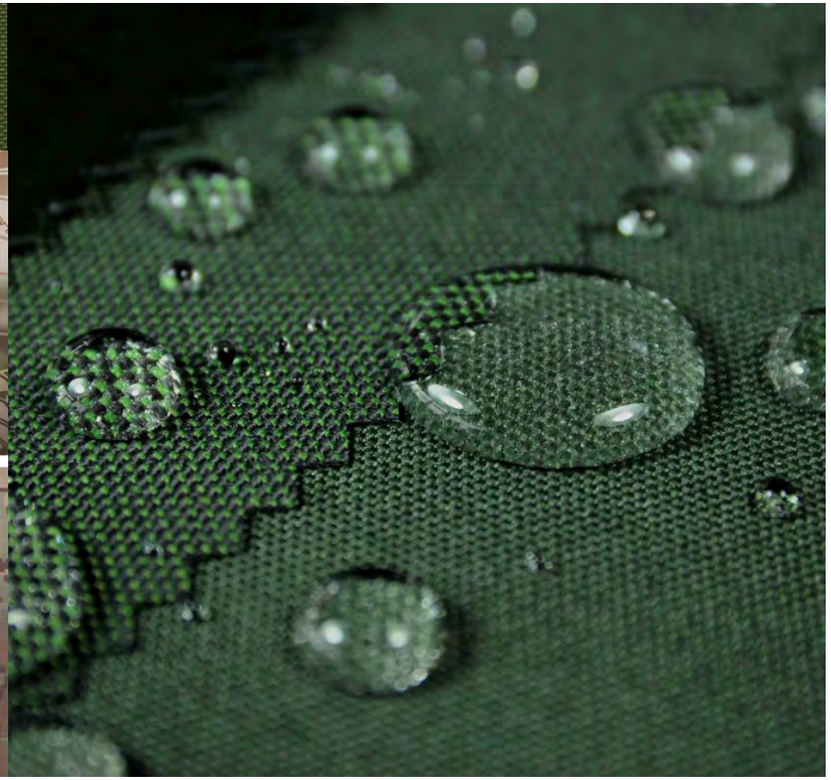
3D Printed Midsole Lattice (Water Drainage)

- Allow for water to flow in and out of shoe effectively
- Cut down on overall-weight and add flexible cushioning



ACUPAT or Digital Camouflage

- Adapted Jungle Camoflauge/ Basic
- Computational Design (Grasshopper Cell Patterns)



Water Repellant/Moisture Wicking

- Synthetic/Natural Full-Grain Leather & Nylon (Cordura)
- Repel moisture and allow for breathability

Material choice and manufacturing will be key in being able to innovate in this Jungle Combat Boot space and environment. JCB boots are very basic and out of all footwear models tested are the least condusive to proper soldier vitality and operation.

IDEATION: NEXT STEPS?

(OUTLINE & CALENDAR)

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
Week 5 MIDTERM REVIEWS				INDIVIDUAL MIDTERM REVIEWS			
Week 6 DESIGN A PROTOTYPE		INITIAL IDEATION **INDIVIDUAL REVIEWS:** **10 Sketches Per Boot**	INITIAL IDEATION **IDEATION:** **10 Sketches Per Boot (Materials)**	INITIAL IDEATION **INDIVIDUAL REVIEWS:** **10 Sketches Per Boot (Silhouette)**	INITIAL IDEATION **IDEATION:** **10 Sketches Per Boot (Traction)**	INITIAL IDEATION **IDEATION:** **Shoemaker Last Set-Up**	INITIAL IDEATION **IDEATION:** **Sketches on 3D Last**
Week7 PROJECT RESEARCH	END INITIAL IDEATION **FINAL INITIAL SKETCHES**	FINAL IDEATION **IDEATION:** **30 Sketches Per Boot**	FINAL IDEATION **IDEATION:** **30 Sketches Per Boot (Materials)**	FINAL IDEATION **INDIVIDUAL REVIEWS:** **30 Sketches Per Boot (Silhouette)**	FINAL IDEATION **INDIVIDUAL REVIEWS:** **Finalized Boot Lasts (Shoemaker)**	FINAL IDEATION **IDEATION:** **Material Selection and Information**	FINAL IDEATION **IDEATION:** **Final Sketches**
Week 8 MIDTERM REVIEWS	END FINAL IDEATION **FINAL SKETCHES**	PROOF OF CONCEPT **PRESENTATION:** **All SKetches (Organized)**	PROTOTYPING **3D Development of Boot Lasts for 3D Printing**	VALIDATION PLANS **PRESENTATION:** **Development of Ideation/Prototypes**	PROTOTYPING **INITIAL PROTOTYPES PER BOOT:** **3 Upper Prototypes per Boot**	PROTOTYPING **INITIAL PROTOTYPES PER BOOT:** **3 Upper Prototypes per Boot**	PROTOTYPING **FINAL PROTOTYPES:** **Final Direction**
Week 9 DESIGN A PROTOTYPE	PROTOTYPING **PROTOTYPE DEVELOPMENT**	STRATEGY SUMMATION **PRESENTATION:** **Prototype Development**	PROTOTYPING **IDEATION:** **Upper Prototypes on Boot Lasts**	STRATEGY SUMMATION **PRESENTATION:** **Prototype Development**	PROTOTYPING **IDEATION:** **Final Prototypes**	PROTOTYPING **FINAL PROTOTYPES:** **Recreate in Shoemaker**	PROTOTYPING **3D DEVELOPMENT:** **3 Combat Boots**
Week 10 DESIGN A PROTOTYPE	FINAL REVIEWS **FINALIZE SLIDES/ PROTOS**	FINAL REVIEWS **PRESENTATION**	FINAL PRESENTATION DEVELOPMENT **FINAL PRESENTATION** **Full Project Ideation - Prototyping**	CLASS PRESENTATION **PRESENTATION**			

Weekly Objectives:

- 100+ Sketches
- Material Identification and Procurement
- Traction Development (Grasshopper)
- 3D Alignment (Boot Lasts, Shoemaker Set-Up, etc.)
- Sizing & Fit Alignment

Looking ahead to Ideation and Prototyping, it will be key to have a clear baseline for all footwear models (last sizing, scanning, 3D Development) to ensure proper alignment across all sectors. Thus will allow for cohesive workflow across all mediums to ensure final deliverable is accruate.



+3°

Analysis of various conditions and applicable materials as well as possible future scenarios/innovations: **this thesis aims to introduce innovative solutions in US Army Standard-issued combat boots for future domains of warfare.**

MAX

ARMY - COLD - MODERATE - HOT/HUMID



Peter Martin R. Walton

(Royal Air Force Reserve, Fighter Jet Pilot. Lifelong Pilot and Aviation Expert. Flew jets longer than anyone)



Bruce Allen Brazo

(US Army Military Police, Served in Japan during WWII Occupation, was 17 years old at the time)



George Jeffery Keith

(Norwich University, US Army 2nd Lieutenant. 4 Years Schweinfurt, Germany)



Mark Stillman Keith

(Retired Lieutenant Colonel US Army, served 20+ years. First deployed in Desert Shield at age 23.)



Lindsay Francis Faith Keith

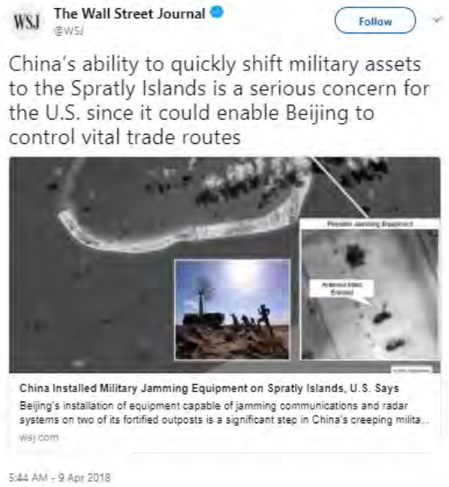
(US Army Intelligence, rank of Captain. About to begin 3rd deployment to Afghansitan.)



Climate Implications

No light = Free Table





Expanding Domains of Conflict

- Warming ice sheets allow for more exploration and intervention in the Artic (land claims and waterways)
- Constant echoes of Cold War, Alaska will be new front lines.
- Combat Boots for this Climate Condition have not been updated since the 1970's

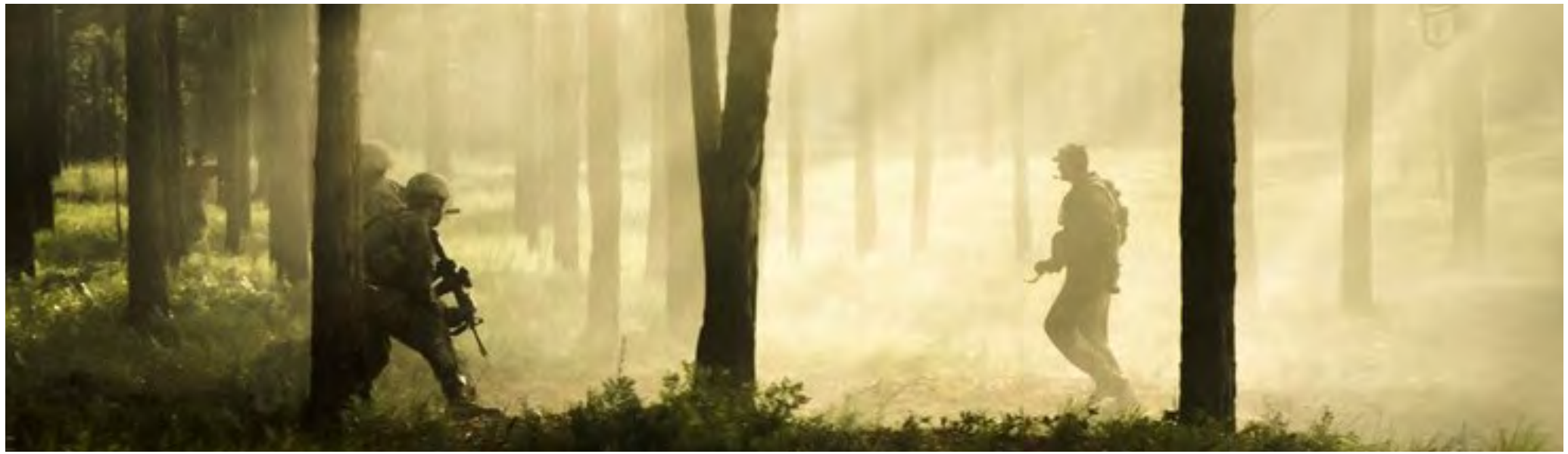


Berry Amendment

- Made in USA
- Security of domestic design methods and manufacturing

“Soldiers live in their boots and many will tell you that there is no piece of equipment more important to their lethality and readiness; Most components of these combat boots have not been updated in almost 30 years...” - Al Adams, TL, Natick Soldier Center





DURABILTY + PROTECTION + COMFORT

⇩ ⇩

Standard Military Issue

C.O.T.S
(COMMERICIAL OFF-THE SHELF)

ARMY - COLD - MODERATE - HOT/HUMID

ENVIRONMENT IDENTIFICATION: MILITARY FOOTWEAR MATRIX

(TARGET CLIMATES)

Sub-Zero (-30°F - 0°F)

Moderate (40°F - 60°F)

Hot/Humid (60°F - 90°F+)



-60°F — 32°F — 120°F

Extreme Cold | **Cold** | **Temperate** | **Hot / Humid / Wet**

Extreme Cold Weather Boot (ECWB)
-60F to -20F



KEY
- Wet/Rainy
- Mountainous
- Standard
- Snow
- Hot/Dry
- Hot/Wet/ Humid

Alpine Comabt Boot



Evaluate in AK
FEB-APR 2015

Intermediate Cold/Wet Boot w/ removable liner (ICWB)
14F to 32F



Temperate Weather Army Combat Boot (TW ACB)
> 32F



Hot Weather Army Combat Boot (HW ACB) > 75F

Hot Weather Flame-Resistant Army Combat Boot (HW FR ACB)

Temperate Weather Mountain Combat Boot (TW MCB)

Hot Weather Mountain Combat Boot (HW MCB)



Tropical Jungle Boot
SEP
25th ID JOTC
2FY2015



ENVIRONMENT IDENTIFICATION: CLIMATE CONDITIONS

(TARGET LOCATIONS)

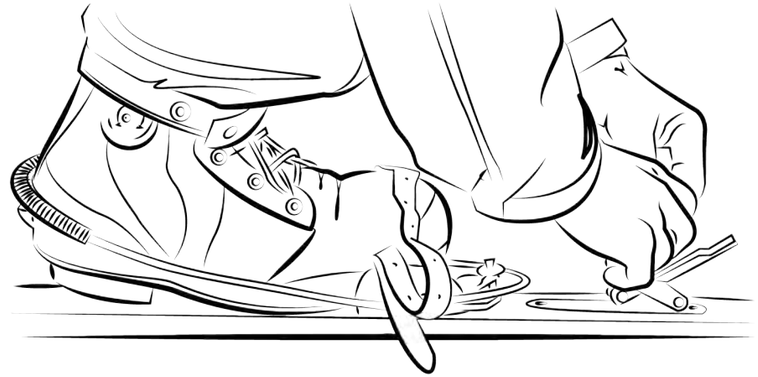


Rough All-Terrain

Extreme Cold Weather Boot (ECWB)
-60F to -20F

(-30 F - 0 F)

MODEL: 950v2 (Made In USA)
BRAND: New Balance
SIZING: 11M
WEIGHT: 10.5 oz





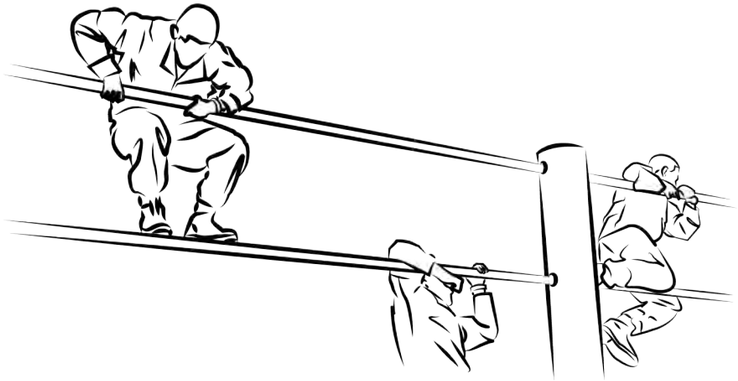
Extreme Cold Weather

Temperate Weather Army Combat Boot (TW ACB)
> 32F



(40 F - 60 F)

MODEL: VB Type II
BRAND: AirBoss
SIZING: 11R
WEIGHT: 56 oz. (3.5 pounds)





Jungle/Hot/Humid

Tropical Jungle Boot
SEP
25th ID JOTC
2FY2015

(60 F - 90 F+)

MODEL: Vietnam Era JCB
BRAND: Rothco
SIZING: 10R
WEIGHT: 48 oz. (3 pounds)



INITIAL PRODUCT WEAR TEST: REVIEW

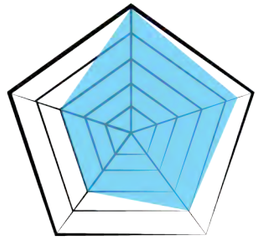
(BASELINE BENCHMARKING)



Wear-Test Trait Scoring

Cushioning	5
Stability	4.5
Traction	4
Flexibility	3
Protection	3

Trait-Relationship Index



Foot Mapping:

- Pain/Discomfort
- Slippage
- Areas of Traction

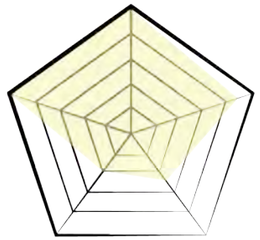




Wear-Test Trait Scoring

Cushioning	5
Stability	4.5
Traction	2.5
Flexibility	2
Protection	5

Trait-Relationship Index



Foot Mapping:

- Pain/Discomfort
- Slippage
- Areas of Traction
- Traction

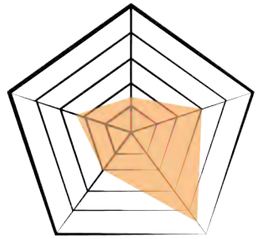




Wear-Test Trait Scoring

Cushioning	1.5
Stability	3
Traction	4.5
Flexibility	2
Protection	2.5

Trait-Relationship Index



Foot Mapping:

- Pain/Discomfort
- Slippage
- Areas of Traction



MARKET RESEARCH: BENCHMARKING

(COMMERCIAL OFF THE SHELF)







ARMY - COLD - MODERATE - HOT/HUMID

INDUSTRY EXPERTS: PROOF OF LIFE

(NETWORKING/MENTORS)


FW: POCs at Northern warfare training center (UNCLASSIFIED)

Keith, Mark S CIV USARMY I CORPS (USA) <mark.s.keith2.civ@mail.mil>
to maxwell.brazo@gmail.com
Wed, Dec 18, 2019, 1:36 PM

CLASSIFICATION: UNCLASSIFIED

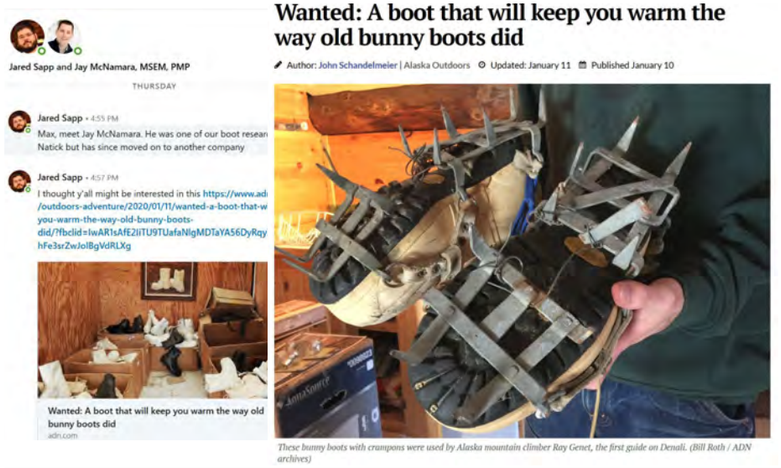
Max, I don't have any good contacts for the US Army Natick Soldier Systems specifically the US Army Combat Capability development command Soldier Center which I believe would work boots. Appears they have some form of linkage with Harvard and therefore should have a method by which you could request a visit. Below is a contact (science advisor) for Alaska. He hasn't responded to me yet but appears they would be receptive. Still working Hawaii. Army is on 1/2 schedule for the holidays so very likely I won't get good info until next year.

Mark S. Keith
I Corps G33, DAC
Global Force Management
Comm: (253) 477-1142
DSN: (312) 477-1142



Ret. Lieutenant Colonel Mark Keith
U.S. Army (30+ years)
Olympia, Washington

"Preparation is key. Without knowing your environment you cannot function or plan accordingly."


Jared Sapp and Jay McNamara, MSEM, PMP

THURSDAY

Jared Sapp • 4:55 PM
Max, meet Jay McNamara. He was one of our boot researchers at Natick but has since moved on to another company

Jared Sapp • 4:57 PM
I thought y'all might be interested in this https://www.adn.com/outdoors-adventure/2020/01/11/wanted-a-boot-that-will-keep-you-warm-the-way-old-bunny-boots-did/?fbclid=IwAR1sAfE2IiTU9TUafaNlgMDTaYA56DyRqyhFe3srZwJolBgVdRLXg

Wanted: A boot that will keep you warm the way old bunny boots did
adn.com

Wanted: A boot that will keep you warm the way old bunny boots did

Author: John Schandelmeier | Alaska Outdoors Updated: January 11 Published January 10

These bunny boots with crampons were used by Alaska mountain climber Ray Genet, the first guide on Denali. (Bill Roth / ADN archives)



Jared Sapp
Science Advisor to US Army Alaska at
U.S. Army Research Development and Engineering Command

"In terms of energy expenditure or calories burned, 1-pound of weight at the feet is equivalent to 4-pounds in your rucksack."



Jay McNamara
Extremity Protection Project Engineer, Engineering Psychologist
U.S. Army CDCC Soldier Center

"In a poll of 14,000 soldiers, the Army said it found that nearly 50 percent choose comfortable sneaker-like commercial boots..."


Cameron Kinder 1st
Product Manager at LALO Tactical

TUESDAY

Max Brazo • 8:53 AM
My name is Max Brazo and I am a graduate student at UO in Portland studying Sports Product Design. I'm working on my thesis looking into solutions for military footwear in extreme climate conditions (ECWB, JCB, etc.) hoping to possibly connect to ask some general questions about LALO!

Cameron Kinder • 8:56 AM
Sure shoot me an email or give me a call. Cam@lalo.com. 503-560-7072. Available anytime tomorrow.



Cameron Kinder
Product Manager
LALO Tactical

"Jungle conditions are unforgiving, the JCB should be able to allow the soldier to overcome while retaining basic functionality."





Johnathan Swegle
Footwear Engineer
W. L. Gore & Associates

"Innovation in insulation and layering of material has shown promise for cutting down weight and adding flexibility."



Quilted Thermal Upper (Aero-Gel Insulation)
Insulated over-boot for increased warmth and comfort



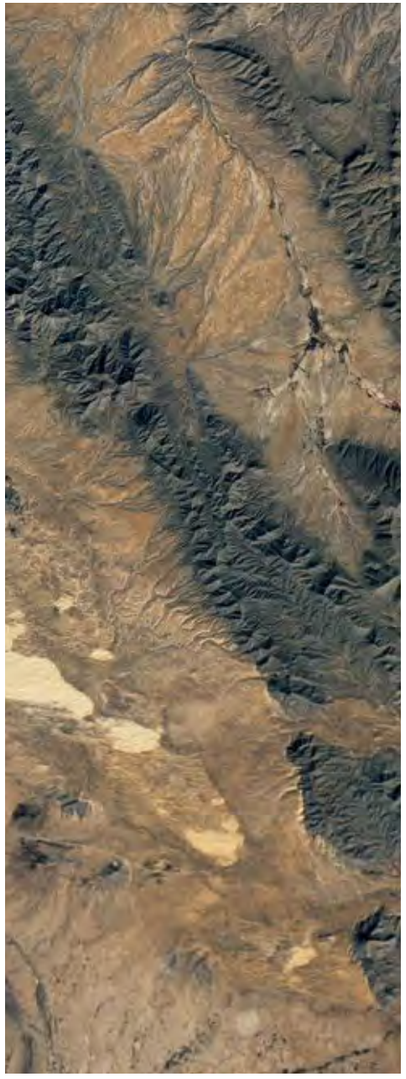
Disruptive Over-white
- Glacier melt, thaw



Over-Boot Silhouette
- Protection from elements, under knee cut-off



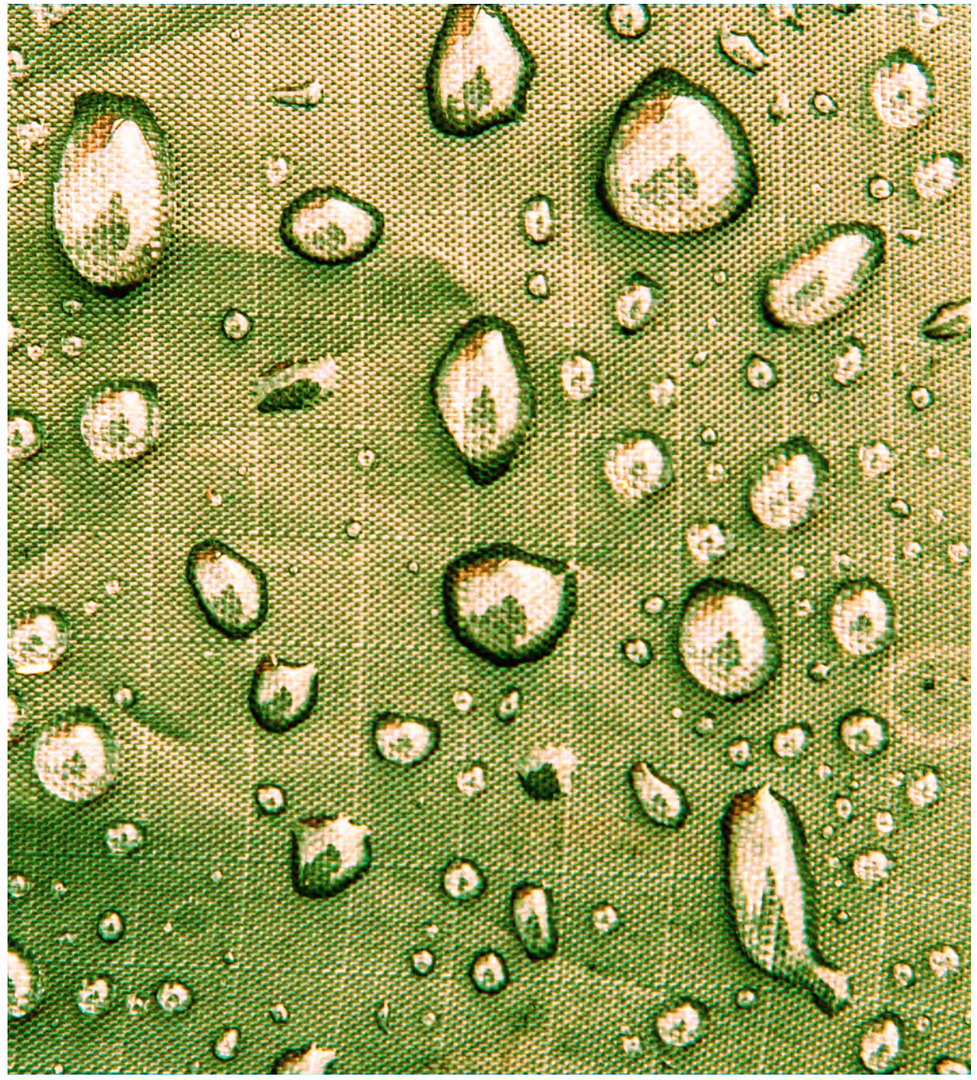
Conditional Resistance (Abrasion, Puncture, Tear)
- Durability and all-around protection from the elements.



