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FACULTY OF DESIGN

**MSc. Design and Technology Futures**

**FROM STANDARD TO ADAPTIVE: A  
DESIGN-DRIVEN DEVELOPMENT OF INCLUSIVE  
AND FUNCTIONAL COMBAT PANTS FOR THE  
ESTONIAN DEFENCE FORCES**

**STANDARDSELT ADAPTIIVSELE: KAASAVATE JA  
FUNKTSIONAALSETE LAHINGPÜKSTE DISAINIPÕHINE  
ARENDUS EESTI KAITSEVÄELE**

MASTER THESIS

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2025

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# THESIS TASK

**Student:** Mirjam Möttus, 232605MADM

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**Thesis topic:**

FROM STANDARD TO ADAPTIVE: A DESIGN-DRIVEN DEVELOPMENT OF INCLUSIVE AND FUNCTIONAL COMBAT PANTS FOR THE ESTONIAN DEFENCE FORCES

**thesis's main objectives:**

1. Identify and categorise the problems with the current Estonian military uniforms.
2. To explore the experiences of both male and female soldiers.
3. Create a knowledge base that connects clothing performance with the physical needs of modern soldiers.
4. Create and test prototypes with real soldiers in their everyday environments.
5. Create a design process that could improve the future development of the Estonian Military uniform.

**Thesis tasks and schedule:**

| No. | Task description                                 | Deadline   |
|-----|--|------------|
| 1.  | The main part of desktop research                | 30.03.2025 |
| 2.  | Design Research, Interviews, and Data Collection | 13.03.2025 |
| 3.  | Design Concept Development and Ideation          | 27.04.2025 |
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## **ABSTRACT**

This thesis investigates the systemic design shortcomings of the current Estonian Defence Forces (EDF) uniform, focusing on combat pants, and, in the process, develops a prototype for an adaptive, mobility-oriented alternative.

Through a combination of desktop research, anthropometric analysis, questionnaire data, and in-depth interviews with EDF and Defence League members, several interconnected problems were identified: inconsistent sizing, restricted mobility, thermal discomfort, material weaknesses, and a lack of inclusivity for diverse body types. These issues reveal deeper structural mismatches between standardised military clothing systems and the physiological realities of contemporary soldiers.

Using a user-centred, iterative design approach, the research applied tools such as “Who, What, Why” mapping, reframing through “How Might We,” and contradiction analysis to uncover opportunities for innovation. Ideation and pattern-based sketch development led to three progressively refined prototypes, culminating in a pre-test model informed by articulated mobility zones, adaptive sizing logic, improved ventilation, and modular knee-protection integration.

Cadets of the Estonian Military Academy field-tested the prototype for two weeks. Feedback highlighted significant improvements in mobility, comfort, and ventilation, while also identifying areas for refinement, including kneepad positioning, vent material durability, and pocket optimisation. These insights informed the final design concept: the Adaptive Combat Pants (AC-P), a proposed next-generation solution that shifts military clothing from standardised to adaptive systems designed around real bodies, environmental conditions, and dynamic soldier tasks.

The thesis concludes with system-level recommendations for procurement, distribution, sizing reform, and lifecycle management, arguing that meaningful uniform improvement requires not only better garments but an updated system around them. Future research directions include long-term durability testing, advanced material development, and expanded anthropometric studies of the EDF population.

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## **PREFACE**

This master's thesis explores how design can improve the fit, functionality, and adaptability of military clothing, with a focus on combat pants used by the Estonian Defence Forces. The topic emerged from an interest in the relationship between the human body, uniform systems, and performance in demanding environments.

The work combines background and field research with a hands-on design process, including sketching, prototyping, and field testing. Insights from soldiers, cadets, and existing uniform systems informed the development of an adaptive combat pants concept that addresses mobility, fit, thermoregulation, and durability.

The thesis is conducted within the framework of design and technology futures and aims to contribute to discussions on user-centred, inclusive, and performance-driven approaches in military clothing design.

## **List of Abbreviations and Symbols**

- DCU - Desert Combat Uniform
- ESTDCU - Estonian Digital Camo Uniform
- HCD - Human Centred Design
- KVARUO - Kaitseväe Akadeemia Rakendusuringute Osakond
- MOD - Modification
- NATO - North Atlantic Treaty Organisation
- NCU - Nothic Combat Uniform
- NORDEFCO - Nordic Defence Cooperation
- WW1 - World War One

# 1. INTRODUCTION

Military uniforms are more than standardised garments; they are functional systems that directly influence soldiers' performance, comfort, safety, and readiness. In contemporary military contexts, uniforms must support a wide range of physical activities, environmental conditions, and body types while remaining durable, cost-effective, and logistically efficient. As operational demands evolve and the diversity of military personnel increases, traditional uniform systems based on rigid standardisation increasingly struggle to meet real user needs.

In the Estonian Defence Forces, the current uniform system is shaped mainly by NATO sizing standards, legacy design solutions, and budgetary constraints. While effective in terms of camouflage and basic functionality, the system shows apparent limitations in fit consistency, mobility support, thermoregulation, and inclusivity. These shortcomings are especially evident during prolonged wear, intense physical activity, and when uniforms are used by soldiers whose body proportions fall outside the assumed "average" user. As a result, soldiers often adapt their uniforms themselves, tolerate discomfort, or rely on unofficial solutions, revealing a disconnect between design intentions and everyday use.

This thesis approaches the military uniform as a design problem rooted in the relationships among the body, the garment, and the operational context. By combining background research with field research conducted through questionnaires, interviews, prototyping, and testing, the work investigates how design-driven methods can improve the performance and adaptability of military clothing. The focus is on combat pants as a critical garment, given their central roles in mobility, durability, and interaction with equipment.

The outcome of this research is the development of an Adaptive Combat Pants concept that addresses key issues identified during the study. Rather than proposing a finalised product, the thesis presents a design framework and prototype-based solution that demonstrates how adaptive sizing, improved pattern construction, and user-centred design principles can support a more inclusive, functional, and future-oriented military clothing system for the Estonian Defence Forces.

## 1.1 Terminology

Some terms used in this thesis may be complex or context-specific. In certain cases, a word might carry multiple meanings depending on its usage. This section clarifies how key terms should be understood within the scope of this research.

- **Anthropometric** - Anthropometric measurements are non-invasive quantitative measurements of the body that can be taken from the body. (Casadei & Kiel, 2022)
- **Comfortability** - Is the degree to which a garment supports physical ease, mobility, and thermal balance without causing irritation or distraction. In military contexts, the term refers to how well a uniform enables soldiers to function effectively and remain focused during physical and environmental stress. (*Comfortability*, n.d.)
- **Durability** - the ability of a physical product to remain functional without requiring excessive maintenance or repair when faced with the challenges of normal operation over its design lifetime (Sabhadiya, n.d.).
- **Inclusivity** - The fact of including all types of people, things, or ideas and treating them all fairly and equally (*INCLUSIVITY | English Meaning - Cambridge Dictionary*, 2025)
- **Mobility** - Mobility is the ability to move freely (*Mobility - Definition, Meaning & Synonyms*, n.d)
- **Thermoregulation** - the process by which the body maintains its internal temperature (Stephens, 2017).
- **Utility** - the usefulness of something, especially in a practical way (*UTILITY | English Meaning - Cambridge Dictionary*, n.d)

## 1.2 Limitations of the Study

This thesis was conducted within a clearly defined timeframe, which limited the research's overall scope and depth. As a result, the study focused on identifying and analysing current challenges related to Estonian military uniforms rather than examining long-term effects, extended field use, or broader systemic transformation. The research prioritised understanding present-day user experiences within the Estonian Defence Forces and the Defence League.

Access to participants and institutions also influenced the research process. While a sufficient number of interviews and questionnaire responses were gathered, some potential participants declined due to time constraints or because their professional background was not closely aligned with the topic. This affected the diversity of perspectives but did not prevent the identification of recurring patterns and key issues.

The research relied on publicly available documentation, user-generated data, and visual and material analysis. Access to classified information, internal design briefs, procurement specifications, or detailed textile performance data from the military or suppliers was not available. As a result, specific technical and institutional decision-making processes could only be analysed indirectly.

User feedback collected through interviews and questionnaires is inherently subjective and reflects individual perceptions shaped by body type, service role, and personal experience. While these insights are valuable for understanding real-world use, they do not represent official positions or the full range of experiences within the military.

Finally, the study deliberately focused on combat uniforms, specifically pants, rather than addressing the entire military clothing system. Other uniform categories, such as ceremonial wear, sportswear, and specialised garments for extreme environments, were excluded to maintain a manageable scope and enable deeper analysis and design development.

## 1.3 Chapter Overview

This thesis consists of ten chapters.

**Chapter 1** - Introduction.

**Chapter 2** - presents the theoretical framework that grounds the research, drawing on concepts from human-centred design, ergonomics, anthropometrics, and performance-oriented clothing design. It establishes the theoretical lenses through which military uniforms are examined.

**Chapter 3** - outlines the methodologies used in the study. It explains the user-centred design approach, the application of the Double Diamond process.

**Chapter 4** provides background research on military uniforms, with a focus on the Estonian Defence Forces. It examines the historical development of uniforms, the current clothing system, sizing standards, and comparative international examples, forming a foundation for the field research.

**Chapter 5** presents the field research findings from questionnaires and interviews with members of the Estonian Defence Forces and Defence League. It identifies recurring issues related to fit, mobility, thermoregulation, durability, and inclusivity, and translates lived experiences into structured insights.

**Chapter 6** describes the design process, detailing how research findings are transformed into design opportunities through stakeholder analysis, reframing, contradiction mapping, and ideation.

**Chapter 7** documents the solution's development, including sketching, prototyping, field testing, and iterative refinement based on feedback and observations.

**Chapter 8** introduces the final design proposal, the Adaptive Combat Pants (AC-P), and explains how the design addresses the identified problems through functional systems, design principles, and visual documentation.

**Chapter 9** expands the discussion to system-level implications, addressing implementation considerations, procurement, distribution, maintenance, and the broader impact on soldiers and organisational structures, while also outlining directions for future development.

**Chapter 10** concludes the thesis by summarising the key findings, reflecting on the work's contribution, and positioning the research within the wider context of military clothing design and future research opportunities.

## **2. THEORETICAL FRAMEWORK**

A theoretical framework provides a foundation for understanding military uniforms not as items but as interfaces between the human body, the surrounding environment, and the operational task. Historically, uniform design has been driven by factors such as camouflage effectiveness, procurement cost, and logistical standardisation. While these dimensions remain critical, they often overlook the embodied experience of the soldier who must perform, move, and adapt in diverse and demanding contexts.

In this thesis, the analysis is conducted from three perspectives: human-centred design (HCD), ergonomics, and inclusivity. Together, they offer a broad perspective and a platform for critically evaluating existing Estonian Defence Forces uniforms and envisioning new adaptive solutions.

### **2.1 Human-Centred Design**

Human-Centred Design (HCD), as described in ISO 9241-210 and by Donald A. Norman in "*The Design of Everyday Things*" (2013), emphasises designing with a deep understanding of users, their contexts, and their needs. Unlike technology-driven or cost-driven approaches, HCD situates the human being at the centre of the design process. In practice, this means not only consulting users during test phases but also integrating their lived experiences, bodily constraints, and task requirements into the very foundation of the design.

Applied to the military context, HCD challenges the traditional top-down model of uniform procurement. Military uniforms are typically standardised to achieve efficiency in production and distribution, which often comes at the expense of individual variation in body type, gender, and operational role. While such standardisation may satisfy institutional requirements, it risks creating mismatches between the system and users' needs, leaving soldiers to adapt their clothing through improvisation, personal purchases, or modifications.

From an HCD perspective, the soldier is not a passive recipient of uniform but an active interactor. Uniforms directly influence how soldiers move, endure the climate, carry equipment, and are perceived within their units. Poorly fitting or uncomfortable clothing becomes more than a minor inconvenience. It undermines morale, operational effectiveness, and the long-term health of soldiers. Clothing designed with a

human-centred approach can enhance performance, enabling soldiers to focus on their tasks rather than compensating for design shortcomings.

## **2.2 Ergonomics**

Ergonomics, often defined as the study of the relationship between people and their working environments, is central to understanding how uniforms influence soldiers' performance. In the military context, clothing is not passive; it serves as equipment that must support mobility, withstand environmental conditions, and accommodate additional load-bearing systems such as body armour and backpacks. Poorly designed clothing can restrict movement, create pressure points, or cause avoidable fatigue, ultimately reducing soldiers' operational effectiveness.

Military ergonomic research emphasises several recurring themes: mobility, thermoregulation, durability, and load distribution. For instance, anthropometric studies highlight that a uniform design that ignores body diversity can result in restricted motion ranges or ill-fitting gear (McConville et al., n.d.). Similarly, garments that fail to provide adequate thermal comfort force soldiers to compensate through layering or improvisation, which can introduce additional risks.

In the Estonian context, questionnaire and interview data suggest that uniforms are frequently criticised for inconsistent sizing and limited adaptability to different body types. From an ergonomic perspective, these issues are not merely inconveniences but systemic flaws that increase strain, reduce endurance, and encourage unofficial modifications. Understanding uniforms as ergonomic interfaces foregrounds the need for adaptive design solutions that support both individual performance and collective operational readiness.

## **2.3 Inclusivity**

Military uniforms have historically been designed with a one-size-fits-all approach, based mainly on male anthropometric data. This approach reflects logistical efficiency and traditional gender assumptions rather than operational inclusivity. As armed forces worldwide become more diverse, the shortcomings of this design approach are increasingly visible. Ill-fitting uniforms for women, for instance, can restrict movement, cause discomfort, or undermine professional identity.

Inclusivity in uniform design extends beyond gender. It also encompasses body diversity (height, weight, and proportions) and role diversity (combat, support, and technology-focused tasks). A soldier piloting a drone or working in logistics has different ergonomic needs than one conducting extended field patrols. If uniforms are designed only around the archetype of the “average infantryman”, large groups of military personnel are disadvantaged.

Incorporating inclusivity as a design principle reframes it from being a matter of comfort or fairness to being an operational necessity. A uniform that fails to accommodate diverse users diminishes overall force effectiveness. To put it another way, creating uniforms with inclusivity in mind strengthens both individual performance and collective cohesion.

By combining insights from human-centred design, ergonomics, and inclusivity, this thesis establishes a framework for evaluating current Estonian Defence Forces uniforms and developing future solutions. Uniforms are understood not merely as standardised garments but as adaptive systems that must respond to the human body, operational roles, and diverse environmental conditions. This perspective positions the soldier not as a passive wearer but as an active interactor whose needs, movements, and context should drive design.

### 3. METHODOLOGIES

This research followed a user-centred design approach guided by the Double Diamond framework (Figure 1; Appendix A). The process is structured around four phases: discover, define, develop, and deliver, allowing for both broad exploration of the problem space and systematic development of design solutions (The Double Diamond, 2014). The methodology was selected to support an in-depth understanding of how the current Estonian military uniform system affects its users and how it could be improved through pattern innovation and design-led intervention.

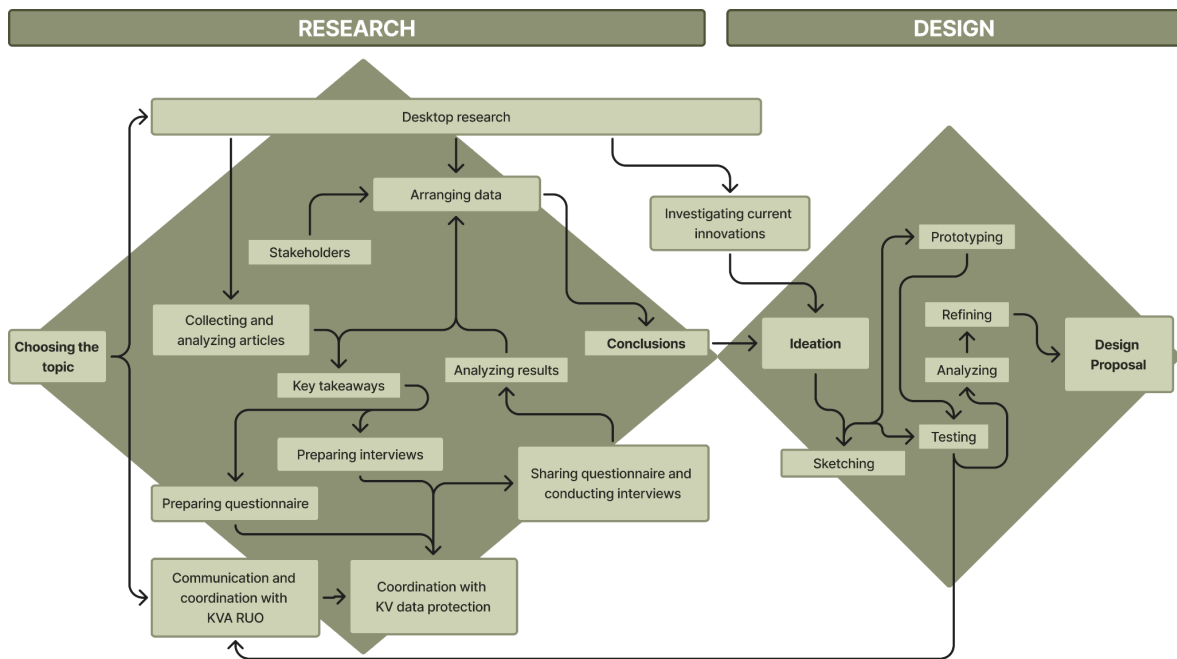


Figure 1: Double diamond framework proposed by Béla H. Bánáthy and adapted for this thesis by the author.

#### 3.1 Discover, Define, Develop & Deliver

The discovery phase began with desktop research focused on the historical development of military uniforms, contemporary advancements in technical clothing design, anthropometric and physiological research, and publicly available documentation from the Estonian Defence Forces. This phase established a theoretical and contextual foundation and helped identify recurring issues related to mobility, comfort, sizing systems, and inclusivity.

To complement the desktop research, a questionnaire was distributed to members of the Estonian Defence Forces and the Estonian Defence League. The questionnaire

collected both qualitative and quantitative data and aimed to reveal recurring patterns in fit, durability, thermal comfort, and overall uniform usability.

Based on the questionnaire results, semi-structured interviews were conducted to gain deeper insight into individual experiences and personal adaptations. The interviews enabled a more nuanced understanding of uniform performance in real-world contexts, particularly regarding movement, environmental exposure, and prolonged wear.

Findings from the desktop research, questionnaires, and interviews were synthesised using visual clustering techniques. Recurring themes, pain points, and stakeholder perspectives were organised and reframed using the “Who, What, Why” framework (Lewrick et al., 2020) and “How Might We” questions (Plattner, 2018). This synthesis phase helped identify key contradictions and opportunity areas and supported the transition from research insights to design intent.

Insights generated through this process informed the ideation phase, where vision sketching and pattern-based exploration were used to develop potential design directions. The focus was placed on improving mobility, breathability, durability, and inclusive fit. The final design proposal is grounded in these research-driven insights and reflects a continuous dialogue between analysis, experimentation, and user feedback.

## **4. BACKGROUND RESEARCH**

This chapter establishes the theoretical foundation of the study. It synthesises findings from research on military clothing systems, human physiology, ergonomics, and anthropometry to contextualise the development of the Estonian army uniform. The purpose of this background research was to identify existing knowledge, identify recurring design problems, and define how these issues intersect with soldiers' everyday experiences.

The desktop research included reviewing unclassified international studies on military clothing, academic literature on ergonomics and performance wear, and publicly available documents from the Estonian Defence Forces. It also examined standardised sizing and anthropometric databases to understand how body diversity is or is not accommodated in uniform design.

Through this review, several key problem areas were identified: inconsistencies in fit, restricted mobility, thermal discomfort, and insufficient adaptation to different body types. Recognising these gaps informed the direction of the empirical research, guiding the structure of the questionnaire and interviews. This phase provided the theoretical grounding for understanding how uniform design directly influences physical performance, comfort, and inclusivity in the field.

## 4.1 History of Modern Uniforms: A Visual Analysis by the Author

The evolution of combat uniforms throughout history has always gone hand in hand with technological advancements and military tactics.

The early roots of modern combat uniforms can be traced to World War II. It was then that the utility of the attire worn by an infantry soldier began to attract more attention from users and designers alike, whereas during the previous major conflict, World War I, the uniforms still served the impractical purpose of distinction and decoration. The prime example is the early French uniform (Figure 2).

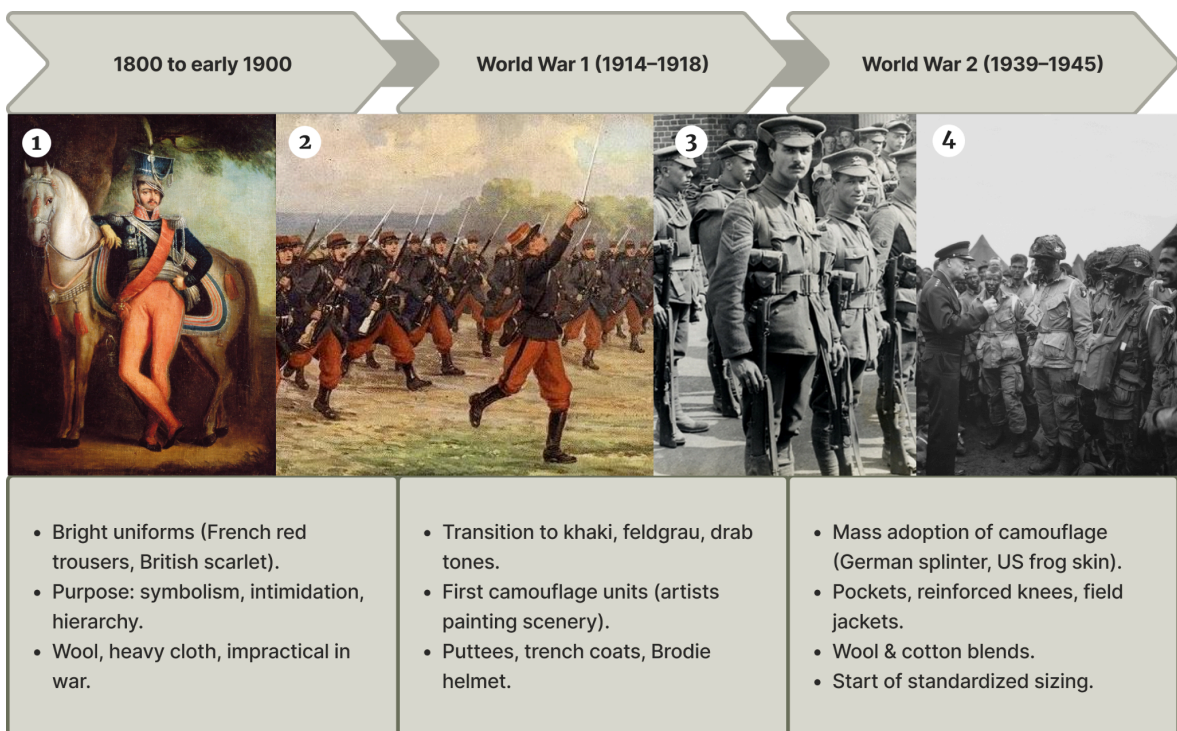


Figure 2: World Uniform History Timeline: 1800s to 1945, visualised by the author.

In contrast, the colours of uniforms in World War II were inspired by nature and were meant to provide soldiers with concealment in their surroundings. Many armies adopted olive green, khaki, or grey uniforms, depending on the type of terrain where fighting took place.

As technology advanced and more equipment became available for normal soldiers to use, the need for utility and carrying space increased dramatically. For example, since fully automatic handheld firearms were now more common, the need to carry more ammunition skyrocketed, resulting in more pockets and pouches on both the uniforms and load carriage systems. Field shirts, smocks, and pants were now littered with cargo pockets and reinforced panels.

During the Vietnam era, the need for utility became even greater. Due to advances in materials science and the introduction of synthetic fibres, personal protective equipment has become lighter, more comfortable, and easier to produce than before. US soldiers were now equipped with ballistic body armour, also known as flak vests. Every soldier was now equipped with a fully automatic firearm, and specialised soldiers carried field radios, grenades, and other various pieces of equipment. The Vietnam conflict also highlighted the need for hot-weather-specific materials and clothing, with heavy emphasis placed on ventilation and breathability.

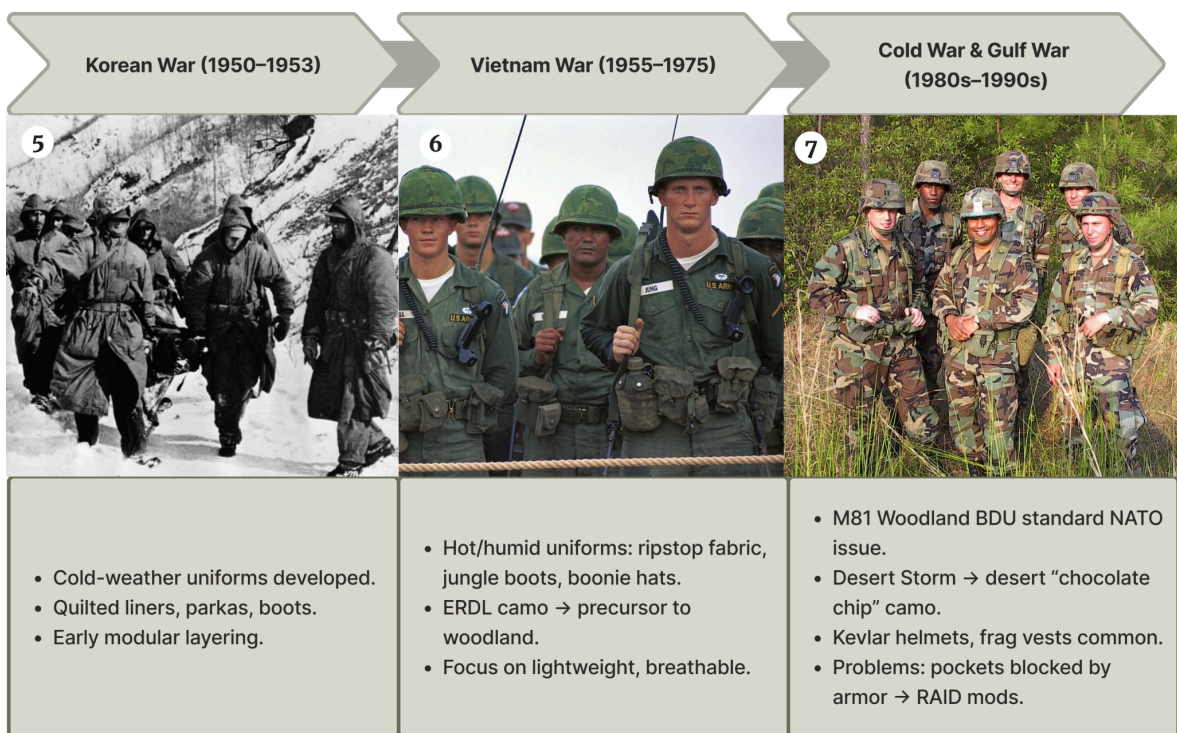


Figure 3: *World Uniform History Timeline: 1950s to 1990s, visualised by the author.*

The general silhouette of combat uniforms has remained somewhat unchanged since Vietnam. Materials, patterns, and camouflage patterns have changed since then, but the main ethos has remained the same. The next significant leap in evolution, leading to modern uniforms, was the conflict in the Middle East.

Around the 80s, during the Gulf War, soldiers were issued the BDU (Battle Dress Uniform), which came in the legendary M81 woodland camouflage pattern. Desert-specific camouflage patterns were developed for the units deployed to the Middle East. Every soldier now carried a Kevlar helmet, a Kevlar ballistic vest, and knee and elbow pads. However, it quickly became clear that the BDU's design was not

compatible with the personal protective equipment of the time. When the ballistic vest was worn over the field shirt, it covered all the jacket's pockets, making them inaccessible and, therefore, useless.