Future All-Terrain
- Unexpected/Unknown

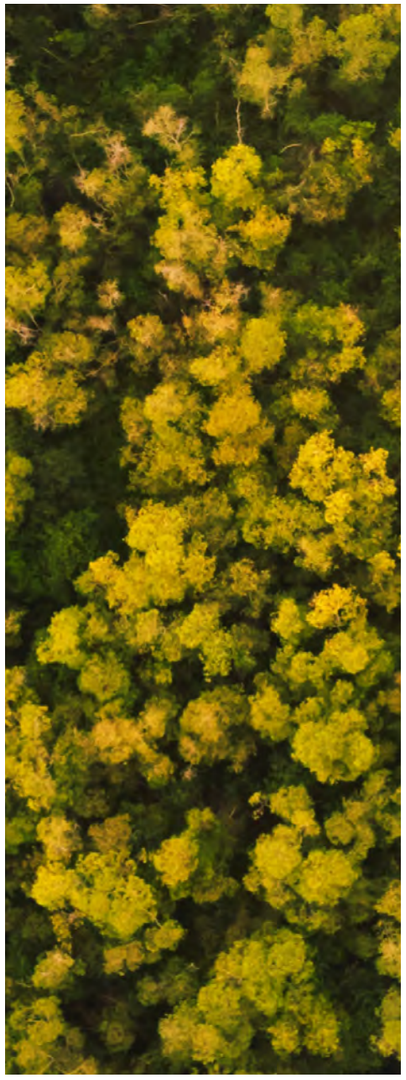


High-Top Ankle Protection
- Support and Flexibility in Key Areas



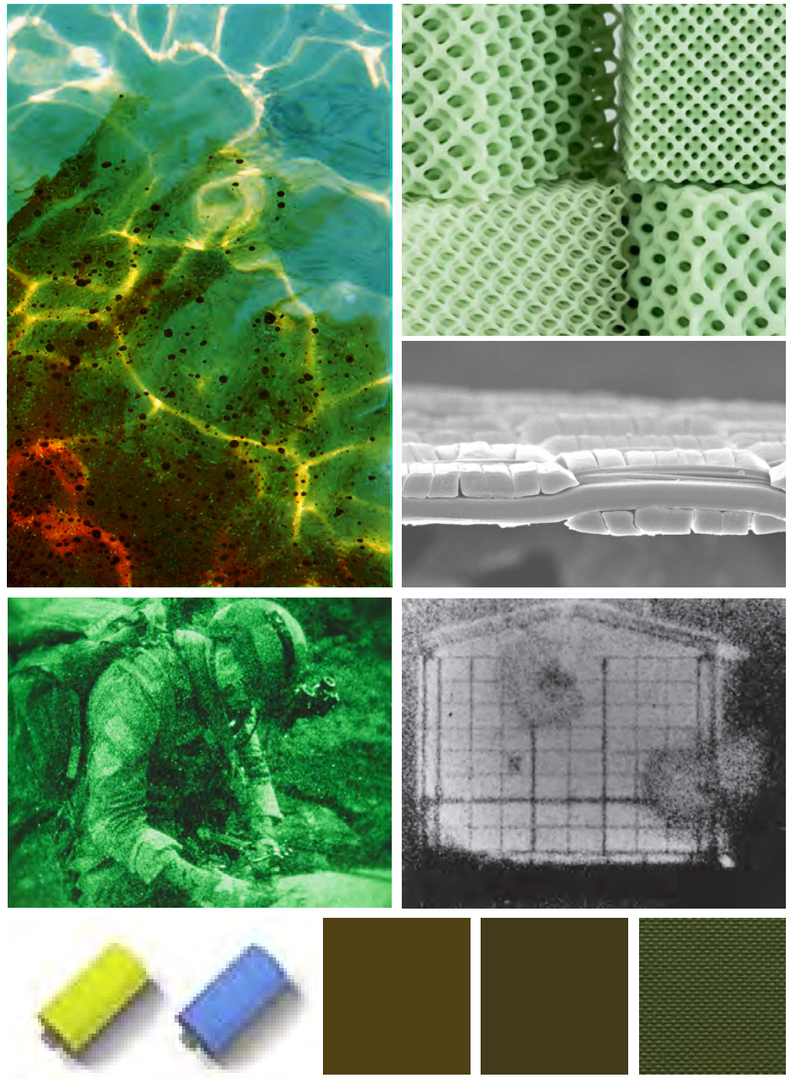
Water Resistant Flexible Upper (Breatheable)

- Resilient Upper provides flexibility with lightweight supportive materials



Chemical Warfare

- Organic, man-made



8in Sneaker Boot w/ Flexible Ankle Lock

- Standard Boot Classification with Modern Technologies

IDEATION PHASE: INITIAL EXPLORATION

(AREAS OF FOCUS)



- OVERBUILT (SIMPLICITY)
- TRACTION/SLIPPAGE

(Important to simplify overall design)





- FLEXIBILITY
- PERFORMANCE

(Durability and Flexibility will help aide performance)





- CUSHIONING
- FIT/FEEL/RESPONSE

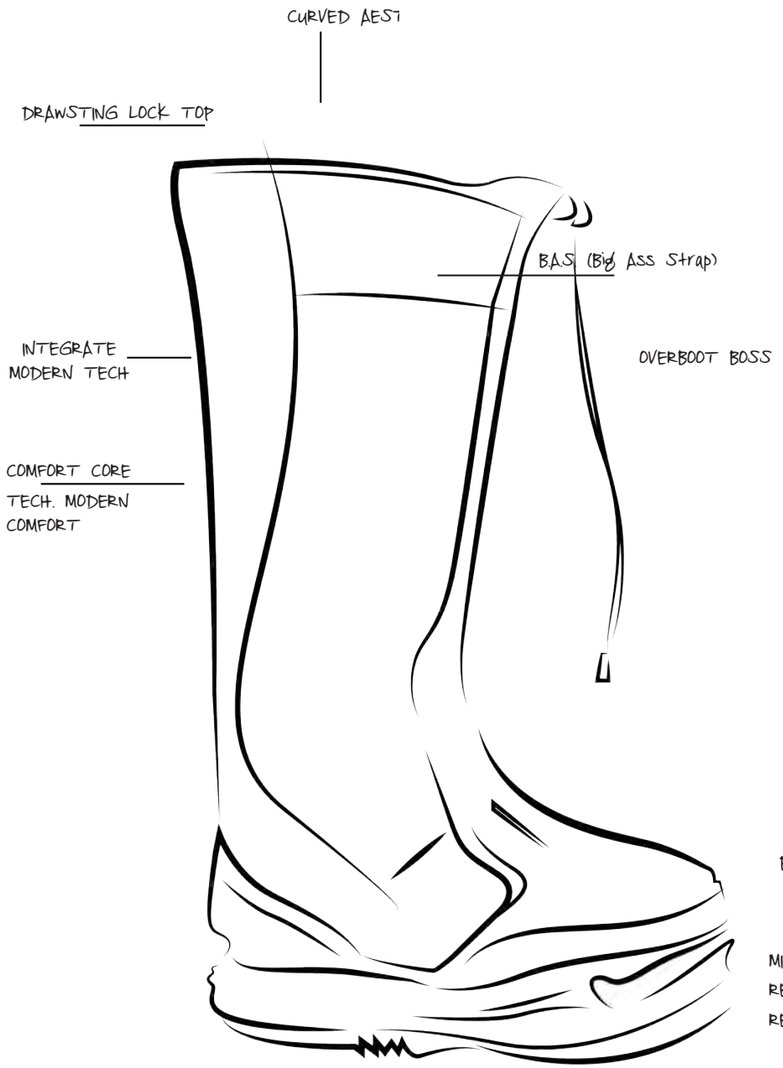
(Increased cushioning for better response)



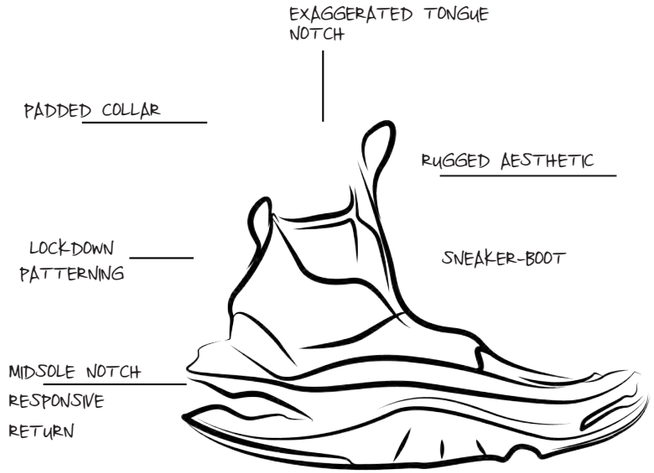


DESIGN DIRECTION: +3 DEGREE FOOTWEAR COLLECTION

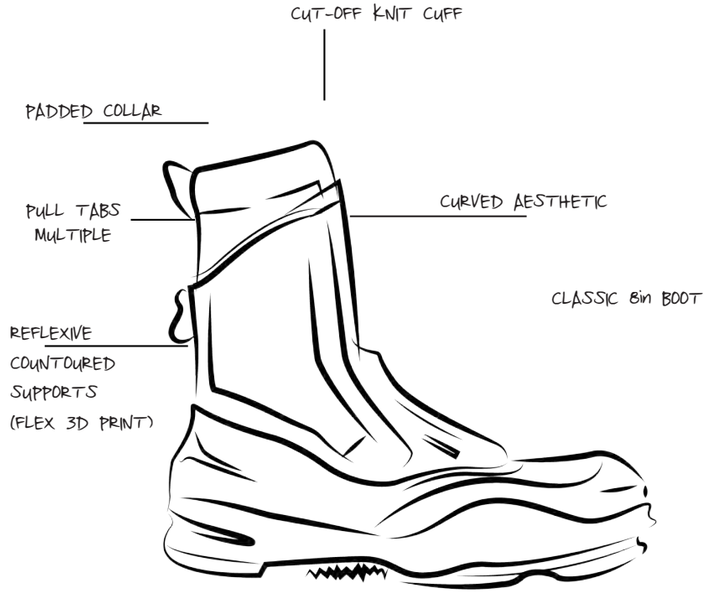
(FINAL DIRECTION)



Sub-Zero
(-30°F - 0°F)



Moderate
(40°F - 60°F)

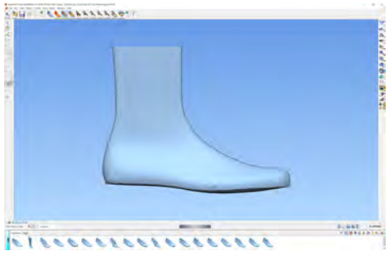


Hot/Humid
(60°F - 90°F+)

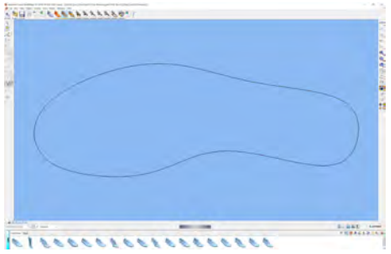
LAST DEVELOPMENT: 8" to 6" SPORT CUSTOMIZATION

(3D DEVELOPMENT)







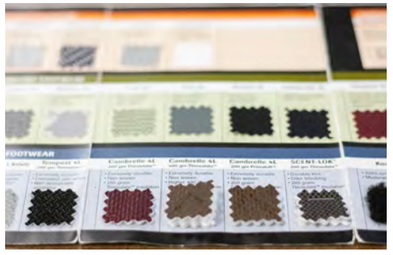












three°

military footwear innovation



...the failure of international climate negotitations means that if all countries acted on all of their commitments, the world would still warm by more than three degrees

3° may be the tipping point where global warming could go out of control

project

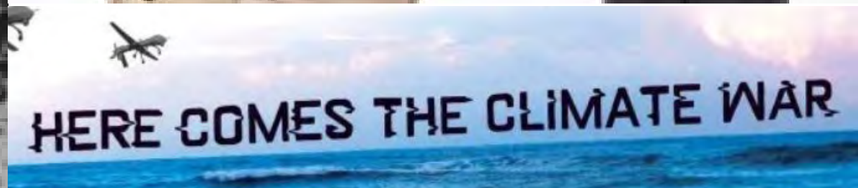
Climate change and future domains of conflict. US Army Standard-Issue footwear innovation in extreme conditions for these forseen inevitablities.

background

Research into current military footwear innovation in various climate related scenarios, pursued development of ehanced footwear options for US Army soldiers both in training and operations.

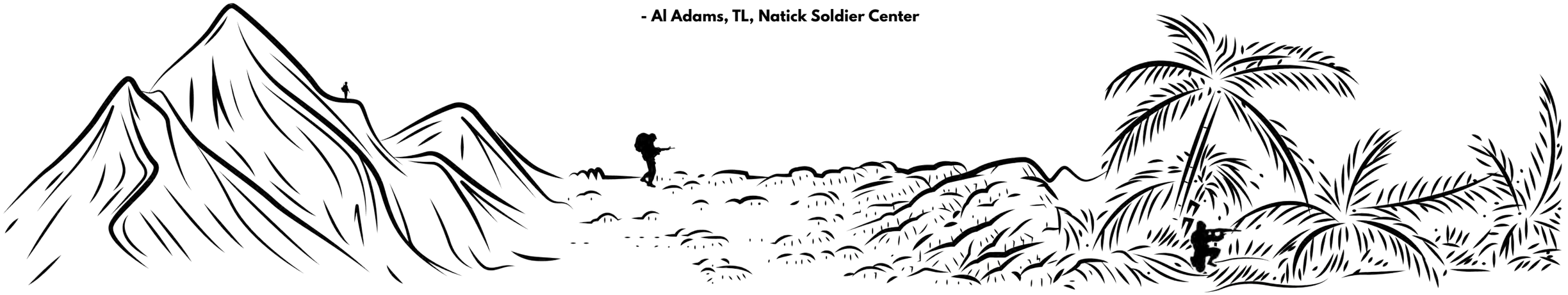






"soldiers live in their boots and many will tell you that there is no piece of equipment more important to their lethality and readiness, **most components of these combat boots have not been updated in almost 30 years...**"

- Al Adams, TL, Natick Soldier Center



-60°F | 32°F | 120°F

Extreme Cold | **Cold** | **Temperate** | **Hot / Humid / Wet**

Extreme Cold Weather Boot (ECWB)
-60F to -20F



KEY
- Wet/Rainy
- Mountainous
- Standard
- Snow
- Hot/Dry
- Hot/Wet/ Humid

Alpine Comabt Boot



Evaluate in AK
FEB-APR 2015

Intermediate Cold/Wet Boot w/ removable liner (ICWB)
14F to 32F



Temperate Weather Army Combat Boot (TW ACB)
> 32F



Hot Weather Army Combat Boot (HW ACB) > 79F



Hot Weather Flame-Resistant Army Combat Boot (HW FR ACB)



Temperate Weather Mountain Combat Boot (TW MCB)



Hot Weather Mountain Combat Boot (HW MCB)



Tropical
Jungle Boot
SEP
25th ID JOTC
2FY2015



1. durabilty + protection + ~~comfort~~

2. extreme environments

problem scope

- Military Standard Issue footwear options lack comfort effecting overall performance and are extremely outdated. Currently most soliders opt for COTS (Commercial Off-The Shelf) options rather than the Standard Issue.

- Implications of climate change and changing domains of conflict highlights the lack of innovation in various temperature categories within the military footwear matirx, soldiers are not currently equipped for these future environ.

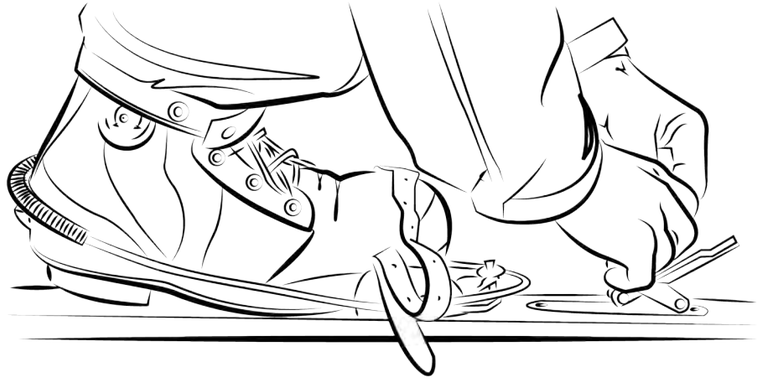


Extreme Cold Weather

Extreme Cold Weather Boot (ECWB)
-60F to -20F

(-30 F - 0 F)

Model: VB Type II
Brand: AirBoss
Sizing: 11R
Weight: 56 oz. (3.5 pounds)





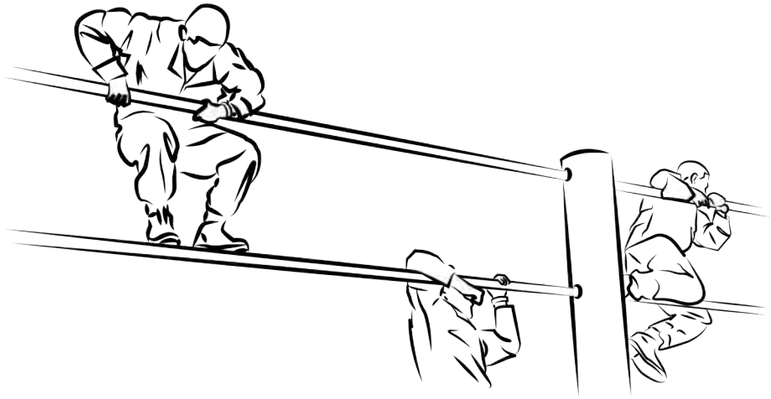
Rough All-Terrain

TemperateWeather Army Combat Boot (TW ACB)
> 32F



(40 F - 60 F)

Model: 950v2 (Made In USA)
Brand: New Balance
Sizing: 11M
Weight: 10.5 oz





Jungle/Hot/Humid

Tropical Jungle Boot
SEP
25th ID JOTC
2FY2015

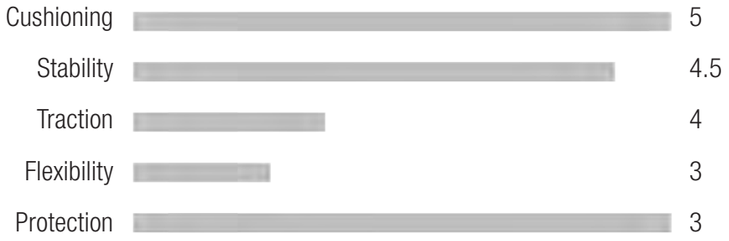
(60 F - 90 F+)

Model: Vietnam Era JCB
Brand: Rothco
Sizing: 10R
Weight: 48 oz. (3 pounds)

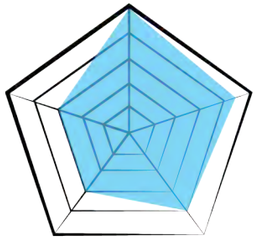




Wear-Test Trait Scoring



Trait-Relationship Index



Foot Mapping:

- Pain/ Discomfort
- Slippage
- Areas of Traction

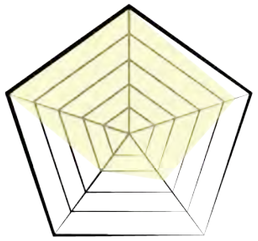




Wear-Test Trait Scoring



Trait-Relationship Index



Foot Mapping:

- Pain/ Discomfort
- Slippage
- Areas of Traction

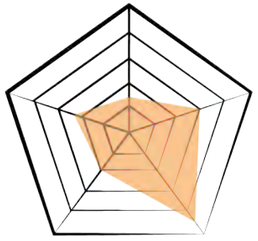




Wear-Test Trait Scoring



Trait-Relationship Index



Foot Mapping:

- Pain/ Discomfort
- Slippage
- Areas of Traction









ARMY - COLD - MODERATE - HOT/HUMI D


FW: POCs at Northern warfare training center (UNCLASSIFIED)

Keith, Mark S CIV USARMY I CORPS (USA) <mark.s.keith2.civ@mail.mil>
to maxwell.brazo@gmail.com
Wed, Dec 18, 2019, 1:36 PM

CLASSIFICATION: UNCLASSIFIED

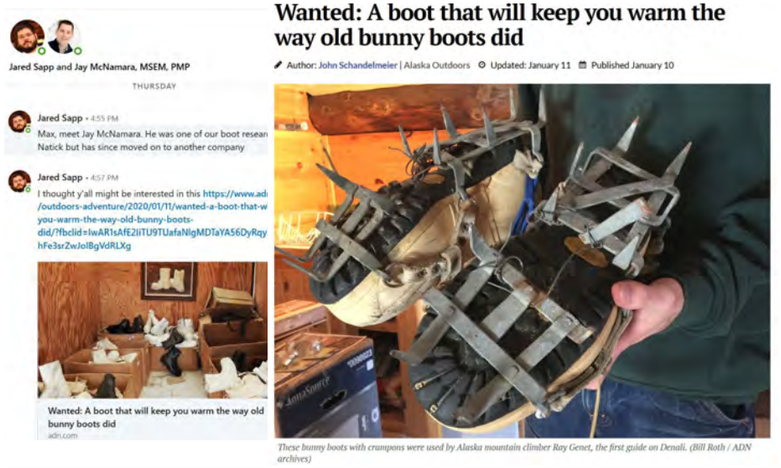
Max, I don't have any good contacts for the US Army Natick Soldier Systems specifically the US Army Combat Capability development command Soldier Center which I believe would work boots. Appears they have some form of linkage with Harvard and therefore should have a method by which you could request a visit. Below is a contact (science advisor) for Alaska. He hasn't responded to me yet but appears they would be receptive. Still working Hawaii. Army is on 1/2 schedule for the holidays so very likely I won't get good info until next year.

Mark S. Keith
I Corps G33, DAC
Global Force Management
Comm: (253) 477-1142
DSN: (312) 477-1142



Ret. Lieutenant Colonel Mark Keith
U.S. Army (30+ years)
Olympia, Washington

"Preparation is key. Without knowing your environment you cannot function or plan accordingly."


Jared Sapp and Jay McNamara, MSEM, PMP

THURSDAY

Jared Sapp • 4:55 PM
Max, meet Jay McNamara. He was one of our boot researchers at Natick but has since moved on to another company

Jared Sapp • 4:57 PM
I thought y'all might be interested in this https://www.adn.com/outdoors-adventure/2020/01/11/wanted-a-boot-that-will-keep-you-warm-the-way-old-bunny-boots-did/?fbclid=IwAR1sAfE2IiTU9TUafaNlgMDTaYA56DyRqyhFe3srZwJolBgVdRLXg

Wanted: A boot that will keep you warm the way old bunny boots did
adn.com

Wanted: A boot that will keep you warm the way old bunny boots did

Author: John Schandelmeier | Alaska Outdoors Updated: January 11 Published January 10

These bunny boots with crampons were used by Alaska mountain climber Ray Genet, the first guide on Denali. (Bill Roth / ADN archives)



Jared Sapp
Science Advisor to US Army Alaska at
U.S. Army Research Development and Engineering Command

"In terms of energy expenditure or calories burned, 1-pound of weight at the feet is equivalent to 4-pounds in your rucksack."



Jay McNamara
Extremity Protection Project Engineer, Engineering Psychologist
U.S. Army CDCC Soldier Center

"In a poll of 14,000 soldiers, the Army said it found that nearly 50 percent choose comfortable sneaker-like commercial boots..."


Cameron Kinder 1st
Product Manager at LALO Tactical

TUESDAY

Max Brazo • 8:53 AM
My name is Max Brazo and I am a graduate student at UO in Portland studying Sports Product Design. I'm working on my thesis looking into solutions for military footwear in extreme climate conditions (ECWB, JCB, etc.) hoping to possibly connect to ask some general questions about LALO!

Cameron Kinder • 8:56 AM
Sure: shoot me an email or give me a call. Cam@lalo.com. 503-560-7072. Available anytime tomorrow.



Cameron Kinder
Product Manager
LALO Tactical

"Jungle conditions are unforgiving, the JCB should be able to allow the soldier to overcome while retaining basic functionality."





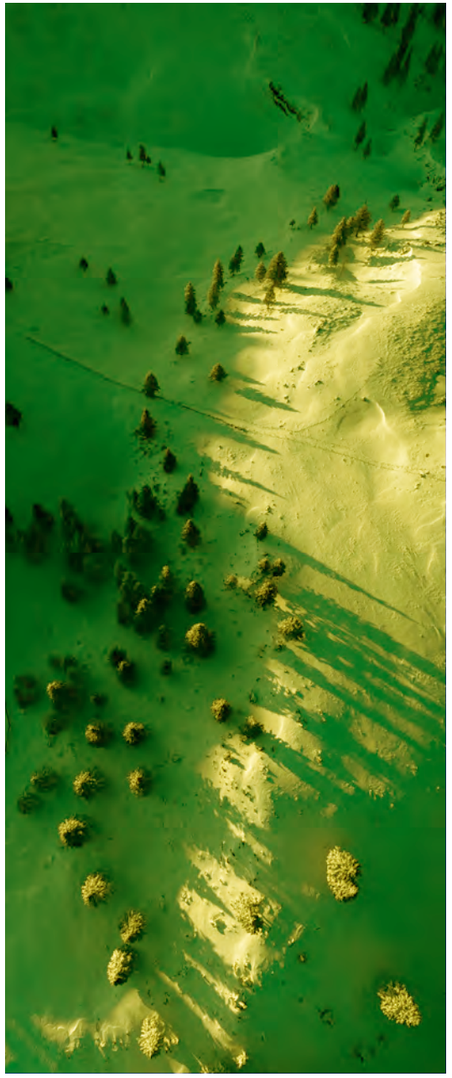
Johnathan Swegle
Footwear Engineer
W. L. Gore & Associates

"Innovation in insulation and layering of material has shown promise for cutting down weight and adding flexibility."

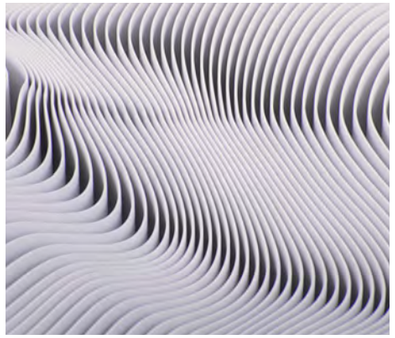
retail 200 00 fob 50 00 release winter 2025



Quilted Thermal Upper (Aero-Gel Insulation)
- Insulated over-boot for increased warmth and comfort



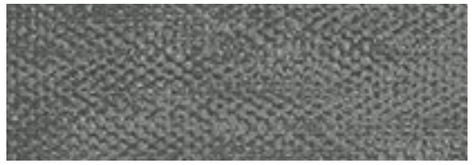
Disruptive Over-white
- Glacier melt, thaw









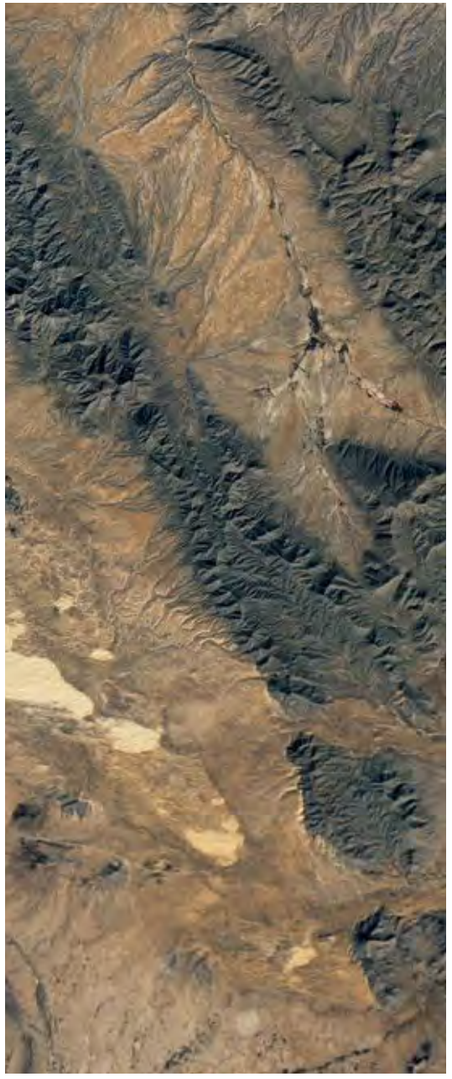


Over-Boot Silhouette
- Protection from elements, under knee cut-off

retail 150 00 fob 37 50 release fall 2024



Conditional Resistance (Abrasion, Puncture, Tear)
- Durability and all-around protection from the elements.



Future All-Terrain
- Unexpected/Unknown





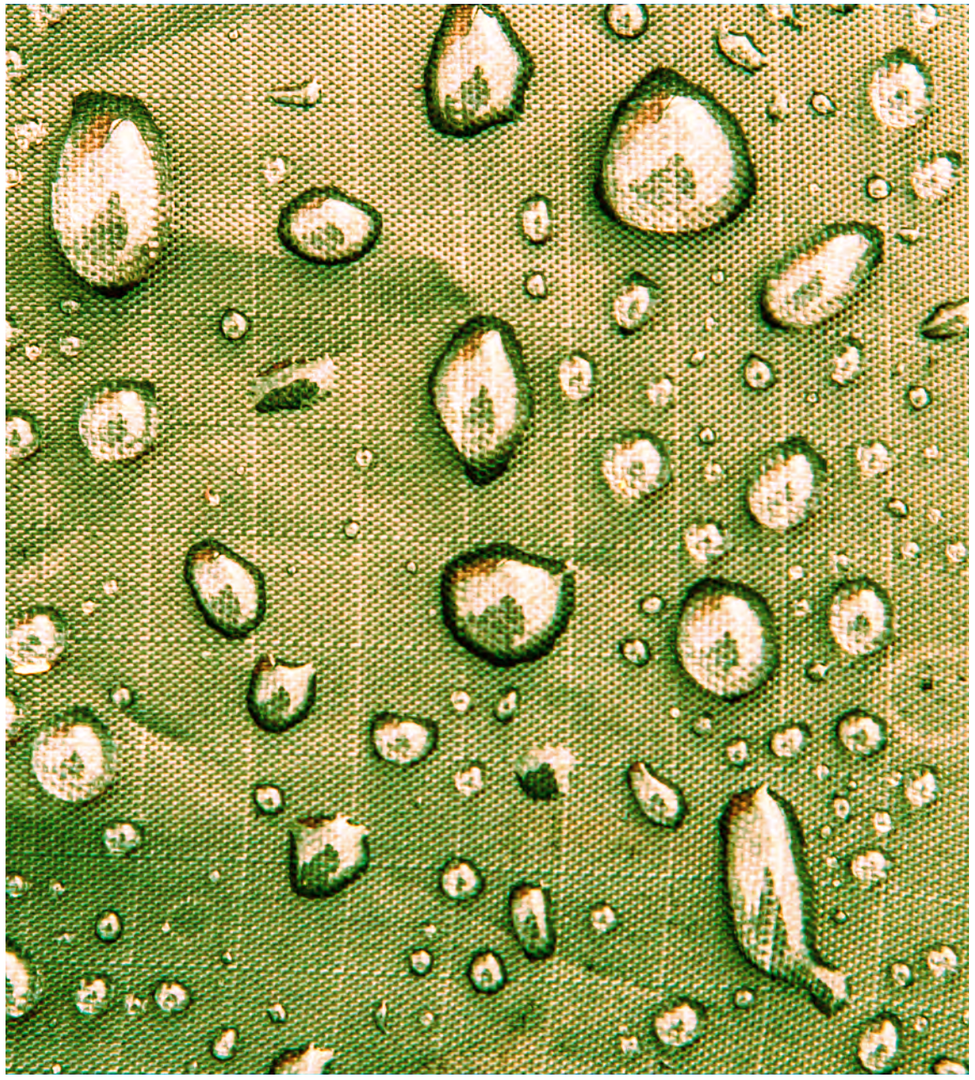






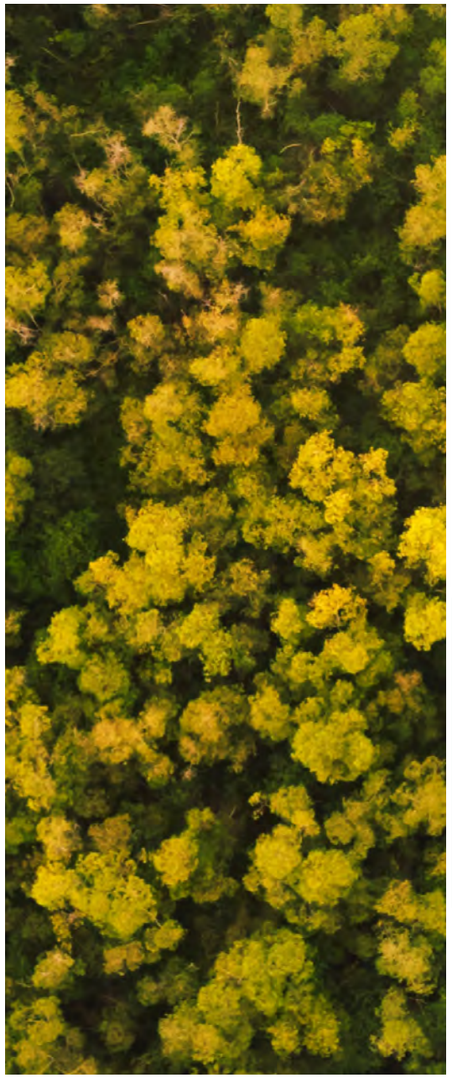
High-Top Ankle Protection
- Support and Flexibility in Key Areas

retail 175 00 fob 43 75 release spring 2025



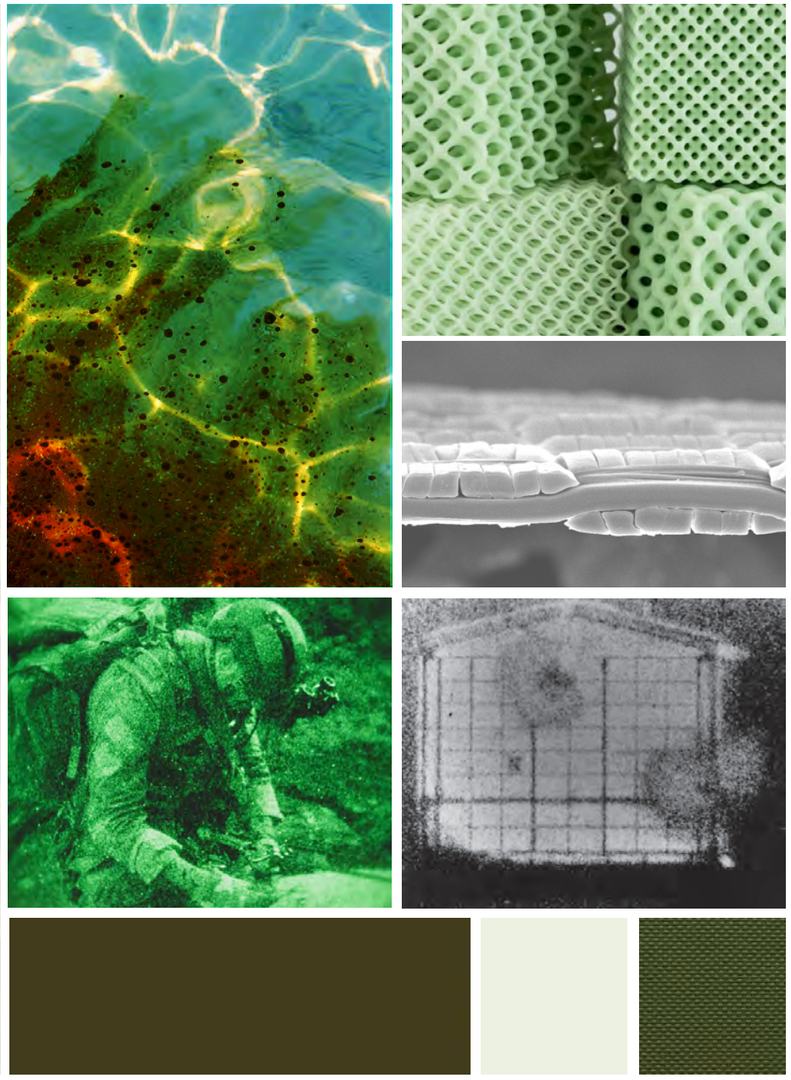
Water Resistant Flexible Upper (Breatheable)

- Resilient Upper provides flexibility with lightweight supportive materials



Chemical Warfare

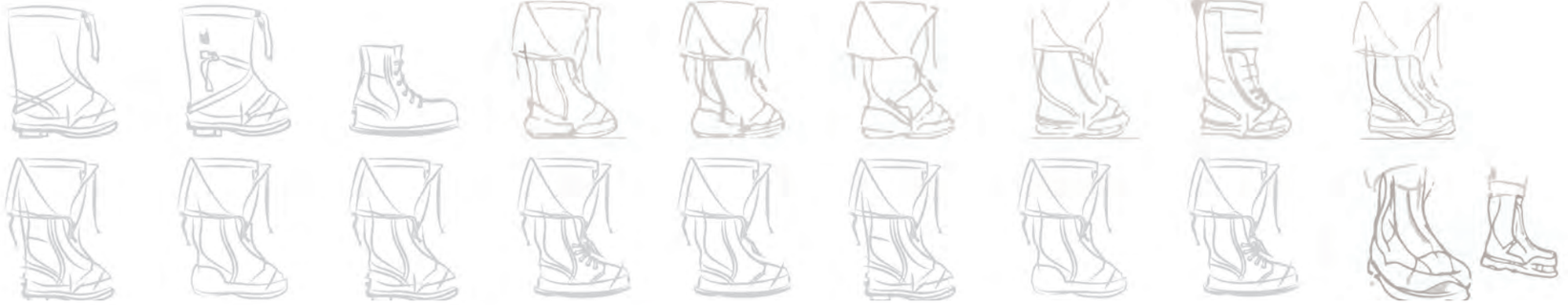
- Organic, man-made



8in Sneaker Boot w/ Flexible Ankle Lock

- Standard Boot Classification with Modern Technologies











INSULATED PANEL

LOCKDOWN
PATTERNING

FLEX ZONE
LOCKED IN AND
FEELS LIKE ONE



CUSTOM LAST





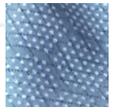
OVERBOOT
LIGHTWEIGHT
MINIMAL/MAXIMAL

























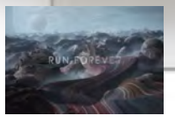
FLEXIBLE
LIGHTWEIGHT
RUGGED FOR
ALL-TERRAINS

HIGH TOP ANKLE
INCREASED
PROTECTION





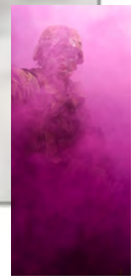




ALL - TERRAIN - ER
ANY OBSTACLE OVERCOME









DURABLE
PROTECTION
AND COMFORT

6 INCH
SNEAKER-BOOT
SILHOUETTE













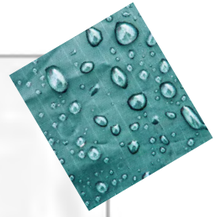




ROOTED IN HISTORY
HIGHLIGHT OLD DESIGN







WATER RESISTANT
BASIC UPPER



ANTI-BACTERIAL
COATING

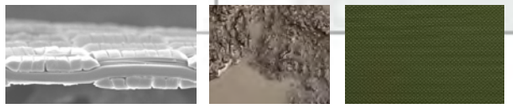
STABILITY AND
TRACTION
ENHANCED GRIP





TOP OF FOOT LOCK

RUGGED/RELENTLESS





JUNGLE/
CHEMICAL
WARFARE

key features

weather resistant

insulation

lightweight

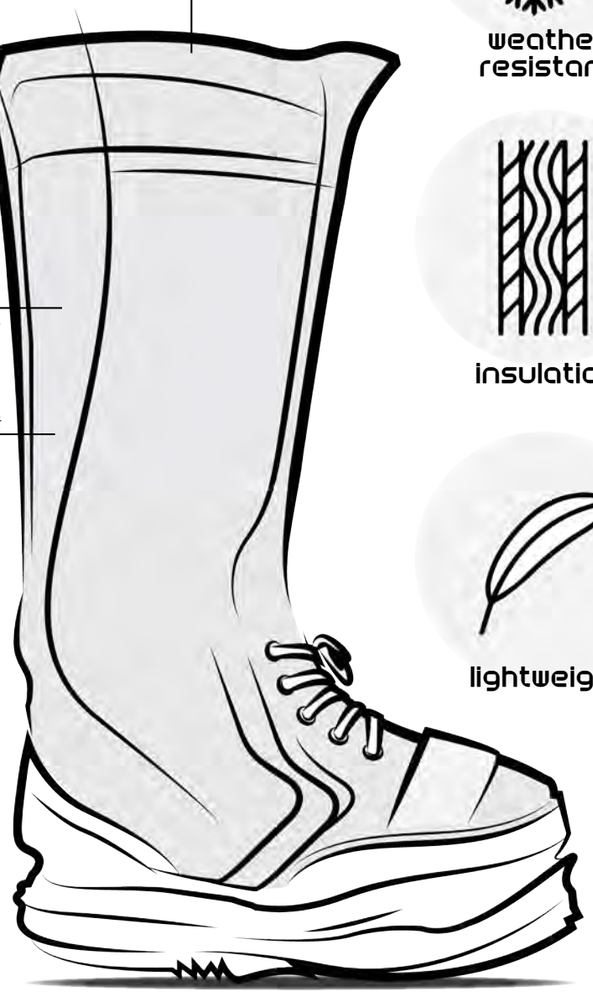
DRAWSTING LOCK TOP

CURVED AESTHETIC

INTEGRATE MODERN TECH

COMFORT CORE

TECH. MODERN COMFORT



key features

water resistant

traction

lightweight

EXAGGERATED TONGUE NOTCH

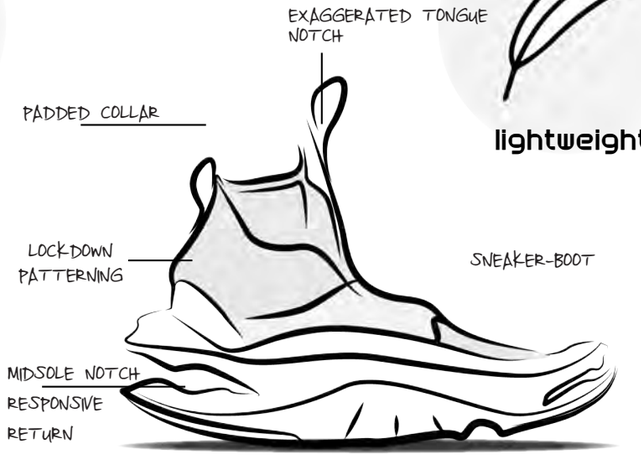
PADDED COLLAR

LOCKDOWN PATTERNING

SNEAKER-BOOT

MIDSOLE NOTCH

RESPONSIVE RETURN



key features

water resistant

antibacterial

lightweight

CUT-OFF KNIT CUFF

CLASSIC 8in BOOT

PADDED COLLAR

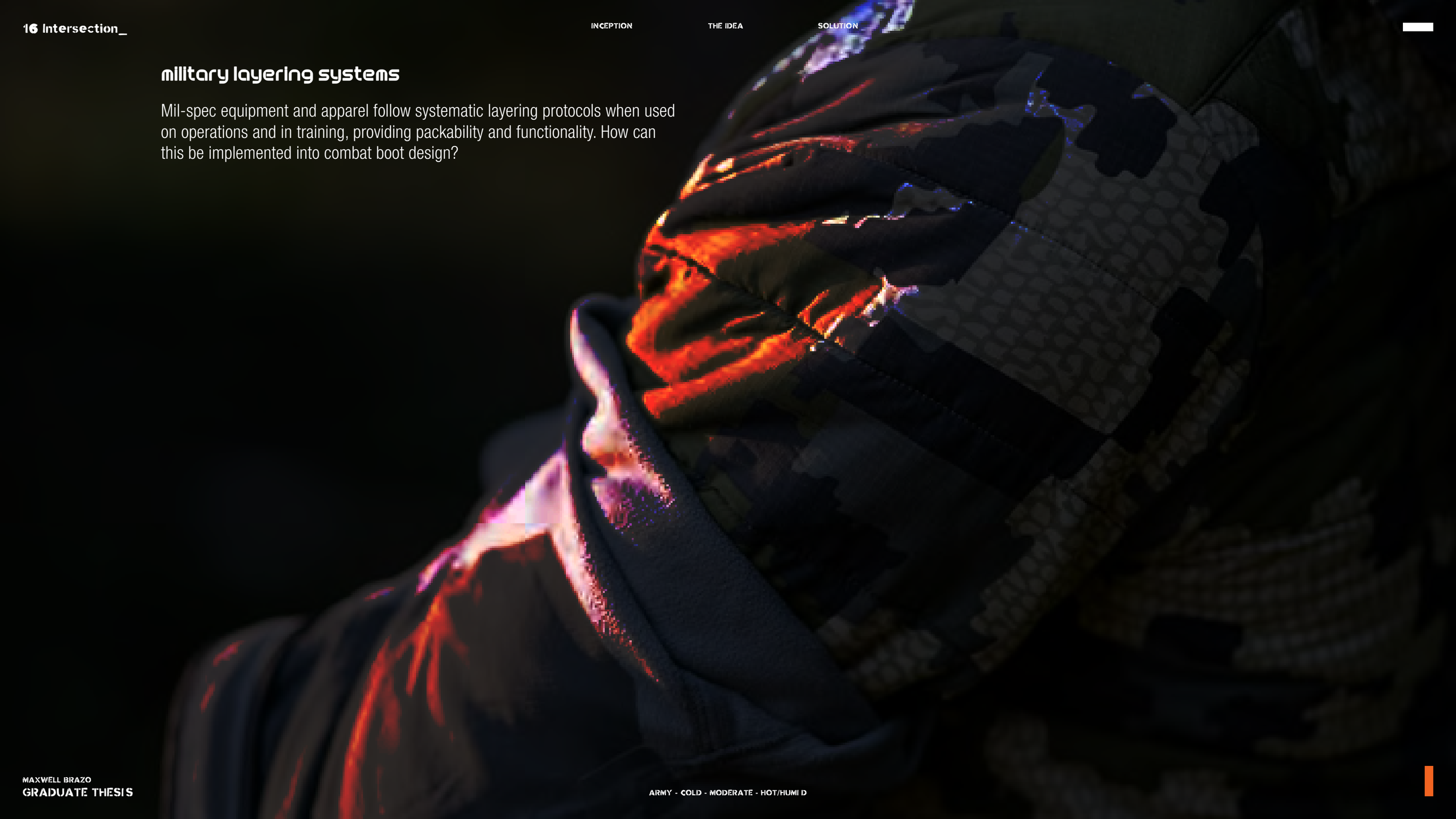
PULL TABS MULTIPLE

REFLEXIVE COUNTOURED SUPPORTS (FLEX 3D PRINT)



military layering systems

Mil-spec equipment and apparel follow systematic layering protocols when used on operations and in training, providing packability and functionality. How can this be implemented into combat boot design?



exploration
modular midsole cage-lock system





HOW CAN IT BE BETTER?



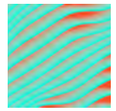




SNAP INTO CAGE STRUCTURE (TOE FIRST!)



FLEXIBLE/RIGID COUNTOURED SUPPORTS (FLEX 3D PRINT)



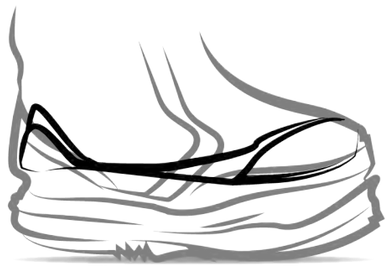




BASE BOOT LOCKS INTO BOTH OVERBOOT AND JUNGLE MIDSOLE



packable





STANDARD ISSUE BASIC
MINIMALIST DESIGN
BAREFOOT LOW-PROFILE
BASE TO BUILD UPON





SECTION CUT VIEW
ATTACHED TO MIDSOLE FOR DYNAMIC WEARABILITY

COUNTOURED CONNECTION AROUND TOE/HEEL



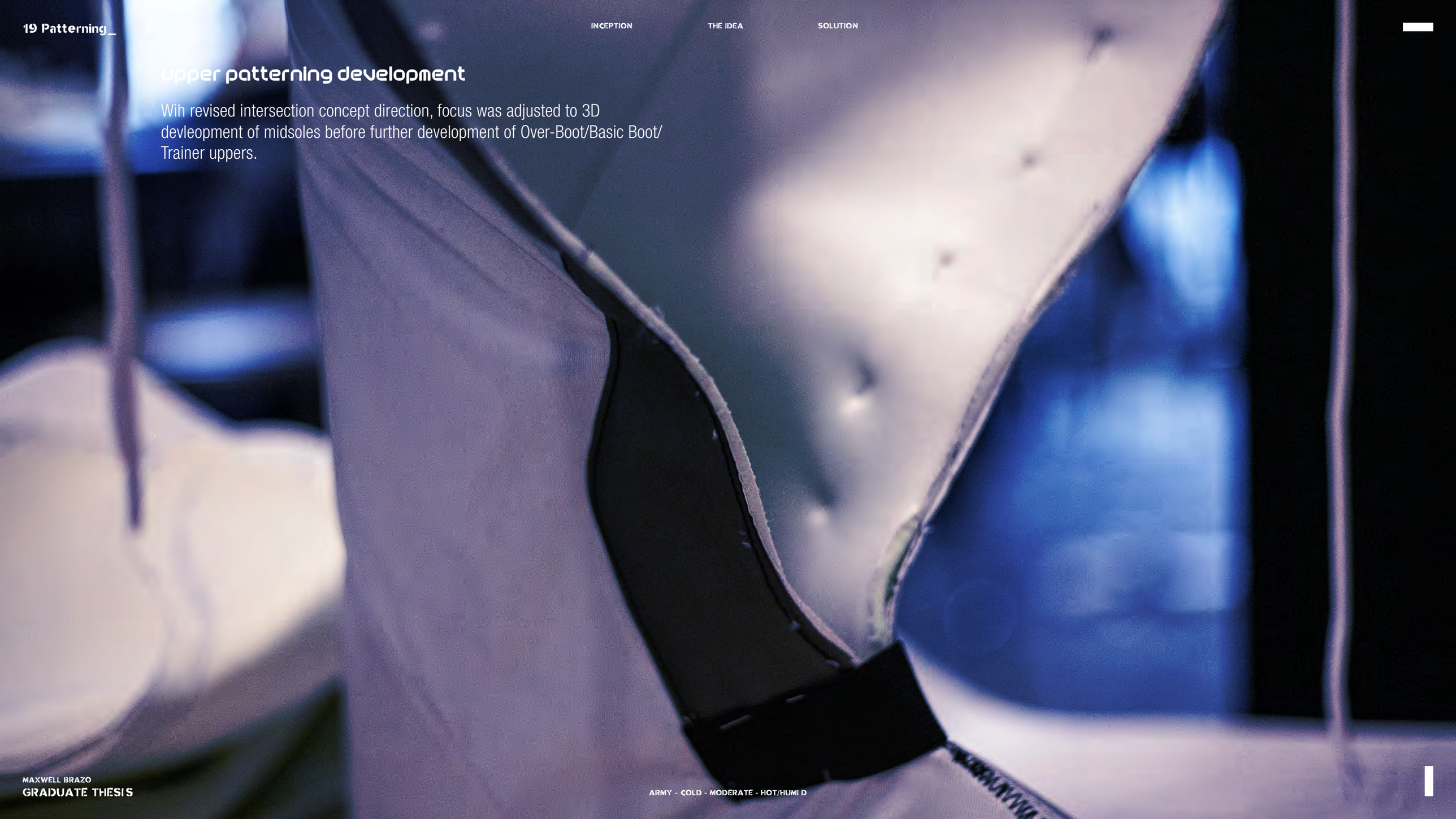
training operations



ARMY - COLD - MODERATE - HOT/HUMID

Upper patterning development

Wih revised intersection concept direction, focus was adjusted to 3D devleopment of midsoles before further development of Over-Boot/Basic Boot/ Trainer uppers.



basic boot upper patterning

The base layer footwear model, it was important to get geneal thickeness of material from upper ideation to use in next steps for 3D development.



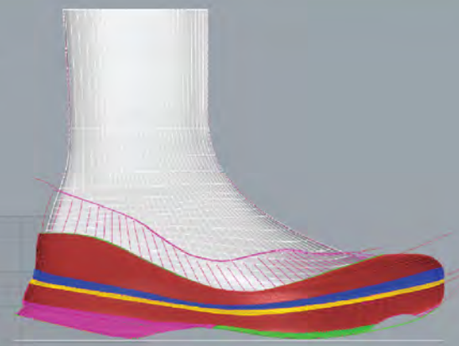
3d development

Three-dimensional models of the proof of cage-lock concept were intitiated to prove fit of system with Basic Boot/Cage-Lock/Jungle Midsole using a Custom Sport Last modeled using Autodesk Shoemaker.

basic boot

3D Development
(Eight Inch Boot Sport Last/Customized)

Size 11 Sport Last (8-inch Height)
Insole Length: 270 mm



Basic Boot 3D Development
(Proof of Silhouette & Midsole/Outsole)



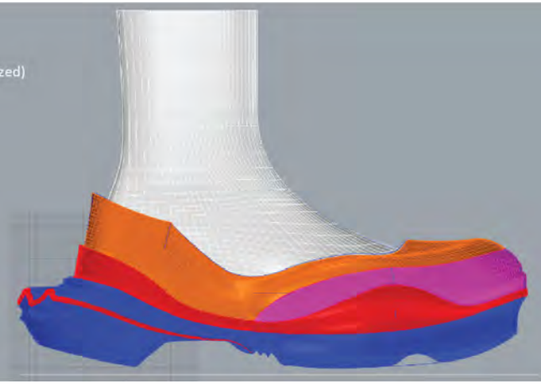
Basic Boot 3D Development
(Proof of Fit into Jungle Midsole
Before Modular Midsole Modelling)



jungle midsole

3D Development
(Eight Inch Boot Sport Last/Customized)

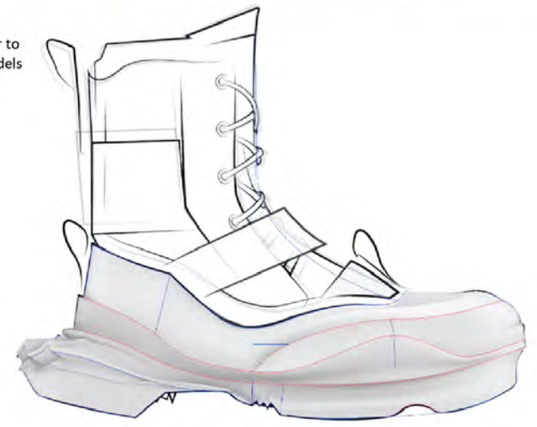
Jungle Modular Midsole
(Base for Cage-Lock System)



Jungle Midsole 3D Development
(Proof of Silhouette &
Midsole/Outsole)



Jungle Midsole 3D Development
(Proof of Fit Around Basic Boot Prior to
Design of Cage-Lock Using Both Models
As Boundary Surfaces)



Contoured Wrap: Around Side of Foot, Single Connection

Connected Under Foot

Contoured More Dynamic: Dual Connections

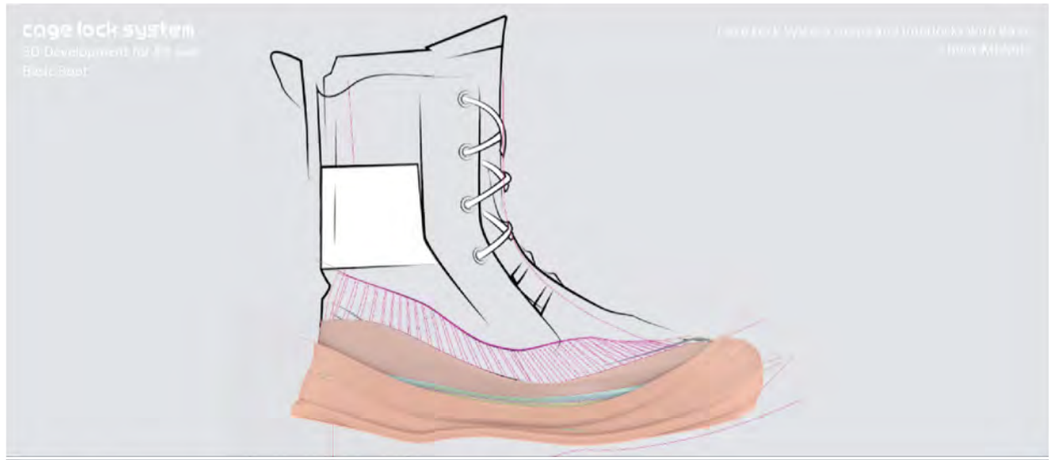
Split Countour More Dynamic: Multiple Connections

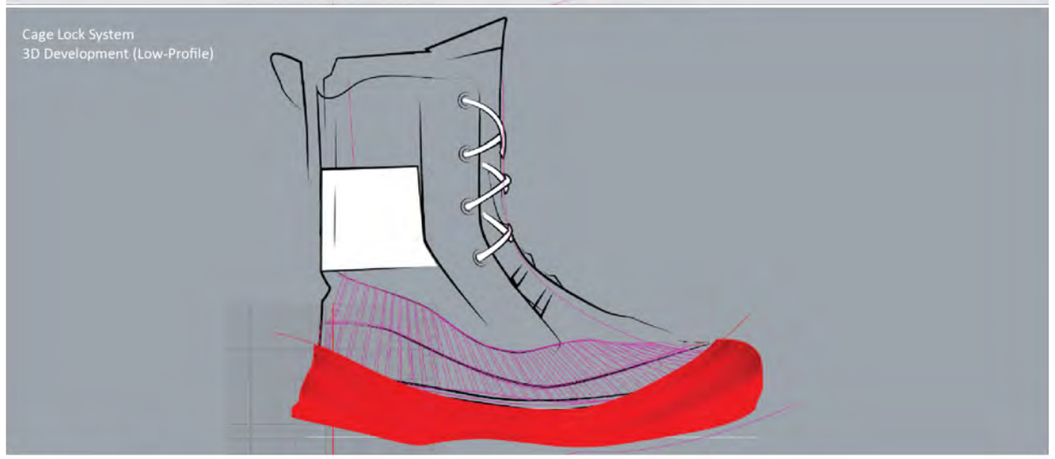




foam and paper mockups

Trying to figure out how to wrap the basic boot to provide a more secure fit at heel and toe and where connections would be made into Basic-Boot. Required further 3D development in Rhino.