A breakthrough occurred when US special forces members began modifying their field shirts to better interface with their protective equipment and load carriage needs. Famously known as RAID Mod (Figure 3), the soldiers would remove the pockets from their field shirts, then sew the chest pockets back, at an angle, so they would be accessible even when wearing a ballistic vest, and the lower pockets were sewn onto the upper sleeves, making the otherwise useless pockets now easily accessible. Velcro loop pieces were then added to the sleeve pockets and shoulders, making it easier to add and remove unit and flag patches. The modified garment would then be worn, tucked into the pants, making the accessories carried on a soldier's belt more accessible.

Later on, the modifications became even more extreme: to make the entire garment more breathable, the entire chest and back portion of the jacket would be removed and replaced with breathable fabric, such as t-shirt material (Figure 4) or another knitted structure. This ensured that the ballistic vest's coverage was breathable and lightweight, while the exposed areas, such as the sleeves and collar, remained rugged. The combat shirt was now born.

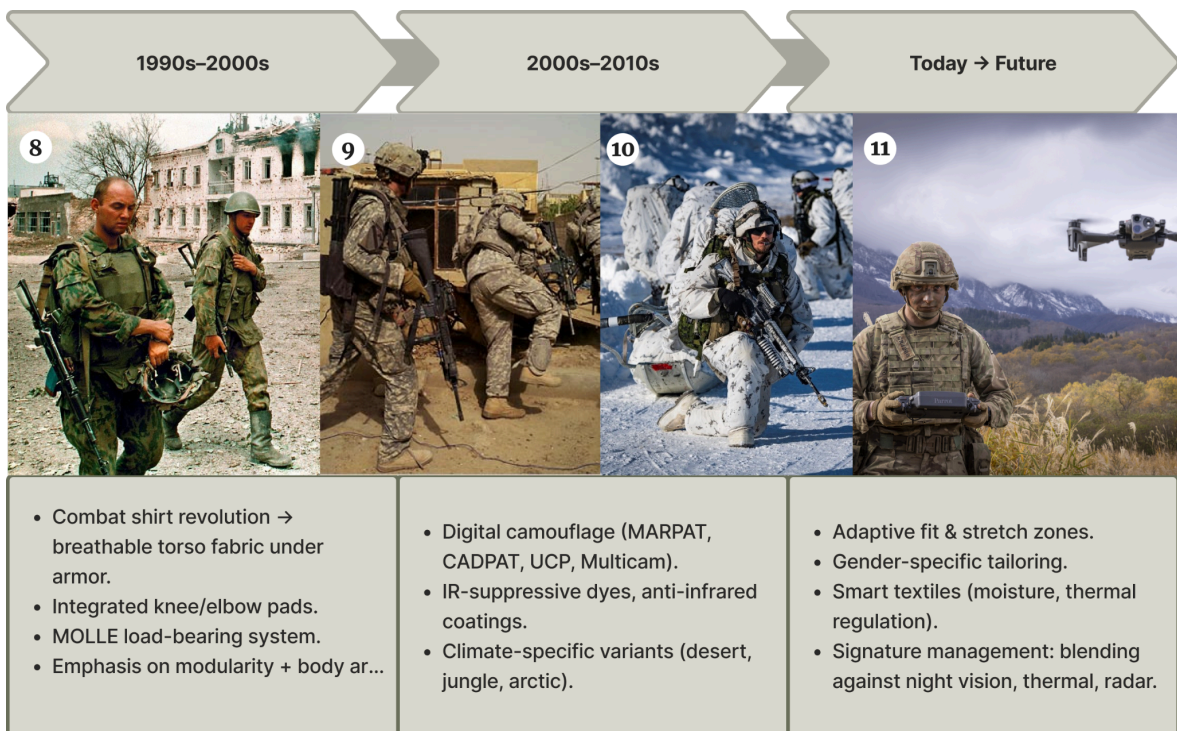


Figure 4: World Uniform History Timeline: 1990s to the future, visualised by the author.

Ever since then, combat shirts have been manufactured with the personal protective equipment in mind. The shirts typically feature a synthetic knit body, crafted from an athletic, breathable material, while the collar and arms are constructed from a more durable camouflage material. Knee and elbow protection is now commonly integrated into garments, eliminating the need to carry them separately.

## 4.2 Brief History of the Estonian Uniform

Estonian military uniforms began in 1917 with the formation of national troops within the Imperial Russian Army (figure 5). At the time, Estonian soldiers wore a mix of Russian military uniforms and civilian clothing, distinguished by a five-pointed star on their hats and a blue-black-white ribbon on the sleeve.

The first official national uniform and insignia were approved in 1919, though various allied supplies meant British and American uniforms also appeared during the War of Independence. In 1920, the uniform colour changed from brownish-grey to khaki. A new design was introduced in 1924, slightly modified in 1926, and remained in use for the next decade.

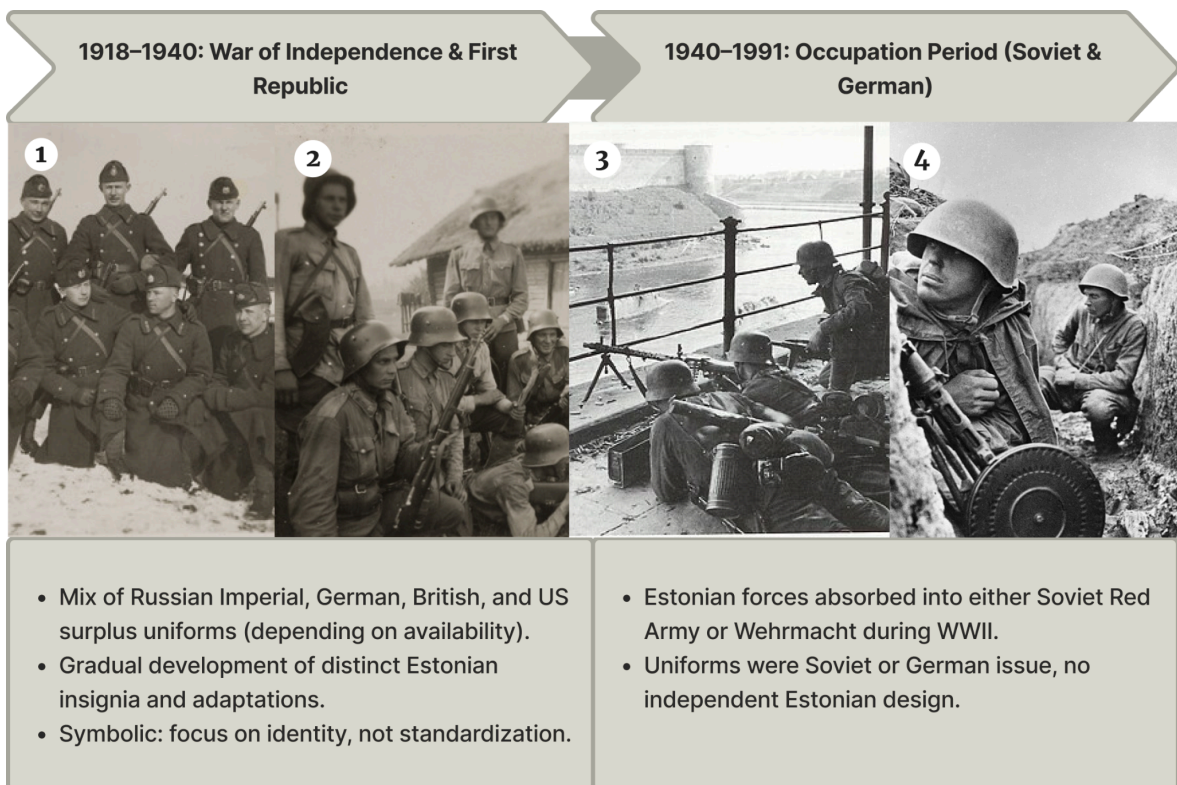


Figure 5: *Estonian Uniform History Timeline: 1918 to 1991, visualised by the author.*

The final uniform regulations were made in 1936. Estonian soldiers in the Red Army wore their national uniforms with Soviet insignia after the Soviet occupation. During WWII, Estonian officers under German command initially had Estonian uniforms before transitioning to Wehrmacht, SS, or German police uniforms. From 1942, Estonian Red Army divisions wore Soviet uniforms, and Estonian national military attire was out of active use for over 50 years. (*Eesti Sõjaväevormi Lugu*, n.d.)

Estonia regained independence in 1991. Initially, the Estonian Defence Forces lacked a standardised uniform system. In the 1990s and early 2000s, soldiers wore a mix of Soviet uniforms, donations from abroad, and civilian outdoor clothing due to limited resources and funding. This period was characterised by variations in patterns, materials, and garment quality across units (Figure 6). Efforts to unify the clothing system intensified after Estonia joined NATO in 2004. (Eesti sõjamuuseum, n.d.)



Figure 6: *Estonian Uniform History Timeline: 1991 to today, visualised by the author.*

In 2008, the Estonian government officially approved a new uniform with a modern, digital camouflage pattern called ESTDCU. These uniforms are still in use today. (*Kaitsevägi saab uue välivormi*, 2008) (*Kaitseministri 23.10.2013 määrus nr 51 „Kaitseväelase Vormiriietuse Kirjeldus Ja Vormiriietuse Väljastamise Kord“ Lisa 5, 2013*)

## 4.4 Estonian Defence Forces

The Estonian Defence Forces (EDF) operate on a reserve-based system designed for rapid mobilisation and national resilience. The EDF consists of the land forces, navy, air force, and Estonian Defence League, coordinated under a unified command. As of 2024, the EDF includes approximately 7,700 active-duty soldiers, 78,800 reservists, and around 10,000 Defence League members, totalling nearly 96,500 personnel. Major General Andrus Merilo leads the organisation. (Defence Advancement, 2024)

Military service in Estonia is mandatory for men through conscription, typically lasting 8 to 11 months, after which conscripts move to the reserve. These rotations ensure a broad base of trained soldiers across society and the continuous renewal of the active force. Professional soldiers and non-commissioned officers from permanent structures support readiness and international cooperation missions.

The EDF operates in diverse conditions, ranging from dense forests and wetlands to urban environments, which often require long hours in changing weather, high mobility, and physical endurance. This underscores the importance of the military uniform's functionality, durability, and comfort to operational efficiency. Clothing must support activities such as crawling, marching, and handling equipment, while maintaining camouflage and protection across Estonia's four distinct seasons.

In addition to the professional and conscription soldiers, the Voluntary Defence League (Kaitseliit) plays a key role in national defence readiness. It provides ongoing training, exercises, and mobilisation capabilities for both reserve soldiers and civilians. Within the Defence League, the Women's Voluntary Defence Organisation (Naiskodukaitse) focuses on support, medics, logistics, and crisis response tasks, with around 3900 members in 2024 (Appendix B) (Naiskodukaitse Taastamisjärgne Ajajoon, n.d.).

### 4.3 Overview of Estonian Military Uniform and Clothing System

The Estonian Defence Forces' clothing system is built on a layered structure intended to meet seasonal and operational needs. In theory, the system enables flexible combinations of garments for varying temperatures and activity levels (Aldošin, 2015). Conscripts receive an initial set that includes a field cap, field jacket, field pants, T-shirt, combat shirt, and black leather ankle boots for summer use. Additional base layers, such as sweaters, gloves, and thermal underwear, are added for cooler weather, while winter jackets, pants, hats, and mittens complete the full cold-weather set (Figure 7).

The clothing system follows the principle of base, mid, and outer layers, which, in theory, should allow thermal regulation across different weather conditions. Waterproof ponchos and rain suits are available for wet environments, while some specialised items are issued only to specific units or roles. (*Individuaalvarustuse kandmise kord*, 2022)

Footwear consists primarily of black leather ankle boots that can be adapted for winter use with liners, while rubber boots are meant for wet, muddy terrain and are rarely issued to soldiers. Additional accessories, such as beanies, scarves, and gloves, are provided to enhance adaptability in extreme weather conditions. Personal protective equipment, such as plate carriers, ballistic helmets, and gear harnesses, is worn over the uniform, completing the standard-issue combat setup (Varustus – Kaitsevägi, n.d.).

Although the system is designed to operate year-round, field feedback highlights limitations in its adaptability and user comfort. Seasonal transitions often expose gaps in thermal balance, and many soldiers report that the current layering system feels either insufficient in cold weather or excessive in warm conditions. Moreover, since the same sizing standards apply across all personnel, the uniforms do not fully accommodate different body types, which impacts comfort and mobility.

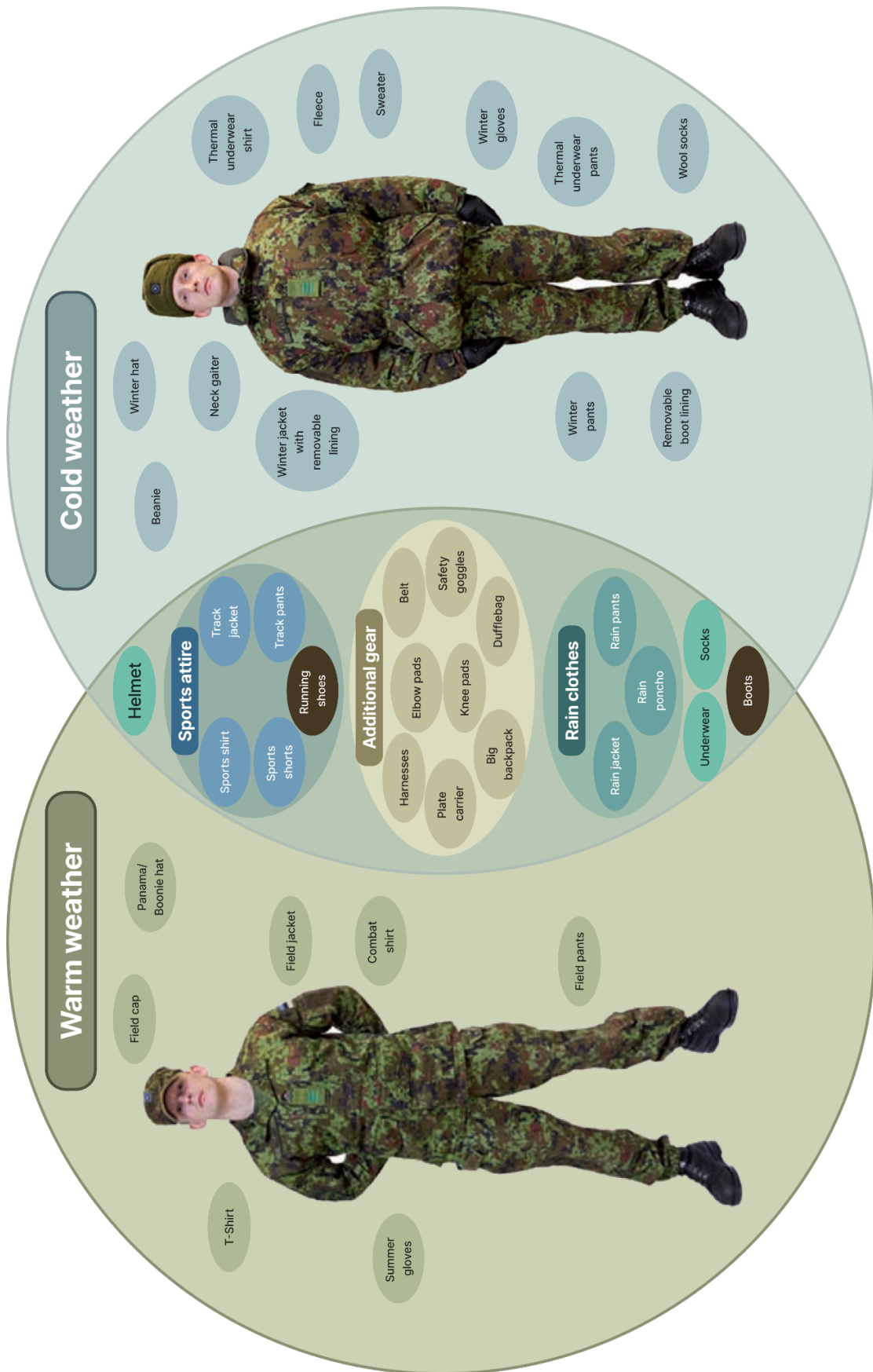


Figure 7: Estonian Uniform Elements, Uniformed models: (Aldošin, 2015), with the author's additions.

## **4.5 Overview and Analysis of Current ESTDCU Solutions**

Understanding the current structure and available solutions within the Estonian military clothing system helps to contextualise the challenges discussed in this thesis. While the Estonian Defence Forces have established a standardised uniform system adapted for different weather conditions, the functional performance and innovation of these garments remain limited. The current camouflage regulation, the local production landscape, and existing market alternatives reveal both the system's strengths and its development gaps, particularly in durability, ergonomics, and user adaptability.

### **4.5.1 Use of Estonian Camouflage**

Access to the use of the national camouflage patterns in Estonia is tightly regulated by the Ministry of Defence. These regulations specify the conditions under which uniforms may be worn and by whom. Active-duty personnel are permitted to wear the Estonian Digital Camouflage Uniform (ESTDCU) only during service or official duties; in civilian life, it is prohibited unless authorised.

This measure preserves the symbolic and professional functions of the uniform, ensuring it remains a clear marker of national defence identity and preventing its misuse or misrepresentation by the Estonian Defence Forces. (*Kaitseministri 23.10.2013 Määrus Nr 51 „Kaitseväelase Vormiriietuse Kirjeldus Ja Vormiriietuse Väljastamise Kord“ Lisa 5, 2013*).

### **4.5.2 Estonian Market Overview**

Estonia's military clothing market is small but active, consisting mainly of local suppliers and importers specialising in combat and outdoor equipment. The primary domestic manufacturer, Proflin, produces most of the higher-quality combat clothing in ESTDCU camouflage. Their designs, such as the Sirius model (Figure 8), show clear influence from international manufacturers, notably Crye Precision's G2 and G3 pants, with nearly identical pocket structures and panel layouts. These products are available for purchase by military personnel, including conscripts, as they offer functional improvements over standard-issue garments, which still lag behind international models in adaptability and comfort.

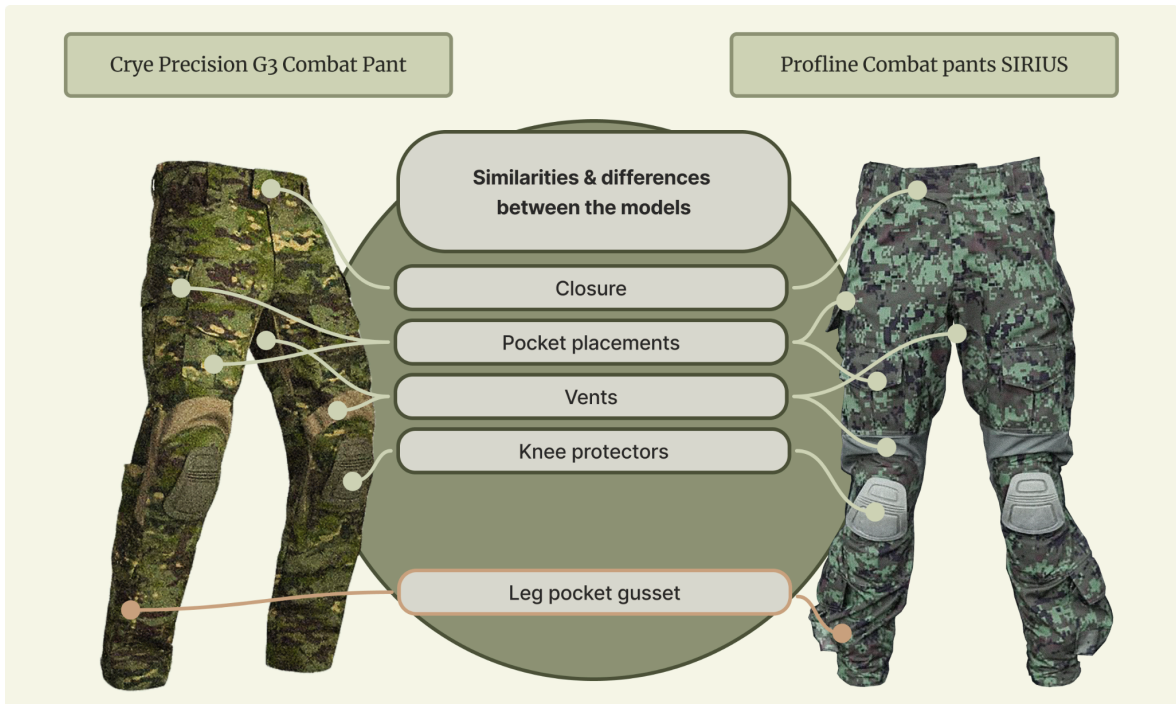


Figure 8: *Proflin Combat pants SIRIUS compared to Crye Precision G3 Combat Pants, visual by the author*

In 2025, Proflin also developed a female-specific uniform line, aiming to address long-standing fit and comfort issues raised by female personnel. This move represents a significant step toward greater inclusivity and ergonomics within the Estonian Defence Forces' clothing system, marking the first step toward tailoring the ESTDCU uniform to gender-specific anatomical differences.

At the international level, Premium models such as Arc'teryx LEAF Assault Pant AR Gen 2 and Crye Precision G3 combat pants continue to represent the benchmark for durability, anatomical cut, and comfort during extended missions. These models use advanced materials and refined patterns that support unrestricted movement and long-term wear comfort.

Overall, the Estonian market currently mirrors global tactical design trends rather than leading them, often through localised adaptations of international designs rather than original innovations. This situation highlights a development opportunity for Estonia to establish its own design identity, one that integrates the nation's environmental context, operational needs, and user diversity more effectively.

## **4.5 Sizing of the Clothing**

A military uniform's performance begins with its fit. Sizing systems determine how well garments align with the human body, directly influencing mobility, comfort, thermoregulation, and durability. In the context of the Estonian Defence Forces, uniform sizing has remained largely standardised through NATO conventions, which prioritise logistical efficiency over anatomical diversity. However, as the military workforce encompasses a broader range of body types, genders, and training backgrounds, this system reveals its limitations. Understanding how sizing systems are constructed and how they correspond to real human variation is essential for designing uniforms that not only fit better but also perform under physical and environmental stress.

### **4.5.1 Anthropometric differences between men and women**

Understanding anatomical and physiological differences between men and women is essential for designing functional military clothing. These differences are not limited to overall size variation but extend to body proportions, muscle distribution, and movement patterns, all of which influence fit, comfort, and performance.

According to Punzalan & Hosken (2010), Sexual dimorphism has been shaped by evolutionary and physiological demands. Men generally have broader shoulders, greater upper body strength, and higher muscle mass. Women tend to have wider hips, a higher body fat percentage, and a more diminutive overall stature. These differences directly affect how clothing interacts with the body. How it stretches, where pressure points form, and how thermal regulation occurs.

Designing with these distinctions in mind allows uniforms to become adaptive systems rather than rigid standards. Acknowledging physiological diversity in sizing and pattern construction supports better ergonomics, reduces fatigue, and minimises the risk of injury. Moreover, it promotes inclusion and morale. Soldiers perform better when their uniforms support rather than hinder their physical capabilities.

### **4.5.2 Comparison of Male and Female Sizing Charts in the Fashion Industry**

Sizing systems define how garment fits the human body, and in military contexts, fit is directly tied to safety and performance. Unlike civilian fashion, where fit is mainly aesthetic, military clothing must accommodate movement, gear layering, and thermal regulation.

The industrial sizing charts compiled by Donanno (2014, p. 29, 217)(Appendix C) clearly demonstrate differences between men’s and women's proportional measurements. For example, two garments with the same hip circumference (96 cm) reveal a 16 cm difference in waistline between male and female sizing standards. This ratio significantly alters how a garment rests and moves on the body.

Chart based on ((Donnanno, 2014, p. 29, 217) (Appendix C)) comparing women’s and men’s waist circumferences based on the same hip circumference.

| <b>Measurement</b>  | <b>Women’s Size 44</b> | <b>Men’s Size 48</b> |
|---------------------|------------------------|----------------------|
| Waist Circumference | 72 cm                  | 88 cm                |
| Hip Circumference   | 96 cm                  | 96 cm                |
| Waist to Hip Ratio* | 0,75                   | 0,91                 |

*\*Waist to Hip Ratio - The waist-to-hip ratio (WHR) measures the ratio of your waist circumference to your hip circumference. (Armstrong & Tinsley, 2025)*

Even within this simple comparison, the design implications are significant. Women's garments require greater hip curvature and shorter torso lengths, whereas men's sizing assumes straighter proportions and longer limbs. Similarly, shoulder widths in women range between 35,3 - 43,5 cm, while men's begin around 42 cm (Punzalan & Hosken, 2010). Using male-based sizing for all soldiers results in oversized shoulders, restricted movements, and poorly aligned weight distribution when wearing gear.

These differences highlight that applying unisex male-derived sizing systems to everyone overlooks basic anthropometric diversity, thereby reducing both performance and comfort.

#### **4.5.3 NATO Sizing System**

The Estonian defence forces use the NATO sizing system (Appendix D) to standardise military clothing, as do many NATO members. While theoretically efficient at covering the majority of military personnel, it still has practical limitations.

The NATO sizing system is built around three number formats denoting height, chest circumference, and waist circumference (e.g., 180/96/80) (NATO Sizing - A Brief Guide | Military Sizing, n.d.). This system was made to improve standardisation among allied forces and maintain consistency across uniform and gear production (STANAG 2333)

(Standardisation, 2022). It offers logistical clarity and simplifies inventory management.

However, as discussed by Armstrong et al. (2024), this “technically unisex” system still relies on male anthropometric averages that do not fully reflect the diversity of modern military personnel. The original NATO data were derived from male conscripts, assuming a proportional distribution across the body, which poorly represents female or non-standard body types. The sizing increments fail to account for bust prominence, hip curvature, or torso-to-leg ratio, resulting in garments that often fit poorly for women and for those with smaller or wider body builds.

According to Carr et al. (2012), incorporating anthropometric data directly into uniform design is critical to maintaining function and comfort. As military clothing also serves as personal protective equipment, a poor fit can reduce mobility, create friction points, and compromise safety.



Figure 9: Illustration of the current sizing of the pants with adapted proportional sizing. By the author.

To visualise these limitations, Figure 9 illustrates the current Estonian Defence Forces sizing grid (outlined in green) and an adapted, more inclusive proposal (outlined in red). The adapted sizing expands coverage for shorter, curvier body types and introduces additional inseam options for a more proportional fit.

## 4.6 Issues and Their Effects on Human Function and the Uniform

### 4.6.1 Mobility and Movement Limitations

Understanding mobility from an ergonomic perspective is essential for evaluating the functional performance of military uniforms. Mobility refers to the ability to move freely and efficiently through a full range of motion across joints and muscles. It is a combination of joint flexibility, muscle extensibility, and neuromuscular coordination, all of which are crucial for performing physical tasks such as running, crawling, lifting, and carrying (Ernstmeyer & Christman, n.d.). In military contexts, optimal mobility supports effectiveness, prevents injuries, and enhances endurance under physically demanding conditions.

When movement is restricted due to garment design (Figure 10), material stiffness, or ill-fitting clothing, the soldier's body is forced to compensate by using alternative and inefficient motions. These compensations place excessive stress on joints, tendons, and soft tissues, increasing the risk of strain, fatigue, and, in some cases, long-term injury. For soldiers who carry heavy loads and move rapidly across complex terrain, even minor mobility restrictions can lead to significant performance decline and higher energy expenditure (Brisbine et al., n.d.).