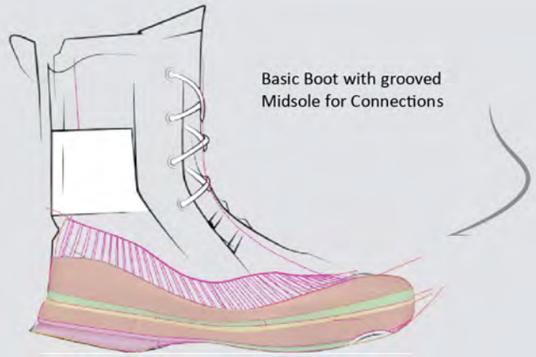


Cage Lock System
Rendered/
Perspective



proof of concept

3D Assembly (Basic Boot into Jungle Midsole with
Cage Lock System Embedded in Jungle Midsole)



Basic Boot with grooved
Midsole for Connections

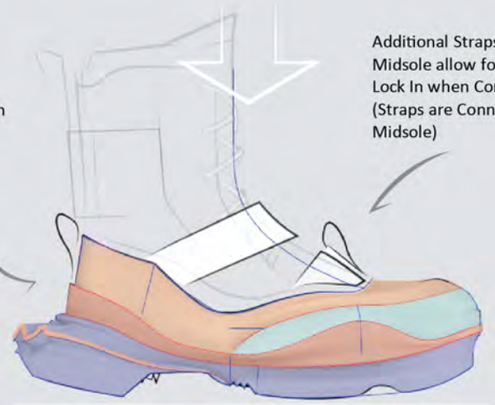
Slip-On Cage Interlocks with
Basic Boot within Grooves



Cage is Fixed into Jungle
Terrain Midsole

Additional Straps on Jungle
Midsole allow for improved
Lock In when Connected
(Straps are Connected to
Midsole)

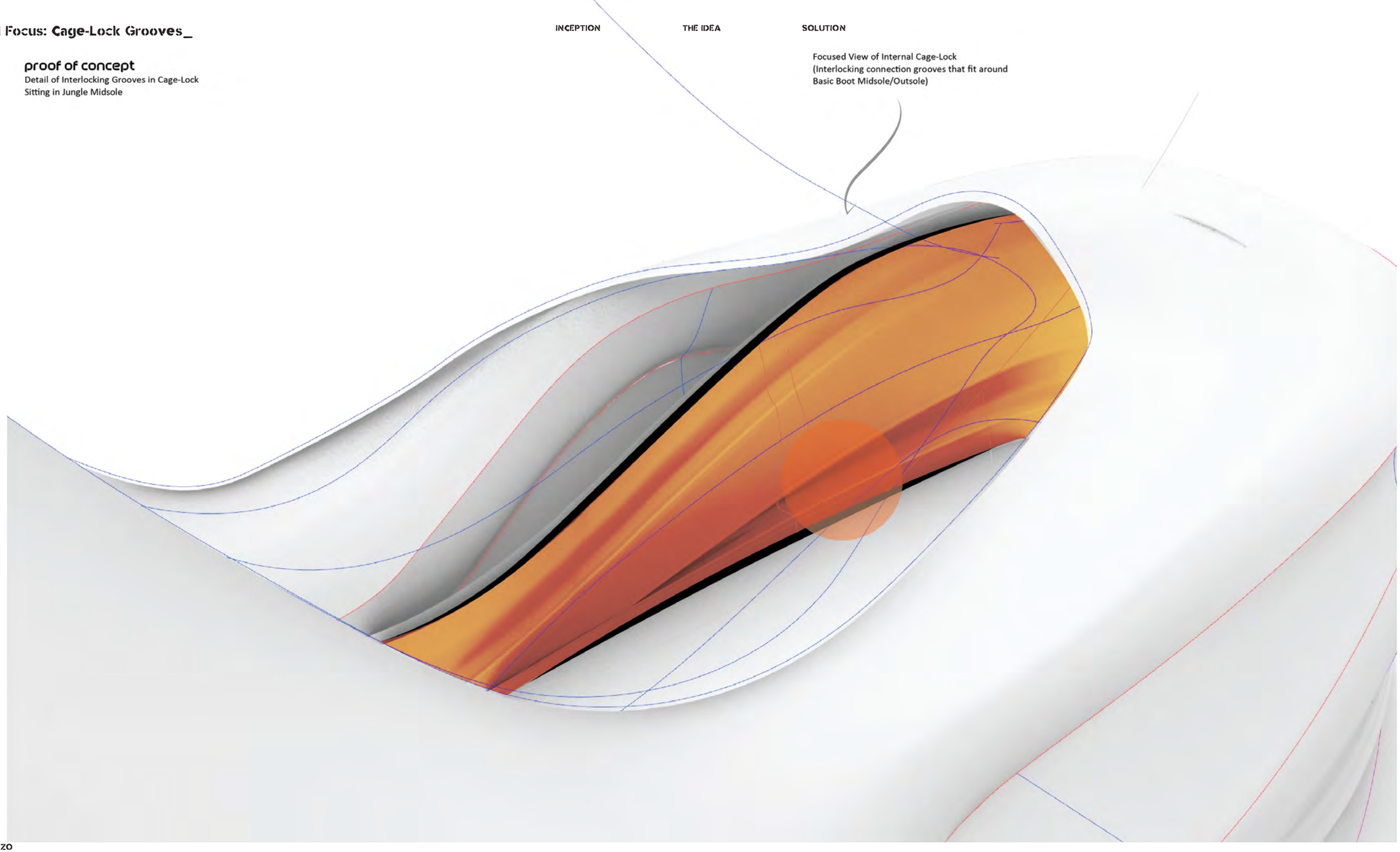
Heel Lock and Toe Lock in
For Enhanced Comfort



proof of concept

Detail of Interlocking Grooves in Cage-Lock
Sitting in Jungle Midsole

Focused View of Internal Cage-Lock
(Interlocking connection grooves that fit around
Basic Boot Midsole/Outsole)



foxtrot_
MIL-SPEC FOOTWEAR INNOVATION

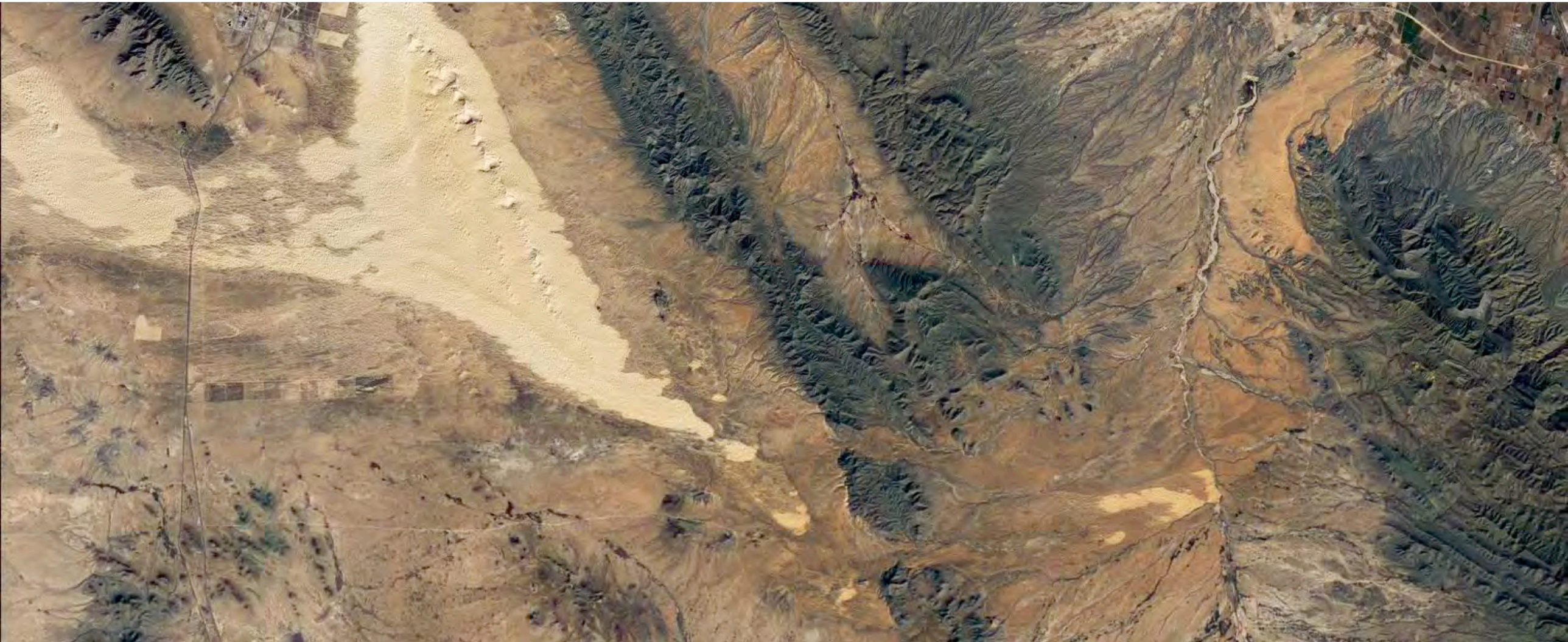
UNIVERSITY OF OREGON | Sports Product Design

United States Army Regulation Temperate Weather Combat Boot (TWCB) research design and development: focus on soldier sustainment and vitality through innvoative footwear solutions for the everyday fight. Foxtrot footwear solutions aims to keep soliders on their feet longer than previously thought possible.



Durability + Protection + Comfort

Military Standard Issue footwear options lack comfort effecting overall performance and are extremely outdated. Current combat boots do not reflect the wants and needs of the average soldier who spends most of their time in garrison and on their own two feet.



Soldier Sustainment & Vitality

The “Basic Boot” offers soliders never before seen options for temperate/hot weather combat footwear for the key activites in their day to day, the unique minimal construction and supportive patterning coupled with a streamlined midsole, ensures proper lock down allows any solider to stay on their feet for longer than thought possible in any other brand name shoe.



Stay in the Fight.

Soldiers live and die in their boots, with only one objective, forward. With these new technologies and desgn, soldiers will be able to rely on new innovative methods of support, enabling soldiers to stay on their feet for longer amounts of time without injury, and to enable them to be the most effective soldiers they can be.



Rucking (Loaded Foot March)

12 mile weighted march, carrying upwards of 50 pounds, footwear options lack features to highlight this everyday activity. Brand name boots do not offer spefic solutions.





Running/Walking

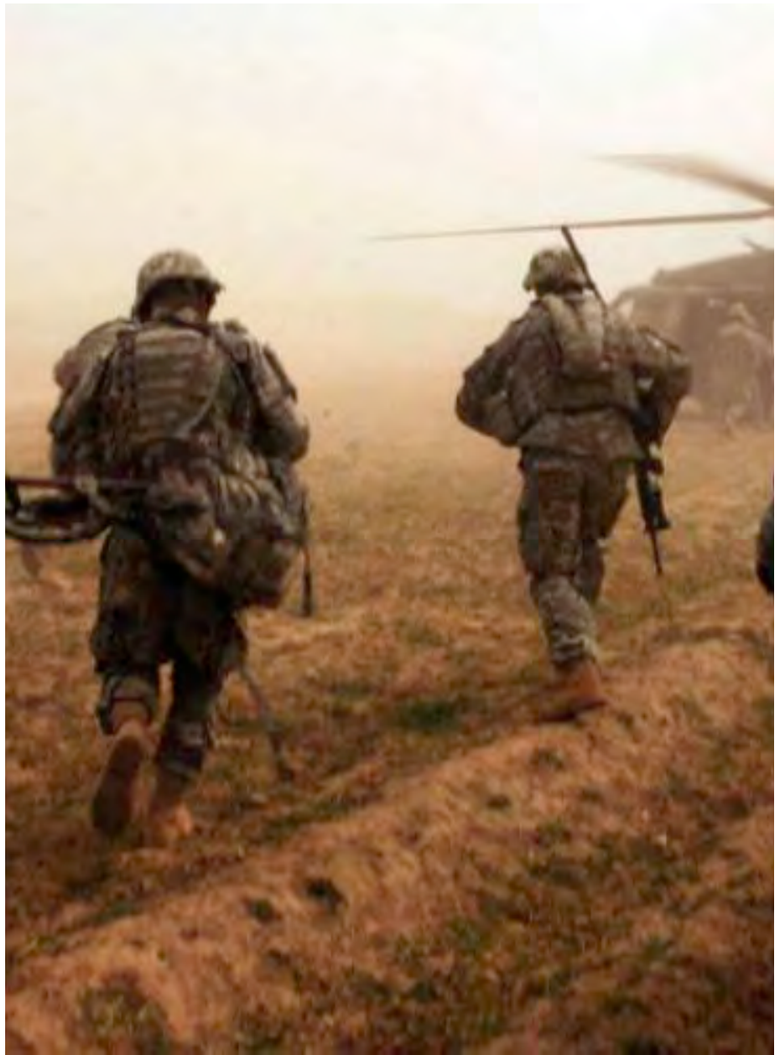
Simple activities are the hardest and most strenuous for soldiers, it is constant. COTS shoe models do not highlight basic activites wth cushioing, stability, etc.



Quick Agility (Sprints)

No current shoe models provide sufficient traction for quick agility excersises, imagine sprinting in a pair of boots....





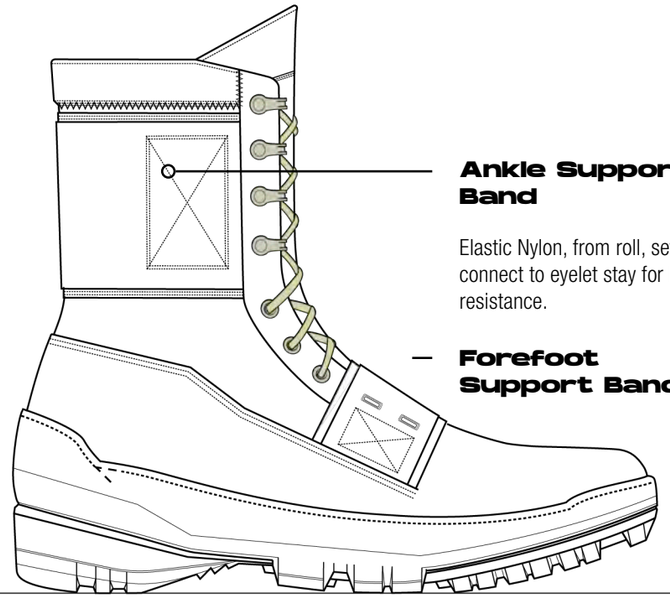


Basic Boot

Isometric views of basic boot to emphasize parts and purpose, key components and and benefits to the user. The “Basic Boot” is the boot to prevent fatigue, injury, and to provide day to day comfort without sacrificing performance.

Construction, Assembly, Etc.

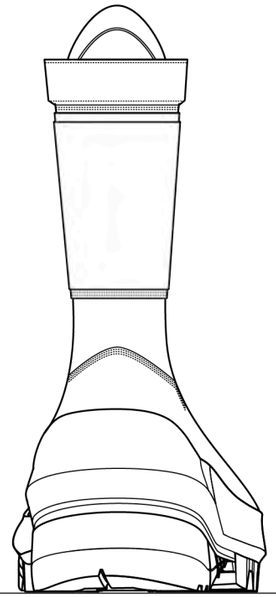
Constructed using custom last shape, utlizing minimal patterning to optimize weight and durability while mainintaing flexibility and performance thorughout the day. The Basic boot is meant to keep soliders on there feet well past 12 hour mark.



Ankle Support Band

Elastic Nylon, from roll, sewn to connect to eyelet stay for lacing resistance.

Forefoot Support Band



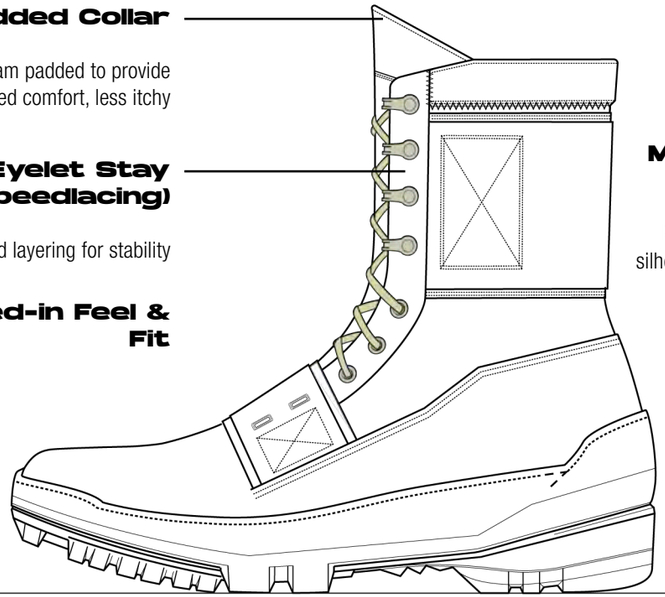
Padded Collar

Foam padded to provide incresed comfort, less itchy

Eyelet Stay (Speedlacing)

Updated layering for stability

Locked-in Feel & Fit

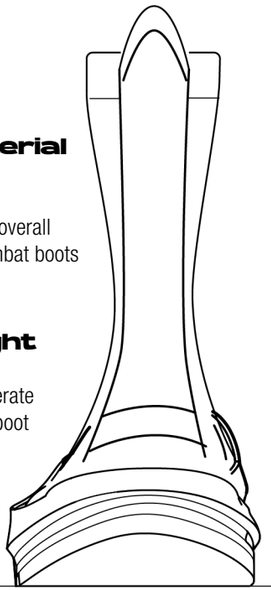


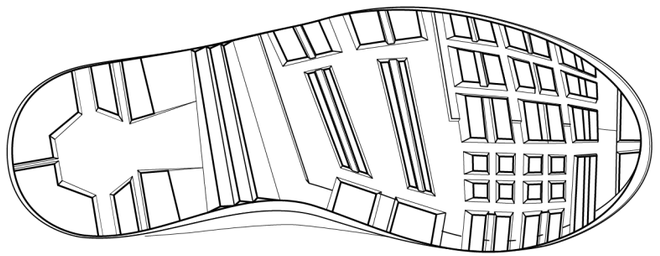
Minimal Material Usage

Reduce weight and overall silhouette, all other combat boots are overbuilt.

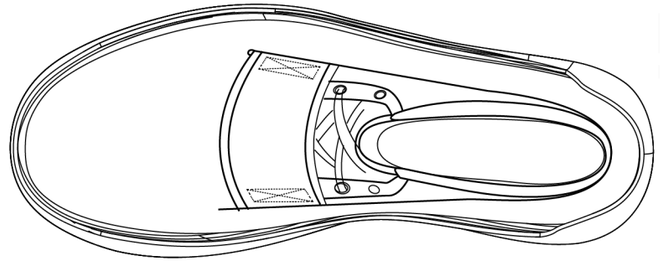
Lightweight

The lightest temperate weather combat boot available.

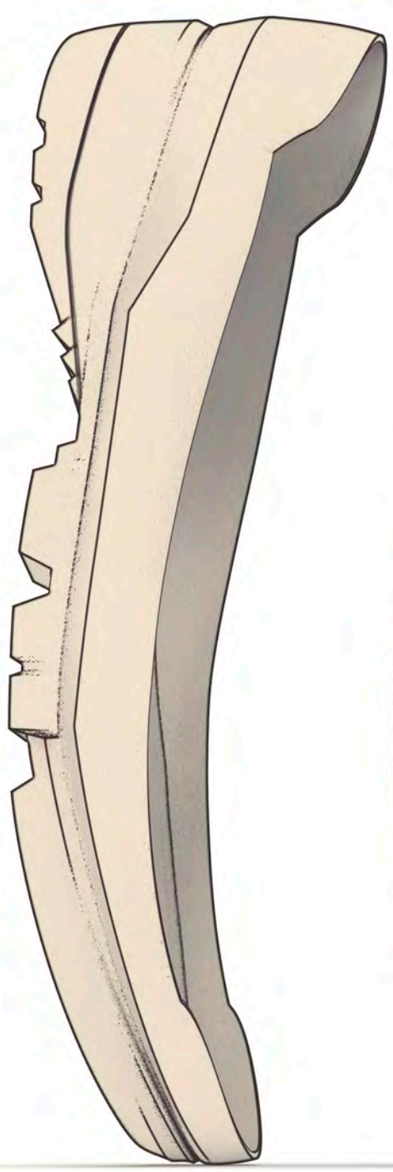


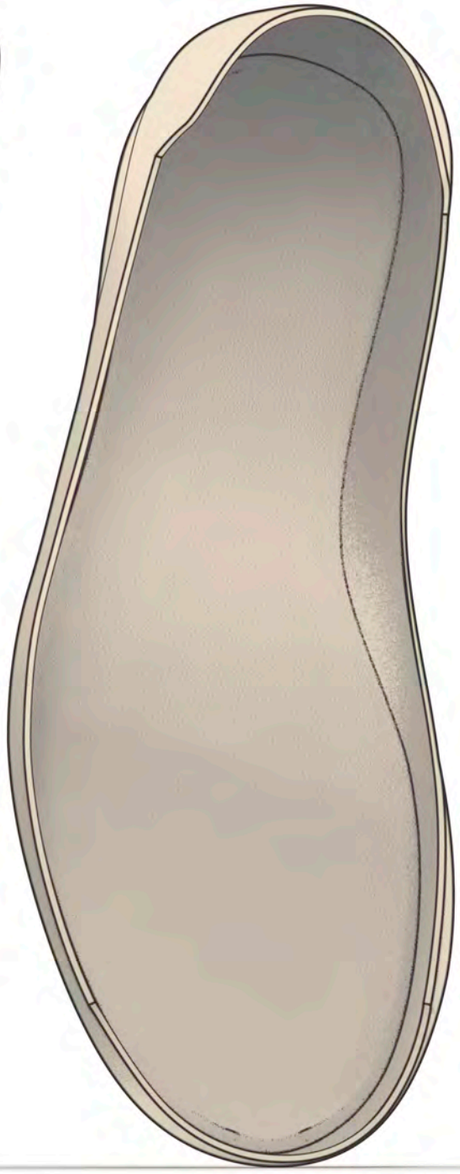


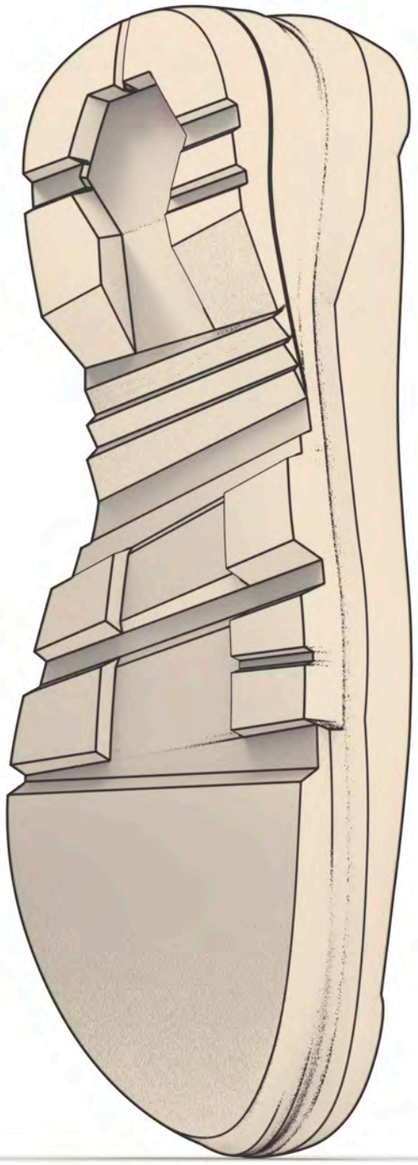


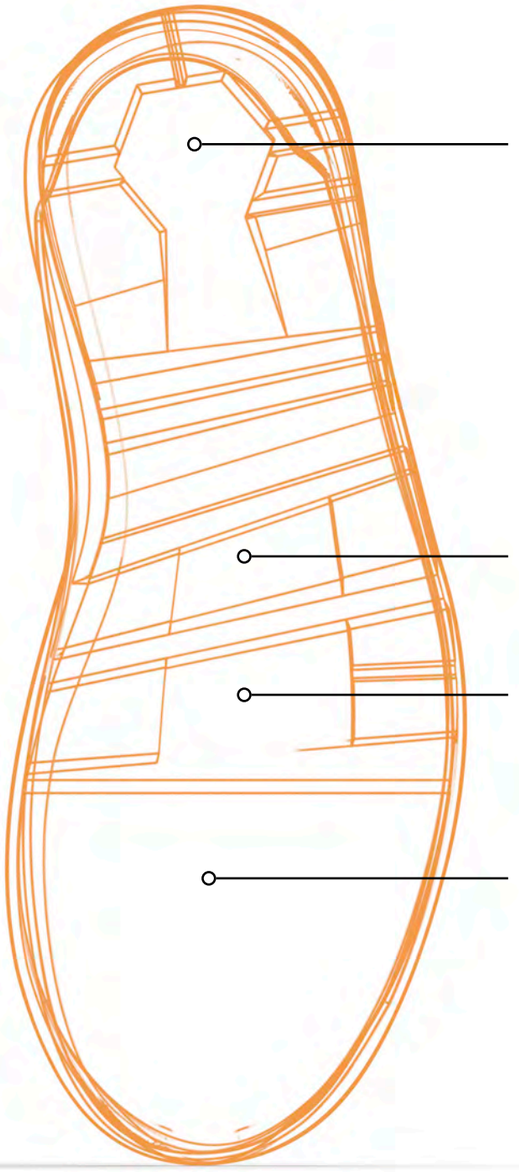












Hilt Heel

Horseshoe like heel cutout to distribute pressure awa from center of the heel, improved comfort all day. 50% Heel.



Flex Groove

Continued support and traction lugs helps with balance.

Tough Traction

Molded hard rubber gives resilient traction.

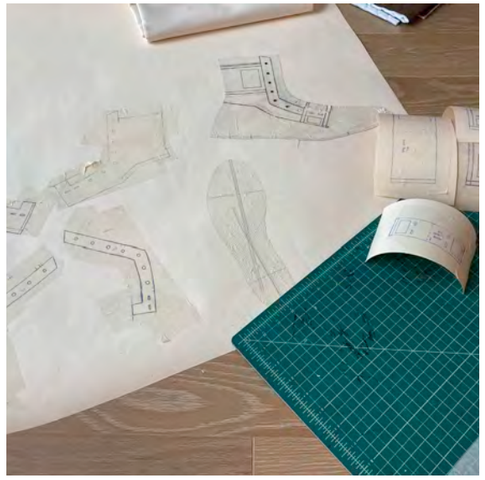
Comfort Core

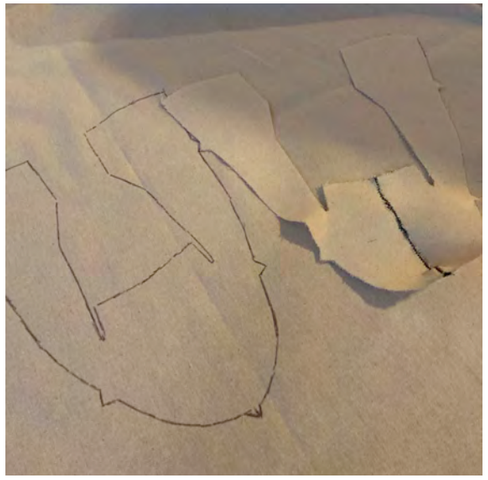
Surafec area of cushioned forefoot strike tread.

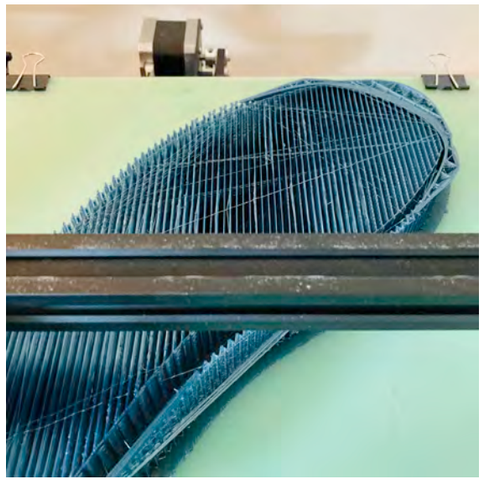


Basic Boot Prototype

Upper patterning process for acts like prototype focusing on material thicknesses and order of operations and assembly. From initial last tape through upper assembly and material selection for final prototype.



”That’s so cool! Looks like I could wear it.”

Initial reaction to basic boot was succesful, knew it was for military, and impressed by the construction and overall design of the basic boot.

”Flat front, flat back on all shoes.”

All other shoes have flat surface area on bottom, adding cutouts along the center help alleviate pressure to center heel and bottom of foot.

”Seems a lot more balanced.”

Weight rests on side traction lugs for wieght distributement thorugh the midsole away from the centers of the foot, giving more balance from side to side.

”Keep them around the 2nd lace (speedlace).”

Speedlacing system usually only falls at the top three eyelets, its important to keep the look clean and to now have loose laces at top of foot.

”Tops get loose all the time, interesting.”

Ankle support, lots of guys roll ankles because of shallow dirt when not wearing proper traction. Hooked to eyelet stays this will provide resistance and support.



Next Step: Fit & Feel Testing

Second upper prototype utilizing final fabric materials, as close to perfectly assembled as possible and with flexible match midsole. Travelling to my athlete for in person fit and feel test, size 11 will fit and feel test two people.

Last Step: Expert Interviews

Further review of design concepts and prototypes for focus on refinement and overall design progression. Waiting for responses from a few people for surveys, questions, etc.



Mary B. Armacost
Textile Technologist (Hot/Cold Weather)
US Army CDCC Soldier Center
- Waiting Response for Basic Boot



Johathan Swegle
Footwear Designer
Gore-Tex
- Prototype Review Zoom Schedule



Jay McNamara
Extremity Protection Project Engineer, Engineering Psychologist
US Army CDCC Soldier Center



Next Step: OverBoot Prototype and Final Basic Boot

Switch gears to further develop custom over-boot last and prototype upper as well as 3D midsole, plan on both being done for fit and feel testing. Final Basic Boot Upper for fit and feel test as well as possible mold for midsole casting rather than flexible 3D printing.

Week 6:

- Over-Boot patterning and 3D Development, as well as isometric views and parts and purpose
- Basic Boot midsole mold
- Review of midterm presentation deck (brand elements, flow, etc.)

Week 7:

- Assembly of prototypes for fit and feel testing, print midsoles all flexible for use.
- Prototypes ready for both testing and expert interviews

Week 8:

- Fit and Feel Testing to be carried out (travel to Washington state for a day or two max for testing.)
- Final prototypes done for both boots for Fit and Feel Test

Week 9:

- Presentation Deck including both boots process through final design, features benefits, exploded views, branding, etc.
-Packaging ideation and creation
- Final Upper Assembly based on Fit and Feel Testing

Week 10:

- Final Presentation Deck completed
- Brand elements and presentation flow refined
- 3D prototypes finished with final materials and flexible midsole/outsole.







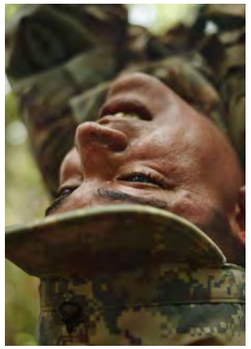




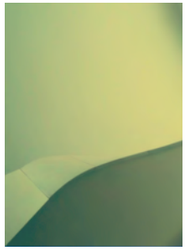




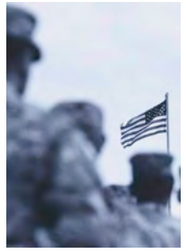


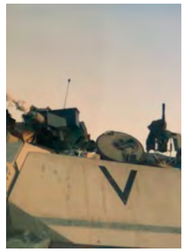


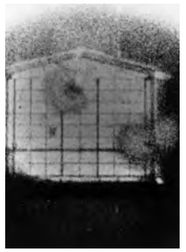












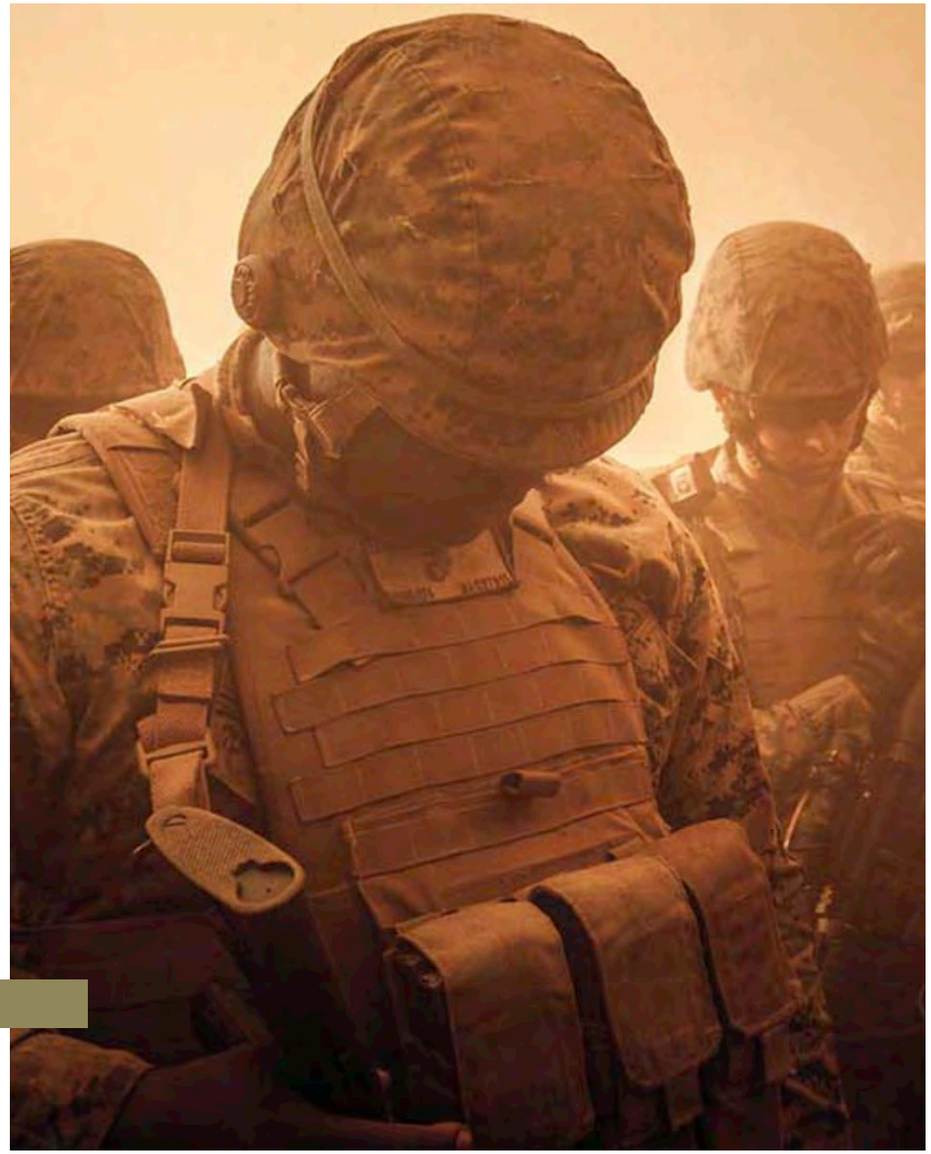


strong x dependable x exact

Dirty Tope/Tan 499

Initial color exploration into basic boot, regulation standards are informed by Mil-Spec colors such as traditional tan, khaki, and coyote tan. This is the progression of initial sketches and colors.

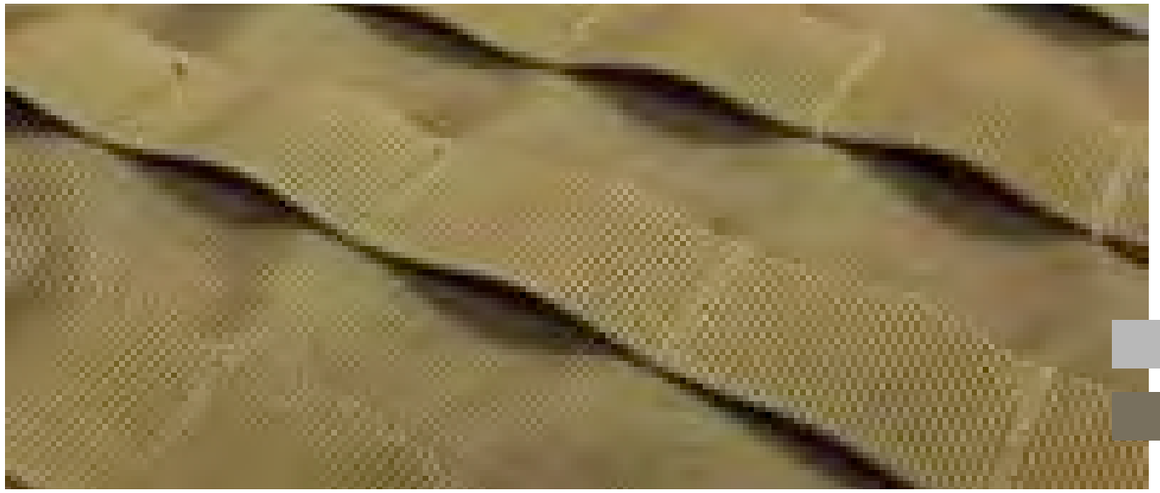


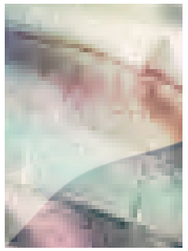












molle utility pouch (cordura, webbing, etc.)

questions? thanks.

Capstone Presentation Deck

foxtrot | UNIVERSITY OF OREGON | Sports Product Design

MAXWELL BRAZO
FOXTROT FOOTWEAR

...inspired by family



- Peter Martin Richmond Walton

(Royal Air Force Reserve, Fighter Jet Pilot. Lifelong Pilot and Aviation Expert. Flew jets longer than anyone)



- Bruce Allen Brazo

(US Army Military Police, Served in Japan during WWII Occupation, was 17 years old at the time)



- George Jeffery Keith

(Norwich University, US Army 2nd Lieutenant. 4 Years Schweinfurt, Germany)



- Mark Stillman Keith

(Retired Lieutenant Colonel US Army, served 20+ years. First deployed in Desert Shield at age 23.)



- Lindsay Francis Faith Keith

(US Army Intelligence, rank of Captain. About to begin 3rd deployment to Afghansitan.)

*“Soliders live in their boots and many will tell you there is no piece of equipment more important to their lethality and readiness...**most components of these combat boots have not been updated in almost 30 years...**”*

– Al Adams, TL, Natick Soldier Center



#1 Regulation boots are failing soldiers, are in most in need of immediate improvements.

“Something comfortable, that breathes, but doesn’t compromise support.”



- Lack of comfort and support
- Materials are stiff and hard to break in
- Too heavy, no flexibility where needed in various activities.

#2 Cold weather boots are the second most in need of improvement voted by soldiers.

“Simple construction and lightweight insulation materials for solider sustainment in lower temperatures.”



- Over-constructed, not practical
- Ineffective in normal conditions


- Rucking (Loaded March)
- Running/Walking
- Quick-Agility



- Over-snow Mobility
- Sustainment

U.S.ARMY

Cpt. Lindsay Keith (Intel)

"Combat boots, in general, are uncomfortable for long periods of time and during specific activities throughout the day; there is definitely a need for boots that will reduce pain and help prevent associated injuries..."

Comfort

Weight

Flexibility



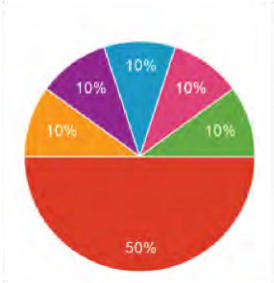
A survery conducted of a total of ten soldiers under her command answered they want a more comfortable boot, followed by reduced overall weight and increased flexibility.



"In general, foot soldiers can sustain a march of between fifteen and twenty miles per day almost indefinitely, provided they have a days rest once every week or five days...injuries such as blistering, hot spots, and fatigue are prevelant..."



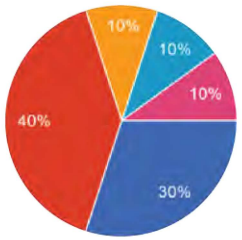




What area of the foot sustains the most injury while wearing your boot?

60% Heel

20% Foot Arch/Underfoot



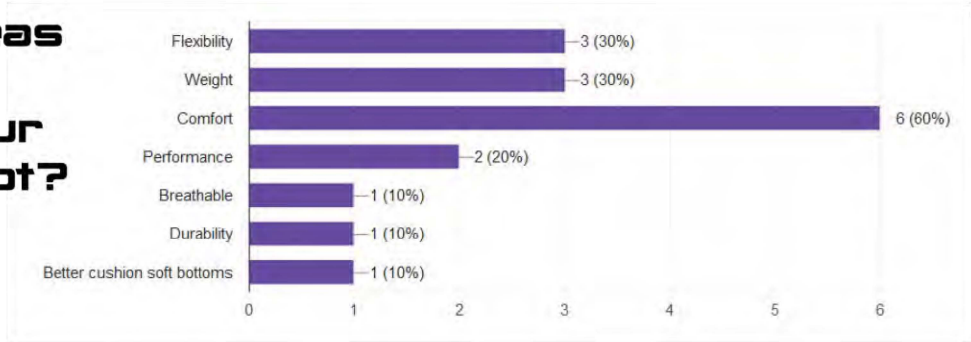
What is most important to you when it comes to your foot for daily wear?

40% Comfort

30% Lightweight

10% Flexible

In what areas would you improve your current boot?



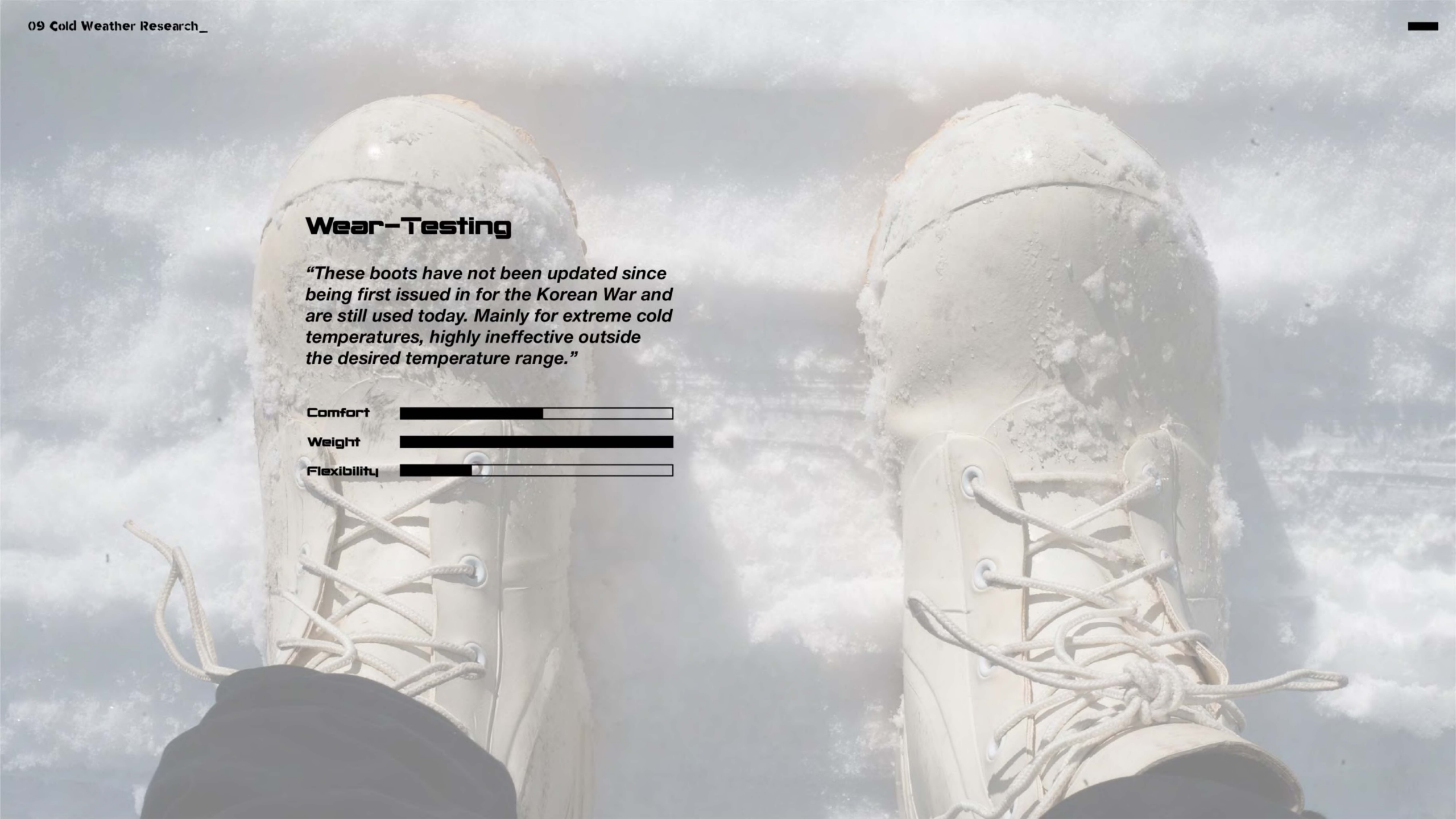
Wear-Testing

“These boots have not been updated since being first issued in for the Korean War and are still used today. Mainly for extreme cold temperatures, highly ineffective outside the desired temperature range.”

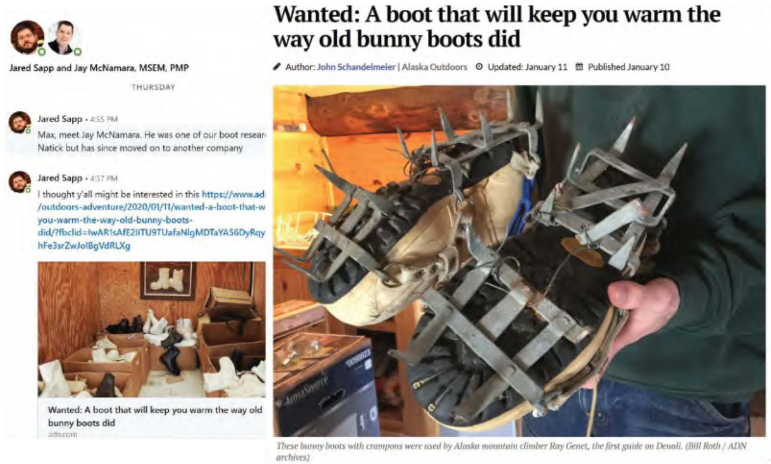
Comfort

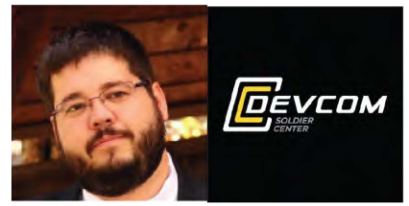
Weight

Flexibility



Talking to Experts





Jared Sapp
Science Advisor to US Army Alaska at
U.S. Army Research Development and Engineering Command

"One case is cold and dry, think oil workers on the North Slope, Mountaineering, etc. Where the primary concern is a warm boot."

"The bunny boot is quickly dried out and with a change of socks (or even wringing them out and waving them dry in the extreme dry air) you can keep going and avoid injury."



Jay McNamara
Extremity Protection Project Engineer, Engineering Psychologist
U.S. Army CDCC Soldier Center

"In a poll of 14,000 soldiers, the Army said it found that nearly 50 percent choose comfortable sneaker-like commercial boots..."

"Over-boot for colder weather makes the most sense, something lightweight and insulated that helps the soldier stay warm."

"With new technologies/materials and design, soldiers will be able to rely on new innovative methods of comfort and support, enabling them to stay on their feet for longer amounts of time without injury, and allow them to be the most effective soldiers they can be."

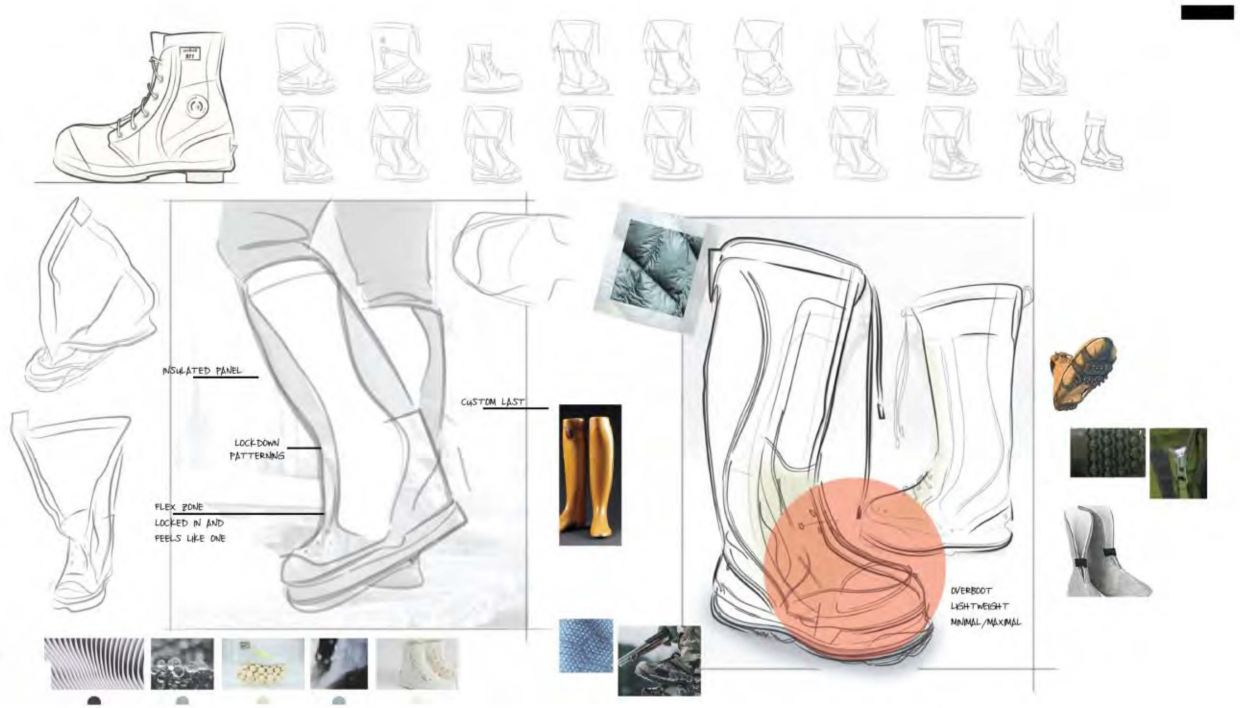
Meant for the outdoors, resistant Mil-Spec materials that last.

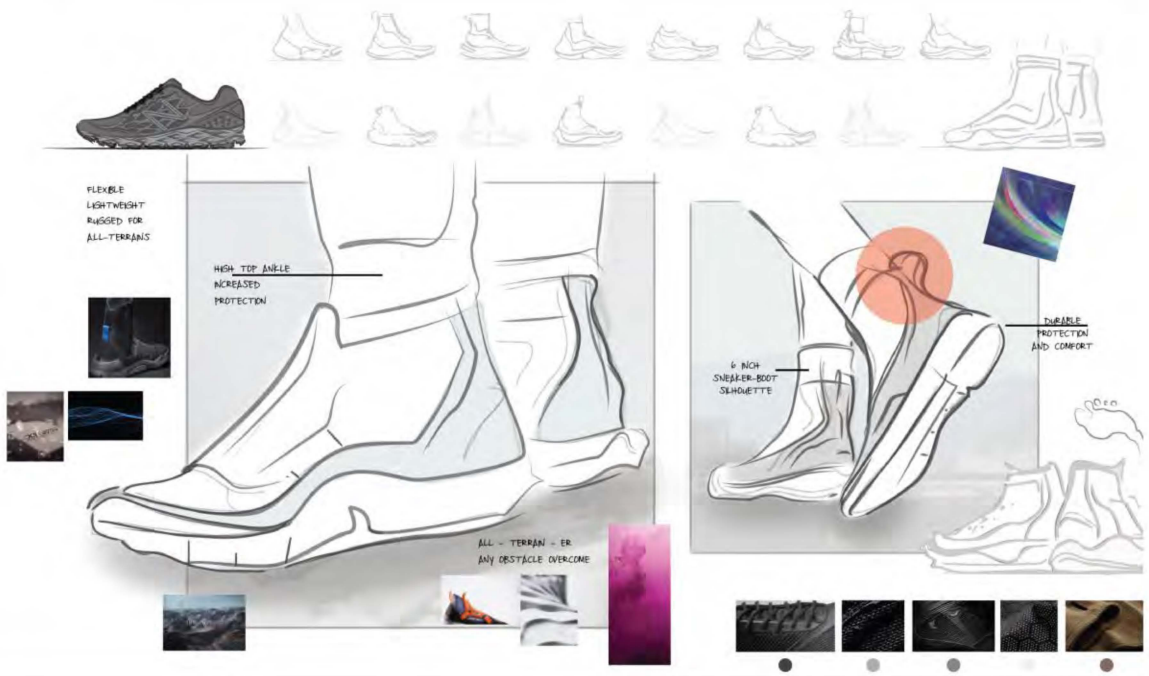
Supportive and mimial design

Lightweight and comfortable for daily activites




HOW CAN IT BE BETTER?
BASE BOOT LOCKS INTO BOTH OVERBOOT AND SINGLE MIDSOLE
packable
STANDARD ISSUE BASIC MINIMALIST DESIGN BAREFOOT LOW-PROFILE BASE TO BUILD UPON
SECTION CUT VIEW ATTACHED TO MIDSOLE FOR DYNAMIC WEARABILITY
CONTOURED CONNECTION AROUND TOE/HEEL
FLEXIBLE/RIGID CONTOURED SUPPORTS (FLEX 3D PRINT)
U.S. ARMY

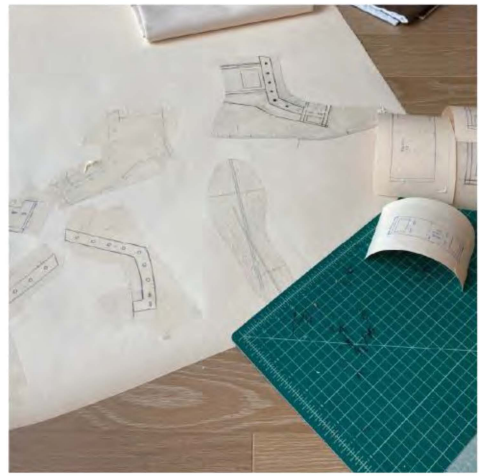

INSULATED PANEL
LOCK-DOWN PATTERNING
FLEX ZONE LOCKED IN AND FEELS LIKE ONE
CUSTOM LAST
OVERBOOT LIGHTWEIGHT MINIMAL/MAXIMAL


FLEXIBLE LIGHTWEIGHT RUGGED FOR ALL-TERRAINS
HIGH TOP ANKLE INCREASED PROTECTION
ALL - TERRAIN - ER ANY OBSTACLE OVERCOME
DURABLE PROTECTION AND COMFORT
6 INCH SNEAKER-BOOT SILHOUETTE


ROOTED IN HISTORY HIGHLIGHT OLD DESIGN
WATER RESISTANT BASIC UPPER
ANTI-BACTERIAL COATING
STABILITY AND TRACTION ENHANCED GRIP
TOP OF FOOT LOCK
RUGGED/RELENTLESS
ANKLE/ CHEMICAL WARFARE

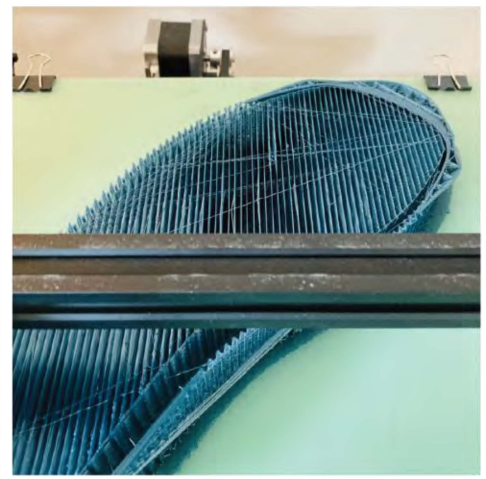
Basic Boot Prototype

Upper patterning process for acts like prototype focusing on material thicknesses and order of operations and assembly. From initial last tape through upper assembly and material selection for final prototype.











Custom Boot Last (3D)

“Deep dive into 3D devlopment of Over-Boot last as well as Regulation Boot last for neccessary prototyping and development. 3D scanned and refined utlizing simple software & equipment.



Upper Patterning

“Working with layered materials and various thicknesses proved difficult, however, refined assembly allowed for desired fit and feel for validation.”

"That's so cool! Looks like I could wear it."

Initial reaction to basic boot was succesful, knew it was for military, and impressed by the construction and overall design of the basic boot.

"Flat front, flat back on all shoes."