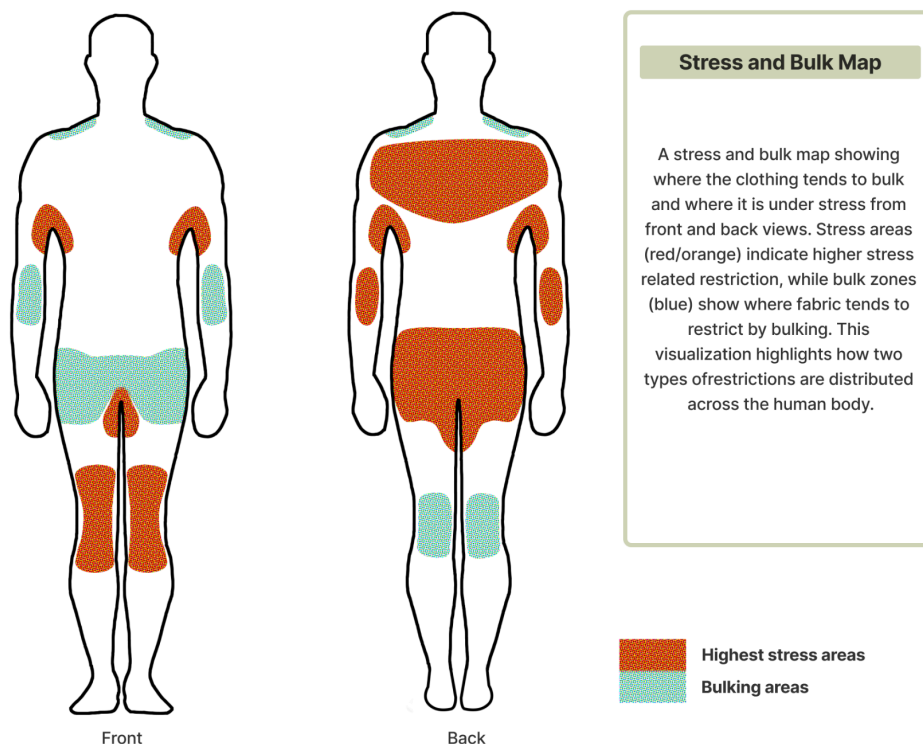


Figure 10: *Stress and bulk map, by the author.*

Military clothing that limits motion in the shoulders, hips, or knees disrupts the natural biomechanics of walking and running. For instance, trousers that are too tight around the thighs or lack flexibility in the crotch area can reduce stride length and restrict kneeling or crouching movements. Similarly, tightness across the shoulders or sleeves with poor articulation, especially when combined with tactical gear, can interfere with lifting, climbing, and handling equipment (Thomas et al., 2018).

Restricting garments may also impair blood circulation and lymphatic flow during extended activities, leading to swelling, discomfort, and reduced alertness, all of which are critical in operational settings (Friedl, 2018). In cold climates, reduced mobility may hinder thermoregulation by limiting active movement, while in warm climates, restricted ventilation can contribute to overheating and moisture buildup.

Mobility limitations in clothing are not merely a matter of comfort but a determinant of soldiers' health, safety, and operational performance. The human body is optimised for movement, and interference with its natural range under stress reduces both efficiency and survivability in the field. These theoretical insights provide a foundation for the field analysis in Chapter 4, which examines how mobility challenges manifest in current Estonian Defence Forces uniforms.

#### **4.6.2 Importance of Thermoregulation**

Thermoregulation is one of the most critical physiological processes supporting human performance, particularly in high-intensity or extreme environmental conditions faced by military personnel. The human body maintains a stable core temperature of approximately 37°C by balancing metabolic heat production with heat dissipation (Figure X), via mechanisms such as sweating and blood flow regulation (Stephens, 2017). Disruption of this balance, whether through environmental exposure or inappropriate clothing, directly threatens health, endurance, and effectiveness.

Military uniforms must therefore be designed to protect against environmental extremes while maintaining adequate ventilation and moisture management. When materials are too insulating or lack breathability, thermal imbalance can occur (Havenith, 2002). In hot climates or during intense physical exertion, this can result in heat stress, marked by elevated heart rate, dehydration, and fatigue, and in extreme cases, heat stroke. Such conditions severely impair cognitive focus and decision

making, increasing the risk of human error in operational contexts (Heat - Overview: Working in Outdoor and Indoor Heat Environments | Occupational Safety and Health Administration, n.d.).

In cold environments, insufficient insulation or ill-fitting garments lead to excessive heat loss, shivering, and reduced manual dexterity. Prolonged exposure can cause hypothermia or frostbite, especially during missions that alternate between high activity and inactivity. (Winter Weather - Cold Stress | Occupational Safety and Health Administration, n.d.).

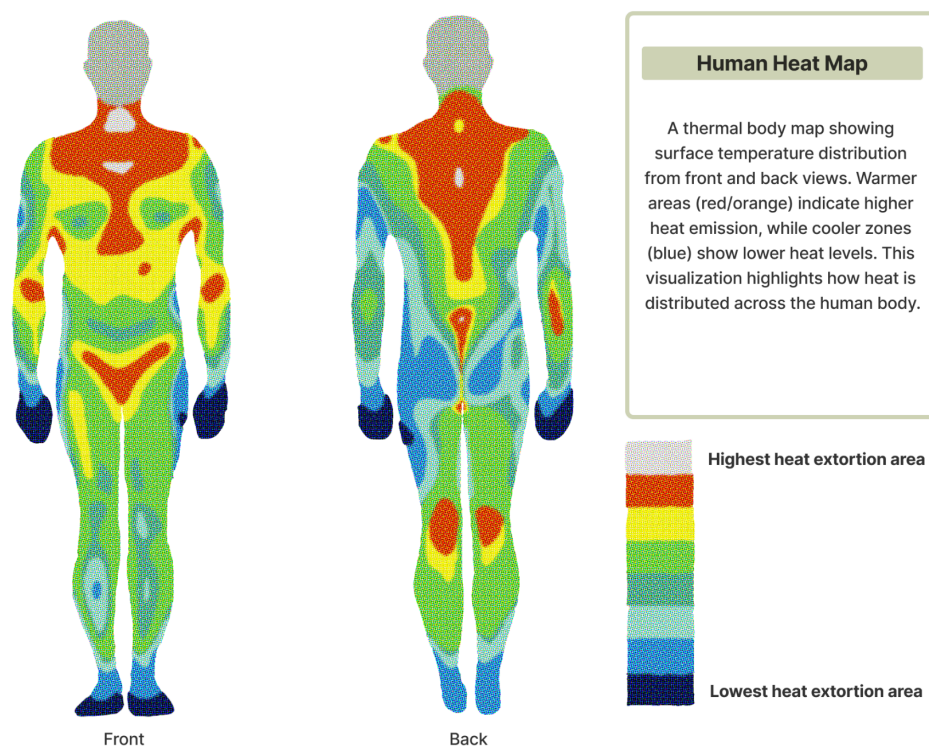


Figure 11: *Thermal Body Map*, by the author.

Moisture management is another central challenge. Poor ventilation traps sweat and humidity, creating damp underlayers that accelerate heat loss in cold environments and promote friction injuries such as chafing, blisters, and infections. In hot and humid conditions, trapped moisture blocks the evaporation of sweat, the body's primary cooling mechanism, leading to thermoregulatory failure (Zhao et al., 2025).

Effective thermoregulation in military clothing is not an optional comfort feature but a functional requirement that directly impacts safety and performance. Achieving this balance requires thoughtful design strategies: a combination of breathable, protective,

and durable materials; zonal ventilation; adaptable layering systems; and fits that accommodate airflow without restricting movement.

#### **4.6.3 Weaknesses and Durability**

Durability in military uniforms is not only a technical property but a factor that directly affects cost-efficiency, safety, and operational readiness. The ability of a uniform to resist tearing, abrasion, seam failure, and general wear is vital for maintaining performance in training and in combat environments. When garments fail to withstand those stresses, the consequences range from discomfort and distraction to reduced protection and increased safety risks.

In the Estonian Defence Forces, as in many other military organisations, premature material wear is a recurring problem. High-friction zones, such as the thighs, elbows, crotch seams, and shoulders, are especially prone to tearing and abrasion. Noted by (Hearle, 2005, pp. 117-150), such failures often result from insufficient textile strength, lack of reinforcement in stress areas, or inadequate stitching quality. Exposure to mud, snow, and gravel, as well as repetitive movements such as crawling, climbing, or lifting, further accelerates fabric degradation.

Weak durability also imposes logistical and financial burdens. Frequent repairs and replacements not only divert time and attention from core duties but also increase maintenance costs. While in Estonia, replacement costs are borne by the state, in larger forces such as the U.S. military, inconsistencies in uniform quality and frequent design revisions have contributed to inequitable out-of-pocket costs among service branches (Military Service Uniforms: DOD Could Better Identify and Address Out-Of-Pocket Cost Inequities, 2021). In both cases, poor durability reflects inefficiencies in design and supply systems.

At the design level, seam rupture and button failure remain key weak points. Stress concentration in areas such as the groin, underarms, or shoulder seams, combined with tight fits or rigid fabrics, leads to early failure. These seemingly minor breakages can compromise protection, interfere with gear, or require emergency field repairs, disrupting readiness.

Improving uniform durability is therefore both a technical and economic opportunity. Using higher-tensile fabrics, reinforcing key stress zones, and designing garments with modular or repairable components can substantially extend their service life. Such

measures also align with sustainability goals by reducing waste and demand for production.

Ultimately, every torn seam or worn-out panel represents not just a loss of fabric but of time, confidence, and efficiency. The following chapter, 4.3.4, expands on this topic by presenting user-reported issues from field research, offering a closer view of how durability problems manifest in practice.

## **4.7 Comparative Analysis of Military Uniforms**

Comparing military uniforms across different national contexts provides a useful view for evaluating the strengths and limitations of the Estonian Defence Forces' current equipment (uniform). While camouflage, patterns, and symbolic identity often dominate public discussions, uniforms also reflect deeper considerations of ergonomics, inclusivity, and adaptability. Examining the practices of larger allies and neighbouring militaries highlights both everyday challenges and alternative approaches, against which Estonia's own solutions can be critically assessed.

### **4.7.1 United States**

The United States has historically been a leader in military clothing development, driven by its global deployments and large defence budget. One of the most notable developments has been the adoption of a modular system, particularly the MOLLE Modular Lightweight Load-carrying Equipment system, which allows soldiers to adapt their load carriage to mission-specific requirements (Kirk et al., 1996). These ideas extend to clothing itself, where the introduction of the combat shirt represented a significant ergonomic improvement. Designed with lightweight fabric on the torso and durable camouflage sleeves, the combat shirt was tailored explicitly for wearing under body armour, addressing heat and discomfort issues identified in earlier uniforms.

Another strength of the U.S system is the attention to functional layering. Cold-weather gear, flame-resistant clothing, and specialised uniforms for jungle or desert environments that reflect recognition of diverse operational contexts. These adaptations demonstrate a soldier-centred design approach by addressing the problems soldiers encounter in the field.

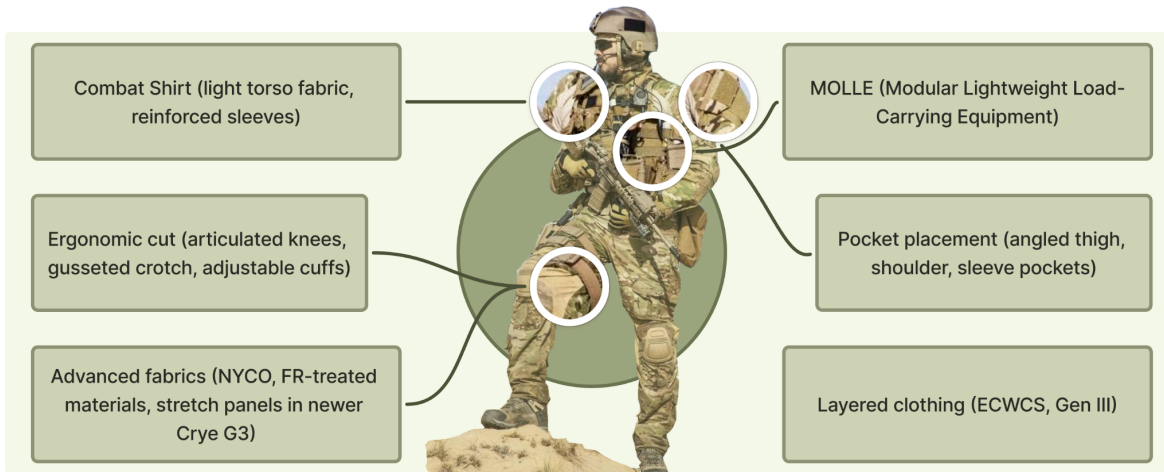


Figure 12: *U.S. Military Uniform, visual by the author.*

However, the U.S. also faces challenges with large-scale military systems. Frequent changes in camouflage patterns, such as transitioning from woodland to digital and later to multicam, generate confusion and create logistical costs. While the combat shirt and modular systems have improved ergonomics, inclusivity issues remain. Uniforms are still primarily designed around male anthropometry, leading to an ill fit and discomfort for female soldiers (Armstrong et al., 2024)

The U.S. presents both the potential of modular and ergonomic design to transform soldiers' experience and, at the same time, reflects the ongoing limitations around inclusivity in a highly resourced but standardised system.

#### **4.7.2 Scandinavia**

Scandinavian countries such as Finland, Sweden, and Norway emphasise cold-weather adaptability and performance in their military clothing. Uniform systems are designed with layering principles to cope with harsh climates, integrating baselayers, insulated midlayers, and durable outer shells. Finland, in particular, has invested in winter camouflage systems that balance concealment with thermal regulation, highlighting the strong link between the environment and clothing design.

Scandinavians have also recently advanced through the Nordic Combat Uniform (NCU) project, a joint effort by Sweden, Norway, Finland, and Denmark under the NORDEF CO Framework. The NCU replaces older national uniforms with a layered system covering everything from underwear and wool base layers to outer shells, rain gear, and specialised winter camouflage. The design prioritises ergonomics and adjustability, featuring adjustable knee and elbow protectors and multiple fit adjustments

throughout the clothing. A key aspect of this project is its inclusion of testing with both men and women. The technical performance is achieved through the use of advanced materials, such as GORE-TEX and modern wool fabrics, to balance durability, thermal regulation, and moisture management (NCU Layering System, 2022).



Figure 13: *Nordic Combat Uniform, visual by the author.*

The NCU also represents a user-centred approach to the procurement process, with around 400 soldiers participating in field testing to validate functionality across different climates. Compared to Estonia's current uniform, which prioritises camouflage and standardisation, the NCU demonstrates how inclusivity, ergonomics, and layered adaptability can be part of uniform development.

This analysis shows how larger militaries, like the United States, have advanced in modularity and ergonomics. At the same time, Scandinavian countries have prioritised climate adaptability and inclusivity through projects such as the Nordic Combat Uniform. Against these, Estonia's ESTDCU stands out as effective in terms of camouflage and simplicity, though less developed in fit, adaptability, and inclusivity. This contrast highlights both the strengths of Estonia's current uniform and its clear potential for future development.

## 4.8 Background Research Conclusions

This research phase revealed that military uniforms are far more than functional garments; they are systems of performance, identity, and adoption. A uniform must

protect and represent, move and endure, fit and unify. Yet, these roles often conflict. What emerged most clearly was that the Estonian uniform system, like many others, still treats the soldier's body as a standardised form rather than a living, variable, and adaptive one.

Across the reviewed material, a recurring contradiction appeared between the uniform's symbolic unity and the body's physical diversity. Uniforms are designed to erase individuality through standardisation, yet the very efficiency this brings creates new inefficiencies, such as discomfort, restricted mobility, and uneven thermal regulation. The soldier's body becomes the site where this tension is felt most acutely.

Another insight concerns the distance between design intention and real use. The NATO sizing system and Estonia's inherited design logic prioritise logistical efficiency and visual order. But this optimisation for system-level clarity comes at the cost of individual comfort and performance. What the system defines as "fit" does not necessarily align with what the soldier experiences as functional.

The symbolic aspect of the uniform adds another layer of complexity. National camouflage patterns serve not only tactical purposes but also reinforce hierarchy, belonging, and pride. However, when a uniform fails to support the physical realities of its wearer, it undermines the very values it is meant to embody: unity, discipline, and readiness.

Taken together, these insights point toward a deeper question: Can a uniform designed for sameness truly support the diversity of the human body and its needs? This tension between collective identity and individual function lies at the core of military clothing design. It invites a reconsideration of what "fit" means, not just as a physical property but as a relationship between the soldier, the system, and the environment.

The field research explores these questions in real contexts: How do soldiers experience their uniforms in daily use? How do they adapt, modify, and integrate into the system? And what might be learned from their experiences about how military clothing could evolve toward a more adaptive user-centred future.

## **4.9 Research Question**

How can a user-centred design approach, informed by field research, anthropometric analysis, and prototyping, be used to develop adaptive combat pants that improve fit, mobility, thermoregulation, and inclusivity within the current Estonian Defence Forces uniform system?

## **5. FIELD RESEARCH**

The field research aimed to understand how Estonian Defence Forces uniforms function in real-life conditions, not in theory or regulation, but in the lived experiences of those who wear them daily. While earlier desktop research mapped the historical and technical background, this phase focused on the human perspective of the uniform: how it feels, performs, and fails in use.

The research followed a qualitative, user-centred approach, combining a questionnaire and in-depth interviews. The questionnaire provided a broader overview of general trends and recurring issues, while the interviews allowed for a deeper understanding of personal experiences, contextual challenges, and user adaptations. Together, they offered a comprehensive picture of the uniform system from both statistical and experiential viewpoints.

The goal was not only to document what soldiers find problematic but to uncover why these problems persist and how they influence movement, comfort, and performance. This insight laid the foundation for identifying key design opportunities for future military uniform development.

### **5.1 Questionnaire**

The questionnaire (Appendix E) served as the first layer of field research, helping to capture a wide range of experiences and identify recurring issues in the current Estonian Defence Forces clothing system. It provided both quantitative and qualitative insights that later guided the interview focus.

The form was structured around themes derived from desktop research and preliminary observations.

The form consisted of a consent form (Appendix F), which was presented to the participant at the beginning. The questionnaire went over the following topics:

1. Background information
2. Uniform quality and durability
3. Design and user experience
4. Care and maintenance
5. Receiving and exchanging the uniform

## 6. Suggestions for improvements and future vision

A total of 135 valid responses were collected from both male and female participants, representing a wide range of service contexts and experiences. Due to the sensitive nature of the information, participants' roles, ranks, and names were not collected in the questionnaire. The survey was available in Estonian via Google Forms to allow easy access across the different branches of service.

The collected data was analysed through basic statistics and qualitative clustering. Written responses were grouped into recurring themes in Figma, forming a foundation for deeper interpretation. These patterns later informed the design of the semistructured interviews, ensuring that the subsequent research stage would build directly on real, data-driven insights rather than on assumptions.

## 5.2 Interviews

The interviews were conducted to gain a deeper understanding of the issues identified in the questionnaire.

While the questionnaire provided an overview of recurring problems, the interviews helped explore the reasons behind them and their impact on soldiers in real situations.

The participants were selected to represent different genders and roles within the Estonian Defence Forces and the Defence League. This helped to collect a range of perspectives and experiences. Each participant signed a consent form (Appendix H) before taking part in the study.

The interviews were semi-structured, meaning they followed a set of open-ended questions but allowed room for discussion. This made it possible to explore unexpected insights and personal experiences.

The main topics discussed during the interviews were (Appendix G):

1. Everyday experience and context
2. Mobility and restrictions
3. Problematic moments while using the uniform
4. Injuries and the role of the uniform
5. Personal adjustments and repair solutions
6. Sensory experience and body perception

7. Interaction between the body, equipment, and uniform
8. Heat, weather, and physical activity
9. Suggestions and future improvements
10. Available but unused solutions

All interviews were recorded and later transcribed. After transcription, the recordings were deleted to ensure complete anonymity and data protection.

The transcriptions were analysed by identifying recurring themes and unique insights. These findings helped interpret the questionnaire results and supported the understanding of uniform performance in real-life conditions. The interviews also provided emotional and human perspectives that statistics alone could not show, helping to illustrate how design affects everyday experience, comfort, and readiness.

### 5.3 General Overview of The Findings

The field research revealed a consistent and interconnected set of issues that go far beyond surface-level discomfort. The findings demonstrate that the uniform is not merely clothing but a system that directly shapes how soldiers move, perform, and perceive themselves in the field. When this system fails to support the body, the consequences reach the morale, efficiency, and even safety.

Through the questionnaires and in-depth interviews, several recurring issues emerged. Soldiers across ranks and genders described similar struggles with mobility, thermal discomfort, poor sizing, and premature wear. These challenges are not isolated; they add to each other. For instance, ill-fitting garments restrict movement, increasing friction and accelerating material fatigue. Heavy or non-breathable fabrics trap heat, which leads to sweating and distraction. Over time, these small inefficiencies accumulate, reducing endurance and physical readiness.

The analysis also revealed how standardised sizing systems and unisex patterns fail to represent the diversity of real bodies in service. Female respondents, in particular, reported discomfort and functional limitations due to patterns designed primarily for male proportions. This mismatch between body and design creates not only ergonomic strain but also psychological strain, a feeling of having to adapt oneself to the uniform rather than the uniform adapting to the person.

While physical comfort and mobility were the most commonly mentioned concerns, durability and maintenance were also highlighted as critical sources of frustrations.

Soldiers frequently reported seam tearing, fabric thinning, and button detachment. All these issues interrupt daily operations and create additional logistical burdens.

Overall, the findings show that these are not minor inconveniences but systematic design shortcomings with direct operational implications. A uniform that restricts movement or traps heat not only hinders performance but undermines trust in the very system meant to protect and support the soldier.

### **5.3.1 Fit and Sizing Problems**

As previously covered in chapter 3.6.1, proper fit is essential to mobility, comfort, and durability in military clothing. Poor sizing not only reduces efficiency during movement but also forces soldiers to adapt their gear, disrupting the uniformity and long-term wear.

Field research highlighted that fit and sizing are among the most common issues in Estonian Defence Forces uniforms. Both questionnaires and interviews revealed repeated frustrations with garments, unavailable sizes, and inconsistent sizing across batches. The soldiers noted that two uniforms with the same label could fit very differently, making it difficult to trust the sizes without trying them on. This led soldiers to request larger clothing to ensure a proper fit, which, in turn, restricted their movement and resulted in baggy, impractical clothing.

*"The winter jacket I received was supposedly the smallest available, but it was still far too large. The pants were too wide at the waist and too short in length, while the jacket was overly long."* (Questionnaire)

### **5.3.2 Mobility and Movement Limitations**

One of the most critical functions of a military uniform is to support unrestricted movement during physically demanding tasks such as crawling, lifting, kneeling, or climbing. While the uniform should allow for these motions, many questionnaire and interview responses revealed that the current uniform restricts movement and reduces comfort, especially during training and field operations.

## **Lower Body Mobility**

The most common issue, reported by both men and women, concerns the trousers. Respondents frequently described tightness around the hips, crotch, and thighs that limited leg movement and caused discomfort during dynamic activities. The pants' restrictive fit caused the fabric to strain during activities like kneeling, climbing, and stepping, sometimes leading to seam tearing under stress.

*"The trousers are too tight in the crotch area, which is a common tearing point in the unit. The pattern doesn't allow for enough space or flexibility."* (Questionnaire)

Winter trousers presented a different problem, excessive bulk. While offering warmth, they were described as heavy and rigid, reducing comfort and mobility during physical activity.

*"Winter trousers are a separate issue, they're warm, but extremely bulky. It's hard to imagine doing any kind of physical activity in them comfortably."* (Interviews)

## **Upper Body and Layering Restrictions**

Mobility restrictions were not limited to the lower body. Respondents reported that shoulder seams and sleeve constructions restricted arm-raising and elbow movement, especially when worn under vests or protective gear. Limited articulation at key joints was repeatedly cited as a barrier to performing tasks that require quick, precise upper-body movements.

*"Many activities, like rescuing the injured or taking cover, require being on your knees or lying flat. The uniform needs to allow flexibility in these positions... As a medic, having sleeves in the way when inserting a cannula is uncomfortable, like trying to do it while wearing a suit jacket."* (Interviews)

Additionally, material stiffness is particularly noticeable in new or winter garments. Several soldiers described how thick fabrics and rigid seams interfered with natural movement, creating pressure points and friction between layers.

These limitations go beyond comfort. Restricted motion delays physical responses, reduces task efficiency, and may even pose safety risks. For instance, lifting an injured friend or manoeuvring through obstacles becomes more difficult when tight clothing

limits the range of motion. Furthermore, friction and stiffness between layers can trap heat and moisture, intensifying fatigue and discomfort during prolonged wear.

The findings indicate that current uniforms do not sufficiently support functional movement. Restrictive fit, stiff materials, and poor articulation reduce soldiers' physical performance and comfort, especially during extended operations. Future designs should prioritise ergonomically mapped patterns, flexible materials, and modular construction that adapt to body movement rather than constrain it.

### **5.3.3 Thermal Issues**

As already covered in Chapter 3.6.2, thermoregulation is a critical function of military clothing. Soldiers operate under varying weather conditions, from summer heat to freezing winters, while also performing physically demanding tasks. Clothing that fails to manage heat, moisture, and breathability not only reduces comfort but also affects performance and safety.

The field research showed and confirmed that overheating is one of the most persistent issues with the current Estonian Defence Forces uniforms. Questionnaires and interviews consistently highlighted issues with field shirts and trousers, which were deemed too heavy, poorly breathable, and ill-suited for the Estonian climate. Many respondents reported excessive sweating and moisture while wearing their clothes.

*"Hot weather, especially during large-scale exercises or shooting drills, makes things really tough, especially when there's no wind." (Interviewee)*

*"I developed a heat rash on my back ... I prefer wearing the combat shirt instead of the standard field shirt because it's more breathable." (Interviewee)*

The questionnaire data revealed that most respondents reported overheating as a frequent issue in both warm and cold weather, as well as during vigorous activity. The areas most affected by that were the back, chest, and legs. These are also the heat zones that are already acknowledged in sportswear and outdoor equipment design as requiring ventilation. Still, EDF uniforms lack knowledgeable design decisions, starting from pattern to material, to improve soldiers' performance.

### 5.3.4 Weaknesses and Durability Issues

As discussed in chapter 3.6.3, durability is critical for military clothing, since uniforms are subjected to repetitive stress, harsh weather, and heavy physical activity. The literature highlights seams, closures, and reinforced zones as common failure points. The field research strongly confirmed these issues in the current Estonian Defence Forces uniforms.

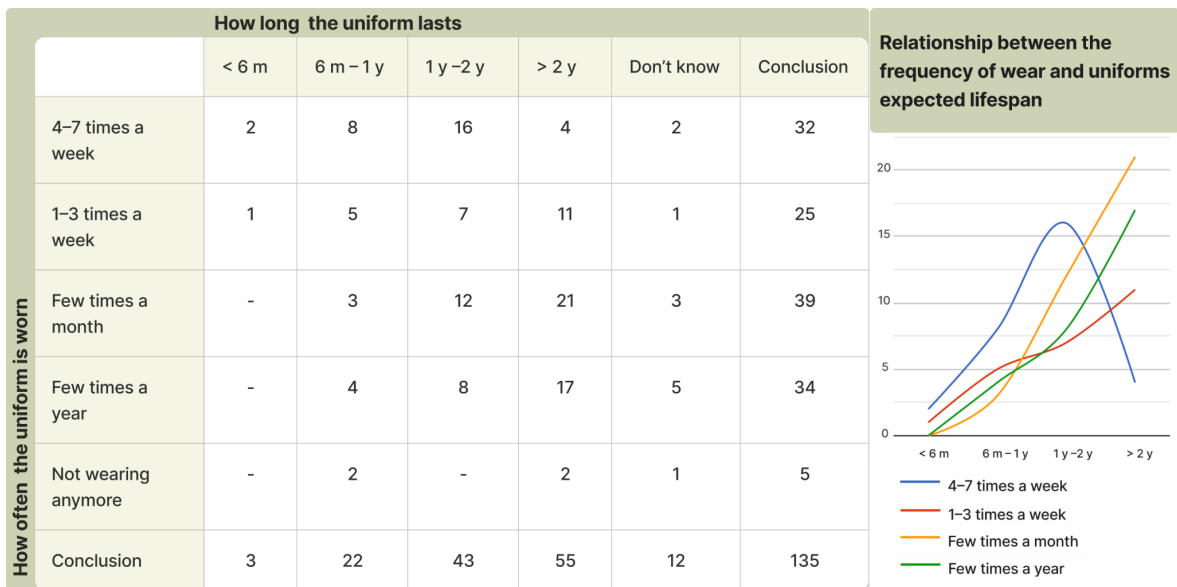


Figure 14: Relationship Between the Frequency of Wear and the Uniforms' Expected Life Span, analysis from field research data by the author.