All other shoes have flat surface area on bottom, adding cutouts along the center help alleviate pressure to center heel and bottom of foot.

"Seems a lot more balanced."

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"Keep them around the 2nd lace (speedlace)."

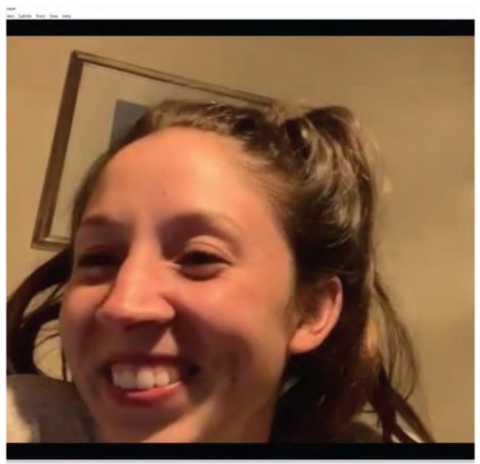
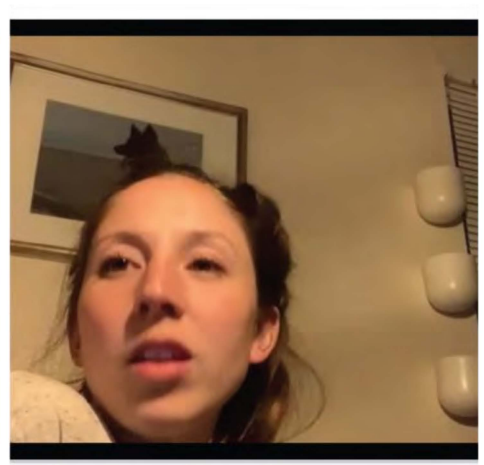
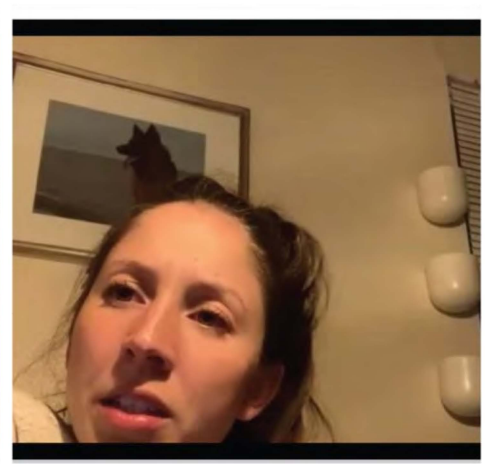
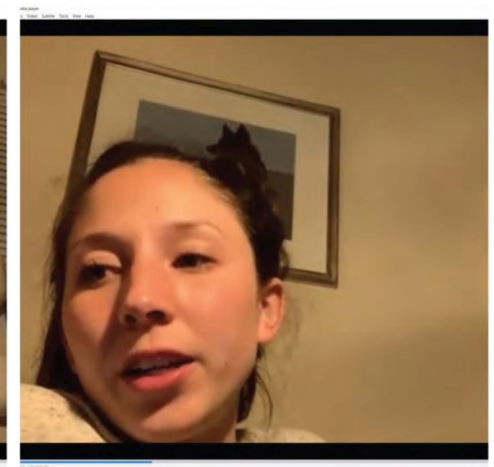
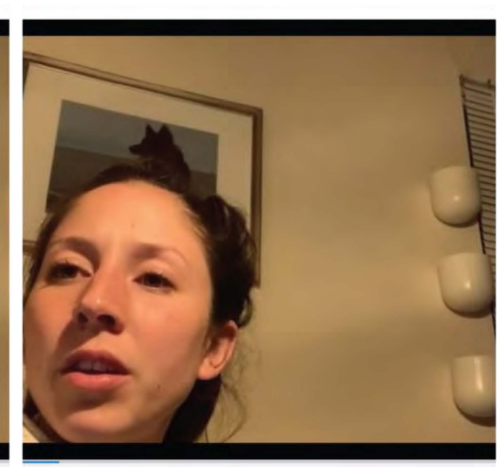
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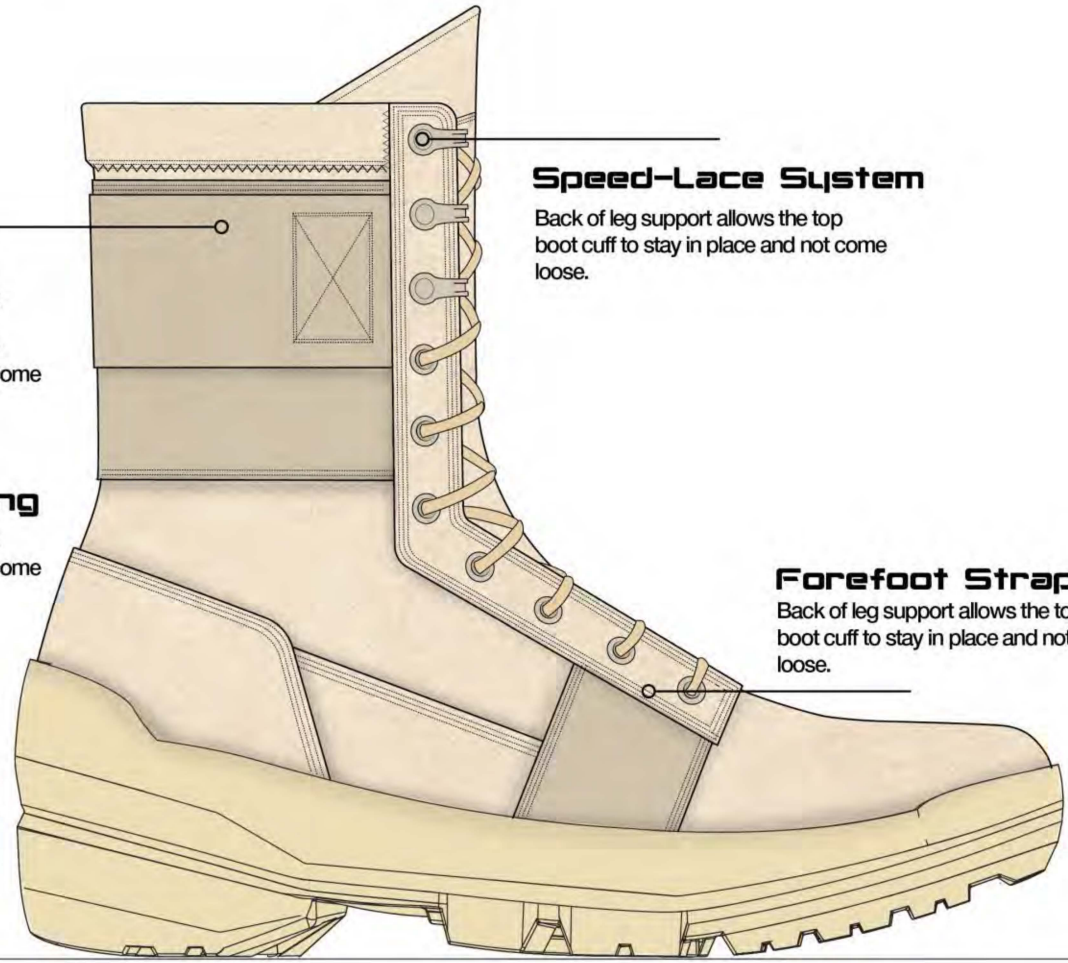


Fit Validation

“Being able to 3D develop and print flexible midsole allowed for fit validation of regulation boot midsole into over-boot midsole.”

Basic Boot (Regulation)

- Focus on Comfort, Weight, Flexibility to reduce hot-spots, blistering, and foot fatigue



MIL-Spec Nylon Support Straps

Back of leg support allows the top boot cuff to stay in place and not come loose.

Minimal Patterning

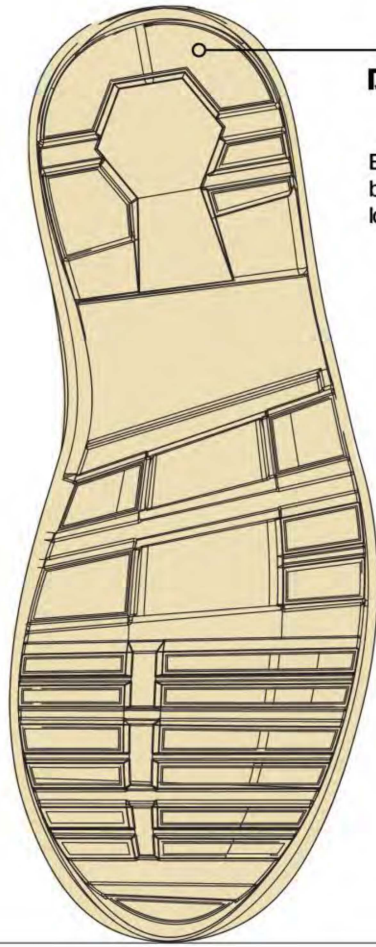
Back of leg support allows the top boot cuff to stay in place and not come loose.

Speed-Lace System

Back of leg support allows the top boot cuff to stay in place and not come loose.

Forefoot Strap

Back of leg support allows the top boot cuff to stay in place and not come loose.



Dynamic Midsole

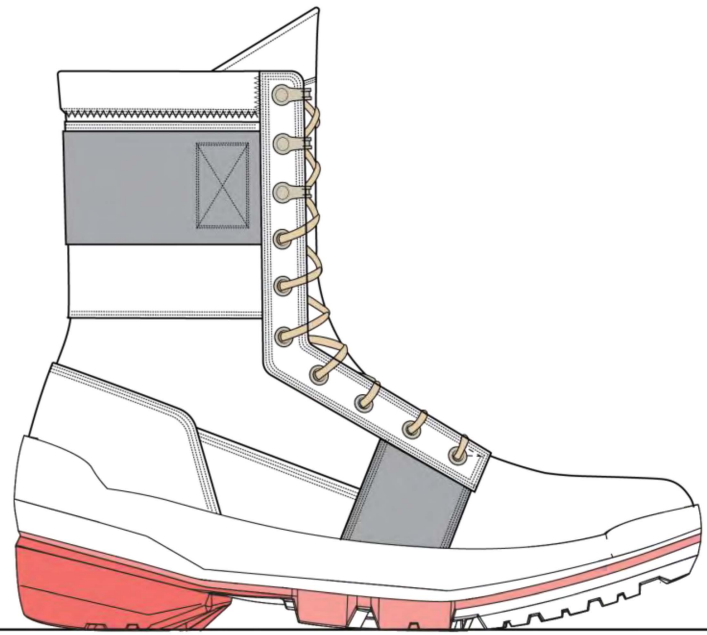
Back of leg support allows the top boot cuff to stay in place and not come loose.

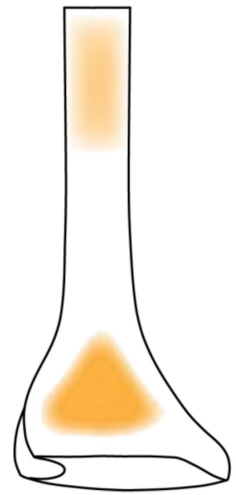
Comfort/Support

- Support Straps
- Minimal
- Speed Lace
- Lightweight
- Flexibility

Performance

- Comfort
- Split Heel
- Tiered Cushioning
- Responsiveness





Back



Front



Bottom



Hilt Heel Cushion

Horseshoe like heel cutout to distribute pressure awa from center of the heel, improved comfort all day.

Flex Groove

Continued support and traction lugs helps with balance. Weight is on perimeter of midsole not the center, reduces foot fatigue.

Tough Traction

Molded lugs allow for greater grip on uneven surfaces and for reduced slippage on rugged terrain.

Comfort Core

Sneaker like forefoot cushining for increased comfort under toes and forefoot.

Insulated Over-Boot

- Focus on areas of thermoregulation to keep warm
- Lightweight
- Midsole support

Leg Closure

Top of leg and back of leg closure,

Quilted Insulation Panelling

Placed in areas of necessary thermoregulation. Membrane insulation for flexbile and lightweight warmth

Minimal Patterning

Streamlined, lightweight design means it can be easily packed and used when needed.



Quilted Insulation

Front and back of leg for added support and thickness.



Minimal Midsole

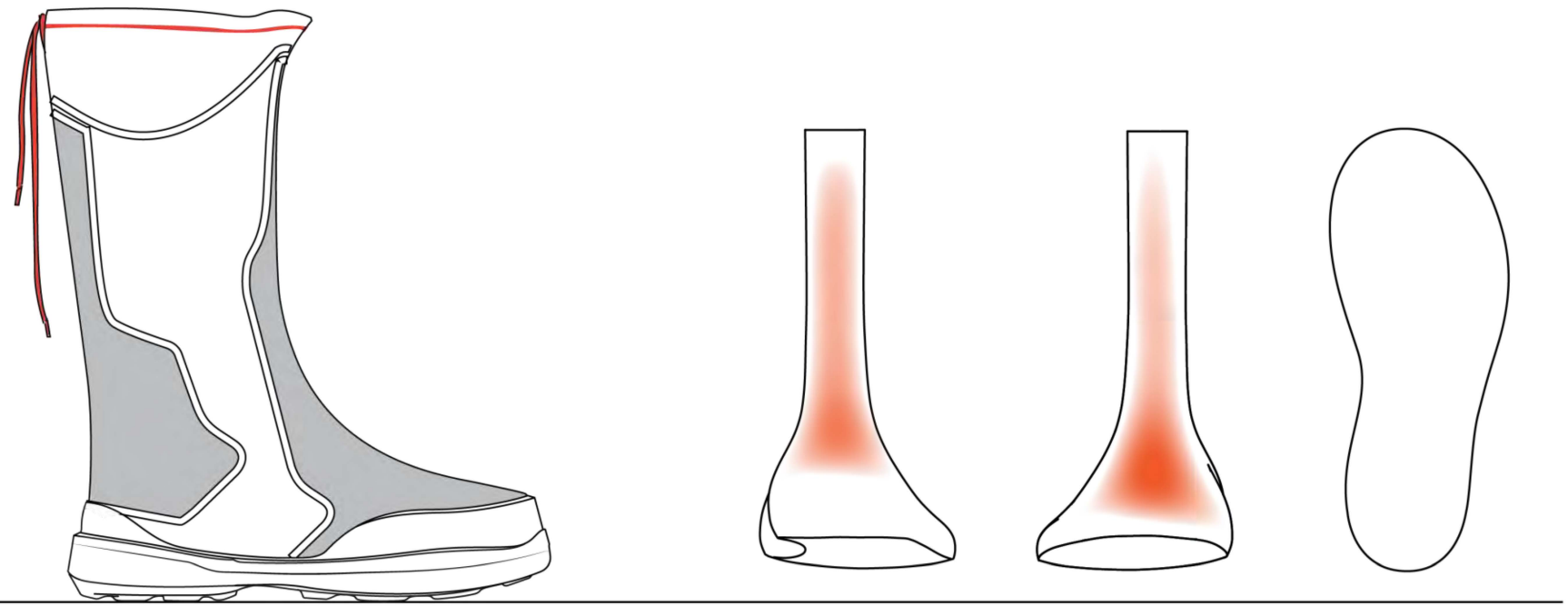
Reduced weight but substantial, very protective for use in all-terrain conditions.

Thermoregulation

- Insulation
- Dynamic Patterns
- Mil-Spec
- Toe/Heel Counters
- Flexible Upper

Usability

- Closures
- Packable
- Lightweight
- Protective





Tread Lightly

Minimal midsole tread allows for easy mobility and traction in both snow and in the dirt.
- Responsive
- Lightweight

Flexible Split

Thinnest point of the midsole to allow for increased flexibility.
- Fit and Feel

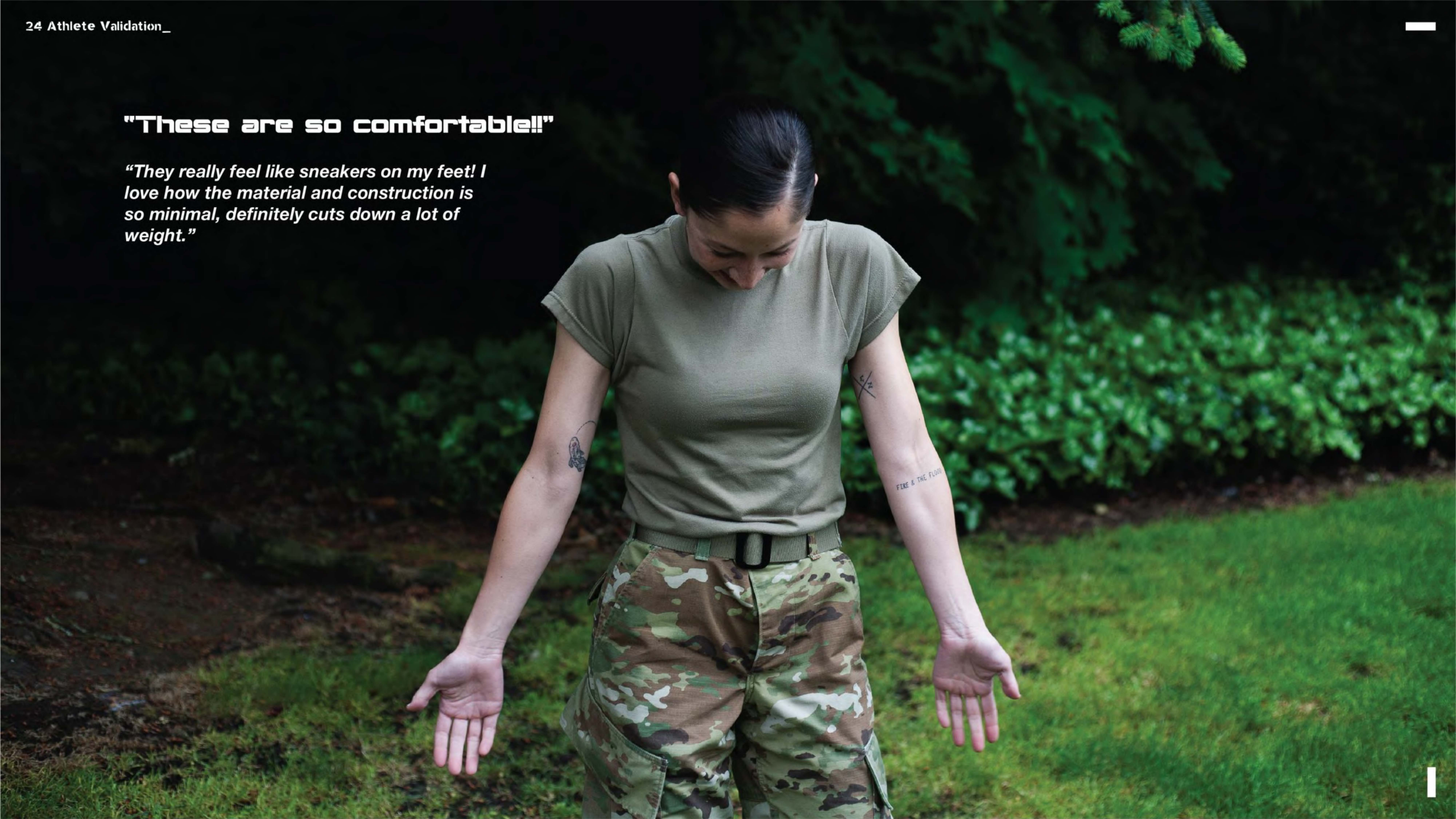
Minimal Grooved Lugs

Rubberized texture allows for more durable and long lasting overboot, and one piece injection molded to simplify construction and assembly.

Integrated Counters

"These are so comfortable!!"

"They really feel like sneakers on my feet! I love how the material and construction is so minimal, definitely cuts down a lot of weight."





"The straps are a lot more supportive."

"Less room for the foot to move around, definitrly will help reduce hotspots and blistering. The tops of my boots want slide down anymore, the resistance at the back of my leg when I lace up feels really good."

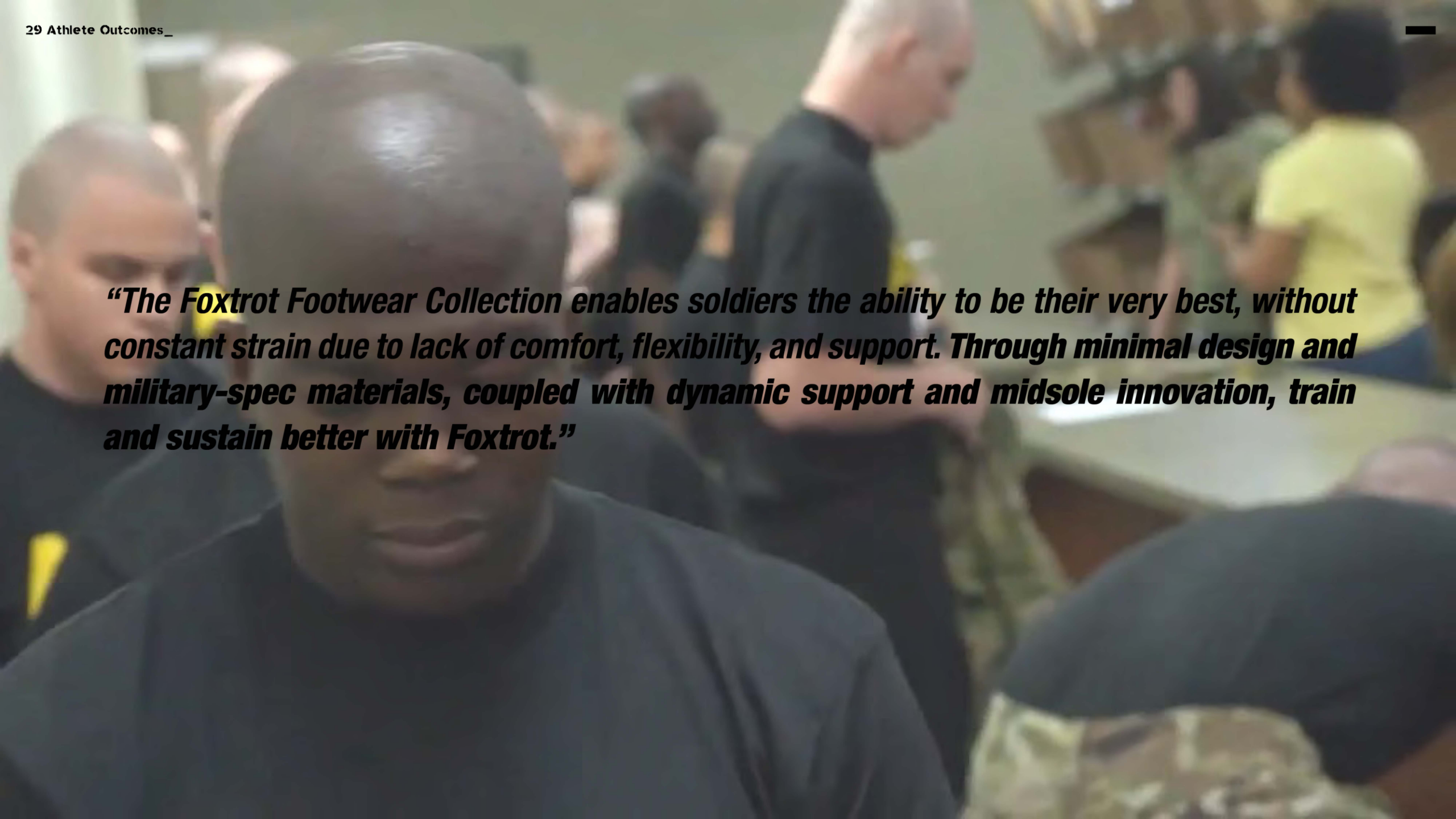




"Already feeling warmth around the front and back of my leg!"

"These are crazy lightweight and the insulation is definitely where I need it the most. The lacing on the back really helps streamline the design being able to secure around the front and knot in the back as well."





*“The Foxtrot Footwear Collection enables soldiers the ability to be their very best, without constant strain due to lack of comfort, flexibility, and support. **Through minimal design and military-spec materials, coupled with dynamic support and midsole innovation, train and sustain better with Foxtrot.**”*

Thank you!

foxtrot



process / version.1

...inspired by family



- Peter Martin Richmond Walton

(Royal Air Force Reserve, Fighter Jet Pilot. Lifelong Pilot and Aviation Expert. Flew jets longer than anyone)



- Bruce Allen Brazo

(US Army Military Police, Served in Japan during WWII Occupation, was 17 years old at the time)



- George Jeffery Keith

(Norwich University, US Army 2nd Lieutenant. 4 Years Schweinfurt, Germany)



- Mark Stillman Keith

(Retired Lieutenant Colonel US Army, served 20+ years. First deployed in Desert Shield at age 23.)



- Lindsay Francis Faith Keith

(US Army Intelligence, rank of Captain. About to begin 3rd deployment to Afghansitan.)

*“Soliders live in their boots and many will tell you there is no piece of equipment more important to their lethality and readiness...**most components of these combat boots have not been updated in almost 30 years...**”*

– Al Adams, TL, Natick Soldier Center



#1 Regulation boots are failing soldiers, are in most in need of immediate improvements.

“Something comfortable, that breathes, but doesn’t compromise support.”



- Lack of comfort and support
- Materials are stiff and hard to break in
- Too heavy, no flexibility where needed in various activities.

#2 Cold weather boots are the second most in need of improvement voted by soldiers.

“Simple construction and lightweight insulation materials for solider sustainment in lower temperatures.”



- Over-constructed, not practical
- Ineffective in normal conditions


AirBoss
11R



-60°F

32°F

120°F

Extreme Cold | **Cold** | **Temperate** | **Hot / Humid / Wet**

Extreme Cold Weather Boot (ECWB)
-60F to -20F



KEY

- Wet/Rainy
- Mountainous
- Standard
- Snow
- Hot/Dry
- Hot/Wet/ Humid

Alpine Comabt Boot



Evaluate in AK
FEB-APR 2015

Intermediate Cold/Wet Boot w/ removable liner (ICWB)
14F to 32F



Temperate Weather Army Combat Boot (TW ACB)
> 32F



Hot Weather Army Combat Boot (HW ACB) > 70F

Hot Weather Flame-Resistant Army Combat Boot (HW FR ACB)

Temperate Weather Mountain Combat Boot (TW MCB)

Hot Weather Mountain Combat Boot (HW MCB)



Tropical

Jungle Boot

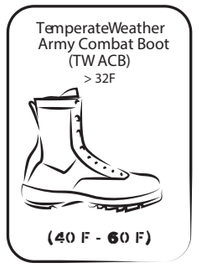
SEP
25th ID JOTC
2FY2015





Extreme Cold Weather

Rough All-Terrain





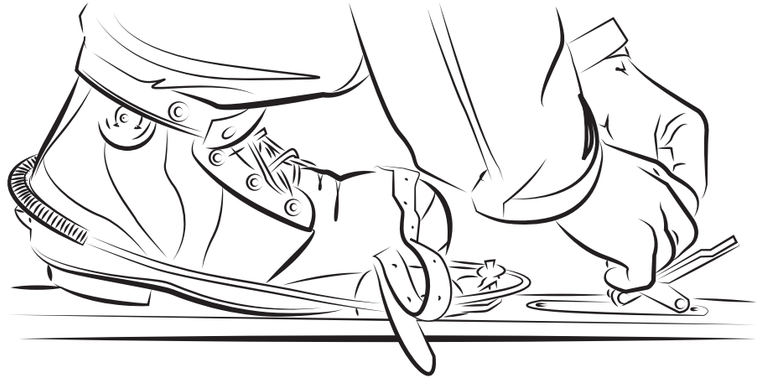


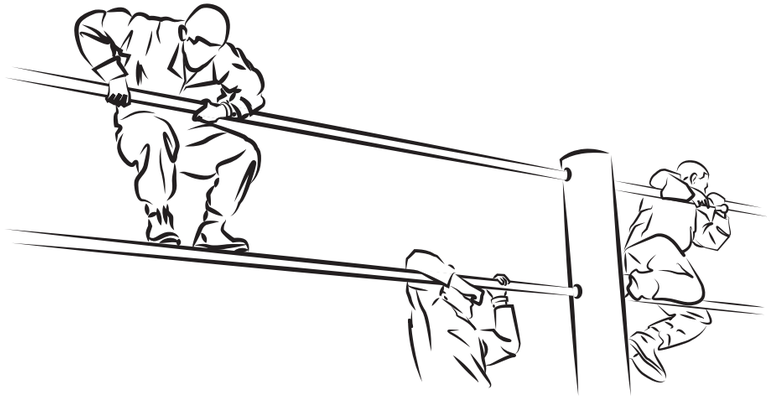
Jungle/Hot/Humid

Model: VB Type II
Brand: AirBoss
Sizing: 11R
Weight: 56 oz. (3.5 pounds)

Model: 950v2 (Made In USA)
Brand: New Balance
Sizing: 11M
Weight: 10.5 oz

Model: Vietnam Era JCB
Brand: Rothco
Sizing: 10R
Weight: 48 oz. (3 pounds)







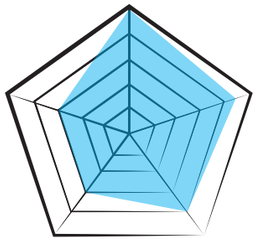


Rough All-Terrain

Wear-Test Trait Scoring

Cushioning	5
Stability	4.5
Traction	4
Flexibility	3
Protection	3

Trait-Relationship Index



Foot Mapping:

- Pain/ Discomfort
- Slippage
- Areas of Traction



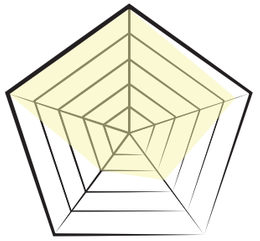


Extreme Cold Weather

Wear-Test Trait Scoring

Cushioning	5
Stability	4.5
Traction	2.5
Flexibility	2
Protection	5

Trait-Relationship Index



Foot Mapping:

- Pain/ Discomfort
- Slippage
- Areas of Traction



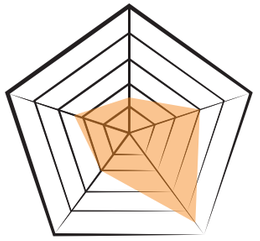


Jungle/Hot/Humid

Wear-Test Trait Scoring

Cushioning	1.5
Stability	3
Traction	4.5
Flexibility	2
Protection	2.5

Trait-Relationship Index



Foot Mapping:

- Pain/ Discomfort
- Slippage
- Areas of Traction



U.S.ARMY

Cpt. Lindsay Keith (Intel)

“Combat boots, in general, are uncomfortable for long periods of time and during specific activities throughout the day; there is definitely a need for boots that will reduce pain and help prevent associated injuries...”

Comfort

Weight

Flexibility

60%

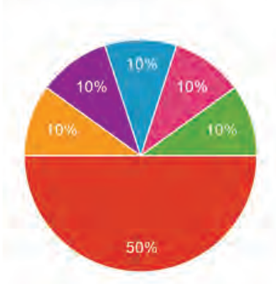
A survery conducted of a total of ten soldiers under her command answered they want a more comfortable boot, followed by reduced overall weight and increased flexibility.



*"In general, foot soldiers can sustain a march of between fifteen and twenty miles per day almost indefinitely, provided they have a days rest once every week or five days...**injuries such as blistering, hot spots, and fatigue are prevelant...**"*



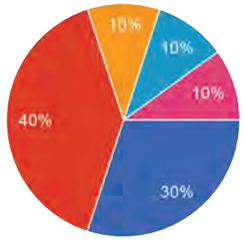




What area of the foot sustains the most injury while wearing your boot?

60% Heel

20% Foot Arch/Underfoot



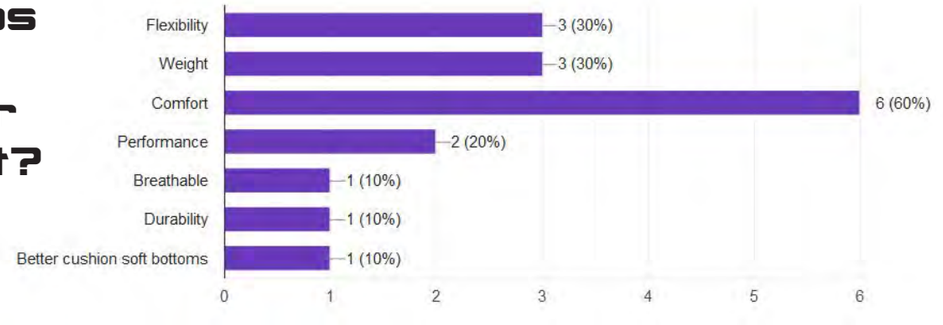
What is most important to you when it comes to your foot for daily wear?

40% Comfort

30% Lightweight

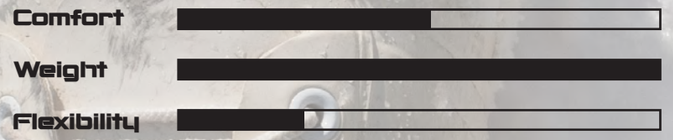
10% Flexible

In what areas would you improve your current boot?

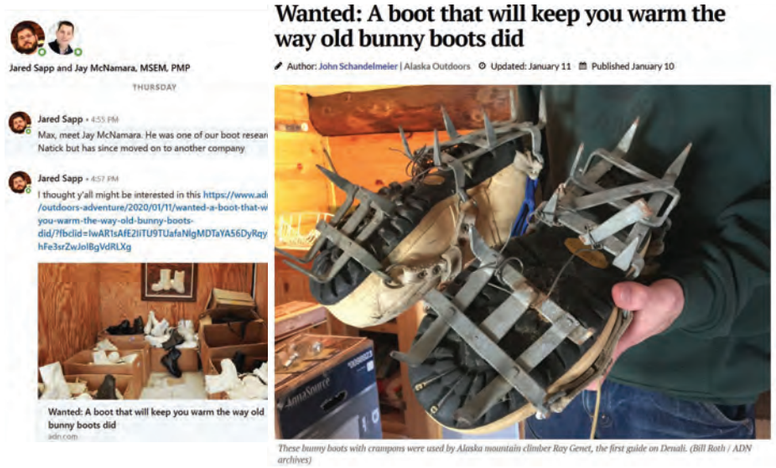


Wear-Testing

“These boots have not been updated since being first issued in for the Korean War and are still used today. Mainly for extreme cold temperatures, highly ineffective outside the desired temperature range.”



Talking to Experts





Jared Sapp
Science Advisor to US Army Alaska at
U.S. Army Research Development and Engineering Command

"One case is cold and dry, think oil workers on the North Slope, Mountaineering, etc. Where the primary concern is a warm boot."

"The bunny boot is quickly dried out and with a change of socks (or even wringing them out and waving them dry in the extreme dry air) you can keep going and avoid injury."



Jay McNamara
Extremity Protection Project Engineer, Engineering Psychologist
U.S. Army CDCC Soldier Center

"In a poll of 14,000 soldiers, the Army said it found that nearly 50 percent choose comfortable sneaker-like commercial boots..."

"Over-boot for colder weather makes the most sense, something lightweight and insulated that helps the soldier stay warm."

"With new technologies/materials and design, soldiers will be able to rely on new innovative methods of comfort and support, enabling them to stay on their feet for longer amounts of time without injury, and allow them to be the most effective soldiers they can be."

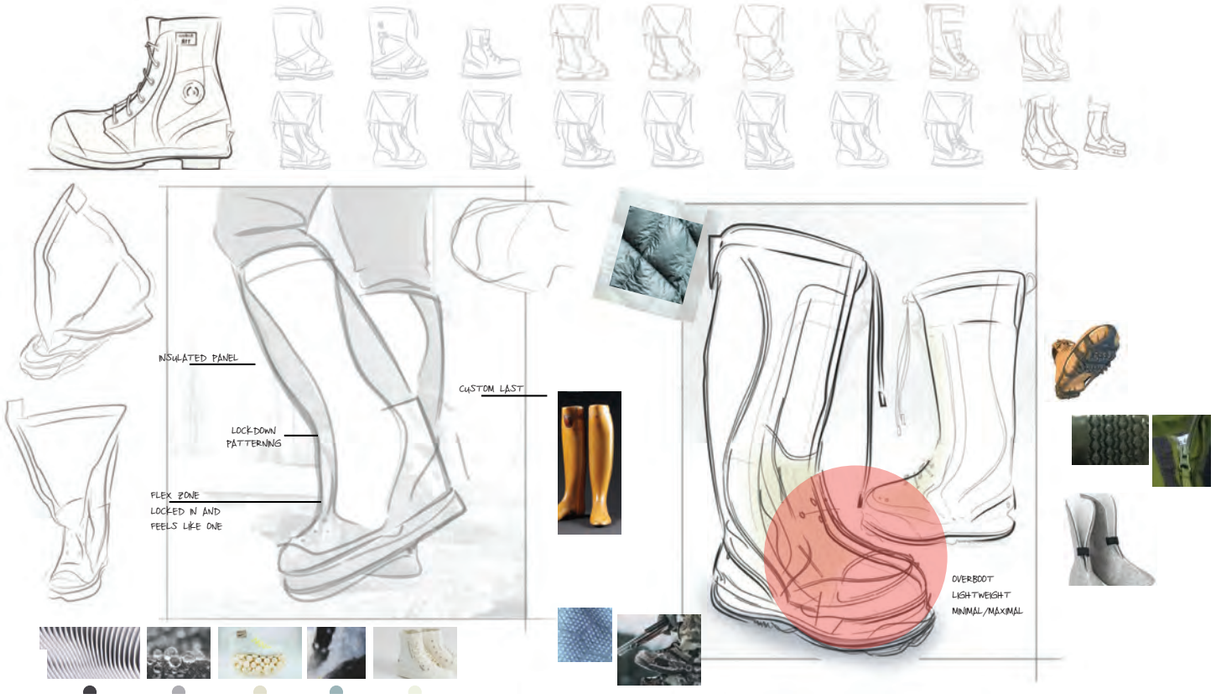
Meant for the outdoors, resistant Mil-Spec materials that last.

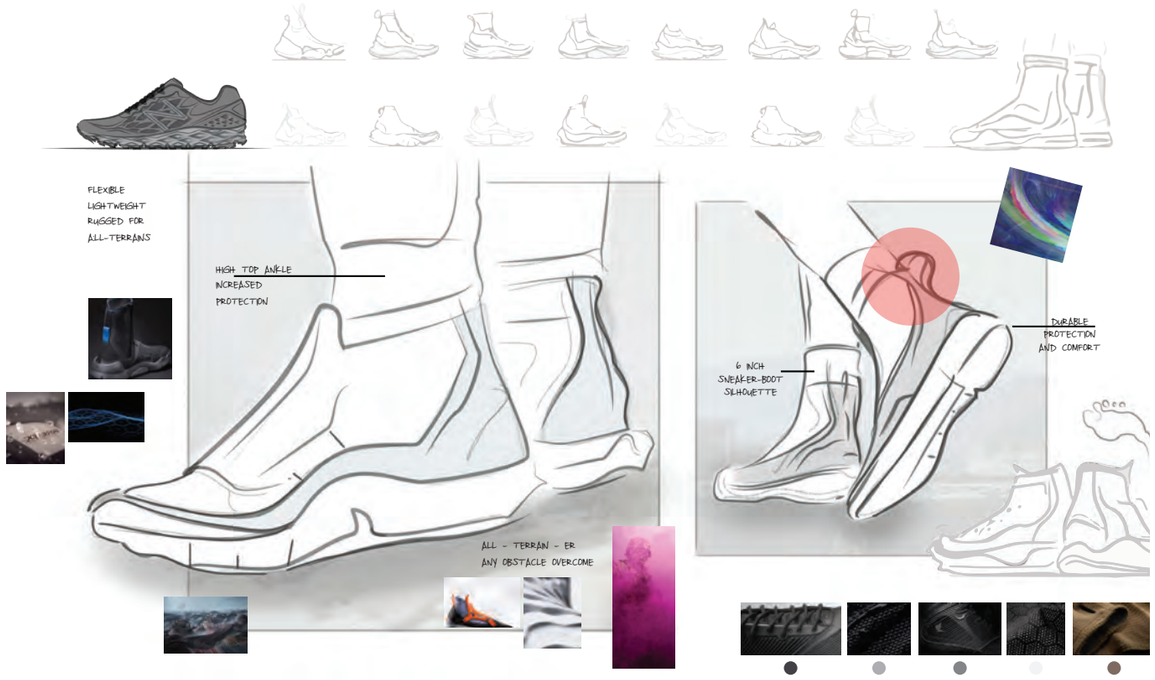
Supportive and minimal design

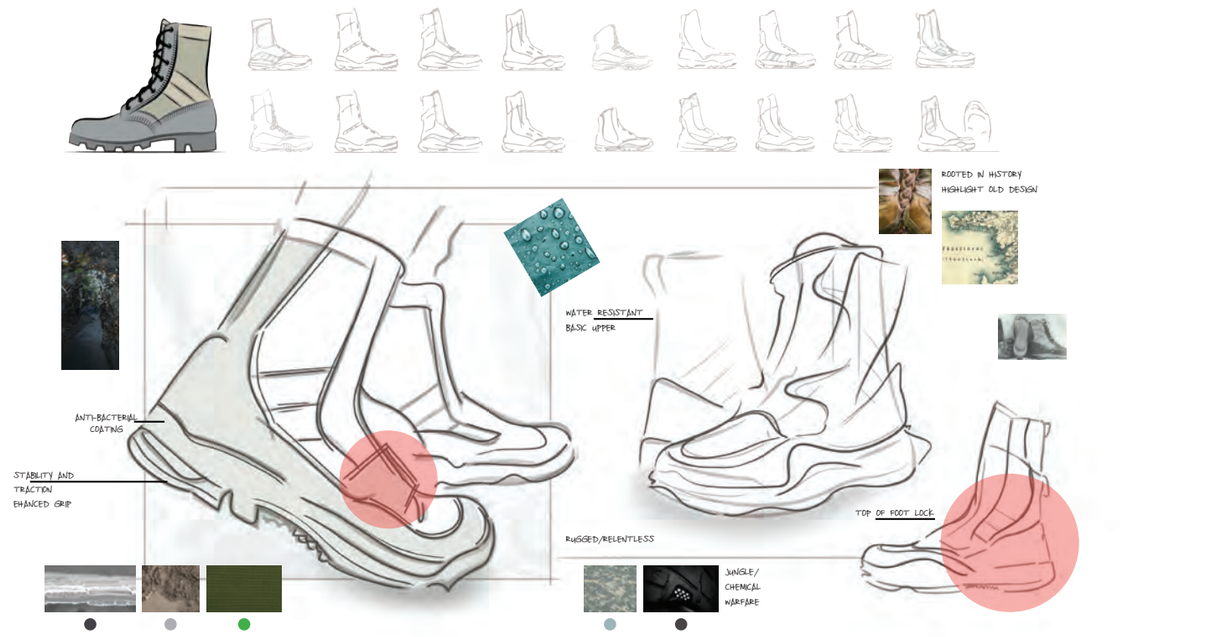
Lightweight and comfortable for daily activites




HOW CAN IT BE BETTER?
BASE BOOT LOCKS INTO BOTH OVERBOOT AND JUNGLE MIDSOLE
packable
STANDARD ISSUE BASIC
MINIMALIST DESIGN
BAREFOOT LOW-PROFILE
BASE TO BUILD UPON
SECTION CUT VIEW
ATTACHED TO MIDSOLE FOR DYNAMIC WEARABILITY
CONTOURED CONNECTION AROUND TOE/HEEL
FLEXIBLE/RIGID
CONTOURED
SUPPORTS
(FLEX 3D PRINT)
U.S. ARMY

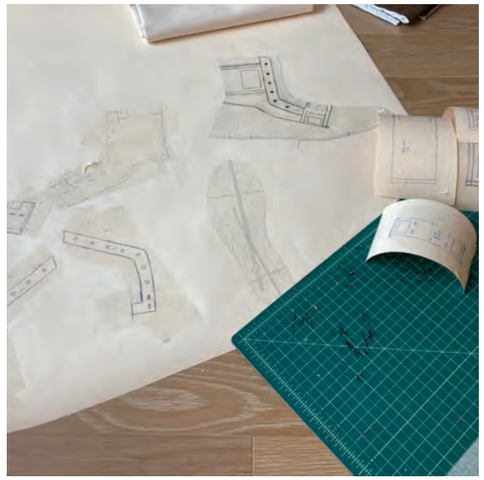

INSULATED PANEL
LOCK-DOWN PATTERNING
FLEX BONE
LOCKED IN AND FEELS LIKE ONE
CUSTOM LAST
OVERBOOT
LIGHTWEIGHT
MINIMAL/MAXIMAL

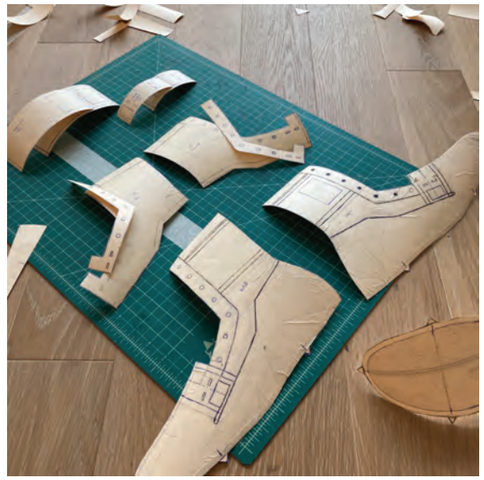

FLEXIBLE
LIGHTWEIGHT
RUGGED FOR
ALL-TERRAINS
HIGH TOP ANKLE
INCREASED
PROTECTION
6 INCH
SNEAKER-BOOT
SILHOUETTE
DURABLE
PROTECTION
AND COMFORT
ALL - TERRAIN - ER
ANY OBSTACLE OVERCOME

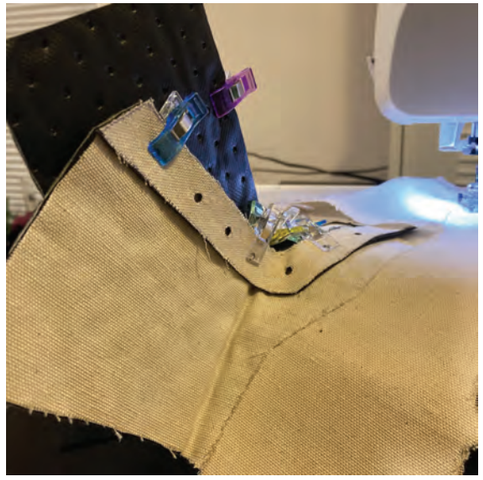

ROOTED IN HISTORY
HIGHLIGHT OLD DESIGN
WATER RESISTANT
BASIC UPPER
ANTI-BACTERIAL
COATING
STABILITY AND
TRACTION
ENHANCED GRIP
TOP OF FOOT LOCK
RUGGED/RELENTLESS
JUNGLE/
CHEMICAL
WARFARE

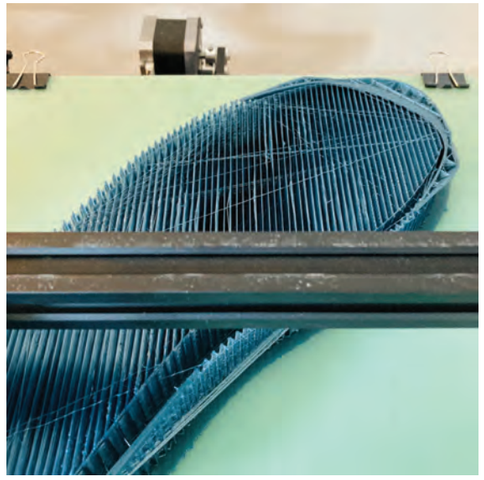
Basic Boot Prototype

Upper patterning process for acts like prototype focusing on material thicknesses and order of operations and assembly. From initial last tape through upper assembly and material selection for final prototype.











Custom Boot Last (3D)

“Deep dive into 3D devlopment of Over-Boot last as well as Regulation Boot last for neccessary prototyping and development. 3D scanned and refined utlizing simple software & equipment.

"That's so cool! Looks like I could wear it."

Initial reaction to basic boot was succesful, knew it was for military, and impressed by the construction and overall design of the basic boot.

"Flat front, flat back on all shoes."

All other shoes have flat surface area on bottom, adding cutouts along the center help alleviate pressure to center heel and bottom of foot.

"Seems a lot more balanced."

Weight rests on side traction lugs for wieght distributement thorugh the midsole away from the centers of the foot, giving more balance from side to side.

"Keep them around the 2nd lace (speedlace)."

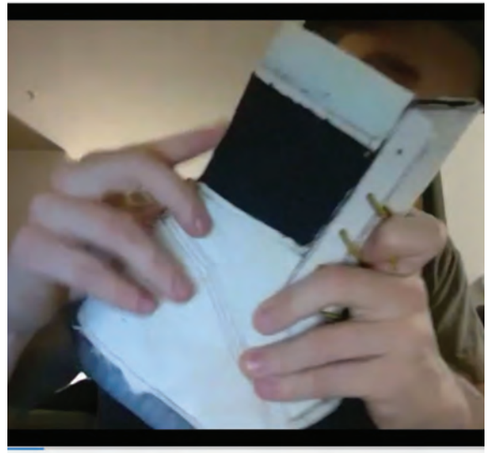
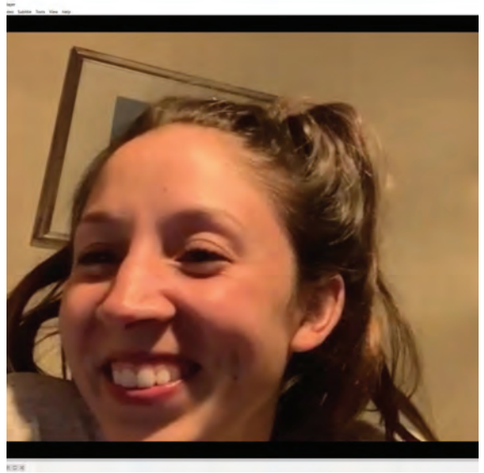
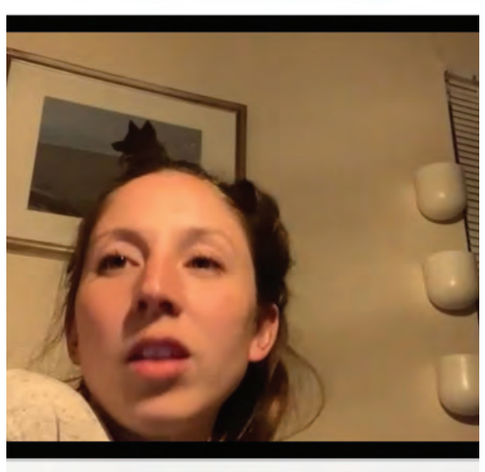
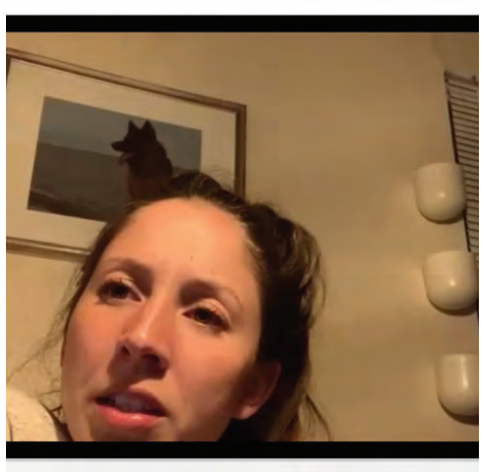
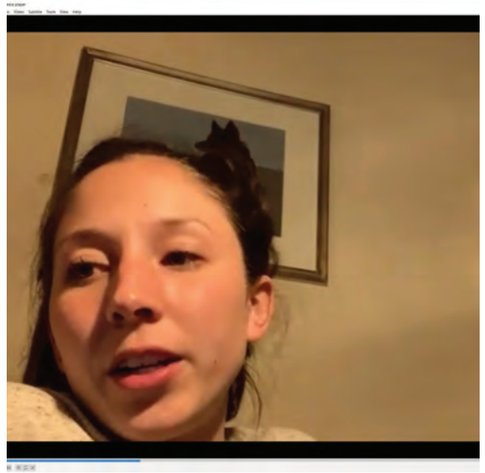
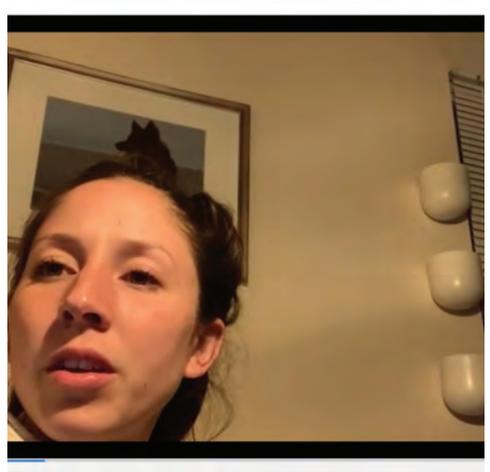
Speedlacing system usually only falls at the top three eyelets, its important to keep the look clean and to now have loose laces at top of foot.

"Tops get loose all the time, interesting. "

Ankle support, lots of guys roll ankles because of shallow dirt when not wearing proper traction. Hooked to eyelet stays this will provide resistance and support.





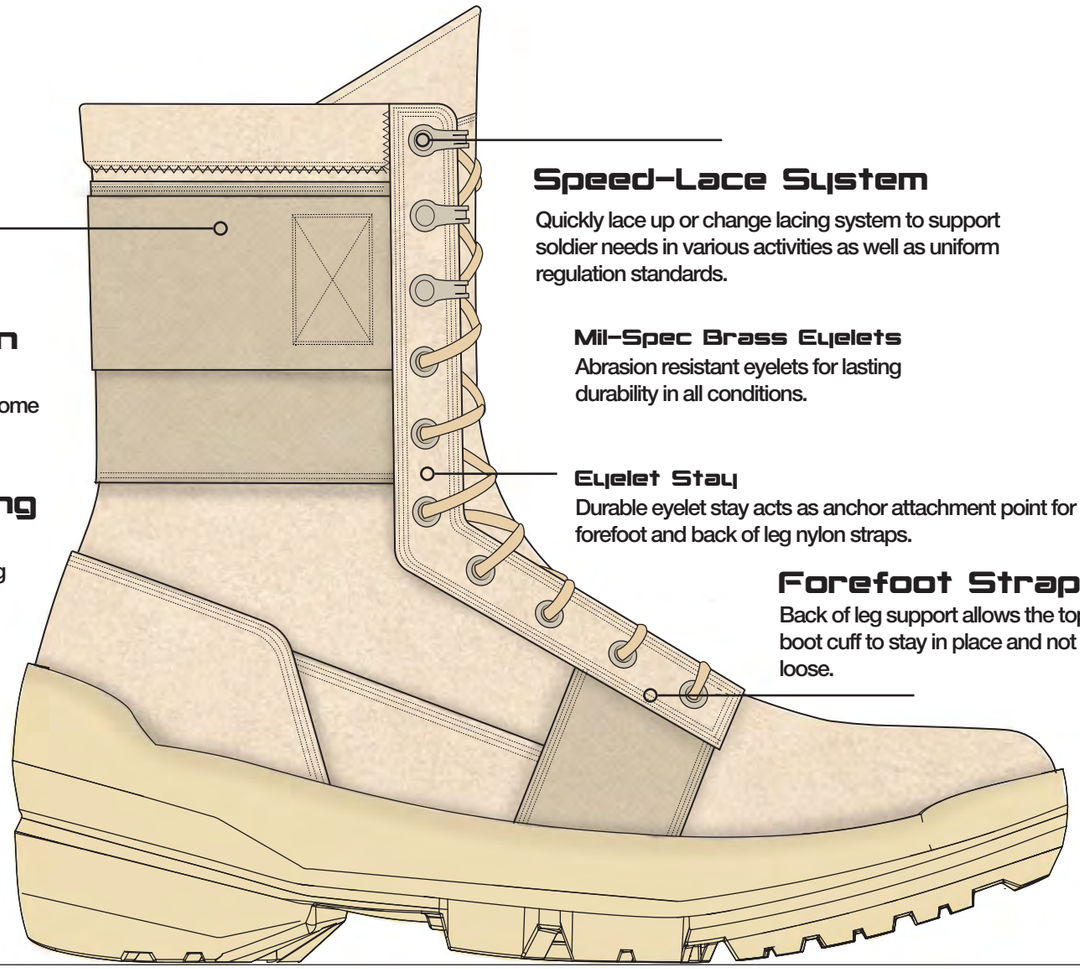


Fit Validation

“Being able to 3D develop and print flexible midsole allowed for fit validation of regulation boot midsole into over-boot midsole.”