The results show a clear relationship between the frequency of uniform wear and its perceived durability. Among respondents who wore their uniform 4-7 times per week, the majority reported that the set lasted only 6-12 months (8 responses) or 1-2 years (16 responses). Very few in this group believed their uniforms would last beyond 2 years. This highlights the accelerated wear associated with intense daily use.

For those wearing the uniform 1-3 times per week, the responses shifted slightly. The durability estimates are spread more evenly across 1-2 years (7 responses) and over 2 years (11 responses), indicating that lighter but still regular use extends the lifespan of garments.

The most positive response came from responders who wore uniforms only a few times a month or a few times a year. In these groups, the majority reported that the uniforms lasted over 2 years (21 and 17 responses, respectively). From them, uniforms often remained intact, with only minor visible wear, even after multiple years.

The data shows a strong correlation between the frequency of use and the expected uniform lifespan. The line chart (Figure 14) clearly illustrates this pattern. Heavy users peak in 6-12 month and 1-2 year categories, while occasional users are in the “over 2 years” category.

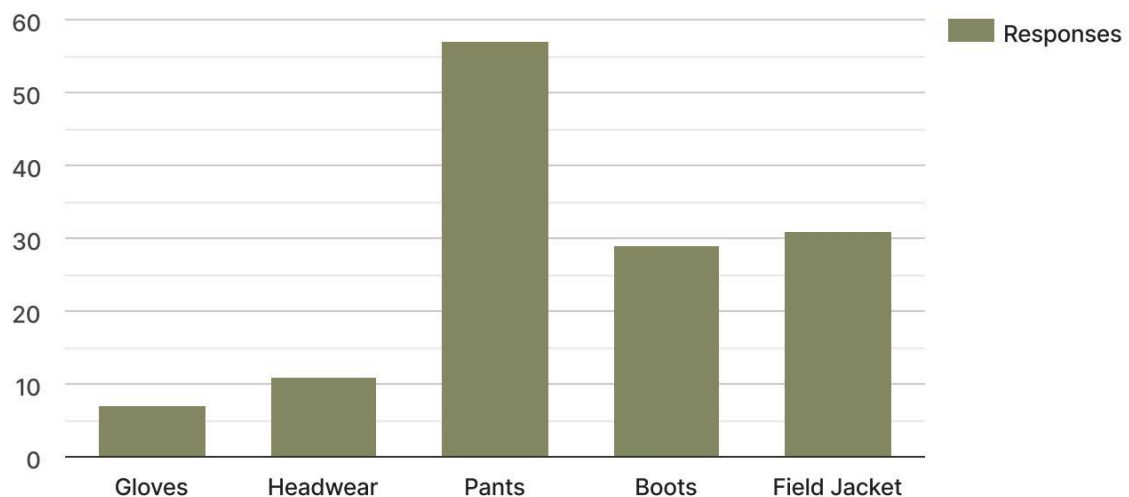


Figure 15: *Weak Points in the Current Uniform System, analysis from field research data by the author.*

When asked to specify weak points, respondents identified pants as the most problematic item with 57 responses, followed by the field jacket with 31. Boots received 29 responses; the issue was not durability but discomfort. Gloves and headwear had 7 and 11, respectively, while they were mentioned less frequently, they were still noted as weak points by some respondents (Figure 15).

The soldiers' experiences lend additional significance to these results. The most common problem was seam breakages, especially around the crotch and seat area of the pants. These issues sometimes appeared within just weeks, mainly when soldiers received previously used or already repaired uniforms. This placed an additional burden on soldiers, who often have to fix their own gear.

*"I've done simple sewing tasks, like attaching buttons, fixing minor tears, or repairing the crotch seam." (Questionnaire)*

Material durability was also a recurring concern. Several respondents noted that repeated washing caused fabrics to lose shape or colour, leading to sagging, bagginess, and a worn-out appearance. The friction from gear, such as body armour,

straps, and backpacks, was another source of wear, particularly on jackets and pants. Velcro attachments on vests and jackets often damage the underlying fabric.

*The winter jacket tends to wear out my pants, especially around the right leg. The Velcro strips over the zipper damage the pants whenever the jacket is folded down. That spot always gets destroyed." (interviews)*

The findings show that the current Estonian uniform performs unevenly under different usage conditions. While occasional users report long durability, soldiers in daily service often experience uniform failures within a year. Weaknesses are mostly in high-stress and friction zones, while more minor recurring issues, such as missing buttons and dirty Velcro, add frustration and additional repair tasks.

From a design perspective, these problems not only affect durability but also comfort, mobility, safety, and professional appearance. They reduce trust in issued equipment, forcing soldiers to adapt through improvisation and self-repair. This indicates that while Estonia has excelled in camouflage and simplicity, the ergonomic and material resilience of its uniforms lags behind international trends. Addressing reinforcement zones, improving material durability, and standardising small details such as closures can extend garment lifespan and align Estonia with broader military clothing developments that emphasise longevity, adaptability, and user-centeredness.

### **5.3.5 Gender-Specific Challenges**

Although women are increasingly active in the Estonian Defence Forces, the uniform system remains designed for male body proportions. This creates fit and comfort issues, especially with pants and field shirts. For many women, the waist-hip-bust differences are not taken into account, resulting in garments that ride up, bunch, or restrict movement. Soldiers reported frequently having to fold, tuck, or even purchase alternative gear to compensate.

*"Unfortunately, I can't modify the pants issued by the warehouse... in the end, I just bought my own." (Interview)*

The problems were also reported in winter uniforms, which were described as bulky and difficult to adapt to changing temperatures, and in sleeve and wrist sizing, which interfered with tasks. A recurring challenge was the limited availability of smaller

sizes, which forced some women to wear oversized gear that compromised both mobility and professional appearance.

These issues show how current uniforms lack inclusivity. Addressing female-specific needs with better sizing systems and through gender-specific or unisex designs would improve comfort, mobility, and equality in the Estonian Defence Forces.

### **5.3.6 Unnecessary or Impractical Elements**

Despite the intention to prioritise function, several elements of the current Estonian uniform were identified by soldiers as unnecessary or even counterproductive. These features add weight, restrict movement, and increase production costs without providing meaningful benefits in use.

The most frequently mentioned issue concerned the lower front pockets of the field shirt, which become inaccessible when body armour or webbing is worn. When tucked into the trousers, these pockets add extra bulk around the waist, causing discomfort and restricting movement. Similar issues were reported with multiple button closures, which slow access during time-critical situations such as first aid or equipment handling.

*"Our combat group members don't keep much in their pockets. Their gear and equipment are attached to their straps, belt, or vest, where there are dedicated storage areas." (Interviews)*

Several respondents noted that certain design elements, such as sleeve pockets, pocket placement, and sleeve length, were based on male proportions, which made them impractical for many women. This mismatch resulted in sleeves that were too long, pockets positioned out of reach, and features that interfered with body movement.

Overall, these elements indicate a lack of user-centred design thinking. Instead of enhancing functionality, they reflect a traditional approach focused on visual symmetry and standardisation. A more efficient design should be purpose-driven, eliminating redundant features and adapting remaining ones to the real contexts of military use.

## 5.4 Conclusion of the Field Research

The field research revealed that the challenges with Estonian military uniforms are not isolated design flaws but symptoms of a broader systemic misalignment between the user, the environment, and the design logic of the clothing. What initially seemed like separate issues, such as poor fit, restricted movement, and overheating, emerged as interconnected outcomes of a uniform system struggling to adapt to the diversity and reality of its users.

A recurring theme across interviews and questionnaires was adaptation, but in the wrong direction. Soldiers repeatedly described modifying, repairing, or avoiding parts of their uniform to make it functional. This inversion of the design relationship, where the user must adapt to the uniform rather than the uniform to the user, reveals a deep disconnect between intended design standards and lived experience. It also demonstrates how standardisation, once a key strength of military efficiency, now limits flexibility and inclusivity.

Another crucial part was the uniform's lifecycle as a mirror of the system itself. Worn-down materials, inconsistent sizing, and reissued garments highlight not just logistical inefficiency but a form of systematic fatigue. Each patch, repair, and replacement tells a story of a design that lacks renewal, not only physically but conceptually. The uniform's wear becomes symbolic of an infrastructure that values durability in theory but struggles to sustain it in practice.

Finally, this research highlighted that military clothing design is not only a technical discipline but a social and strategic one. The uniform acts simultaneously as protection, identity, and interface between the soldier and their environment. When its design fails, the breakdown is not just mechanical but human. It affects confidence, equality, and performance.

The insights from the field point toward a broader understanding of uniform design as a living system, one that requires feedback, iteration, and sensitivity to difference. The goal is no longer merely to fix faults but to reimagine how clothing can serve as an adaptive, responsive partner to the soldier, an instrument of readiness rather than resistance.

## 6. DESIGN PROCESS

This chapter outlines the design process (Figure 16) that guided the creation of the new uniform concept. The process began with simple yet essential questions: Who is affected by the current uniform problems? What exactly isn't working? And why does any of it matter? These questions formed the foundation for the "Who, What, Why" analysis, which helped map the relationships among soldiers, their equipment, and the clothing system itself.

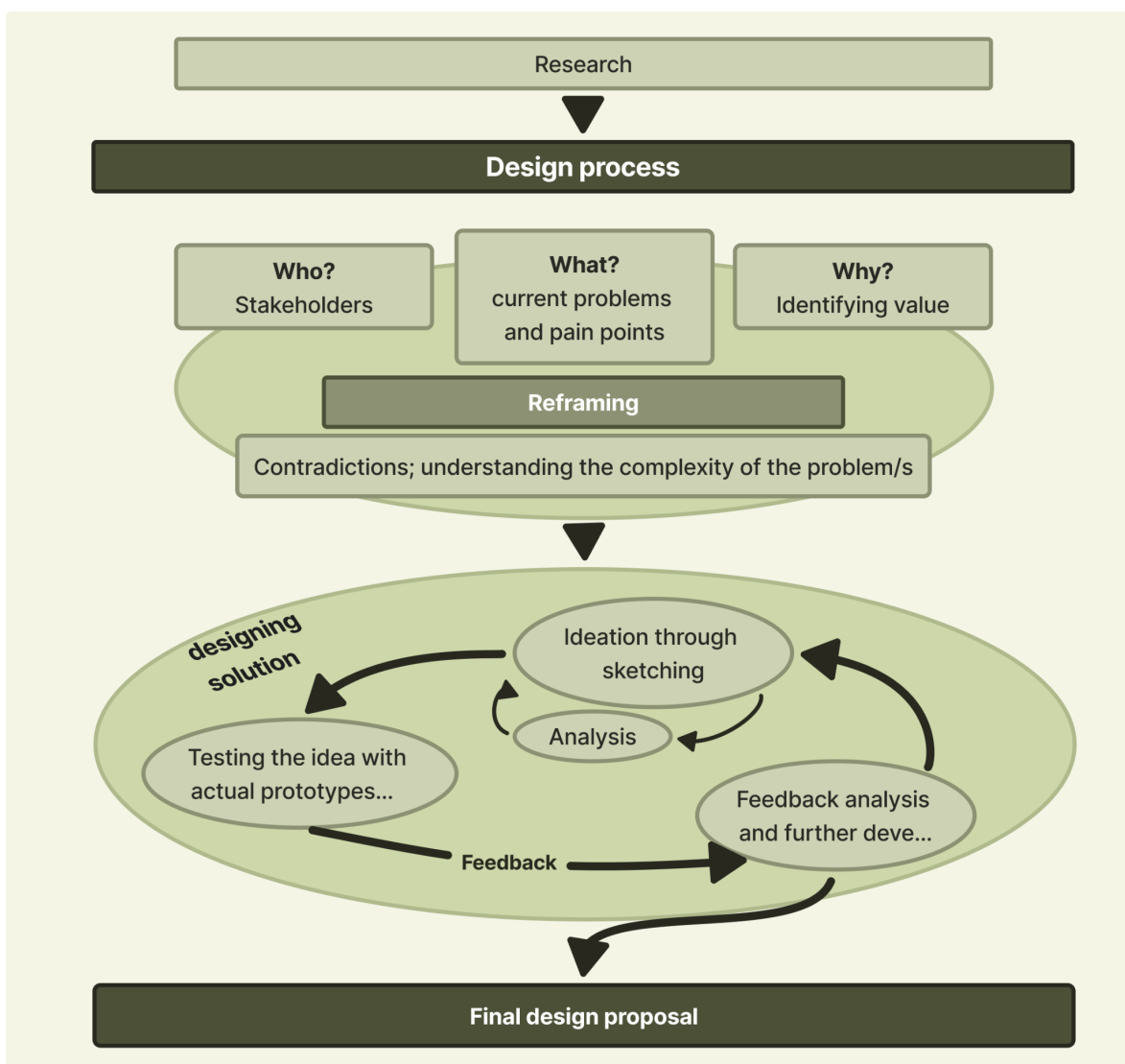


Figure 16: *Design Process Model*, by the author

From these insights, patterns began to emerge not only of practical issues, but of deeper systemic mismatches between the uniform and its users. To move beyond problem identification, the challenges were reframed through tools such as "How Might We" questions and contradiction mapping. This step shifted the focus from deficiencies

to opportunities, allowing new directions to form where user needs, functionality, and inclusivity could intersect.

With this reframed understanding, the design process entered a phase of creative exploration. An early ideation exercise visualised uniforms not as static garments but as adaptive systems responsive to different bodies, environments, and tasks. Each stage was built upon research insights, translating real issues into tangible design principles. Ultimately, these explorations were refined into a concept ready for testing and further development through prototyping.

## **6.1 Identifying Value and Key Problems “Who, What, Why.”**

The transition from research to design began with a question of connection: Who is affected by the current uniform system? What exactly isn't working? And why does it matter? Using a modified 5W+H and “Who, What, Why” analysis (Lewrick et al., 2020, pp. 71-73), the findings from desktop and field research were mapped into relationships between user problems and underlying needs. This helped reveal not just separate issues but a larger pattern: a system in which the uniform's structure, its material performance, and its cultural meaning have grown disconnected from the body and the people who rely on it.

### **6.1.1 Stakeholders: Who is affected by the issue?**

Understanding stakeholders was essential for uncovering real problems and ensuring that future solutions remain grounded and inclusive. The primary users, such as soldiers, medics, conscripts, and instructors, experience the uniform as both a protection and a constraint. For them, comfort, mobility, durability, and thermoregulation are not conveniences but conditions for performance and survival.

Among them, female soldiers emerged as a particularly overlooked group. Their needs reveal where the system falls short. This shows that inclusivity is not only a social issue but a functional one. When uniforms fail to accommodate diverse body types, they reduce efficiency and perpetuate inequality.

Among these wearers exists a secondary layer of stakeholders, including procurement officers, designers, tailors, and logistics staff, who manage distribution, replacement, and quality control. They form the operational ecosystem that sustains the uniform

system. When feedback does not circulate between these layers, the design becomes static, disconnected from use, and expensive to maintain.

Recognising this network reframed the problem: the uniform system is not a single object but a chain of relationships that begins with the soldier's body and extends through supply, maintenance, and identity. A successful redesign must therefore respond not only to performance needs, but also to structural and communicative gaps within the system.

### **6.1.2 What Are the Problems? What does not work?**

The findings from questionnaires and interviews revealed consistent issues that go beyond surface-level discomfort and the uniform's aesthetics. They pointed to systemic design shortcomings that undermine both performance and inclusivity.

Fit and sizing were the most dominant issues. Many soldiers received garments that did not align with their body proportions, resulting in restricted movement and reduced comfort. For women, this problem was amplified by patterns based on male anthropometry, leaving them with uniforms that feel wrong rather than designed for them.

Thermal discomfort followed closely. Uniforms tend to trap heat during high activity, while offering insufficient insulation in cold weather. This reflects a lack of adaptability in the system, especially in materials and layering, which fail to support the body's natural thermoregulation.

Material and construction weaknesses were also evident. Seams ripping under strain, poor waterproofing, and fast-wearing fabric make the uniforms unreliable in the field. Such failures increase physical risk and undermine trust in the equipment itself.

Outdated design details, such as misplaced pockets, excessive buttons, and friction with gear, further disconnect the uniform from the soldiers' workflow. The design remnants persist because the system prioritises standardisation over usability.

Ultimately, these problems intersect. Poor fit intensifies heat stress, weak seams limit durability and mobility, and static design choices ignore user diversity. Together, they signal a deeper issue: The uniform has stopped evolving with the soldier.

### **6.1.3 Why does it matter?**

These issues extend far beyond comfort; they shape performance, identity, and long-term health.

A poorly-fitted or thermally unbalanced uniform forces soldiers to adapt their posture, movement, and even their confidence. Overheating and restricted mobility impair judgement and reaction times, while premature wear increases replacement costs and causes logistical strain. In extreme cases, the uniform becomes a risk rather than a resource.

But the more profound significance lies in the psychological relationship between the soldier and their equipment. When a soldier feels the uniform working with their body, it builds trust and readiness. When it works against them, it erodes morale and a sense of belonging. This is not simply a technical failure, it is a design failure of empathy and adaptation.

Recognising this systemic disconnect made the next steps clear: the problem is not just about fixing individual flaws, but about redefining what a military uniform should be. This realisation became the bridge into the design phase, transforming scattered pain points into design principles for adaptability, inclusivity, and movement-centred performance.

## **6.2 Reframing**

The study of Estonian Military uniforms revealed more than a collection of technical flaws; it exposed deeper systemic patterns of how soldiers are expected to adapt their bodies, movement, and comfort to a standardised design logic. The uniform is not just clothing; it is a negotiation between the body and institution, between what is expected to endure and what is allowed to feel. Reframing the findings is therefore not about fixing seams or replacing fabric, but about questioning the underlying assumptions that dictate how soldiers and systems co-exist within cloth, form, and function.

### **6.2.1 From Problems to Possibilities: "How Might We."**

The "How might we" approach (Plattner, 2018) was used to transform the field of findings into open design provocations. Each question began as a problem, a complaint about heat, sizing, or movement, but evolved into a lens for imagining a

fundamentally different relationship between soldier and uniform. These questions move beyond the “what” of discomfort to explore the “why” of systemic misfit.

| <b>Theme</b>        | <b>Reframed Through Design</b>  | <b>Interpretation</b>  |
|---------------------|---|--|
| <b>Movement</b>     | <b>From restrictions to responsiveness:</b><br>Design for motion-based adaptability rather than static sizing | Military garments should not fight the body's natural mechanics but anticipate and support them, stretching, flexing, and aligning with movement rather than constraining it.                      |
| <b>Fit</b>          | <b>Fit as a function:</b><br>Treat it as an ergonomic system, not an aesthetic one.                           | Fit defines the quality of performance; it is not cosmetic but physiological. The closer the interference between the body and uniform, the more efficient the body's response to physical demand. |
| <b>Adaptability</b> | <b>Adaptive systems:</b><br>Design uniforms that read and respond to the body's changing needs.               | Instead of expecting soldiers to modify, layer, or tolerate their uniforms, future systems could dynamically adapt through modularity, flexible material, or responsive patterns.                  |
| <b>Equality</b>     | <b>Inclusive ergonomics:</b><br>Start with diversity in body shape and movement as the foundation for design. | Designing from male proportions is not neutral. A truly universal design begins with difference, incorporating inclusivity into the pattern, rather than adding it afterwards.                     |

The reframed perspectives shift the discussion away from isolated garment problems toward a vision of responsive military design, one that values adaptability, inclusivity, and bodily intelligence as integral to performance and readiness.

### **6.2.2 Contradictions: Where Innovation Hides**

Innovation often emerges in the space between two opposing needs. Military clothing embodies a series of contradictions, places where function, tradition, and identity collide. Rather than seeing them as failures, they can be read as indicators of where the system resists change and where it most needs it (van Amstel, 2020).

### **The Endurance paradox - Durability vs. Comfort**

The military values toughness, a fabric that resists tearing, a seam that never gives. But toughness often comes at the cost of breathability, flexibility, and wearability. The result is a uniform that survives the environment, not the body.

The future challenge is not to choose between durability and comfort, but to design materials that endure harsh conditions while providing comfort, working in harmony with the body rather than against it.

### **The Overload Problem - Functionality vs. Accessibility**

Every pocket, strap, and Velcro patch promises utility. Yet, as garments accumulate functions, the body becomes burdened in its own equipment. Efficiency turns into friction.

Actual functionality lies in clarity. Designing interfaces that reduce cognitive load and let the body act instinctively.

### **The Body Mismatch - Masculine Legacy vs. Inclusive Reality**

Uniforms were built around a "default soldier", a broad-shouldered, straight-hipped male. This legacy design logic persists even as demographic realities shift. Women are constructed differently, and soldiers adapt to a system not designed for them.

Redesigning the uniform is not just a gender issue; it is a question of systematic equality. Inclusivity starts when the standard body changes.

### **The Uniform Illusion - Visual Discipline vs. Hidden Discomfort**

Uniforms symbolise unity, discipline, and order. They must look sharp, identical, and presentable. But at the same time, visual discipline hides invisible discomfort, sweat, restriction, and fatigue.

The challenge is to redefine discipline not as visual sameness, but as collective readiness, where comfort, mobility, and confidence are part of what it means to look professional.

### **6.2.3 From Standardisation to Adaptation**

The contradictions above reveal that military uniform design is not merely a technical practice but also a philosophical one. It reflects how an institution imagines the relationship between the individual and the system. Current Uniforms are designed for standardisation; the soldier must adapt to the garment. But the research points toward a new future where adaptation is seen as the central design principle.

Future military clothing could function as a dynamic interface between the human body and the operational environment, responsive, modular, and inclusive. It could shift from passive protection to active performance support. Instead of hiding individuality under uniformity, it could integrate it by recognising that a system's strength lies not in identical bodies, but in adaptable ones.

To redesign the uniform is to redesign how we understand readiness, not as conformity, but as the harmony between human diversity and material intelligence.

## **6.3 Ideation**

The ideation phase drew on research findings and user insights to develop early visual and conceptual directions for uniform improvement. After identifying recurring problems with sizing, movement restriction, and thermoregulation, the goal was to explore how clothing could move with the soldier rather than restrict them. This process was exploratory and iterative, involving the compilation of sketches, user reflections, and comparisons with existing military and performance clothing.

Early sketching began with an analysis of pattern structures and stress zones identified through interviews and questionnaire data. Many soldiers describe specific points of tension, such as the hips, shoulders, and the area behind the knees, which became the first focus of redesign. By visualising these high-friction and tension zones, it became possible to envision new seam placements, joint articulations, and material layering strategies that could improve mobility and ventilation.

The ideation was concentrated on combat pants, as they were identified as one of the most problematic garments in the current Estonian uniform system. All of the interviewees mentioned discomfort in the thigh or crotch area, limited stride length, or tearing at the seams. These recurring issues made pants the most critical piece to redesign if the goal was to enhance movement, comfort, and inclusivity.

In parallel, reference models such as the Crye Precision G3, Proflin Sirius, and Arc'teryx LEAF Assault Pant AR Gen 2 were studied. These designs provided valuable insights into mobility and ventilation. The goal was not imitation but adaptation, extracting principles such as articulated joints, stretch zoning, and ventilation panels to develop a more inclusive and movement-responsive system.

## **7. DEVELOPMENT OF THE SOLUTION**

### **7.1 From Analysis to Concept**

The development of the Adaptive Combat Uniform Pants began from the patterns identified in the research. The questionnaire and interviews revealed that issues such as restricted movement, poor fit, overheating, and material wear were not isolated design flaws but part of a larger systemic problem: the uniform's inability to adapt to the soldier. Rather than supporting movement, the clothing often required soldiers to adapt to it.

The realisation shaped the concept's foundation. The design goal became to create a garment that would move with the body, not against it. A uniform that responds to physical activity, adapts to different anatomies, and maintains comfort throughout varying levels of exertion. The emphasis shifted from static protection to dynamic performance, where comfort, durability, and flexibility coexist.

The concept was guided by three core principles drawn from research:

- Mobility vs. performance factor: Clothing should support a full range of motion without restriction or friction.
- Thermal adaptability - Materials and structure must manage heat and moisture effectively in both high and low activity levels.
- Inclusive fit - The pattern must account for anatomical differences among soldiers.

Instead of creating multiple competing concepts, the design process focused on progressive refinement. A single evolving idea tested and reshaped through sketching, prototyping, and user feedback. This iterative approach allowed the design to develop gradually, each version responding to insights from movement testing and material performance. The design for Adaptive Combat Uniform Pants emerged not as a completely new invention, but as an evolutionary solution.

### **7.2 Sketch Development**

The concept stage transitioned into a series of sketch iterations aimed at translating conceptual principles into a practical form. Three main sketch versions were developed (Figure 17), each evolving through analysis, testing, and reflection. The process was

guided by the goal of improving fit, articulation, and adaptability, while maintaining uniform discipline and considering durability.

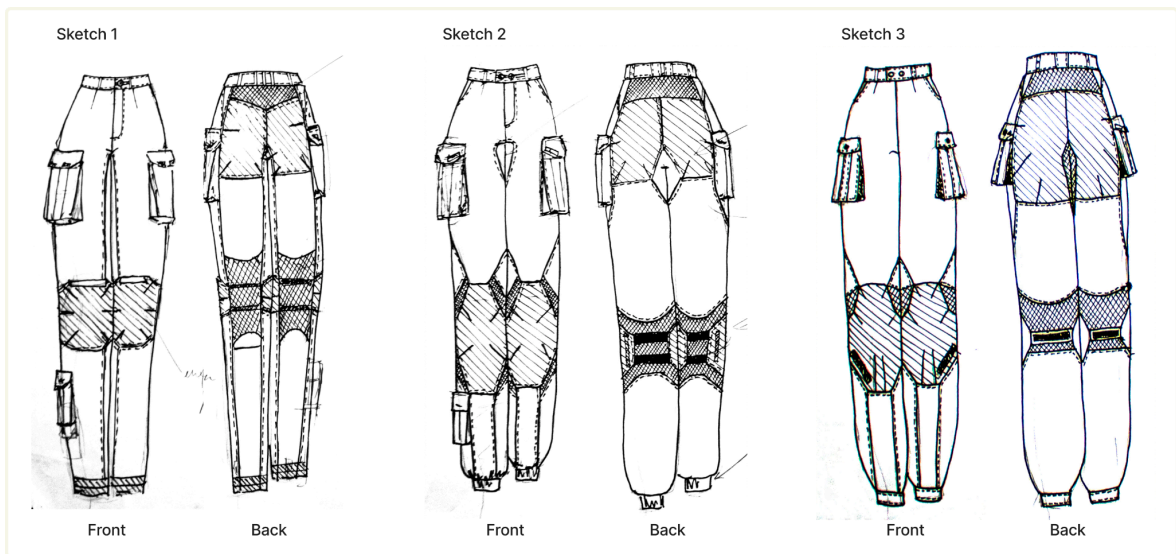


Figure 17: *Three initial sketches, by the author.*

The first sketches began with conventional Estonian field pant proportions and seam placements, with a few adaptations that started the focus shift towards restructuring the pattern around areas of tension and movement, around hips, thighs, and knees. By overlaying anatomical mobility zones onto the pant structure (Figure 18), pressure points were identified and redistributed. This led to more natural articulation zones and a more dynamic range of motion.

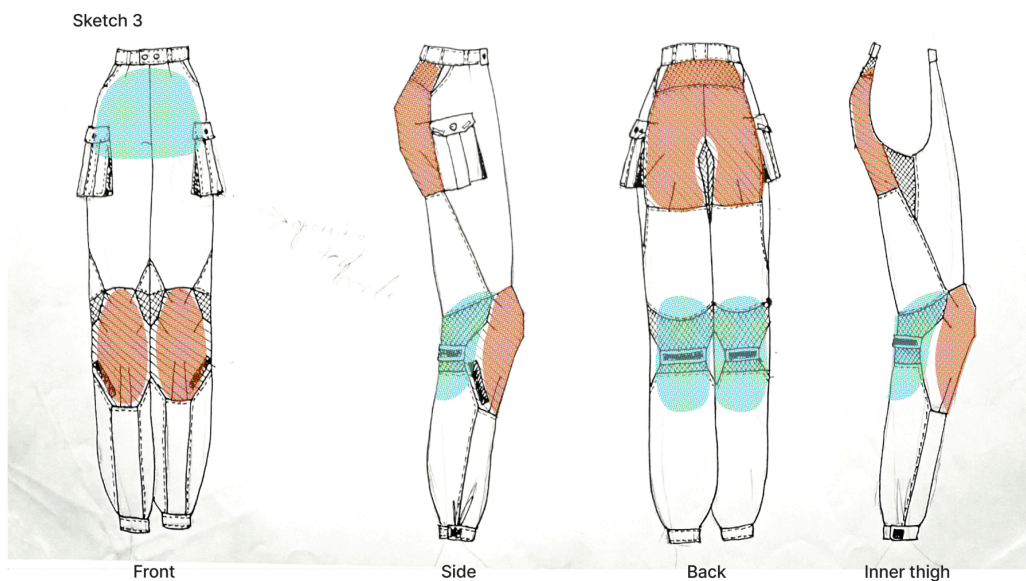


Figure 18: *Stress and Bulk Zones Mapped on Sketch 3, by the author.*

Through this sketching process, the concept of adaptive zones emerged. Areas where the pant flexes, ventilates, or reinforces depending on body movement and environmental conditions. These were expressed through diagonal seam lines, stretch panels, and strategically ventilated inserts inspired by high-performance outdoor wear but tailored for military application.

Each iteration brought a new understanding of proportion and material behaviour. Adjustments in waist geometry, hip curvature, and thigh shaping were tested on mannequins and later confirmed through initial prototypes. The waistband and seat were reshaped to follow natural motion curves, improving comfort during crouching, squatting, and kneeling.

By the fifth sketch, the design achieved a balance between form and function. An articulated pant structure that maintained uniform aesthetics while introducing features typically reserved for performance gear. These sketches laid the groundwork for the Adaptive Combat Mobility prototypes, in which the focus shifted to testing different waistband, cuff, and articulation constructions and evaluating the adjusted sizing chart developed earlier.

### **7.3 Prototyping Process**

The prototyping phase focused on translating design insights into tangible, testable garments. Its primary goal was to validate the pattern structure, movement range, and fit developed through iterative sketching, while integrating key improvements identified in the research, particularly in areas such as crotch seam durability, mobility, overheating, and general comfort.

All prototypes were developed and constructed by the author, beginning from basic pattern drafting and modification to final assembly. This hands-on approach enabled direct testing and refinement of design choices through hands-on making. Each prototype informed the next, revealing how theoretical adjustments performed in real-world conditions.

The process also included technical experimentation: several trims were digitally modelled and 3D-printed to explore functional detailing options for closures and adjustment components. These small but critical trials contributed to understanding how material behaviour, seam placement, and articulation respond to physical stress and body dynamics.

Through three iterative prototypes, the concept evolved from a structural exploration into a refined, field-ready pre-test model. This progressive development enabled continuous evaluation, with each stage informing both design and construction logic.

### 7.3.1 Prototype 1 – Exploratory Mockup

The first prototype (Figure 19) served as a foundational exploration of pattern structure, sizing, and articulation. It was drafted entirely from scratch, using the current NATO sizing chart as the base reference. This approach enabled testing of how well standardised proportions translate into real patterns and where they begin to fail without adaptation.

The prototype was constructed from repurposed Estonian camouflage fabric, similar to the material currently used by the Estonian Defence Forces. This ensured that sewing, handling, and thermal performance reflected real-life conditions.

Already during construction, it became clear that several areas were difficult to manufacture. Seam bulk, complex articulation, and material stiffness made assembly challenging and highlighted early barriers for scalable production. These insights directly influenced later simplifications in pattern design.

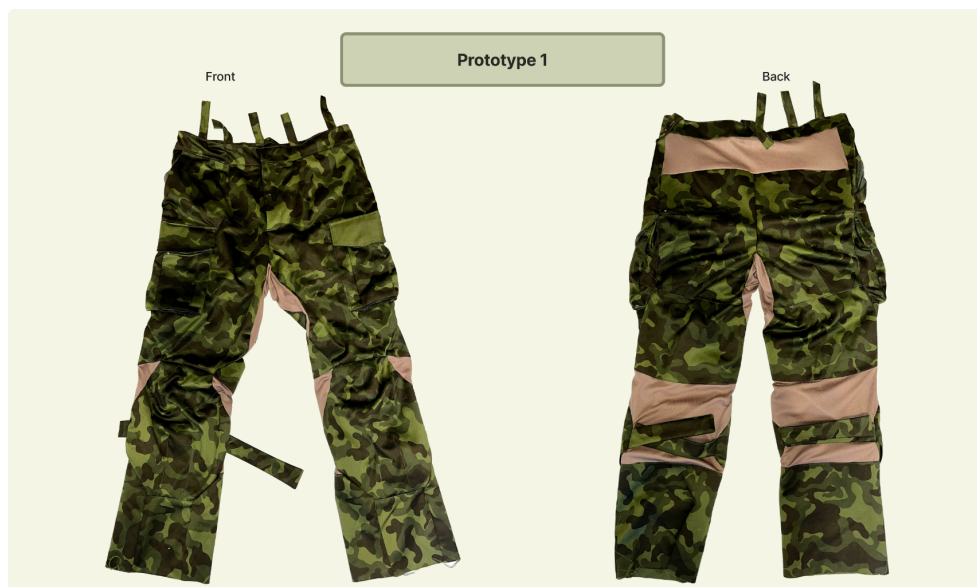


Figure 19: *Prototype 1, Front and Back View, by the author.*

When worn and tested through crouching, kneeling, and reaching motions, several performance issues surfaced. The fit proved poor, primarily because the oversized

waistband, as per the NATO chart, failed to stabilise the garment during motion. The seam placement around the hips and inner thigh restricted movement and required redesign for better articulation.

Some elements, however, performed notably well. The integrated knee pad holders showed potential for functional improvement, though their construction was too bulky. The pocket placement was ergonomically sound and well-aligned with the soldiers' movement range. Mesh panels improved ventilation but required redrafting due to minor miscalculations in the crotch gusset, resulting in construction issues.

Overall, Prototype 1 served as an exploratory model that exposed the technical, ergonomic, and construction-related weaknesses of the original draft. It provided essential insights into how material behaviour, seam positioning, and standardised sizing interact in practice. This set the foundation for more refined solutions in the next iteration.

### **7.3.2 Prototype 2 – Functional Refinement**

The goal of the second prototype (Figure 20) was to refine the fit and validate the modified sizing system developed during the analysis phase. This stage focused on improving adaptability, simplifying construction, and testing how these refinements influenced mobility and comfort in real use.

Compared to the first mockup, significant changes were made to the knee pad holder, reducing its bulk and making assembly easier. The structure was redesigned to minimise seam intersections, simplify sewing, and improve flexibility in the knee area during movement. Additionally, adapting the modified sizing system, derived from observed anthropometric differences, results in a noticeably more balanced fit. The pants fit the body better, eliminating excessive looseness at the waistband and creating a more natural articulation through the hips and thighs.



Figure 20: *Prototype 2: Front and Back View, by the author.*

The prototype was personally tested by the author, who performed a range of mobility assessments, including crouching, kneeling, and sprint simulation, to evaluate articulation and comfort under dynamic movement. The new pattern allowed for greater freedom of motion and reduced material strain in critical stress areas. Construction time also decreased significantly, confirming that the simplified pattern would make the pants more efficient to produce at scale.

While overall fit and usability improved, this iteration revealed opportunities for future adaptability features, such as adjustable waist and ventilation systems, to support wider user diversity and environmental needs. These insights shaped the direction for the next prototype phase, which aimed to test adaptive components in practice.

### **7.3.3 Prototype 3 – Pre-Test Model**

The third prototype (Figure 21) aimed to consolidate all improvements from the earlier iterations and test the final construction logic before field testing. The focus was on simplifying the pattern for production efficiency, integrating adaptive features, and evaluating two functional design variations within a single model.

To reduce manufacturing complexity, several pattern pieces were merged or removed, streamlining both the sewing process and material use. The prototype was divided into two halves to explore different functional concepts. One leg included an integrated knee protection system featuring 3D-printed adjustment components at the back, while the other leg was built as a simplified, lightweight version without a knee

protector pocket. Both versions incorporated ventilation openings on the back of the leg to improve airflow during physical activity.



Figure 21: *Prototype 3: Front and Back View, by the author.*

This prototype also introduced a built-in waistband (Figure 22) system with a quick-release buckle for easy regulation. The idea was to allow adaptability in different activity settings while reducing the need for additional gear. However, feedback from the Estonian Defence Academy indicated that such systems might not be universally preferred or cost-effective. Soldiers have varied belt preferences: some favour wide belts for support, while others prefer narrow or elastic belts. Additionally, the feedback emphasised that any regulating mechanisms or added parts, such as buckles or buttons, should be easily replaceable if damaged.



Figure 22: *Waistband and Buckle Details of Prototype 3, by the author.*

The testing and feedback phase confirmed that the simplified pattern was far more production-friendly and retained functional benefits without unnecessary complexity. However, it also revealed the importance of modularity and repairability in military clothing systems. The insights suggested that future iterations should prioritise adaptable yet durable solutions that maintain comfort and ease of maintenance in field conditions.

#### **7.3.4 Feedback to Prototypes**

Before moving to field testing, the feedback gathered from the Estonian Defence Academy highlighted key refinements to be made. The most essential points concerned simplifying the waistband system to make it compatible with different belt types. It was emphasised that every added element, such as buckles, buttons, or adjustment straps, should be replaceable or easily fixable and not create unnecessary failure points.

These insights will guide the final adjustments before testing, ensuring that the design remains practical, cost-efficient, and adaptable to user preferences. The next step is to validate these refinements through field testing, focusing on long-term comfort, durability, and the uniform's adaptability in real operational contexts.

### **7.4 Field Testing**

Field testing was the stage at which assumptions, design intentions, and prototype refinements were evaluated in real military training environments. The goal was not only to observe how the pants performed during everyday soldier activities, but also to understand how the design interacted with movement, climate, gear, and user routines over extended wear. Through this testing period, the aim was to validate fit, mobility, ventilation, and functional systems while uncovering new, context-dependent insights that cannot be identified through sketches or controlled prototyping alone. The field test served as a bridge between the concept and system-level applicability, revealing which elements of the current design hold up under real demands and which require further development.

### 7.4.1 Prototypes

The field testing will be carried out using a modified version of prototype 3 (Figure 23), which represents the most advanced iteration of the Adaptive Combat pants. This prototype includes the full set of functional features, including articulated construction, ventilation zones, thigh pockets, and integrated knee pad holders. It also features a newly developed adaptive waistband, designed to enhance comfort and accommodate variations in soldier preferences and body shapes.

While earlier prototypes were essential for exploring pattern geometry, articulation, and construction, Prototype 3 is the first version mature enough to be tested under real field conditions. It reflects the refined pattern developed through iterative sketching, studio testing, and expert feedback from the Estonian Defence Academy. Because the prototype uses substitute materials, long-term material durability cannot be fully evaluated; however, stress points, wear tendencies, seam tension, and construction weaknesses will still become visible and will be systematically documented.

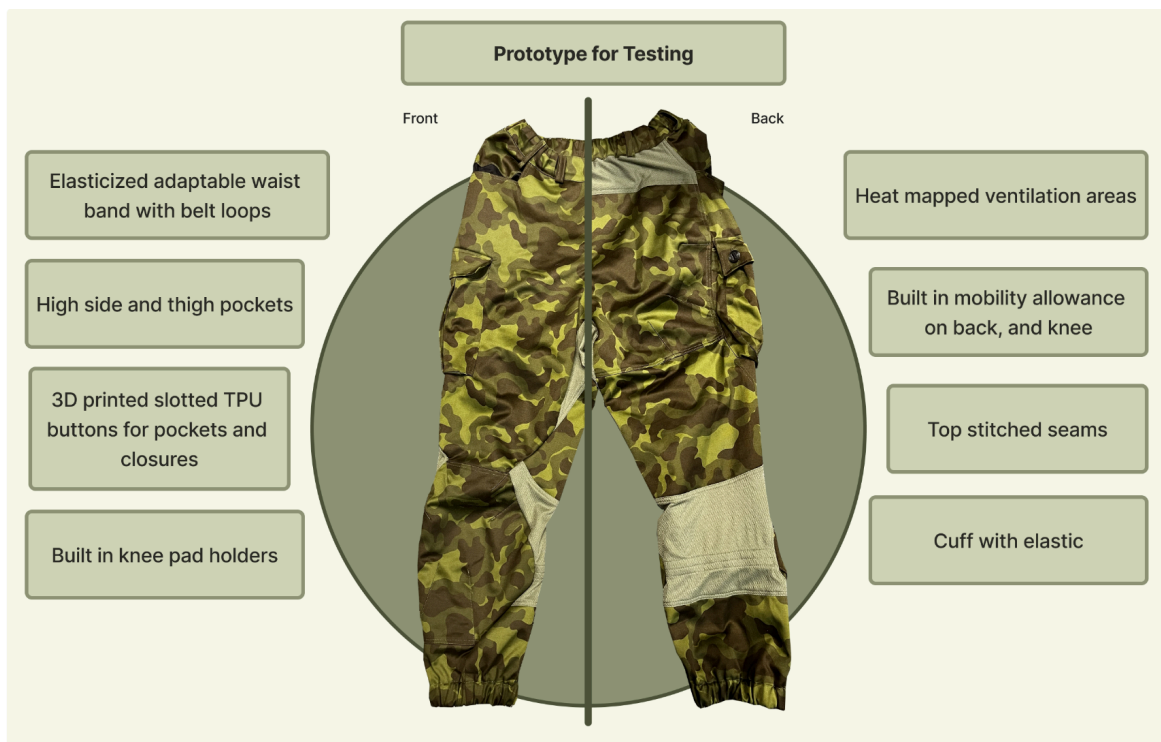


Figure 23: *Prototype for Field Testing, by the author.*

The primary goal of field testing this prototype is to validate the design's fit, mobility, ventilation, and functional coherence, the core performance indicators that emerged from previous research. Key focus areas include:

- Whether the modified sizing and adjustable waistband provide a reliable fit across movements.
- How effectively the pants support dynamic tasks such as kneeling, sprinting, low crawling, and climbing.
- The functionality, position, and stability of the kneepad system in real use.
- The effectiveness of ventilation zones in managing heat and moisture during physical exertion.
- Overall comfort during prolonged wear across varied environmental conditions.

By evaluating these aspects in an operational context, the testing aims to confirm whether the design successfully addresses the most critical issues identified in earlier research: mobility restriction, thermal discomfort, poor fit, and functional limitations, and assess how well the prototype aligns with soldiers' real-world needs.

#### **7.4.2 Testing Plan**

The field testing was conducted with seven cadets from the Estonian Military Academy. Because participants were recruited through the Academy, their gender distribution was not known in advance, allowing the prototype to be tested on a naturally diverse group. This supported the core objective of evaluating how the pants performed across different body types and training demands rather than validating a single morphological profile.

The testing took place over two weeks, during which participants wore the modified version of Prototype 3 in their everyday training routines. This included classroom activities, physical workouts, outdoor drills, forest exercises, and exposure to a variety of Estonian weather conditions. By integrating the pants into everyday use, the evaluation reflected authentic operational behaviour instead of isolated or artificial test scenarios.

Participants were also asked to complete a series of mobility exercises to assess articulation, range of motion, and interaction between the garment and the body during dynamic tasks. Beyond these guided movements, the primary intention was to observe how well the pants supported soldiers' daily functioning. Each participant documented whether their activities occurred indoors or outdoors and recorded the environmental conditions during use, as outlined in the probe kit (Appendix I).

Feedback was collected through three channels: the probe kit, a structured feedback form, and a final group discussion. The probe kit included a daily diary, visual wear documentation, a problem-mapping exercise, and environmental tracking tools, enabling soldiers to record impressions and emerging issues without disrupting their routines. The concluding feedback session captured more subjective insights, clarified experiences, and helped assess whether the design direction aligned with real operational needs.

Photo documentation complemented the written feedback. Participants photographed the pants during use to illustrate fit, posture, and problem areas. Additionally, each pair of pants was photographed before and after testing to record stress points, wear patterns, and construction performance. Although long-term durability could not be validated due to the use of substitute materials in the prototypes, early indications of stress and abrasion were still helpful in guiding refinement.

Overall, the testing ensured that the pants were evaluated not only as garments but as functional tools exposed to real environments, physical strain, and diverse user behaviours, providing a comprehensive foundation for further development.

### **7.4.3 Actual Testing**

The field testing period lasted two weeks. Cadets received their prototype pants on Friday, 07.11.2025, and began systematic testing the following Monday, 10.11.2025. Throughout these two weeks, the pants were worn in real training conditions that reflected the everyday life of a soldier. Most activities took place outdoors, ranging from movement-intensive drills to long periods of standing, walking, or completing tasks in changing weather. Only a small portion of activities occurred indoors, allowing observation of how the prototypes functioned during transitions between environments. Out of the seven prototypes issued, six were consistently in active use, providing a sufficient spread of daily wear scenarios.

During the testing period, each cadet completed their assigned probe kit (Appendix I), documenting daily activities, environmental conditions, comfort levels, mobility, and any problems or positive experiences that emerged. The exercises included structured tasks designed to evaluate real-world uniform performance, such as daily journaling of comfort, moisture, temperature response, and activity level; short mobility tests like squatting, stretching, sprinting, and crawling to assess articulation and fit; and environmental reflection, noting how the pants behaved in rain, mud, cold, and

variable terrain. Cadets were also instructed to map any problematic areas directly onto printed garment outlines, marking points of irritation, wear, constraint, or malfunction. Photo documentation formed a key component of the probe kit: participants submitted images of the pants in different states and contexts, including clean and dirty conditions, in the forest, during activities, and capturing any damage or unexpected wear.

The testing phase concluded with a group feedback session, during which all participants gathered to share their experiences. This session created a space for collective reflection and comparison across different body types, activity patterns, and personal expectations. The combination of written documentation and in-person discussion offered a nuanced understanding of how the prototype performed in real use and highlighted which aspects of the design should be carried forward, changed, or reconsidered in the next iteration.

#### **7.4.4 Test Results, Feedback, and Analysis**

Across the two-week testing period, the cadets identified several consistent strengths and weaknesses in the prototype. The most prominent issue concerned the knee protection system. Even when the trouser length was correct, the kneepads sat too low and did not align with the anatomical knee during movement. This misalignment was observed across nearly all pairs, indicating that the articulation point and pocket geometry require further adjustment. Additionally, although the kneepad pocket accommodated different pad models, compatibility varied; some pads fit but were uncomfortable for prolonged wear. This suggests the need for a more universal integration system that adjusts to the range of pads already in use across the Defence Forces.

Mobility was generally rated good, and testers consistently noted improvements over the standard uniform. However, a recurring issue was waist slippage: when the trousers shifted downward during physical activity, mobility became restricted, particularly in crouching or stepping movements. This underlines the importance of a more stable, easily adjustable waist system that maintains position under load. Ventilation performance received largely positive feedback. The vents worked effectively during field exercises, preventing overheating even during long outdoor sessions. One concern came specifically from female participants, who noted that crotch ventilation may be unsuitable in winter months due to cold exposure. Back-of-leg vents were deemed unnecessary because they did not provide noticeable

benefits during typical field movements. The lower-back vent was considered functional but potentially vulnerable to early wear, suggesting that reinforcement or alternative material may be required.

Pocket functionality produced detailed feedback. Testers recommended a larger, double-button version of the sewn-on thigh pocket for security and usability. They found the side pocket more functional when narrower and slightly smaller at the opening. However, they also noted that the construction of the sewn pocket should be reconsidered to improve accessibility and durability. The typical lower-leg cargo pockets, which are common in many combat pants, were not missed. Testers explained that these pockets are usually prone to getting wet or dirty, are generally inaccessible, and therefore are not used for storing anything important. Their absence was viewed as an improvement rather than a limitation.

Durability performance was positive overall, though the short testing window limits the ability to draw long-term conclusions. The pants endured heavy mud, multiple wash cycles, and fluctuating temperatures from 0 to 8°C. They remained functional in light snow and wet environments, confirming that the general construction approach is sound. Only one pair developed damage, traced to a missing top stitch in a stress area, a production error rather than a design flaw. This highlights the importance of quality-controlled construction methods but supports the viability of the prototype's structural design.

Overall, the testing revealed a design that performs well in mobility, ventilation, and environmental handling but requires targeted improvements in kneepad articulation, pocket ergonomics, and waist stability. These findings form the basis for the subsequent refinement phase, where usability and modularity will guide further development.

## **7.5 Refinement of the Design Based on Testing**

The field testing phase highlighted specific areas that required targeted refinement before moving toward a final design. The most substantial adjustments concern the kneepad construction, ventilation strategy, waistband system, pocket configurations, and several pattern and seam updates that directly influence fit and performance.

The kneepad system emerged as one of the most critical elements requiring redesign. Testing showed that the kneepads consistently sat too low and did not accommodate

different kneepad models comfortably. Two clear pathways for refinement were identified: developing a system optimised for one specific, widely used kneepad model, or designing an adjustable interface that can accept multiple models while maintaining sufficient stability and comfort. This decision will affect the entire knee area pattern, which will be altered accordingly.

Ventilation also requires significant modification. Based on tester feedback, the behind-the-knee vents will be removed entirely and replaced with side ventilation featuring an adjustable zipper, allowing soldiers to tailor airflow to changing weather conditions—particularly relevant in Estonia’s predominantly cold climate. The lower-back ventilation area will retain its functional role, but the material must be replaced. Two issues emerged during testing: early signs of pilling raised durability concerns, and the current fabric showed strong reflectivity under night vision, posing a risk during low-visibility operations. Selecting a more durable, low-reflective material will be essential.

The waistband system will be refined to improve stability and comfort during movement. Testing showed that when the pants slid downward, mobility was restricted. To address this, the waistband will integrate a dual adjustment system that includes a built-in adjustable rubber component, providing a more adaptive fit while accommodating different soldier preferences.

Pocket functionality and construction will also be improved. The sewn-on cargo pockets will be redesigned to be larger and more accommodating, while maintaining the existing visual language. The side pockets will have narrower openings and shallower depths to improve accessibility and prevent items from shifting excessively during movement. Since testers did not miss the lower leg pockets, they will not be reintroduced.

Additional refinements will be made to pattern proportions, seam placement, and overall fit to accommodate the revised kneepad system and improve comfort and mobility. These changes collectively enhance compatibility with soldiers’ needs, improve consistency of fit across different body types, and increase adaptability without adding unnecessary complexity.

These refinements bring the design significantly closer to a functional design, even though the next prototype incorporating these updates will not be developed within the timeline of this thesis.

## **7.6 Reflections on the Development Process**

The development process demonstrated the importance of iterative refinement when designing for highly demanding, user-specific environments such as the military. Each stage, through sketching, drafting, prototyping, and field testing, revealed new layers of insight that could not have been predicted through research alone. The progression from initial pattern experiments to a functional pre-test model showed how quickly assumptions can shift once real users interact with the garment. The testing feedback highlighted mismatches between intended function and practical performance, particularly in kneepad placement, ventilation strategy, and the waistband system. These insights were not failures but critical turning points that directed the project toward more realistic, durable, and inclusive solutions.

Throughout the process, the importance of balancing innovation with practicality became increasingly apparent. Some ideas worked well on paper but proved too complex, fragile, or incompatible with soldiers' preferences and operational constraints. Engaging real users even for a short testing period reinforced the value of simplicity, maintainability, and adaptability in military clothing design. The refinement decisions moving forward reflect this understanding: improving compatibility, durability, and fit while avoiding unnecessary complexity. Although the final refined prototype will not be produced within the thesis timeline, this design process has established a strong foundation for future development and demonstrated the changes needed for a genuinely adaptive combat uniform.

## **8. FINAL DESIGN PROPOSAL: “ADAPTIVE COMBAT UNIFORM (ACU): ADAPTIVE COMBAT PANTS (AC-P)”**

### **8.1 Core Problems Addressed**

The development of the Adaptive Combat Pants (AC-P) began with a precise aim: to address recurring, systemic problems identified through research, interviews, field observations, and prototype testing. A central challenge has been poor fit, driven by an outdated sizing system that does not accommodate the range of body proportions found among soldiers. Ill-fitting pants restrict movement, reduce comfort, and force soldiers to adapt their posture or modify their garments. The AC-P directly responds by introducing an improved pattern, an adaptable waistband system, and refined proportional balance.

Mobility limitations formed another consistent concern. Soldiers frequently reported restricted motion when crouching, kneeling, sprinting, or navigating uneven terrain. The new design introduces improved articulation through revised seam placement, a more functional crotch gusset, and an evolving kneepad interface allowing the garment to move with the body rather than resist it.

Thermoregulation issues were equally significant. Existing uniforms often trap heat, especially during physically intensive tasks, while ventilation is either insufficient or poorly placed. Field testing confirmed the need for a more functional and climate-appropriate system. In response, the AC-P incorporates adjustable ventilation zones and reconsidered their placement for both performance and durability.

Material and construction concerns also emerged throughout the research. Fast wear in stress areas, fragile seams, and components that were difficult to repair in the field all contributed to reduced reliability. The AC-P addresses these issues by simplifying high-stress construction areas, enabling easier repairs, and redesigning components, such as pockets and kneepad holders, to be more robust and easier to maintain.

Finally, several functional elements of the current uniform and the prototypes, especially pocket design and storage, proved misaligned with real soldiers' needs. Unused lower-leg pockets, poorly shaped thigh pockets, and inconsistent accessibility repeatedly surfaced as pain points. The new design restructures pocket placement and size to reflect actual use patterns and reduce unnecessary complexity.

Together, these addressed problems form the foundation of the AC-P. Rather than adding features for their own sake, the design proposes more adaptive, durable, and movement-oriented pants that respond to real operational needs in the Estonian context.

## **8.2 Design Principles, Key Features, and Functional Systems**

The Adaptive Combat Pants (AC-P) (Figure 24) are built on a set of principles derived from research insights, field feedback, and the requirements of the Estonian climate and military tasks. The design prioritises mobility, adaptability, environmental responsiveness, durability, and repairability. Together, these principles form the foundation for the functional systems integrated into the final garment.

### **8.2.1 Design Principles**

#### **Mobility-Centered Construction**

The pant is shaped around the body in motion, using articulated patterning, strategic seam placement, and a refined gusset system that supports crawling, kneeling, sprinting, and climbing. The aim is to eliminate resistance points and maintain comfort during extended periods of activity.

#### **Adaptive Fit and Personal Adjustability**

Soldiers differ significantly in body shape. The integrated dual-adjustment waistband and improved sizing logic are designed to ensure a secure fit even during intense movement. Adaptability reduces sagging, enhances mobility, and supports wearing different equipment set-ups.

#### **Climate-Responsive Ventilation**

Ventilation is treated as an adjustable system rather than a fixed feature. Side-zip vents allow soldiers to regulate airflow based on temperature and activity level, while improved lower-back ventilation materials ensure breathability without compromising durability or visual signature under night vision.

## Modularity and Compatibility

Functional systems such as the kneepad integration and pocket architecture are designed to work with a range of gear while avoiding unnecessary bulk. The knee system is structured either for a dedicated pad type or for an adjustable mechanism compatible with commonly used models.

## Field Repairability and Longevity

Every high-wear component is designed to be easily replaceable or repairable in field conditions. Pocket closures, adjustment hardware, and stress-point reinforcements are positioned and constructed so that failure of one part does not compromise the entire garment.



Figure 24: *Illustration of Adaptive Combat Pants (AC-P), by the author.*

### **8.3 Limitations of the Current Solution**

Although the Adaptive Combat Pants concept synthesises research insights, prototype testing, and user feedback, it remains a pre-implementation design and therefore carries several limitations. The final version of the AC-P has not undergone comprehensive field testing, meaning its long-term durability, material performance, and behaviour during real training cycles remain unverified. While earlier prototypes revealed important patterns in fit, mobility, and ventilation, these insights cannot fully predict how the refined concept will perform across broader soldier populations, varied body types, and different operational environments.