Basic Boot (Regulation)

- Focus on Comfort, Weight, Flexibility to reduce hot-spots, blistering, and foot fatigue



1.5 inch (38mm) Solution Dyed CORDURA® Nylon

Back of leg support allows the top boot cuff to stay in place and not come loose.

Minimal Patterning

SImple construction coupled with durable stich seams provide lasting support and lightweight flexbility.

Speed-Lace System

Quickly lace up or change lacing system to support soldier needs in various activities as well as uniform regulation standards.

Mil-Spec Brass Eyelets

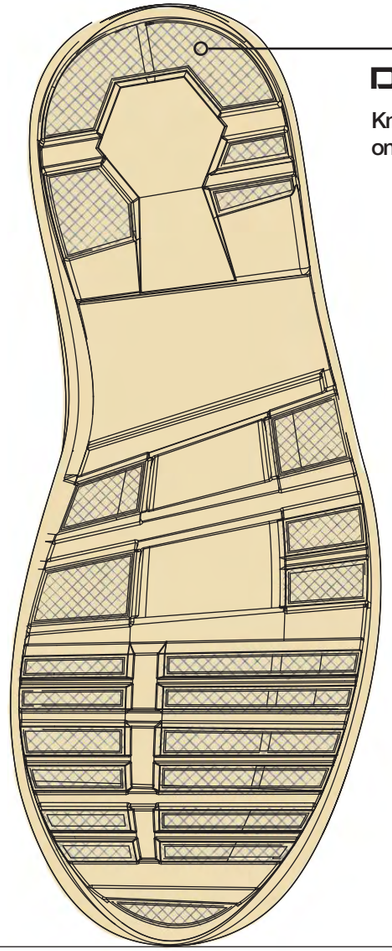
Abrasion resistant eyelets for lasting durability in all conditions.

Eyelet Stay

Durable eyelet stay acts as anchor attachment point for forefoot and back of leg nylon straps.

Forefoot Strap

Back of leg support allows the top boot cuff to stay in place and not come loose.



Dynamic Midsole

Knurled texturte allows for enhanced grip on slippery surfaces and uneven terrain

Minimal Midsole

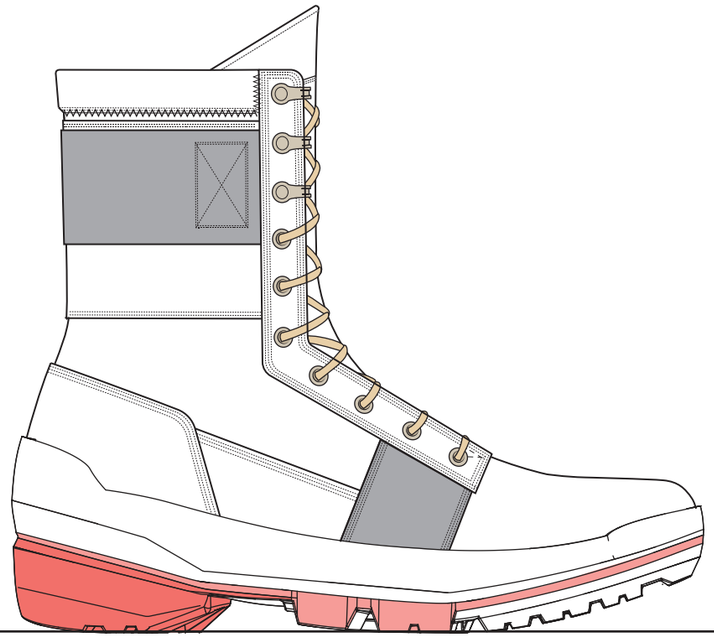
Reduced weight but substantial, very protective
for use in all-terrain conditions.

Comfort/Support

- Support Straps
- Minimal
- Speed Lace
- Lightweight
- Flexibility

Performance

- Comfort
- Split Heel
- Tiered Cushioning
- Responsiveness

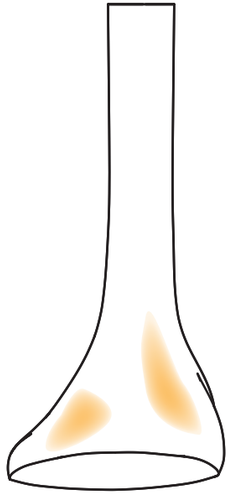


"Material selection for regulation combat boots is highly specific, need for lightweight durable leathers and nylon fabirc/webbing to provide resistance and support."

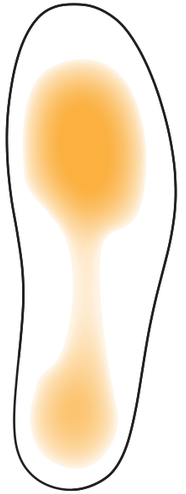
-Jay McNamara



Back

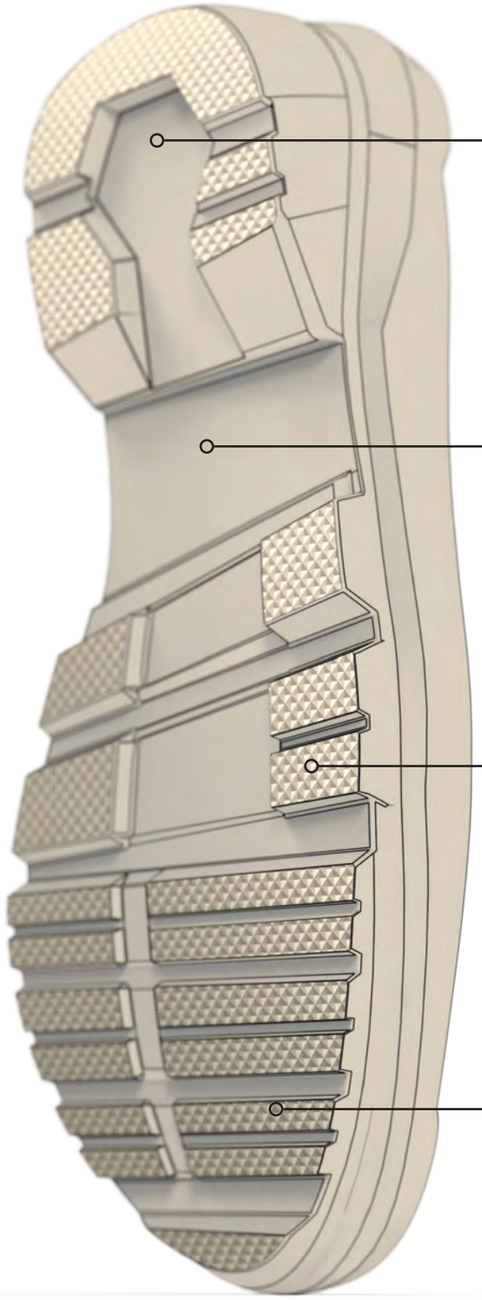


Front



Bottom





Hilt Heel Cushion

Horseshoe like heel cutout to distribute pressure awa from center of the heel, improved comfort all day.

Flex Groove

Continued support and traction lugs helps with balance. Weight is on perimeter of midsole not the center, reduces foot fatigue.

Tough Traction

Molded lugs allow for greater grip on uneven surfaces and for reduced slippage on rugged terrain.

Comfort Core

Sneaker like forefoot cushining for increased comfort under toes and forefoot.

Insulated Over-Boot

- Focus on areas of thermoregulation to keep warm
- Lightweight
- Midsole support

Double Oval Cord Lock

Back of leg closure, improved fit and security





831B-062
23x22mm
2.9g



TP21 Mil-Spec Heavyweight Mesh

Recommended for comfort and flexibility

Quilted Insulation

(Primaloft CAMB 400g)
Front and back of leg for added support and thickness.

Quilted Insulation Panelling

(Primaloft CAMB 400g)
Areas of necessary thermoregulation. Membrane insulation for flexbile and lightweight warmth

Minimal Patterning

Lightweight design means it can be easily packed and used when needed.

Stay Warm, Without the Weight

Back of leg support allows the top boot cuff to stay in place and not come loose.



Tread Texture

Knurled texture tread for ehnaced grip in icy and slippery conditions.. Minimally offset from tread to ensure proper footing.

Minimal Midsole

Reduced weight but substantial, very protective for use in all-terrain conditions.

Thermoregulation

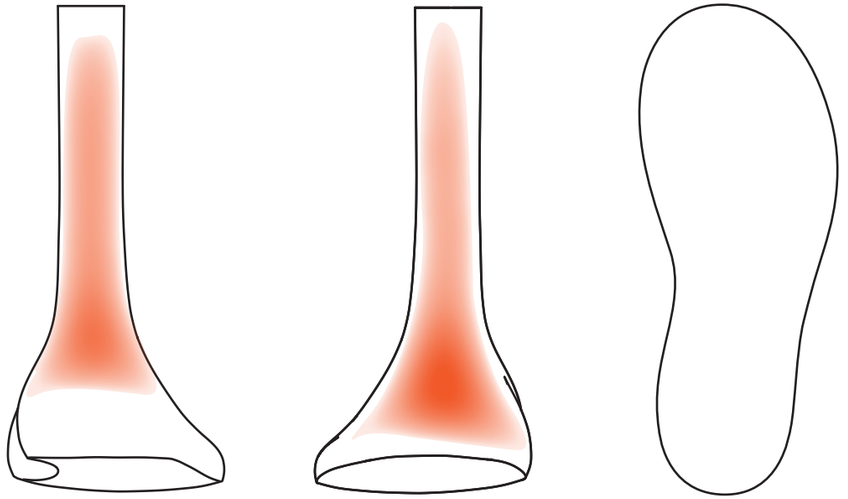
- Insulation
- Dynamic Patterns
- Mil-Spec
- Toe/Heel Counters
- Flexible Upper

Usability

- Closures
- Packable
- Lightweight
- Protective



"Recommended materials for an insualted over-boot are something similar to a heavyweight mesh for lightweight flexibiltiy as well as quilted thermal insulation panelling." -Jared Sapp





Tread Lightly

Minimal midsole tread allows for easy mobility and traction in both snow and in the dirt.
- Responsive
- Lightweight

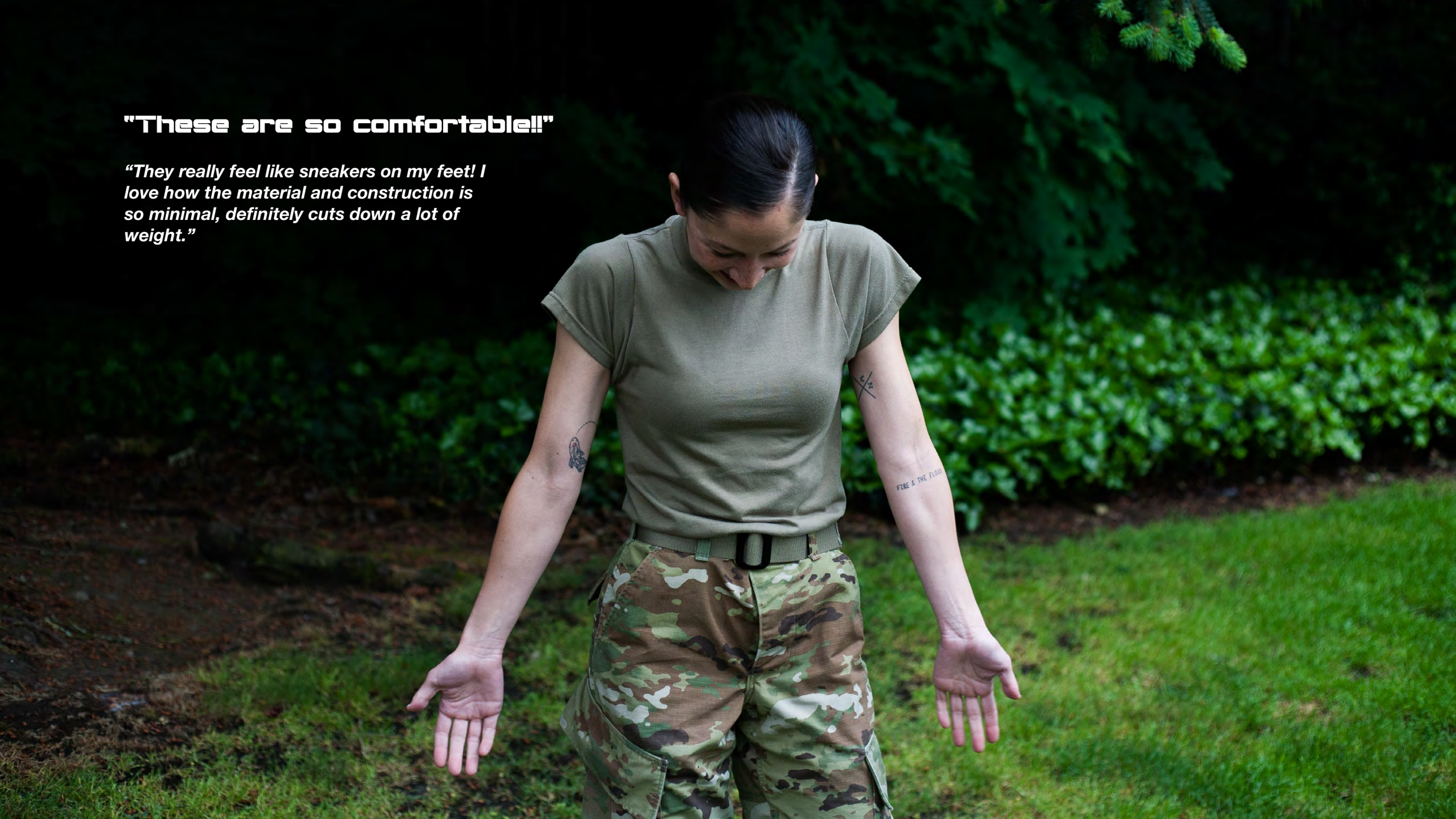
Flexible Split

Thinnest point of the midsole to allow for increased flexibility.
- Fit and Feel

Minimal Grooved Lugs

Rubberized texture allows for more durable and long lasting overboot, and one piece injection molded to simplify construction and assembly.

Integrated Counters



"These are so comfortable!!"

"They really feel like sneakers on my feet! I love how the material and construction is so minimal, definitely cuts down a lot of weight."



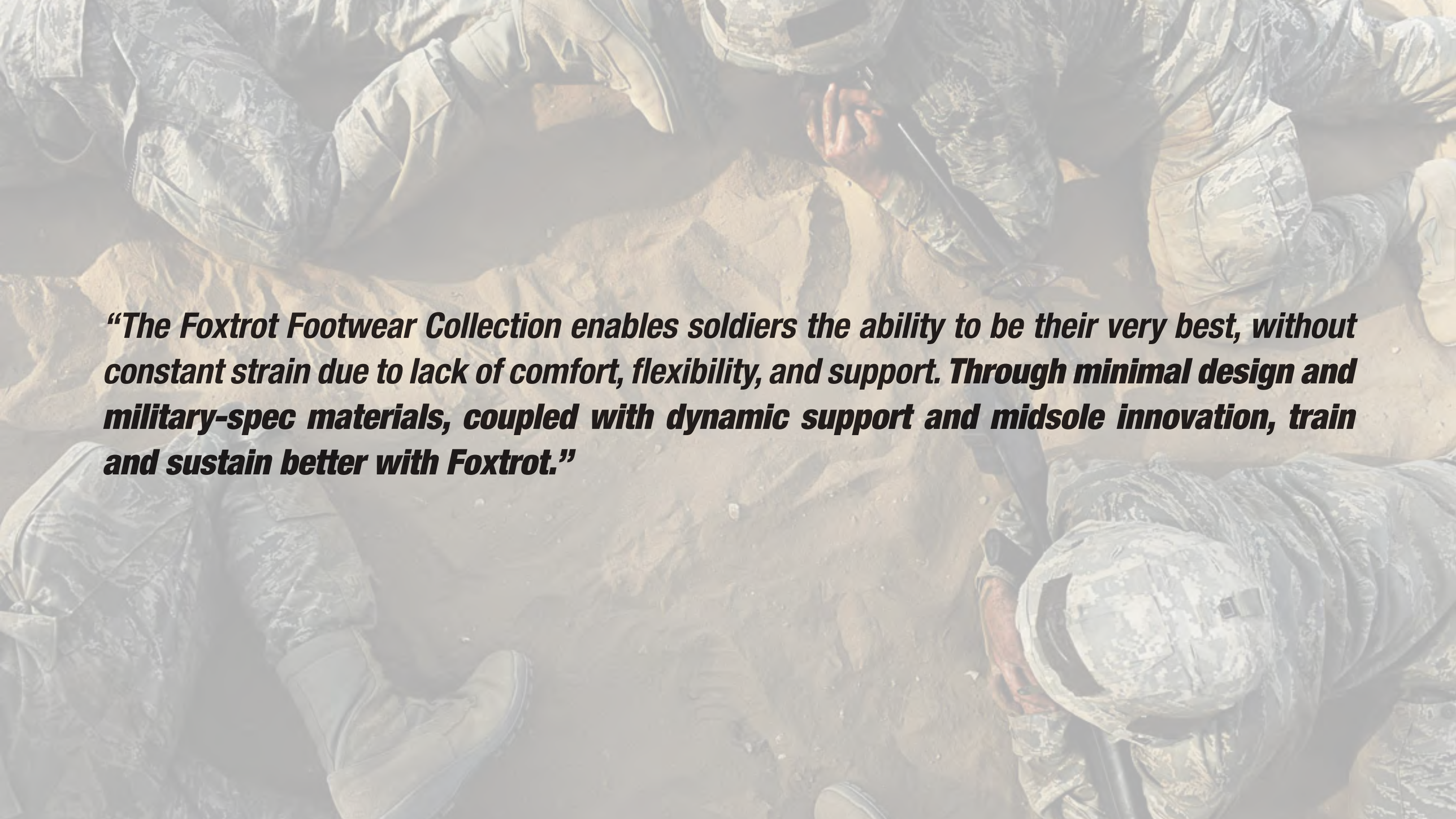
"The straps are a lot more supportive."

"Less room for the foot to move around, definitely will help reduce hotspots and blistering. The tops of my boots don't slide down anymore, the resistance at the back of my leg when I lace up feels really good."

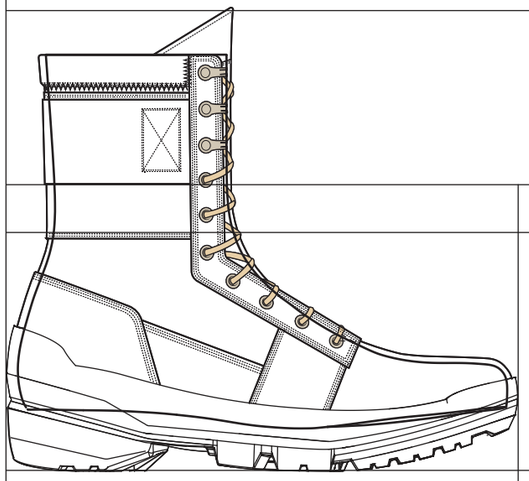


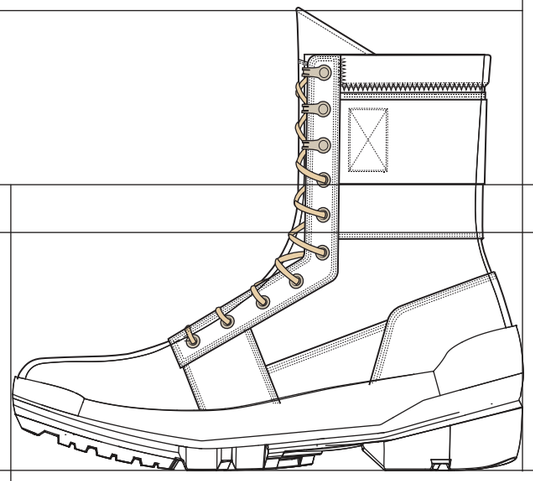
"Already feeling warmth around the front and back of my leg!"

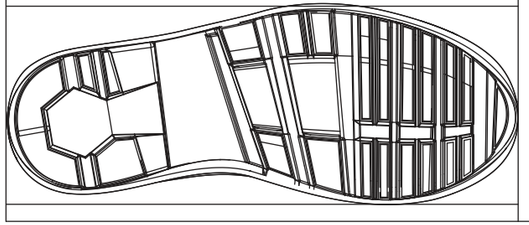
"These are crazy lightweight and the insulation is definitely where I need it the most. The lacing on the back really helps streamline the design being able to secure around the front and knot in the back as well."

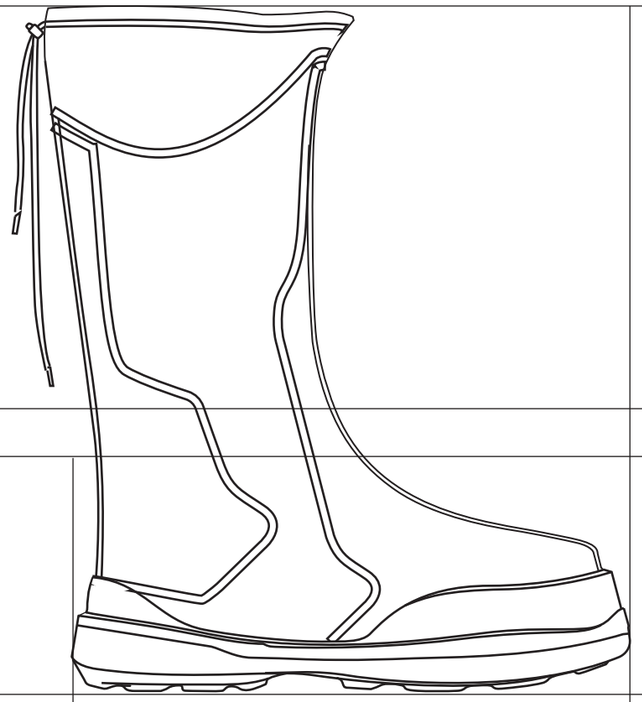


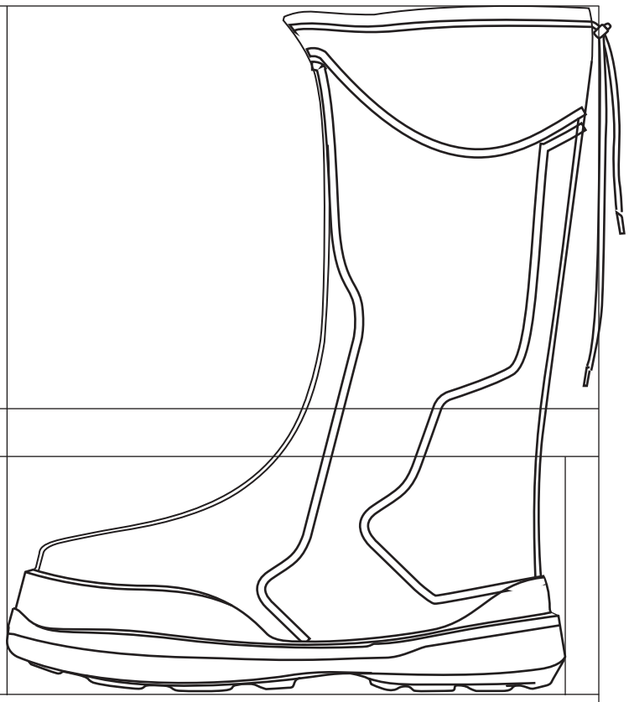
“The Foxtrot Footwear Collection enables soldiers the ability to be their very best, without constant strain due to lack of comfort, flexibility, and support. ***Through minimal design and military-spec materials, coupled with dynamic support and midsole innovation, train and sustain better with Foxtrot.”***

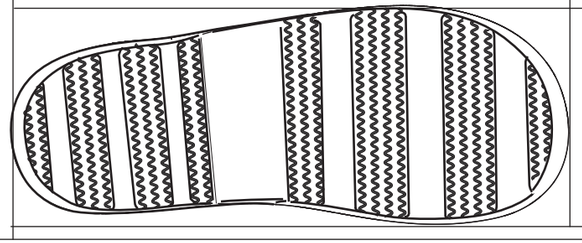
















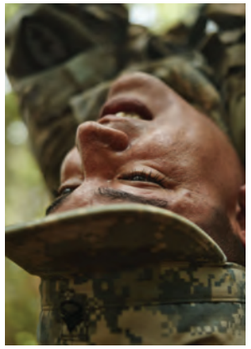


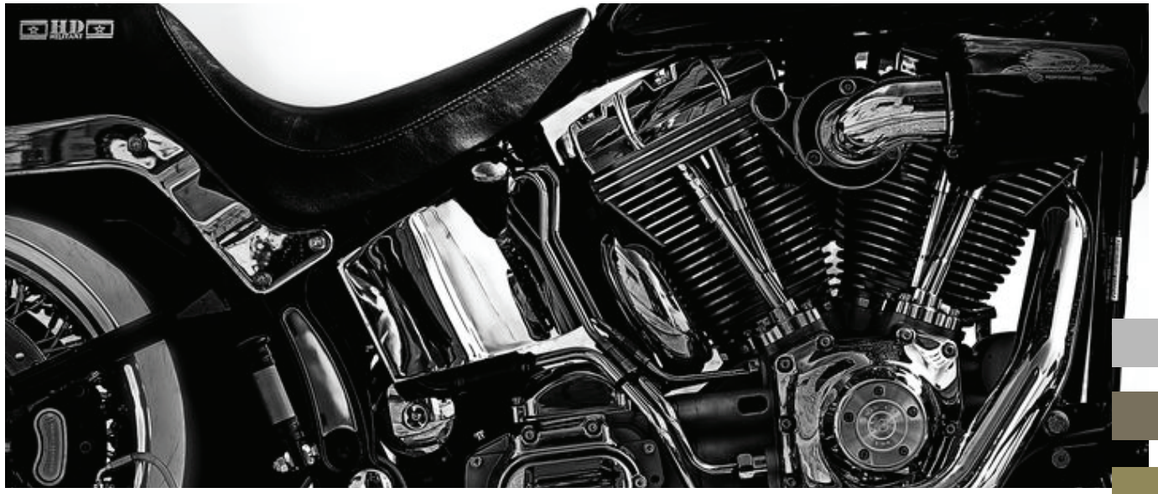


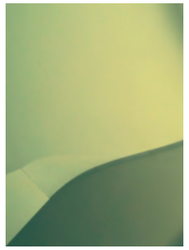






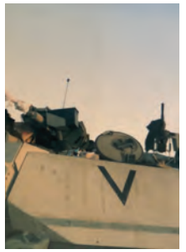














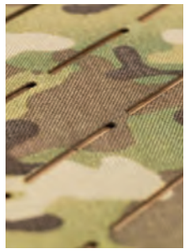


strong x dependable x exact

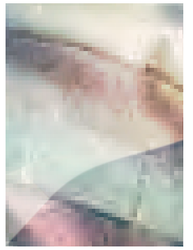








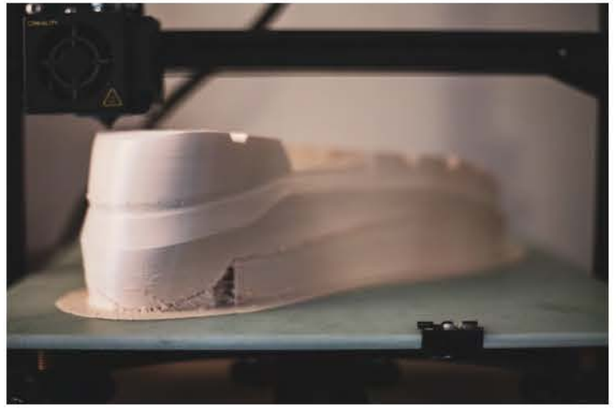
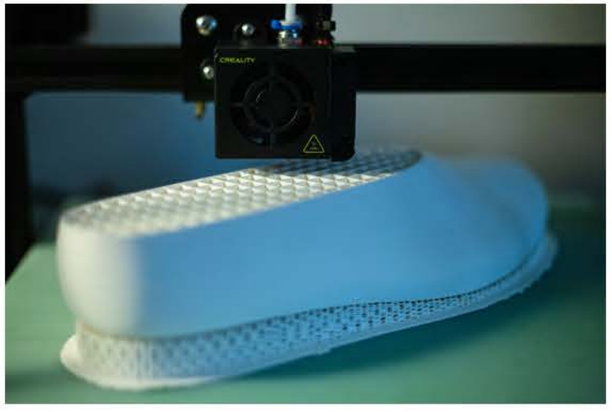




molle utility pouch (cordura, webbing, etc.)


foxtrot
footwear.
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foxtrot.






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