Another limitation stems from materials and trims. Due to the constraints of the prototyping process, substitute fabrics and 3D-printed trims were used, which do not accurately represent the intended final components. This restricts the ability to conclude abrasion resistance, seam longevity, weather protection, noise levels, or compatibility with professional gear such as issued kneepads and belts. The kneepad system, waistband structure, and ventilation redesigns are currently validated only through theoretical analysis and user feedback, not real-world endurance trials.

The current scope of testing participants also limits the design. Feedback was gathered from a small group of cadets, whose training context and physical profiles do not fully represent the broader Estonian Defence Forces population, including reserve units, special operations, or soldiers with different body proportions. Broader testing could reveal new needs or contradictions not captured within this project.

Finally, because the AC-P remains a conceptual proposal rather than a finalised, manufacturable product, several aspects such as cost analysis, industrial-scale production feasibility, and supply-chain integration have not yet been assessed. These factors will significantly influence whether and how the design can be adopted into the wider clothing system.

Despite these limitations, the concept provides a direction for future development: it identifies core problems, proposes practical solutions grounded in field feedback, and offers a framework for the future development of military clothing.

## **9. SYSTEM-LEVEL IMPLEMENTATION AND FUTURE DEVELOPMENT**

The development and testing of the Adaptive Combat Pants revealed that improving a single garment inevitably exposes deeper structural issues within the wider military clothing system. This chapter shifts the focus from the product to the system that surrounds it, examining how procurement, sizing, distribution, maintenance, and feedback cycles shape the everyday reality of soldiers' uniforms. The field testing showed that even the most well-designed item cannot reach its full potential within an unchanging system. For this reason, the following sections outline the system-level changes required to support adaptive design, improve procurement logic, streamline distribution and sizing, and establish a lifecycle strategy. By mapping these adjustments alongside implementation pathways, organisational impacts, and areas for future research, this frames the AC-P not as an isolated solution but as a push for a more responsive, efficient, and soldier-centred military clothing system.

### **9.1 Changes in the Sizing System**

A transition to adaptive sizing is one of the most significant changes required for the current Estonian military clothing system. The existing standardised sizing model, based on outdated NATO measurements, does not reflect the real proportional diversity of contemporary soldiers. As a result, many users—regardless of gender—struggle to find uniforms that align with their body shape, leading to discomfort, reduced mobility, and unnecessary alterations in wear.

Moving from rigid, predetermined size categories to a system built around body proportions offers a more accurate and inclusive foundation for sizing. Instead of relying solely on fixed combinations, an adaptive model would categorise clothing by key proportional indicators, such as hip-to-adaptable waist ratios. This creates a flexible framework that better captures how bodies differ in width, shape, and movement, rather than just linear measurements.

The pant-specific regulatory system developed in this thesis supports this shift. Adjustable waist components and flexible articulation zones allow each soldier to fine-tune fit within their size range. This reduces reliance on particular size codes, broadens compatibility across user groups, and enhances comfort during dynamic activity. The long-term impact is a more resilient sizing ecosystem—one where

garments accommodate the soldier, not the other way around, and where fewer size variants can serve a larger population more effectively.

## **9.2 Procurement, Distribution, and Lifecycle Management**

### **9.2.1 Procurement**

#### **Procurement Structure and Strategy for a New Military Clothing System**

The procurement process for the new uniform system must ensure that the final solution is functional, durable, and aligned with the operational needs of the Estonian Defence Forces. The objective is to establish a balanced evaluation model where quality, performance, and innovation carry equal weight alongside cost. The goal of the procurement is to create a modern, adaptable uniform system that supports soldier mobility, withstands environmental conditions, and provides long-term reliability.

#### **Objectives and Requirements**

The procurement aims to develop a new functional, durable, and innovative uniform system. Core requirements include freedom of movement, weather protection, abrasion resistance, ease of maintenance, and a modular or adjustable design. Cost, quality, and innovation must remain proportional, ensuring that the economically most advantageous solution is also technically suitable.

#### **First Stage: Submission of Documentation and Initial Evaluation**

In the initial round, suppliers are asked to submit complete documentation demonstrating their capability and proposed design approach. Required materials include:

1. Description of the solution, covering materials, construction choices, innovative elements, and production feasibility.
2. Portfolio of previous work, demonstrating experience with similar clothing systems.
3. Description of production and supply chain, outlining how product quality and delivery reliability will be ensured.

This stage filters out suppliers who do not meet baseline competence, technical expertise, or capacity standards.

### **Second Stage: Prototype Submission and Technical Testing**

All qualified suppliers progress to the second round, where they must present prototypes of selected garments (e.g., pants, jacket, base layers). These prototypes should enable testing and comparison. Required tests include:

- Mobility and ergonomics evaluations
- Material durability and abrasion resistance tests (if standards are not provided)
- Water resistance, breathability, and thermal performance checks (if standards are not provided)
- User feedback collection from soldiers in field conditions

These tests allow objective, field-relevant comparison of performance, avoiding decisions based solely on descriptive promises or cost.

### **Evaluation Criteria**

The evaluation process is based on multiple weighted criteria to ensure the strongest overall solution is selected:

| <b>Criteria</b>                   | <b>Description</b>   | <b>Scale</b> |
|-----------------------------------|--|--------------|
| <b>Technical quality</b>          | materials, seam construction, pattern engineering                            | 1-10         |
| <b>Functionality and comfort</b>  | mobility, practicality, ecological fit to use scenarios                      | 1-10         |
| <b>Innovation and added value</b> | Modularity, adjustability, and new material technologies                     | 1-7          |
| <b>Durability and care</b>        | maintenance, repairability   | 1-10         |
| <b>Cost</b>                       | evaluated in relation to quality and functionality, not as a dominant factor | 1-5          |

Weights are assigned based on importance. For example, technical quality may be rated on a 1–10 scale, while cost is rated on a 1–5 scale to prevent price from

disproportionately distorting results. This prevents low-cost, low-quality bids from winning and also filters out proposals that exceed budget constraints.

### **Final Selection and Contracting**

The winning supplier is chosen based on the combined results of all evaluation criteria: quality, functionality, innovation, durability, and cost. Procurement documents must include minimum technical and functional requirements to prevent acceptance of substandard solutions. Likewise, excessively high-cost proposals that do not justify the expense are excluded.

The contract should include phased approval steps, such as prototype verification and a small-scale pre-production batch, before beginning complete manufacturing. This ensures that design details, quality levels, and production processes meet previously agreed standards and that any last adjustments can be made before large-scale rollout.

### **9.2.2 Distribution and Issuance**

The effectiveness of a uniform system depends not only on design quality but also on how reliably and accurately garments reach the soldiers who need them. Distribution and issuance form the operational bridge between procurement and daily use. In the current system, inconsistent availability of sizes, limited fitting opportunities, and rushed issuance sessions often result in soldiers receiving garments that do not fit or perform as intended. A revised distribution model must therefore prioritise accuracy, adaptability, and user feedback.

The proposed system introduces an issuance process that builds on the current one, beginning with precise size identification using the updated sizing framework. Instead of relying on estimates or limited stock, soldiers are measured according to a standardised protocol that includes height, chest circumference, waist circumference, hip circumference, and inseam length. These measurements determine the correct size range, reducing misallocation and minimising the need for immediate exchanges.

Distribution should be supported by a digital tracking system that records: soldiers' measurements, sizes, issued quantities, and follow-up needs. This record becomes part of the soldier's equipment profile, enabling smoother re-issuance, exchanges, and

long-term lifecycle tracking. The integration of this data also strengthens procurement predictability by showing which sizes or models require replenishment.

By restructuring distribution and issuance to focus on precision, verification, and traceability, the military clothing system becomes more reliable and responsive. This approach reduces waste, supports soldiers' operational readiness, and ensures that design improvements translate effectively into daily use.

### **9.2.3 Lifecycle Management**

Effective lifecycle management is essential for ensuring that the Adaptive Combat Uniform system remains functional, cost-efficient, and responsive to soldiers' real operational needs. Instead of treating garments as fixed-use items, the system introduces a lifecycle (Figure 25) that tracks a uniform from its first issuance to its eventual replacement, ensuring transparency, repairability, and maximised service life.

#### **Durability Expectations**

Each garment is expected to withstand the full spectrum of Estonian military training and field environments, including moisture, mud, abrasion, repeated washing, and seasonal temperature shifts. Durability standards should be defined through measurable performance criteria: minimum seam strength, abrasion resistance thresholds, and material stability after multiple laundering cycles. These expectations guide both procurement decisions and ongoing quality control.

#### **Repairability Requirements**

To reduce waste and extend garment lifespan, repairability must be built into both the design and the support system. Key components such as buttons, adjustment elements, and reinforcement parts should be easily replaceable. The design must allow field repairs and standardised repair procedures at unit-level workshops. A clear categorisation system (minor repair, major repair, non-repairable) ensures consistent handling across units.

#### **Exchange and Replacement Processes**

Uniform management should follow a predictable loop in which each item moves through stages based on its condition. A soldier returns a garment when it becomes worn, damaged, or no longer fits due to body changes. The item is evaluated and then routed to repair, returned to active stock, moved into reserve, or discarded. This approach minimises unnecessary new production while maintaining readiness.

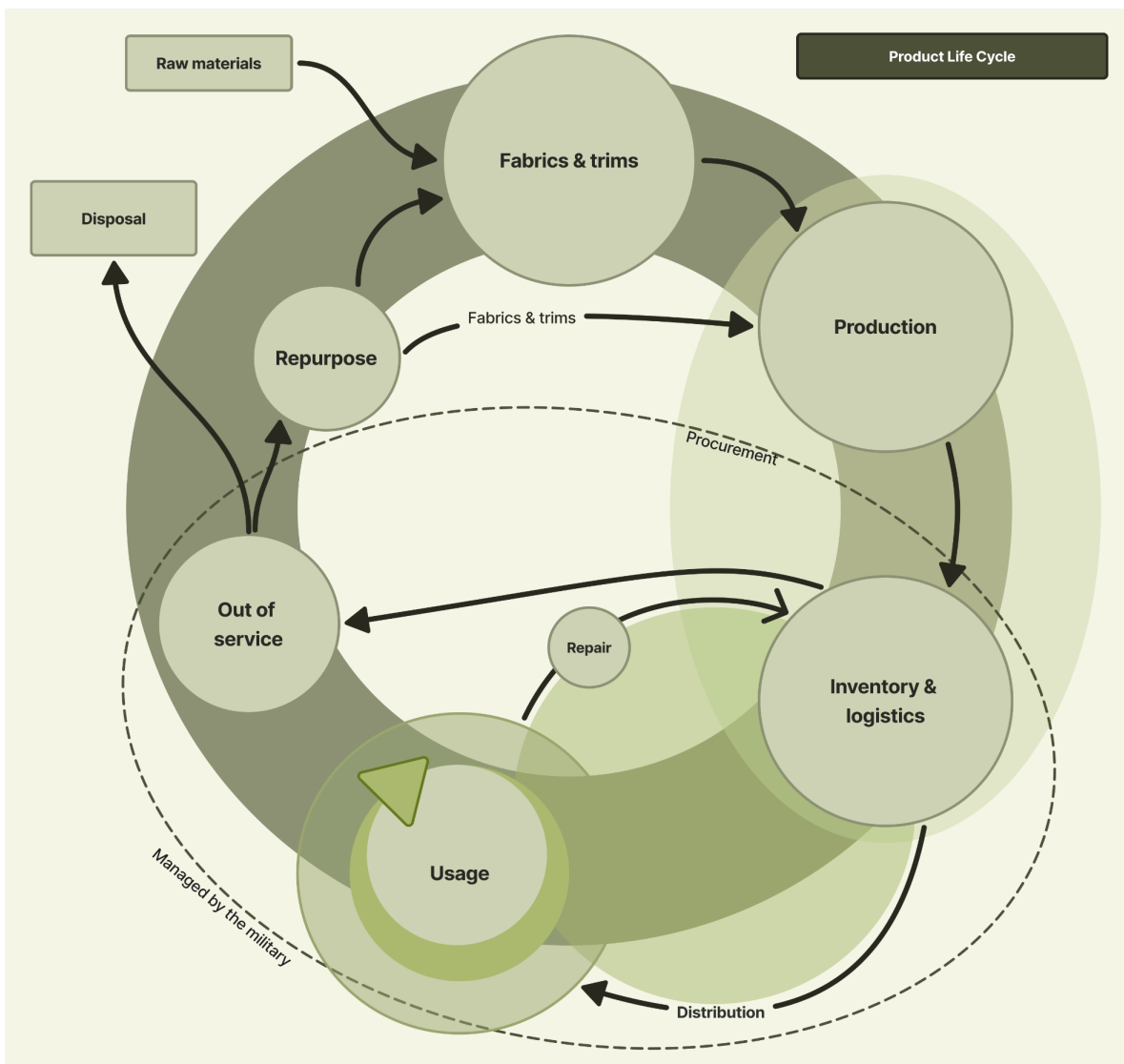


Figure 25: *Product Life Cycle for Military Uniform, by the Author.*

## 9.4 Implementation Roadmap

The implementation of the Adaptive Combat Pants follows a staged process designed to ensure technical reliability, user acceptance, and system-level integration. The roadmap (Figure 26) begins with final design consolidation, during which refinements from prototype testing are incorporated into a production-ready specification. This is followed by a pre-production pilot phase, during which a small test batch is manufactured using final materials and evaluated under controlled field conditions to validate durability, fit consistency, and compatibility with equipment.

Once validated, the process moves into procurement and industrial scaling. This stage includes selecting qualified manufacturers, verifying production capability through sample runs, and establishing quality-control checkpoints tailored to the new design features, such as adjustable waist systems, ventilation components, and kneepad compatibility. In parallel with procurement, the Defence Forces initiate logistics preparation, updating sizing charts, issuance procedures, and exchange policies to align with the adaptive design.

The final stages centre on deployment and feedback integration. The pants are gradually introduced to active units through phased roll-out cycles, beginning with training environments before transitioning into broader operational use. A structured feedback system ensures that insights from early adoption inform minor adjustments, long-term maintenance planning, and future iterations of the uniform system.

This roadmap ensures that the new design does not enter service as an isolated garment but is embedded within a coherent supply, maintenance, and user feedback cycle, supporting both operational performance and long-term system evolution.

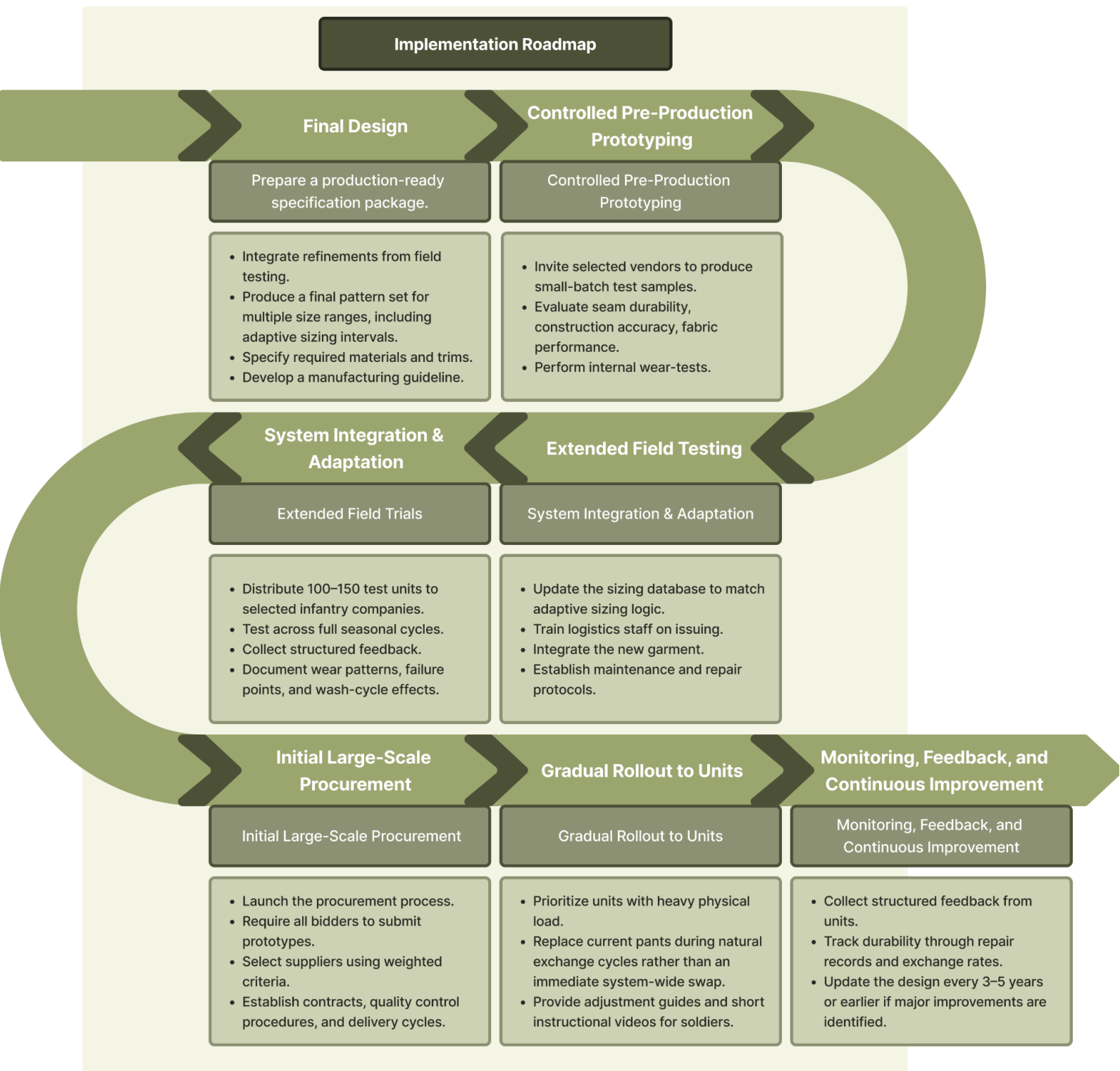


Figure 26: *Implementation Roadmap for New Military Uniform, by the author.*

## **9.5 Organisational and Soldier-Level Impact**

The introduction of an adaptive, better-fitting uniform system has implications that extend beyond individual comfort. Changes in fit, thermoregulation, construction, and adjustability influence how soldiers move, perform, and maintain operational readiness, while also affecting logistics, procurement efficiency, and long-term organisational resources. This section outlines the broader impact of the proposed design improvements on soldier experience, military operations, and the efficiency of the Estonian Defence Forces' clothing system.

### **9.5.1 Soldier Experience**

Improved fit, mobility, and thermoregulation directly enhance soldiers' daily lived experience. A uniform that adapts to different body shapes and movement patterns reduces discomfort, chafing, and movement restriction. These changes support natural body movement, enabling soldiers to kneel, sprint, climb, and crawl without hesitation or pain. Better ventilation and material placement help maintain stable thermal comfort during physical exertion, reducing overheating—a frequent complaint in the current system.

A more dependable garment also increases psychological comfort. Soldiers expressed that unreliable clothing: ripping seams, sagging waistbands, unstable kneepads, creates frustration and reduces confidence during training. A uniform perceived as functional and supportive can strengthen motivation and morale. Additionally, the more inclusive fit minimises the need for unofficial garment modifications, reinforcing a sense of belonging and equal treatment among all personnel.

### **9.5.2 Operational Performance**

Uniform performance directly shapes operational capability. Improved mobility supports faster response times and more efficient transitions between postures. Consistent kneepad positioning protects joints during prolonged kneeling and crawling, reducing the risk of injury and fatigue. Enhanced ventilation and adaptability improve endurance in both warm and cold conditions, enabling soldiers to sustain performance during extended drills or field operations.

A uniform that maintains its structure under stress also supports efficiency in tactical movements. When clothing does not require constant adjusting, like when lifting sagging waistbands, repositioning kneepads, and rearranging pockets, attention remains on the task rather than on correcting the equipment. These incremental gains accumulate during long exercises, making the clothing system an active contributor to operational readiness rather than a barrier.

### **9.5.3 Logistics and Organisational Efficiency**

At a system level, improved fit consistency and adaptive features reduce the volume of exchanges, returns, and tailoring work required upon issuance. A more rational sizing system, based on real anthropometric data, decreases stock imbalance and the chronic shortage of specific sizes. Adjustable features extend the usable lifespan of garments, reducing the number of replacements required due to poor fit rather than true material wear.

The emphasis on repairability, through replaceable components, accessible seams, and simplified construction, supports more efficient maintenance workflows. Instead of discarding whole garments due to a broken buckle or damaged kneepad attachment, repairs can be done quickly at low cost. Over time, this reduces procurement pressure, stabilises inventory, and supports a cost-efficient uniform lifecycle.

Operational logistics may also benefit from standardised modular elements. If future uniform systems adopt shared components (e.g., buckles/belts, adjustment systems, pocket modules), procurement processes become more predictable, and repair parts easier to stock and distribute. Together, these improvements contribute to a more resilient and efficient organisational clothing system that better aligns resources with actual soldier needs.

## **9.6 Recommendations for Further Research**

While the proposed design and system-level recommendations outline a clear direction for improving Estonian military clothing, several areas require continued investigation before large-scale implementation. First, long-term durability and stress testing are essential. The prototype testing period was too short to meaningfully evaluate fabric longevity, seam endurance, and hardware resilience under sustained field conditions. Extended wear trials across different seasons, terrains, and activity types are needed

to confirm material suitability and identify high-stress zones that require reinforcement.

Second, material research and development remain a crucial area for exploration. Future work should investigate fabrics and ventilation materials with better durability, reduced pilling, and improved thermal performance, particularly in cold climates. Special attention should be given to infrared and night-vision visibility, as testing revealed unintended reflectivity in mesh materials, with potential operational consequences. Research into lightweight, modular insulation and stretch reinforcements would further enhance the uniform's adaptability.

Third, sizing research is needed to refine the adaptive fit system. A comprehensive body-measurement study across the Estonian Defence Forces would provide the data foundation for a new sizing framework based on proportions rather than traditional graded sizing. Such research should include variation across gender, age, body composition, and service roles to ensure inclusive fit and reduce distribution inefficiencies.

Lastly, additional research should explore integration with other gear systems, such as plate carriers, belts, and load-bearing equipment, to ensure full interoperability. Investigating soldier-driven repair practices and maintenance behaviours could also inform design decisions that support longer lifecycle and reduce replacement costs.

## **10. CONCLUSION**

### **10.1 Summary of Findings**

This thesis set out to investigate how the current Estonian military clothing system supports or fails to support the real bodies, movements, and environments of its users, with a specific focus on combat pants. Through background research, questionnaires, interviews, prototyping, and field testing, it became clear that many of the challenges soldiers experience are not isolated problems but interconnected symptoms of a system built around standardisation rather than adaptation.

The research showed that issues related to fit, mobility, thermoregulation, durability, and inclusivity are deeply linked. Poor sizing affects movement; restricted movement accelerates wear; limited ventilation increases discomfort and fatigue; and a lack of adaptability forces soldiers to modify, tolerate, or replace issued equipment. These findings highlighted a fundamental mismatch between the assumptions embedded in the current uniform system and the diverse, dynamic realities of soldiers' everyday use.

By shifting the focus from isolated garment improvements to a user-centred and system-aware design approach, the thesis reframed the uniform not as static clothing but as an operational tool that must adapt to the wearer. This perspective guided the development of the Adaptive Combat Pants concept, which integrated insights from research into pattern construction, fit logic, ventilation placement, and functional detailing. Prototyping and field testing demonstrated that targeted design changes can meaningfully improve comfort, mobility, and usability, while also revealing practical constraints related to manufacturing, durability, and system compatibility.

Overall, the findings suggest that improving military clothing performance requires more than material upgrades or aesthetic updates. It requires rethinking sizing logic, adaptability, and feedback integration as core elements of the clothing system.

## **10.2 Contribution of the Thesis**

The main contribution of this thesis lies in bridging research, design, and system-level thinking within the context of Estonian military clothing. Rather than proposing a final, deployable product, the work presents a validated design direction supported by empirical user data, iterative prototyping, and field-based testing.

At a design level, the thesis contributes a structured process for developing adaptive military garments, demonstrating how anthropometric research, user feedback, and real-world testing can directly inform pattern construction and functional decisions. The Adaptive Combat Pants concept serves as a concrete example of how mobility, thermoregulation, and fit can be addressed simultaneously without compromising durability or uniform identity.

At a systemic level, the thesis highlights the limitations of rigid standardisation in military clothing and argues for a shift toward adaptive sizing, modular adjustment, and repair-aware design. It also outlines how procurement, distribution, and maintenance systems could better support such an approach, offering a foundation for future development beyond individual garments.

Finally, this work contributes to the broader discussion of inclusivity in functional clothing by showing that designing for diverse bodies is not merely about accommodation but about performance, safety, and operational effectiveness. By grounding design decisions in lived experience and testing, the thesis positions user-centred design as a strategic asset rather than a secondary consideration in the development of military clothing.

## **SUMMARY**

This thesis examined the current Estonian Defence Forces combat uniform system, focusing on how design decisions affect soldiers' performance, comfort, and inclusivity. Through a combination of background research, questionnaires, interviews, and hands-on design exploration, the study revealed that many issues experienced by soldiers are not isolated flaws but symptoms of a system built around standardisation rather than adaptation. Problems related to fit, restricted mobility, thermoregulation, durability, and gender inclusivity repeatedly emerged as interconnected challenges that influence both physical performance and everyday usability.

Building on these findings, the research transitioned from analysis into a user-centred design process guided by the Double Diamond framework. The insights from field research were reframed into design opportunities using "Who, What, Why" analysis, "How Might We" questions, and contradiction mapping. This reframing phase highlighted key tensions such as durability versus comfort and standardisation versus bodily diversity, which became central drivers for the design development.

The thesis design outcome is a conceptual proposal for Adaptive Combat Pants (AC-P), developed through iterative sketching, pattern experimentation, and three prototype stages. Each prototype refined fit, mobility, ventilation, and construction complexity, informed directly by user feedback and material testing. Field testing with cadets from the Estonian Military Academy provided practical validation of the concept, revealing strengths in mobility and thermoregulation while also exposing areas requiring further refinement, such as knee pad positioning and adjustment systems.

Rather than presenting a finalised product ready for immediate implementation, this thesis positions the AC-P as a design-driven system proposal. It demonstrates how military clothing can evolve from rigid, average-based solutions toward adaptable, user-responsive systems that better reflect real bodies, environments, and operational demands. The work contributes both a concrete design concept and a structured design methodology that can inform future development of military clothing systems, procurement processes, and further research into inclusive, performance-oriented uniform design.

## KOKKUVÕTE

Käesolev lõputöö käsitleb Eesti Kaitseväge lahingvormi süsteemi, keskendudes sellele, kuidas disaini otsused mõjutavad sõdurite sooritusvõimet, mugavust ja nende kaasavust. Taustauuringu, küsimustike, intervjuude ning praktilise disainitöö kaudu selgus, et paljud sõdurite kogetud probleemid ei ole üksikud vead, vaid sümptomid süsteemist, mis on üles ehitatud standardiseerimise, mitte kohandatavuse põhimõttel. Korduvalt ilmnesid omavahel seotud probleemid seoses sobivuse, liikumispiiratuse, termoregulatsiooni, vastupidavuse ja soolise kaasavusega, mis mõjutavad nii füüsilist sooritusvõimet kui ka igapäevast kasutusmugavust.

Nendele leidudele toetudes liikus uurimus analüüsist edasi kasutajakeskse disainiprotsessi, mida raamistas Double Diamond'i mudel. Välitööde käigus kogutud andmed sõnastati ümber disainivõimalusteks „Who, What, Why“ analüüsi, „How Might We“ küsimuste ja vastuolude kaardistamise abil. See etapp tõi esile keskseid pingeid, näiteks vastupidavuse ja mugavuse või standardiseerimise ja kehalise mitmekesisuse vahel, mis said disaini arenduse peamisteks lähtepunktideks.

Lõputöö disainitulemuseks on kontseptuaalne Adaptive Combat Pants (AC-P) lahendus, mis töötati välja iteratiivse visandamise, lõike arendamise ja kolme prototüübi etapi kaudu. Iga prototüüp täpsustas sobivust, liikuvust, ventilatsiooni ja konstruktsiooni keerukust, tuginedes otseselt kasutajatelt saadud tagasisidele ja materjalikatsetustele. Välitestimine Eesti Kaitseväge Akadeemia kadettidega võimaldas kontseptsiooni praktiliselt hinnata, tuues esile tugevused liikumisvabaduse ja termoregulatsiooni osas ning samal ajal ka valdkonnad, mis vajavad edasist arendamist, näiteks põlvekaitse süsteemi asetus ja reguleeritavus.

Lõputöö ei paku välja lõplikku, koheseks kasutuselevõtuks valmis toodet, vaid käsitleb AC-P-d kui disainipõhist süsteemset ettepanekut. Töö näitab, kuidas militaarriietus saab areneda jäikadelt, „keskmisele kasutajale“ suunatud lahendustelt kohandatavate ja kasutajale reageerivate süsteemide suunas, mis arvestavad paremini tegelike kehade, keskkondade ja operatiivsete nõudmistega. Lõputöö panus seisneb nii konkreetse disainikontseptsiooni loomises kui ka struktureeritud disainimetoodika pakkumises, mis võib toetada tulevasi militaarriietuse arendusi, hankeprotsesse ning edasisi uuringuid kaasava ja sooritusvõimet toetava vormiriietuse disaini valdkonnas.

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## GRAPHICAL MATERIAL

**Figure 1:** Double diamond framework proposed by Béla H. Bánáthy and adapted for this thesis by the author.

**Figure 2:** World Uniform History Timeline: 1800s to 1945, visual by the author.

1. Prince Josef Anton Poniatowski (1763-1813) by his horse, c.1800-13, Polish School, (19th century). Location: Czartoryski Museum, Cracow, Poland  
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3. "Men of The Leicestershire Regiment Circa 1917"  
<https://branches.britishlegion.org.uk/branches/ashby-de-la-zouch/remembrance/>
4. "Photograph of General Dwight D. Eisenhower Giving the Order of the Day"  
<https://catalog.archives.gov/id/531217?objectPage=2>

**Figure 3:** World Uniform History Timeline: 1950s to 1990s, visual by the author.

5. "Removing Battle Casualties From the Snow, 1950"  
<https://www.gettyimages.dk/photos/evacuation-of-hungnam>
6. "Vietnam Era American Soldiers"  
<https://pixels.com/featured/vietnam-era-american-soldiers-solders-everett.html>
7. "Remembering Sgt. 1st Class Jared C. Monti"  
<https://api.army.mil/e2/c/-images/2009/09/09/50075/army.mil-50075-2009-09-15-090945.jpg>

**Figure 4:** World Uniform History Timeline: 1990s to future, visual by the author.

8. "Russian troops in Chechnya during the First Chechen War"  
<https://georgy-konstantinovich-zhukov.tumblr.com/post/49633492884/russian-troops-in-chechnya-during-the-first>
9. "Soldiers of the Second Battalion, 12th Cavalry, conducted a weapons raid in Baghdad."  
<https://www.nytimes.com/2007/04/09/world/middleeast/09surge.html>
10. "Canadian Army soldiers from the 3rd Battalion"  
<https://www.canada.ca/en/department-national-defence/corporate/reports-publications/departmental-results-report/2021-22-index/results-core-resp/ready-forces.html>
11. "British Army drones flown for first time in Japan"  
<https://www.adsadvance.co.uk/british-army-drones-flown-for-first-time-in-japan.html>

**Figure 5:** Estonian Uniform History Timeline: 1918 to 1991, visual by the author.

1. Eesti sõjamuuseum - kindral Laidoneri muuseum, EKV pildid, kolmekümnendad  
<https://www.muis.ee/museaalview/4268599>
2. Eesti sõjamuuseum - kindral Laidoneri muuseum, EKV pildid, kolmekümnendad  
<https://www.muis.ee/museaalview/4268621>
3. Wikipedia, "German soldiers defending the western bank of the Narva River, with the Ivangorod Fortress on the eastern side"  
[https://en.wikipedia.org/wiki/Battle\\_of\\_Narva\\_%281944%29](https://en.wikipedia.org/wiki/Battle_of_Narva_%281944%29)
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[https://en.wikipedia.org/wiki/File:RIAN\\_archive\\_58228\\_Leningrad\\_Front\\_Soldiers\\_Before\\_Offensive.jpg#filelinks](https://en.wikipedia.org/wiki/File:RIAN_archive_58228_Leningrad_Front_Soldiers_Before_Offensive.jpg#filelinks)

**Figure 6:** Estonian Uniform History Timeline: 1991 to today, visual by the author.

5. U.Ojaste, "Sideta radistid"; from book "Leegitseval Piiril"
6. Kalve, Mati, Eesti Rahva Muuseum, "Kaitseväe lahingõppus "Kevadtorm 2003" Lääne-Virumaal, sõdur metsas."  
<https://www.muis.ee/museaalview/3984341>

7. Eesti Kaitseväge, "1. jalaväebrigaadi pidulik rivistus 01.08.2025"  
<https://pildid.mil.ee/picture.php?/607317/category/63535>

**Figure 7:** Estonian Uniform Elements, Uniformed models: (Aldošin, 2015), with the author's additions.

**Figure 8:** Proflin Combat pants SIRIUS compared to Crye Precision G3 Combat Pants, visual by the author.

**Figure 9:** Illustration of the current sizing of the pants with adapted sizing for diversity. By the author.

**Figure 10:** Stress and bulk map, by the author.

**Figure 11:** Thermal Body Map, by the author.

**Figure 12:** U.S. Military Uniform, visual by the author.

**Figure 13:** Nordic Combat Uniform, visual by the author.

**Figure 14:** Relationship Between the Frequency of Wear and the Uniforms' Expected Life Span, analysis from field research data by the author.

**Figure 15:** Weak Points in the Current Uniform System, analysis from field research data by the author.

**Figure 16:** Design Process Model, by the author.

**Figure 17:** Three initial sketches, by the author.

**Figure 18:** Stress and Bulk Zones Mapped on Sketch 3, by the author.

**Figure 19:** Prototype 1, Front and Back View, by the author.

**Figure 20:** Prototype 2: Front and Back View, by the author.

**Figure 21:** Prototype 3: Front and Back View, by the author.

**Figure 22:** Waistband and Buckle Details of Prototype 3, by the author.

**Figure 23:** Prototype for Field Testing, by the author.

**Figure 24:** Illustration of Adaptive Combat Pants (AC-P), by the author.

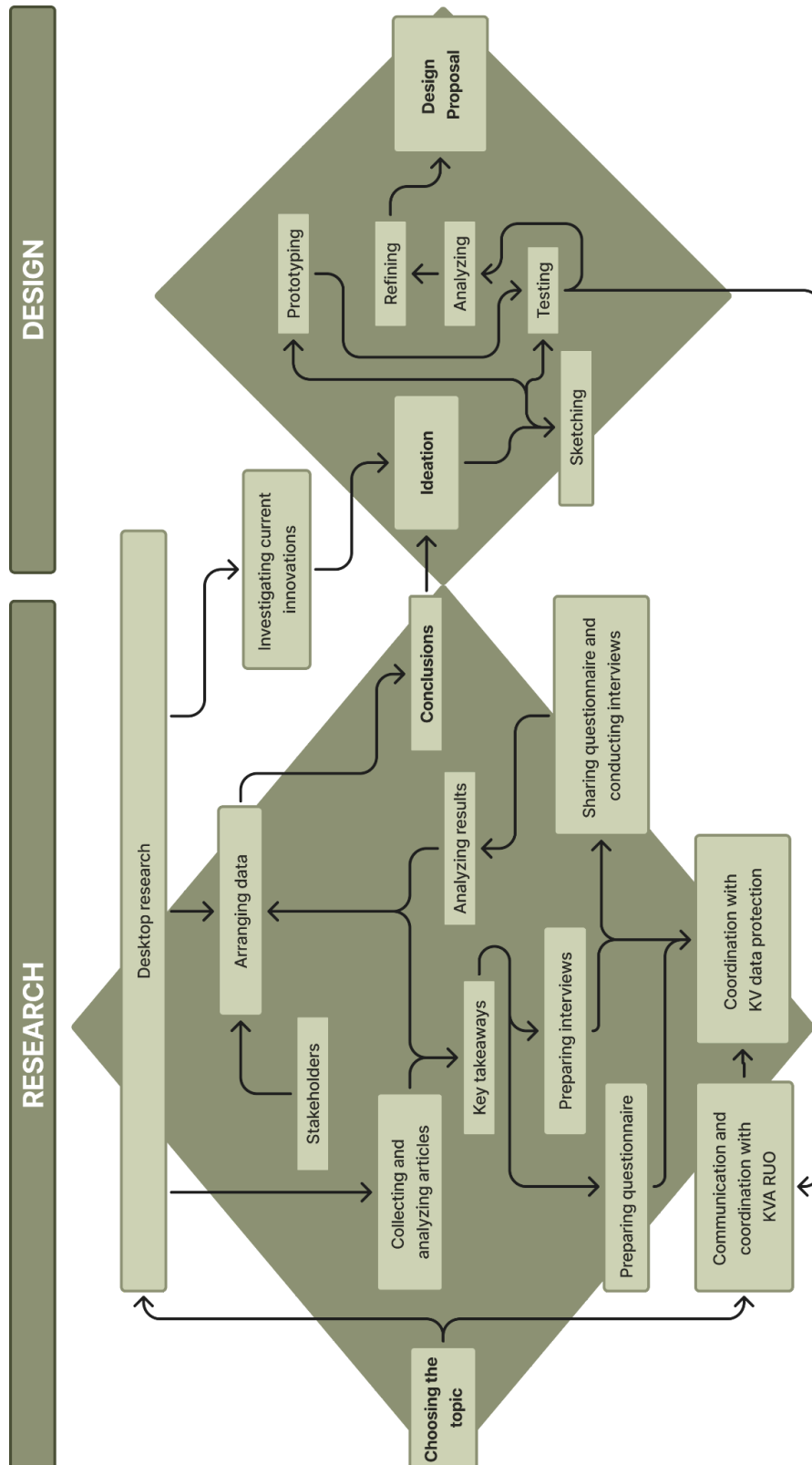
**Figure 25:** Product Life Cycle for Military Uniform, by the author.

**Figure 26:** Implementation Roadmap for New Military Uniform, by the author.

# APPENDICES

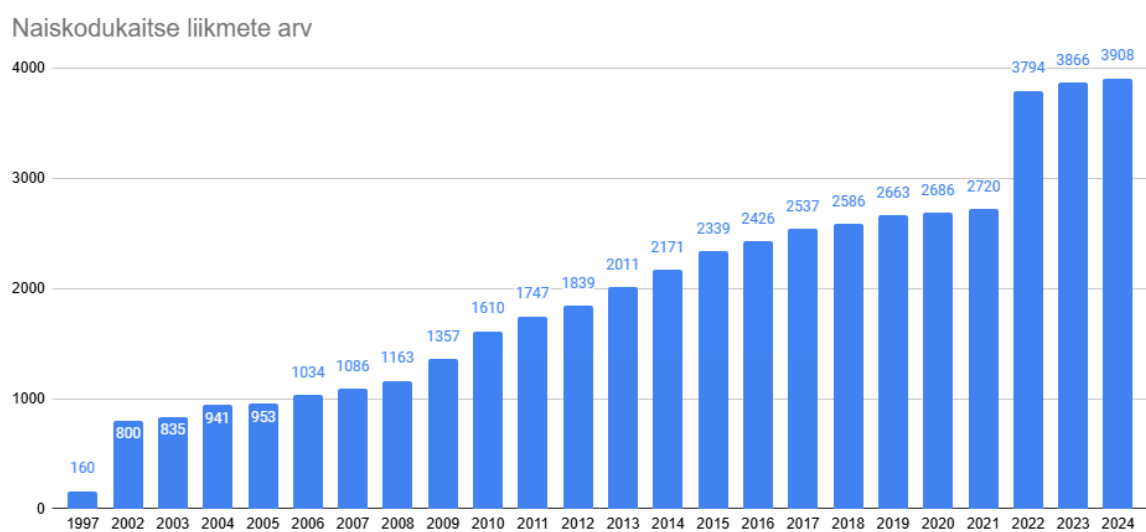
## Appendix A

Double diamond visualized and illustrated by the author.



## Appendix B

Graph of the Womens Voluntary Defence Organizations growth.



[https://www.naiskodukaitse.ee/taasloomine\\_3391](https://www.naiskodukaitse.ee/taasloomine_3391)

## Appendix C

Industrial chart with control measurements for women's sizes (Donnanno, 2014, p. 29)

| Measurements of circumference in cm. |           |           |           |           |           |           |
|--------------------------------------|-----------|-----------|-----------|-----------|-----------|-----------|
| <b>SIZES</b>                         | <b>40</b> | <b>42</b> | <b>44</b> | <b>46</b> | <b>48</b> | <b>50</b> |
| Bust circumference                   | 89        | 92        | 96        | 100       | 105       | 110       |
| Waist circumference                  | 66        | 68        | 72        | 76        | 81        | 86        |
| Hip circumference                    | 89        | 92        | 96        | 100       | 105       | 110       |
| Neck Circumference                   | 36        | 37        | 38        | 39        | 40        | 41        |
| Back shoulder width                  | 35,3      | 36,5      | 37,9      | 39,5      | 41,5      | 43,5      |
| Measurements of length               |           |           |           |           |           |           |
| Seat depth                           | 23,5      | 24        | 24,6      | 25,2      | 25,8      | 26,5      |
| Outer leg length                     | 102       | 104       | 105       | 106       | 107       | 108       |
| Sleeve length                        | 57        | 58        | 59        | 60        | 61        | 61        |

Industrial chart with control measurements of men's sizes (Donnanno, 2014, p. 217)

| Measurements of circumference in cm. |           |           |           |           |           |           |
|--------------------------------------|-----------|-----------|-----------|-----------|-----------|-----------|
| <b>SIZES</b>                         | <b>44</b> | <b>46</b> | <b>48</b> | <b>50</b> | <b>52</b> | <b>54</b> |
| Chest circumference                  | 88        | 92        | 96        | 100       | 104       | 108       |
| Waist circumference                  | 80        | 84        | 88        | 92        | 96        | 100       |
| Hip circumference                    | 89        | 92        | 96        | 100       | 105       | 110       |
| Neck Circumference                   | 40        | 41        | 42        | 43        | 44        | 45        |
| Back shoulder width                  | 42        | 43        | 44        | 45        | 46        | 47        |
| Measurements of length               |           |           |           |           |           |           |
| Seat depth                           | 23,2      | 23,6      | 24        | 24,4      | 24,8      | 25,2      |
| Outer leg length                     | 104       | 106       | 108       | 110       | 112       | 114       |
| Sleeve length                        | 60        | 61        | 62        | 63        | 64        | 65        |

# Appendix D

## Nato Sizing Chart

| Clothing Size Chart |              |             |            |          |                   |               |                |                  |           |
|---------------------|--------------|-------------|------------|----------|-------------------|---------------|----------------|------------------|-----------|
| Jacket & Shirt      |              |             |            |          |                   |               |                |                  |           |
| Int. Size           | Height       |             | Chest Size |          | 8 Digit NATO Size | NATO Size     | German BW Size | Austrian Size    | Euro Size |
|                     | cm           | ft          | cm         | In       | Height / Chest    | Height / Size |                | width / Length   |           |
| Small-Short         | 165 - 175 cm | 5'5" - 5'9" | 92         | 36 - 38" | 6575 / 9095       | 170 / 88      | Gr Nr.1        | 88 - 92 I-II     | -         |
| Medium-Short        | 165 - 175 cm | 5'5" - 5'9" | 97         | 38 - 40" | 6575 / 9000       | 170 / 96      | Gr Nr. 2       | 96 - 100 I-II    | -         |
| Large-Short         | 165 - 175 cm | 5'5" - 5'9" | 102        | 40 - 42" | 6575 / 0005       | 170 / 104     | Gr Nr. 3       | 104 - 108 I-II   | 40        |
| XLarge-Short        | 165 - 175 cm | 5'5" - 5'9" | 107        | 42 - 44" | 6575 / 0510       |               | Gr Nr. 4       | 112 - 116 I-II   | 42        |
| XXLarge-Short       | 165 - 175 cm | 5'5" - 5'9" | 112        | 44 - 46" | 6575 / 1015       | 170 / 112     | Gr Nr. 5       | -                | 44        |
| Small               | 175 - 185 cm | 5'9" - 6'1" | 92         | 36 - 38" | 7585 / 9095       | 180 / 88      | Gr Nr. 6       | 88 - 92 III-IV   | 46        |
| Medium              | 175 - 185 cm | 5'9" - 6'1" | 97         | 38 - 40" | 7585 / 9500       | 180 / 96      | Gr Nr. 7       | 96 - 100 III-IV  | 48        |
|                     | 175 - 185 cm | 5'9" - 6'1" | 102        | 40 - 42" | 7585 / 0005       | 180 / 104     | Gr Nr. 8       | 104 - 108 III-IV | 50        |
| Large               | 175 - 185 cm | 5'9" - 6'1" | 107        | 42 - 44" | 7585 / 0510       |               | Gr Nr. 9       | 112 - 116 III-IV | 52        |
|                     | 175 - 185 cm | 5'9" - 6'1" | 112        | 44 - 46" | 7585 / 1015       | 180 / 112     | Gr Nr. 10      | -                | 54        |
| XLarge              | 175 - 185 cm | 5'9" - 6'1" | 117        | 46 - 48" | 7585 / 1520       | 180 / 112     | Gr Nr. 11      | -                | 56        |
| Small-Long          | 185 - 195 cm | 6'1" - 6'5" | 97         | 38 - 40" | 8595 / 9500       | 190 / 96      | Gr Nr. 12      | 96 - 100 V-VI    | -         |
| Medium-Long         | 185 - 195 cm | 6'1" - 6'5" | 102        | 40 - 42" | 8595 / 0005       | 190 / 104     | Gr Nr. 13      | 104 - 108 V-VI   | -         |
| Large-Long          | 185 - 195 cm | 6'1" - 6'5" | 107        | 42 - 44" | 8595 / 0510       |               | Gr Nr. 14      | 112 - 116 V-VI   | -         |
| XLarge-Long         | 185 - 195 cm | 6'1" - 6'5" | 112        | 44 - 46" | 8595 / 1015       | 190 / 112     | Gr Nr. 15      | -                | -         |
| XXLarge-Long        | 185 - 195 cm | 6'1" - 6'5" | 117        | 46 - 48" | 8595 / 1520       | 190 / 120     | Gr Nr. 16      | -                | -         |
| Medium-XLong        | 195 - 205 cm | 6'5" - 6'9" | 102        | 40 - 42" | 9505 / 0005       | -             | Gr Nr. 17      | -                | -         |
| Large-XLong         | 195 - 205 cm | 6'5" - 6'9" | 107        | 42 - 44" | 9505 / 0510       | -             | Gr Nr. 18      | -                | -         |
| XLarge-XLong        | 195 - 205 cm | 6'5" - 6'9" | 122        | 44 - 46" | 9505 / 1015       | -             | Gr Nr. 19      | -                | -         |
| XXLarge-XLong       | 195 - 205 cm | 6'5" - 6'9" | 117        | 46 - 48" | 9505 / 1520       | -             | Gr Nr. 20      | -                | -         |

| Trousers    |                   |                |                |                |                 |              |             |
|-------------|-------------------|----------------|----------------|----------------|-----------------|--------------|-------------|
| Int. Size   | NATO Size         | UK Size        | US Size        | German BW Size | Height / Inseam | Waist        | Seat        |
|             | Height/Waist/Seat | Waist / Height | Width / Length |                | cm   in         | cm   in      | cm   in     |
| XSmall      | 80 / 65 / 84      | 26" W / 32" H  | 26" W / 32" L  | Gr Nr. 10      | 80 cm / 32"     | 65 cm / 26"  | 84 cm / 33" |
|             | 80 / 70 / 84      | 28" W / 32" H  | 28" W / 32" L  | -              | 80 cm / 32"     | 70 cm / 28"  | 84 cm / 33" |
| Small       | 80 / 75 / 92      | 29" W / 32" H  | 29" W / 32" L  | Gr Nr. 11      | 80 cm / 32"     | 75 cm / 29"  | 92 cm / 36" |
|             | 80 / 79 / 92      | 31" W / 32" H  | 31" W / 32" L  | -              | 80 cm / 32"     | 79 cm / 31"  | 92 cm / 36" |
| Medium      | 80 / 80 / 96      | 32" W / 32" H  | 32" W / 32" L  | Gr Nr. 12      | 80 cm / 32"     | 80 cm / 32"  | 96 cm / 38" |
|             | 80 / 87 / 100     | 34" W / 32" H  | 34" W / 32" L  | Gr Nr. 13      | 80 cm / 32"     | 85 cm / 34"  | 100cm/39"   |
| Medium-Long | 85 / 87 / 100     | 34" W / 33" H  | 34" W / 33" L  | -              | 85 cm / 33"     | 87 cm / 34"  | 100cm/39"   |
| Large       | 80 / 90 / 108     | 35" W / 32" H  | 35" W / 32" L  | Gr Nr. 14      | 80 cm / 32"     | 90 cm / 35"  | 108cm/43"   |
|             | 80 / 94 / 112     | 37" W / 32" H  | 37" W / 32" L  | Gr Nr. 15      | 80 cm / 32"     | 94 cm / 37"  | 112cm/44"   |
| Large-Long  | 85 / 90 / 104     | 35" W / 33" H  | 35" W / 33" L  | -              | 85 cm / 33"     | 90 cm / 35"  | 104cm/41"   |
|             | 85 / 94 / 108     | 37" W / 33" H  | 37" W / 33" L  | -              | 85 cm / 33"     | 94 cm / 37"  | 108cm/43"   |
| XLarge      | 80 / 97 / 112     | 38" W / 32" H  | 38" W / 32" L  | -              | 80 cm / 32"     | 97 cm / 38"  | 112cm/44"   |
|             | 80 / 102 / 116    | 40" W / 32" H  | 40" W / 32" L  | -              | 80 cm / 32"     | 102 cm / 40" | 116cm/45"   |
| XLarge-Long | 85 / 97 / 120     | 38" W / 33" H  | 38" W / 33" L  | -              | 85 cm / 33"     | 97 cm / 38"  | 120cm/47"   |
|             | 85 / 102 / 124    | 40" W / 33" H  | 40" W / 33" L  | -              | 85 cm / 33"     | 102 cm / 40" | 124cm/48"   |

| Shorts       |                     |         |         |                 |             |             |
|--------------|---------------------|---------|---------|-----------------|-------------|-------------|
| Int. Size    | NATO Size           | UK Size | US Size | Height / Inseam | Waist       | Seat        |
|              | Height/ Waist /Seat | Waist   | Width   | cm   in         | cm   in     | cm   in     |
| XSmall-Short | 24 / 68 / 84        | 26" W   | 26" W   | 24 cm / 9.5"    | 68 cm / 26" | 84 cm / 33" |
| Small-Short  | 24 / 72 / 88        | 28" W   | 28" W   | 24 cm / 9.5"    | 72 cm / 28" | 88 cm / 35" |
|              | 24 / 76 / 92        | 30" W   | 30" W   | 24 cm / 9.5"    | 76 cm / 30" | 92 cm / 36" |
| Medium-Short | 24 / 80 / 96        | 32" W   | 32" W   | 24 cm / 9.5"    | 80 cm / 32" | 96 cm / 38" |
|              | 24 / 86 / 100       | 34" W   | 34" W   | 24 cm / 9.5"    | 86 cm / 34" | 100cm/39"   |
| Large-Short  | 24 / 88 / 104       | 35" W   | 35" W   | 24 cm / 9.5"    | 88 cm / 35" | 104cm/41"   |
|              | 24 / 94 / 108       | 37" W   | 37" W   | 24 cm / 9.5"    | 94 cm / 37" | 108cm/43"   |
| Small        | 27 / 72 / 88        | 28" W   | 28" W   | 27 cm / 10.5"   | 72 cm / 28" | 88 cm / 35" |
|              | 27 / 76 / 92        | 30" W   | 30" W   | 27 cm / 10.5"   | 76 cm / 30" | 92 cm / 36" |
| Medium       | 27 / 80 / 96        | 32" W   | 32" W   | 27 cm / 10.5"   | 80 cm / 32" | 96 cm / 38" |
|              | 27 / 86 / 100       | 34" W   | 34" W   | 27 cm / 10.5"   | 86 cm / 34" | 100cm/39"   |
| Large        | 27 / 88 / 104       | 35" W   | 35" W   | 27 cm / 10.5"   | 88 cm / 35" | 104cm/41"   |
|              | 27 / 94 / 108       | 37" W   | 37" W   | 27 cm / 10.5"   | 94 cm / 37" | 108cm/43"   |
| Small-Long   | 30 / 76 / 92        | 30" W   | 30" W   | 30 cm / 12"     | 76 cm / 30" | 92 cm / 36" |
| Medium-Long  | 30 / 80 / 96        | 32" W   | 32" W   | 30 cm / 12"     | 80 cm / 32" | 96 cm / 38" |
|              | 30 / 86 / 100       | 34" W   | 34" W   | 30 cm / 12"     | 86 cm / 34" | 100cm/39"   |
| Large-Long   | 30 / 88 / 104       | 35" W   | 35" W   | 30 cm / 12"     | 88 cm / 35" | 104cm/41"   |
|              | 30 / 94 / 108       | 37" W   | 37" W   | 30 cm / 12"     | 94 cm 37"   | 108cm/43"   |
| Medium-XLong | 33 / 80 / 96        | 32" W   | 32" W   | 33 cm / 13"     | 80 cm / 32" | 96cm / 38"  |
|              | 33 / 86 / 100       | 34" W   | 34" W   | 33 cm / 13"     | 86 cm / 34" | 100cm/39"   |
| Large-XLong  | 33 / 88 / 104       | 35" W   | 35" W   | 33 cm / 13"     | 88 cm / 35" | 104cm/41"   |
|              | 33 / 94 / 108       | 37" W   | 37" W   | 33 cm / 13"     | 94 cm / 37" | 108cm/43"   |

<https://military4u.co.uk/image/catalog/Size-Chart/International Size Chart.jpg>

## Appendix E

### Küsitlus/questionnaire (translation below)

Kaitseväe vormi Kasutuskogemus ja Probleemid

\*Nõusolkuvorm

(Taustateave)

#### **Kui kaua olete teeninud/teenisite Eesti Kaitseväes?**

Vähem kui 1 aasta/ainult ajateenistuses/ 1–3 aastat/ 4–6 aastat/ 6–10 aastat/ Üle 10 aasta

#### **Kui sageli kannate kaitseväe vormi?**

Iga päev/ 4–5 korda nädalas/ 1–3 korda nädalas/ Muu...

#### **Millistes tingimustes kasutate/kasutasite kaitseväe vormi kõige sagedamini?**

Linnakeskkond/ mets ja maastik/ Ekstreemsed ilmastikutingimused (külm, vihm, lumi)/ Sisetingimustes (kontor, staap)/ Väline keskkond linnakus/ Väline keskkond maastikul/ Hoonestatud ala/ Sõiduk/ Muu...

(Vormiriietuse kvaliteet ja vastupidavus)

#### **Kuidas hindaksite praeguse kaitseväe vormi üldist kvaliteeti?**

Väga hea/ Hea/ Keskmine/ Kehv/ Väga kehv

#### **Milliseid probleeme olete oma kaitseväe vormiga kogenud?**

Materjal kulub kiiresti/ Tugevused ja õmblused rebenemise suhtes nõrgad/ Veekindlus ei ole piisav/ Vorm ei hoia soojust hästi külmades tingimustes/ Riietus ei hinga hästi kuumades tingimustes/ Suurused ei ole ühtlased/ Vorm on liikumisel ebamugav/ Muu...

#### **Kui kaua peab üks kaitseväe vormi komplekt tavaliselt vastu enne, kui see vajab väljavahetamist? (Kui ei tea siis võib pakkuda kuidas tundub)**

Vähem kui 6 kuud/ 6 kuud – 1 aasta/ 1–2 aastat/ Üle 2 aasta/ Muu...

(Disain ja kasutusmugavus)

#### **Kas tunnete, et kaitseväe vorm on mugav ja toetab teie liikumist?**

Jah, see on mugav ja ei takista liikumist/ Pigem mugav, kuid mõningaid piiranguid esineb/ Keskmine – mõni osa on ebamugav/ Pigem ebamugav, liikumine on piiratud/ Väga ebamugav, segab liikumist

#### **Millised kaitseväe vormi osad on kõige probleemsemad?**

Jope/ Püksid/ Saapad/ Kindad/ Peakatte osad (nt müts, kiiver)/ Muu...

**Kas suurused ja sobivus tunduvad ühtlased erinevate partiide puhul?**

Jah, suurused on järjepidevad/ Ei, sama suuruse riided erinevad märgatavalt/ Ei oska öelda

(Vormiriietuse hooldus)

**Kui sageli peate/pidite kaitseväge vormi pesema?**

Peaegu iga päev/ 2–3 korda nädalas/ 1 kord nädalas/ Harvem kui kord nädalas

**Kas peate/pidite ise tegema parandusi oma kaitseväge vormile?**

Jah, sageli/ Mõnikord/ Väga harva/ Ei, kunagi

**Milliseid parandusi olete oma vormile teinud?**

(Kaitseväge vormi väljastamine ja vahetamine)

**Kui lihtne on saada uut või asendusvormi, kui praegune on kulunud või kahjustatud?**

Väga lihtne, asendus on kiire ja sujuv/ Pigem lihtne, kuid võib esineda viivitusi/ Keskmise, tuleb eraldi taotleda ja oodata/ Pigem keeruline, asendust on raske saada/Väga keeruline, peab ise lahenduse leidma

**Kas olete pidanud ise ostma või hankima lisavarustust, sest väljastatud varustus pole olnud piisav?**

Jah, tihti/ Mõnikord/ Väga harva/ Ei, kunagi

**Millist varustust olete ise hankinud?**

(Parendusettepanekud ja tulevikuarendused)

**Mida muudaksite oma kaitseväge vormis esimesena? Proovige nimetada vähemalt kolm.**

Aitäh, et võtsite aega sellele küsimustikule vastamiseks!

Teie tagasiside aitab kaasa paremate ja vastupidavamate kaitseväge vormide arendamisele. Kui soovite jagada lisakommentaare või täiendavaid tähelepanekuid, võite need kirja panna allolevasse lahtrisse.

**Lisa Kommentaarid ja tähelepanekud**

## **Translation**

Use Experience and Problems of the Defence Forces Uniform

\*Consent form

(Background Information)

### **How long have you served / did you serve in the Estonian Defence Forces?**

Less than 1 year / only during conscription / 1–3 years / 4–6 years / 6–10 years / More than 10 years

### **How often do you wear the Defence Forces uniform?**

Every day / 4–5 times a week / 1–3 times a week / Other...

### **In what conditions do/did you most often use the Defence Forces uniform?**

Urban environment / Forest and terrain / Extreme weather conditions (cold, rain, snow) / Indoor conditions (office, штаб) / Outdoor environment in garrison / Outdoor environment in terrain / Built-up area / Vehicle / Other...

(Uniform Quality and Durability)

### **How would you rate the overall quality of the current Defence Forces uniform?**

Very good / Good / Average / Poor / Very poor

### **What problems have you experienced with your Defence Forces uniform?**

Material wears out quickly / Reinforcements and seams are weak and prone to tearing / Waterproofing is insufficient / The uniform does not retain heat well in cold conditions / The clothing does not breathe well in hot conditions / Sizes are inconsistent / The uniform is uncomfortable when moving / Other...

### **How long does one set of Defence Forces uniform usually last before it needs to be replaced?**

(If unsure, you may estimate.)

Less than 6 months / 6 months – 1 year / 1–2 years / Over 2 years / Other...

(Design and Usability)

### **Do you feel that the Defence Forces uniform is comfortable and supports your movement?**

Yes, it is comfortable and does not restrict movement / Rather comfortable, but some limitations exist / Average – some parts are uncomfortable / Rather uncomfortable, movement is restricted / Very uncomfortable, significantly hinders movement

### **Which parts of the Defence Forces uniform are the most problematic?**

Jacket / Trousers / Boots / Gloves / Headgear (e.g. cap, helmet) / Other...

**Do the sizes and fit seem consistent across different production batches?**

Yes, sizes are consistent / No, items of the same size differ noticeably / Cannot say

(Uniform Maintenance)

**How often do/did you have to wash the Defence Forces uniform?**

Almost every day / 2-3 times a week / Once a week / Less than once a week

**Have you had to make repairs to your Defence Forces uniform yourself?**

Yes, often / Sometimes / Very rarely / No, never

**What repairs have you made to your uniform?**

(Issuing and Replacing the Uniform)

**How easy is it to get a new or replacement uniform when the current one is worn out or damaged?**

Very easy, replacement is fast and smooth / Rather easy, but delays may occur / Average, requires a separate request and waiting / Rather difficult, replacement is hard to obtain / Very difficult, you have to find a solution yourself

**Have you had to purchase or obtain additional equipment yourself because the issued equipment was insufficient?**

Yes, often / Sometimes / Very rarely / No, never

**What equipment have you obtained yourself?**

(Improvement Suggestions and Future Developments)

**What would you change first in your Defence Forces uniform? Please try to name at least three.**

Thank you for taking the time to complete this questionnaire!

Your feedback contributes to the development of better and more durable Defence Forces uniforms. If you wish to share additional comments or observations, you may write them in the field below.

**Additional Comments and Observations**

## Appendix F

### Uuritava informeerimise leht ja teadliku nõusoleku vorm *(Translation below)*

Palume Teid osalema küsitlusuuringus. Uuringu eesmärk on kaardistada võimalikud probleemid ja parendusvõimalused. Uuringut viib läbi Mirjam Mõttus.

Küsimustiku täitmine võtab aega ligikaudu 5 minutit.

Teie osalemine uuringus jääb rangelt konfidentsiaalseks, mis tähendab, et Teie poolt antud vastuseid ei seostata Teie isikuga. Anonüümseid, vastajat mittetuvastavaid andmeid analüüsitakse Mirjam Mõttuse poolt ning uuringu tulemused esitatakse üldistatult. Andmeid kasutatakse uurimistöö tulemuste esitamiseks magistritöös viisil, mis ei võimalda identifitseerida konkreetseid isikuid. Uurimistööga mitteseotud isikutel puudub juurdepääs Teiega seotud uurimistöö andmetele. Pärast uurimistöö esitamist ja positiivse resultaadi saamist kaitsmisel/hindamisel hävitatakse kogutud andmed jäädavalt kuu aja jooksul.

Magistritöö on avalik, mistõttu palume Teil küsitluse avatud küsimustele vastates Kaitseväge juurdepääsupiiranguga asutusesiseseks kasutamiseks mõeldud või riigisaladusega kaitstud teavet mitte avaldada. Küsitluse käigus ei küsita küsimusi, mis eeldavad detailset vastust Teie ametikoha, teenistusülesannete jm (riigikaitse) teabe kohta, mida loetakse AvTS § 35 alusel juurdepääsupiiranguga teabeks.

Uuringus osalemine on vabatahtlik ja Teil on õigus selles osalemisest keelduda või loobuda. Teil on igal ajal õigus nõusolek kirjalikku taasesitamist võimaldavas vormis (nt e-kirja teel) tagasi võtta, ilma et see mõjutaks enne nõusoleku tagasivõtmist toimunud andmetöötluse seaduslikkust.

Teades eeltoodut kinnitan oma nõusoleku uuringus osalemiseks ja minu kohta kogutud anonüümsete andmete töötlemise eelpool kirjeldatud viisil:

- Jah
- Ei

Uuringu kohta saab täiendavat informatsiooni

Mirjam Mõttus

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tel: +372 5519055

## **Participant Informing Sheet and Informed Consent Form** *(Translation)*

You are invited to participate in a survey study. The aim of the study is to map potential problems and opportunities for improvement. The study is conducted by Mirjam Mõttus.

Completing the questionnaire will take approximately 5 minutes.

Your participation in the study will remain strictly confidential, meaning that your responses will not be linked to you personally. The anonymous, non-identifiable data will be analysed by Mirjam Mõttus, and the results of the study will be presented in an aggregated form. The data will be used to present the research results in a master's thesis in a way that does not allow the identification of individual participants. Persons not involved in the research will not have access to data related to you. After the submission of the research and a positive result in the defence/evaluation, the collected data will be permanently destroyed within one month.

The master's thesis will be publicly available. Therefore, when answering open-ended questions in the survey, we ask that you do not disclose information intended for internal use only within the Defence Forces or information protected as state secrets. The survey does not include questions that require detailed information about your position, service duties, or other (national defence-related) information classified as access-restricted under §35 of the Public Information Act.

Participation in the study is voluntary, and you have the right to refuse participation or withdraw at any time. You also have the right to withdraw your consent at any time in a form that allows written reproduction (e.g. by email), without this affecting the lawfulness of data processing carried out prior to the withdrawal of consent.

Having read and understood the above, I confirm my consent to participate in the study and to the processing of anonymised data collected about me in the manner described above:

Yes

No

Additional Information About the Study

Mirjam Mõttus

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## **Appendix G**

### **Interview Questions**

#### **Igapäevane kogemus ja kontekst**

Kirjelda tavalist päeva, mil sa kannad kaitseväge vormi. Jäta välja detailsed tööülesande kirjeldused ja keskendu rõivastusele mida kannad läbi päeva.

Millised tegevused on sagedasemad?

Millistes keskkondades viibid vormi kandes kõige rohkem?

Milliseid muutuseid rõivastuses viid läbi päeva jooksul?

Millistel hetkedel märkad kõige rohkem vormi mugavust või ebamugavust?

millised on tegevused või olukorrad, kus see eriti välja tuleb?

Kas ja kuidas sa valmistad ennast teadlikult ette vormi kandmiseks teatud olukordades?

Näiteks kuidas sa paned selle selga või kohandad enne välja minekut?

#### **Liikumine ja piirangud**

Millised on olnud olukorrad, kus liikumine vormis on sind füüsiliselt takistanud?

Milliseid liigutusi on kõige raskem teha?

Millistes olukordades tulevad piirangud kõige paremini esile?

Millistes situatsioonides oled pidanud mingit liikumist ümber mõtlema või muutma selle tõttu, kuidas vorm istub või töötab?

Kirjelda olukorda, kus vorm takistas su liikumist või sooritust (nt ronimine, jooksmine, madalal liikumine jne).

Millised osad vormist takistasid kõige rohkem ja miks?

Mida suudsid teha, et olukorda parandada, või kohandasid oma tegevust, et takistusi ületada?

Millised vormi osad mõjutavad sinu liikumisvabadust kõige rohkem?

Millised on olnud olukorrad, kus liikumise piiratus on tekitanud ohuolukorra või takistanud ülesande täitmist?

Kui oled pidanud kandma kaitseväge vormi ekstreemsetes ilmastikutingimustes (külm, kuumus, vihm), kuidas on see mõjutanud sinu kehatunnetust ja vaimset vastupidavust?

Millised omadused (materjal, kaal, õhutus) aitasid või raskendasid toimetulekut?

Millised on olnud kõige raskemad olukorrad selles kontekstis?

Mõtle hetkedele, kus oled kunagi kandnud vormi, kui pidid töötama madalal, kitsastes kohtades (nt varjus, keldris, ruumides), kirjelda oma keha ja vormi koostööd sellistel hetkedel.

Kuidas vormi kandmine mõjutab sinu liikumisvõimekust sellistes kitsastes ja piiratud ruumides?

Mis oleks võinud vormi disainis aidata neid olukordi lihtsustada?

### **Probleemsed hetked kasutuses**

Kirjelda viimast korda, kui sul oli vormiga mingi probleem – mis juhtus ja mis selle põhjustas?

Mis sel hetkel toimus?

Kuidas sa olukorra lahendasid?

Millised on korduvad olukorrad, kus probleemid kipuvad ilmema?

Näiteks treeningud, ilmastik, kindel varustus?

Milliste probleemidega oled ajas hakanud „leppima“ või neid lihtsalt ignoreerima?

Miks sa neid ei lahenda?

Oled sa kunagi tundnud, et vorm on sulle füüsiliselt liiga kitsas või liiga suur (nt liiga tihe, liiga lai)?

Kirjelda olukorda, kus see probleem tekkis ja kuidas see mõjutas sinu liikumisvõimekust.

Millal viimati tekkis olukord, kus vajasin kiiret liikumist või paindlikkust, aga vormi kandmine takistas seda?

Milliste hetkedega oli see seotud näiteks kaitsepositsioonide võtmiseks, vältimise või muude kiirete liikumistega?

Kuidas said selles olukorras toimida ja milline vormi osa või omadus seda kõige rohkem takistas?

### **Vigastused ja vorm**

Kuidas on kaitseväe vorm põhjustanud hõõrdumist või villide teket?

Milliseid tegevusi olete pidanud kohandama, et vältida hõõrdumist või villide teket?

Kui tihti tekib hõõrdumine või villide teke vormi kandmisel?

Kuidas on need hõõrdumise või villide tekkega seotud probleemid mõjutanud teie teenistust?

Kuidas hindate kaitseväe vormi sobivust vigastuste vältimise osas?

Milliseid muid vigastusi olete kogenud vormi kandmise tõttu, näiteks liigeste pingeid, lihasevalu või kukkumised?

Millised vormi osad on põhjustanud valu või ebamugavust?

### **Kasutajapoolsed lahendused ja kohandamised**

Mida oled kunagi ise vormi juures muutnud, lisanud või eemaldanud, et vorm paremini töötaks?

Näiteks lõiganud, õmmelnud, lisanud kihte vms?

Milliseid „nippe“ või isiklike süsteeme oled kasutusele võtnud, et mugavust või funktsionaalsust parandada?

Kas need on sinu enda leiutatud või kuskilt õppinud?

Kas on olnud vajadust kasutada tsiviilriideid või muud varustust, sest vorm ei toimi soovitud viisil?

Kui sa peaksid õpetama uuele teenistujale, kuidas kaitseväge vormiga kõige paremini hakkama saada, mida sa talle soovitaksid?

### **Tunnetuslik kogemus ja keha tunnetamine**

Kuidas sa tajud oma keha, kui kannad vormi? Kas see tunne erineb tsiviilriietest?

Kas sa tunned ennast vormis liikuvana, kaitsutuna, piiratud või millegi muuna?

Millistel hetkedel oled tundnud, et vorm muudab seda, kuidas sa end ruumis või teiste inimeste suhtes tajud?

Kuidas see mõjutab sinu enesekindlust, valmisolekut ja väsimust?

Kuidas sa end vaimselt tunned, kui kannad kaitseväge vormi?

Kas see mõjutab sinu meeleolu, enesetunnet või enesekindlust?

Kas tunned, et see aitab sul „rolli sisse minna“ või hoopis pingestab?

### **Keha, varustuse ja vormi koostoime**

Kuidas sinu keha, vorm ja muu varustus (nt relv, varustusevest) omavahel koostöötavad?

Kuidas nende vaheline suhtlus toetab sind või lausa segab?

Millised on olukorrad, kus vorm ja muu varustus satuvad vastuollu?

Näiteks vorm ja rakmed, saapad ja püksisääred jne.

Millistel hetkedel oled tundnud, et mõni vormiosa takistab ligipääsu olulisele varustusele või tegevusele?

### **Soojus, ilm ja füüsiline koormus**

Kuidas mõjutab vormi kandmine su keha termoregulatsiooni?

Millistel hetkedel tekib ülekuumenemist, külmatunnet, higistamist?

Kuidas sa reageerid olukordades, kus ilm ja füüsiline koormus nõuavad erinevaid riietuslahendusi?

Millistel hetkedel sa kohandad midagi ja millistel hetkedel kannatad lihtsalt välja?

Milliseid viise oled leidnud, enda jahutamiseks või soojendamiseks, mis ei ole vormi enda lahendus?

Kirjelda olukorda kus oled pidanud kasutama mõnda nendest viisidest.

## **Soovitused ja kujutluspilt ideaalvormist**

Kui sa saaksid ise disainida uue kaitseväge vormi, millised oleksid kolm esimest muudatust, mida teeksid?

Mis muutuks mugavamaks, praktilisemaks või esteetilisemaks?

Millistest teiste riikide lahendustest oled kunagi näinud või kuulnud?

Mis nende juures kõige rohkem silma jäi?

## **\*Lahendused mis on olemas aga mis ei ole kasutusel**

Milliseid uusi lahendusi või tooteid olete näinud või kuulnud, mis võiksid aidata kaitseväge vormi kasutamise mugavust või funktsionaalsust?

Kas need lahendused on juba kasutusel teistes riikides või organisatsioonides?

Milliseid tehnoloogilisi või disaini uuendusi olete märganud, mis võiksid kaitseväge vormide kandmismugavust parandada?

Millised muudatused või täiustused võiksid teie arvates oluliselt muuta Eesti kaitseväge vormide kasutamist ja üldist efektiivsust?

Kas on mingeid lahendusi, mida teie arvates võiks Eestis kohandada, et need vastaksid rohkem teenistuses esinevatele väljakutsetele?

Kas need lahendused võiksid parandada teenistuse tõhusust ja liikuvust?

Kuidas hindate olemasolevaid lahendusi, nagu näiteks hingavad materjalid, modulaarsed disainid või kohandatavad omadused, mis võiksid vähendada vigastuste ja ebamugavuse riski?

Millised nendest lahendustest võiksid olla sobilikud Eesti kaitseväge vajadustele?

Millised lahendused võiksid olla kõige kasulikumad just Eesti kaitseväge teenistuses?

Märkused, tähelepanekud, kommentaarid

## **Interview Questions** (*Translation*)

### **Everyday Experience and Context**

Describe a typical day when you wear the Defence Forces uniform.

Please leave out detailed descriptions of work tasks and focus on the clothing you wear throughout the day.

What activities are most frequent?

In which environments do you spend most of your time while wearing the uniform?

What changes do you make to your clothing during the day?

At which moments do you notice the comfort or discomfort of the uniform the most?

What kinds of activities or situations make this especially noticeable?

Do you consciously prepare yourself in advance for wearing the uniform in certain situations?

For example, how do you put it on or adjust it before going out?

### **Movement and Restrictions**

In what situations has the uniform physically restricted your movement?

Which movements are the most difficult to perform?

In which situations do these restrictions become most apparent?

In which situations have you had to rethink or change a movement because of how the uniform fits or functions?

Describe a situation where the uniform hindered your movement or performance (e.g. climbing, running, moving low to the ground, etc.).

Which parts of the uniform caused the most restriction, and why?

What did you do to improve the situation, or how did you adapt your actions to overcome the obstacles?

Which parts of the uniform affect your freedom of movement the most?

Have there been situations where restricted movement created a hazardous situation or prevented task completion?

If you have worn the uniform in extreme weather conditions (cold, heat, rain), how did this affect your bodily sensation and mental endurance?

Which properties (material, weight, ventilation) helped or made coping more difficult?

What have been the most challenging situations in this context?

Think of moments when you had to work low to the ground or in tight, confined spaces (e.g. cover, basements, rooms). Describe the interaction between your body and the uniform in these moments.

How does wearing the uniform affect your mobility in such confined and restricted spaces?

What aspects of the uniform's design could have helped make these situations easier?

### **Problematic Moments in Use**

Describe the last time you experienced a problem with the uniform – what happened and what caused it?

What was happening at that moment?

How did you resolve the situation?

What are recurring situations where problems tend to arise?

For example, training, weather conditions, specific equipment?

Which problems have you gradually “come to accept” or simply ignore?

Why do you not address them?

Have you ever felt that the uniform was physically too tight or too loose

(e.g. too restrictive, too wide)?

Describe the situation and how it affected your mobility.

When was the last time you needed quick movement or flexibility but the uniform hindered it?

What situations was this related to (e.g. taking defensive positions, avoidance, other rapid movements)?

How did you manage in that situation, and which part or property of the uniform hindered you the most?

### **Injuries and the Uniform**

How has the Defence Forces uniform caused chafing or blisters?

What activities have you had to adapt to avoid chafing or blisters?

How often does chafing or blistering occur when wearing the uniform?

How have these issues affected your service?

How do you assess the suitability of the Defence Forces uniform in terms of injury prevention?

What other injuries have you experienced due to wearing the uniform, such as joint strain, muscle pain, or falls?

Which parts of the uniform have caused pain or discomfort?

### **User-Devised Solutions and Adaptations**

What have you personally changed, added, or removed from the uniform to make it work better?

For example, cutting, sewing, adding layers, etc.

What “tricks” or personal systems have you adopted to improve comfort or functionality?

Did you come up with these yourself or learn them from somewhere else?

Have you needed to use civilian clothing or other equipment because the uniform did not function as needed?

If you had to teach a new service member how to best cope with the Defence Forces uniform, what would you recommend?

### **Sensory Experience and Body Awareness**

How do you perceive your body when wearing the uniform? Does this feel different from civilian clothing?

Do you feel mobile, protected, restricted, or something else while wearing the uniform?

In which moments have you felt that the uniform changes how you perceive yourself in space or in relation to others?

How does this affect your confidence, readiness, and fatigue?

How do you feel mentally when wearing the Defence Forces uniform?

Does it affect your mood, self-perception, or confidence?

Does it help you "get into role," or does it create tension?

### **Interaction Between Body, Equipment, and Uniform**

How do your body, uniform, and other equipment (e.g. weapon, load-bearing vest) work together?

How does this interaction support you, or how does it interfere?

In which situations do the uniform and other equipment come into conflict?

For example, uniform and harnesses, boots and trouser legs, etc.

In which moments have you felt that a part of the uniform blocked access to essential equipment or actions?

### **Heat, Weather, and Physical Load**

How does wearing the uniform affect your body's thermoregulation?

In which moments do overheating, cold sensations, or excessive sweating occur?

How do you respond in situations where weather and physical load require different clothing solutions?

When do you adapt something, and when do you simply endure it?

What methods have you found to cool down or warm up that are not part of the uniform itself?

Describe a situation where you had to use one of these methods.

### **Recommendations and Vision of an Ideal Uniform**

If you could design a new Defence Forces uniform yourself, what would be the first three changes you would make?

What would become more comfortable, practical, or aesthetic?

What solutions from other countries have you seen or heard about?

What stood out the most about them?

**\*Existing Solutions That Are Not in Use**

What new solutions or products have you seen or heard about that could improve the comfort or functionality of Defence Forces uniforms?

Are these solutions already in use in other countries or organisations?

What technological or design innovations have you noticed that could improve wearing comfort?

What changes or improvements could, in your opinion, significantly improve the use and overall effectiveness of Estonian Defence Forces uniforms?

Are there solutions that could be adapted in Estonia to better meet service-related challenges?

Could these solutions improve service efficiency and mobility?

How do you assess existing solutions such as breathable materials, modular designs, or adjustable features that could reduce the risk of injuries and discomfort?

Which of these solutions would be most suitable for the needs of the Estonian Defence Forces?

Which solutions would be most beneficial specifically in Estonian Defence Forces service?

Notes, Observations, Comments

## Appendix H

### Uuritava informeerimise leht ja teadliku nõusoleku vorm (*Translation below*)

Kutsume Teid osalema Eesti Kaitseväe vormi puudutavas uuringus, mis viiakse läbi intervjuuna. Arutelus osalemine võtab aega ligikaudu 1-1,5 tundi. Te võite oma mõtteid väljendada vabalt, otsimata õigeid vastuseid ning uuringus osalemine ei eelda disaini haridust või eriteadmisi. Uuringut viib läbi Mirjam Mõttus.

Teie osalemine uuringus jääb rangelt konfidentsiaalseks, mis tähendab, et Teie poolt antud vastuseid ei seostata Teie isikuga. Arutelu/intervjuu viiakse läbi kas kohapeal või veebis, räägitu salvestatakse ning hiljem tehakse salvestuse põhjal üleskirjutused (transkriptsioonid), kust on eemaldatud isikuandmed (andmed on anonüümitud). Intervjuude transkribeeritakse ja transkriptsioonid säilitatakse välisel kõvakettal kuni kuu peale töö kaitsmist. Transkriptsioonile on juurdepääs ainult töö autoril. Uurimistööga mitteseotud isikutel puudub juurdepääs Teiega seotud uurimistöö andmetele.

Anonüümseid, vastajat mittetuvastavaid andmeid analüüsitakse Mirjam Mõttuse poolt. Andmeid kasutatakse uurimistöö tulemuste esitamiseks magistritöös viisil, mis ei võimalda identifitseerida konkreetseid isikuid. Pärast uurimistöö esitamist ja positiivse resultaadi saamist kaitsmisel/hindamisel hävitatakse intervjuude üleskirjutused jäädavalt kuu aja jooksul.

Magistritöö on avalik, mistõttu palume Teil intervjuu käigus Kaitseväe juurdepääsupiiranguga asutusesiseseks kasutamiseks mõeldud või riigisaladusega kaitstud teavet mitte avaldada. Intervjuu käigus ei küsita küsimusi, mis eeldavad detailset vastust Teie ametikoha, teenistusülesannete jm (riigikaitse) teabe kohta, mida loetakse AvTS § 35 alusel juurdepääsupiiranguga teabeks.

Uuringus osalemine on vabatahtlik ja Teil on õigus selles osalemisest keelduda või loobuda. Teil on igal ajal õigus nõusolek uuringus osaleda kirjalikku taasesitamist võimaldavas vormis (nt e-kirja teel) tagasi võtta, ilma et see mõjutaks enne nõusoleku tagasivõtmist toimunud andmetöötluse seaduslikkust.

Teades eeltoodud kinnitan oma nõusoleku uuringus osalemiseks ja minu kohta kogutud anonüümitud andmete töötlemisega eelpool kirjeldatud viisil:

- Jah
- Ei

Nimi:

Kuupäev:

Allkiri:

Uuringu kohta saab täiendavat informatsiooni:

Mirjam Mõttus

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## **Participant Information Sheet and Informed Consent Form** *(Translation)*

You are invited to participate in a study concerning the uniform of the Estonian Defence Forces, conducted in the form of an interview. Participation in the discussion will take approximately 1–1.5 hours. You may express your thoughts freely, without searching for “correct” answers, and participation in the study does not require a background in design or any specialised knowledge. The study is conducted by Mirjam Mõttus.

Your participation in the study will remain strictly confidential, meaning that your responses will not be linked to your identity. The discussion/interview will be conducted either in person or online. The conversation will be recorded and later transcribed based on the recording. All personal data will be removed from the transcripts (the data will be anonymised). The interviews will be transcribed, and the transcripts will be stored on an external hard drive until one month after the thesis defence. Access to the transcripts is restricted solely to the author of the thesis. Individuals not involved in the research will not have access to any research data related to you.

Anonymous, non-identifiable data will be analysed by Mirjam Mõttus. The data will be used to present research results in a master’s thesis in a way that does not allow the identification of individual participants. After submission of the thesis and receiving a positive result at the defence/evaluation, the interview transcripts will be permanently destroyed within one month.

As the master’s thesis will be publicly available, we kindly ask that during the interview you do not disclose information intended for internal use within the Defence Forces or information protected as state secrets. The interview will not include questions that require detailed information about your position, service duties, or other (national defence-related) information classified as access-restricted under §35 of the Public Information Act.

Participation in the study is voluntary, and you have the right to refuse participation or withdraw at any time. You also have the right to withdraw your consent to participate in the study at any time in a form that allows written reproduction (e.g. by email), without this affecting the lawfulness of data processing carried out prior to the withdrawal of consent.

Having read and understood the above, I confirm my consent to participate in the study and to the processing of anonymised data collected about me in the manner described above:

Yes

No

Name:

Date:

Signature:

Additional Information About the Study

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