[1.] Orsolya GONDÁN–JANCSÓ

COMMUNICATING MILITARY MODERNITY THROUGH UNIFORM DESIGN: A COMPARATIVE PERCEPTION STUDY OF HUNGARIAN AND GERMAN FIELD UNIFORMS

[1.] Óbuda University, Doctoral School on Safety and Security Sciences, Budapest, HUNGARY

Abstract: The development of military field uniforms has traditionally been guided by textile engineering and functional considerations; however, their visual appearance may also influence perceptions of technological sophistication, modernity and professionalism. This study examined whether different generations of military uniforms can be identified on the basis of visual information alone and whether visually more modern–looking systems are perceived as technologically more advanced. Anonymised images of four military field uniforms (2004M, 15M, Flecktarn and Multitarn) were evaluated by 20 soldiers, 20 civilians and 10 fashion designers using seven–point Likert scales, forced–choice questions and open–ended responses. Participants in all three groups were able to distinguish between older and newer generations. Multitarn consistently emerged as the most modern system, whereas the 2004M was most frequently perceived as the oldest. Civilians showed a particularly strong association between visual modernity and perceived technological sophistication, while soldiers evaluated the systems more cautiously and rated the 15M similarly to Multitarn across several dimensions. Fashion designers primarily differentiated between the uniforms on the basis of visual coherence, design innovation and the relationship between form and function. The findings suggest that technological development in military uniforms is visually recognisable, although its interpretation depends on the observer's professional background. The results further indicate that military uniforms function as instruments of communication and carriers of symbolic meaning.
Keywords: military uniform, visual perception, Multitarn, Flecktarn, 15M

1. INTRODUCTION

The development of military uniforms is primarily driven by engineering parameters; however, the perception of a clothing system does not depend solely on its material composition, fabric structure or measurable functional performance. Increasing attention has been given to the idea that field uniforms serve not only a protective function but also act as instruments of visual communication. Observers frequently draw conclusions regarding the modernity, technological sophistication and professional character of a uniform on the basis of its pattern, colour structure, surface characteristics and overall visual appearance.

In modern warfare, it is therefore becoming increasingly important to recognise that technological differences between successive generations of development cannot be understood solely through textile engineering parameters. Consideration must also be given to the extent to which these characteristics are expressed visually and how readily they can be recognised by different groups of observers.

2. EVOLUTION AND TEXTILE ENGINEERING CHARACTERISTICS OF MILITARY FIELD UNIFORMS

Modern field uniforms underwent significant technological transformation during the twentieth century [1], evolving from simple protective garments into complex engineered systems in which textile technology, ergonomics and operational requirements all play an important role. The growing demands of modern warfare require soldiers to maintain a high level of performance across a wide range of environmental conditions, necessitating multifunctional protective systems. Uniforms have progressively incorporated innovations from materials science and the textile industry, leading from cotton-based garments to synthetic fibre blends and, more broadly, to developments that improve durability, comfort and operational functionality [2]. Such advances include enhanced mechanical durability when encountering hard terrain features, improved comfort during prolonged wear, greater adaptability to different environments, and reduced visual and infrared detectability [3].

Over recent decades, a form of material-technological convergence has emerged in the development of military clothing systems, whereby different armed forces have adopted similar technological solutions [2]. Similarities can therefore be observed among the uniforms of NATO member states. Despite operational differences and varying design philosophies, contemporary field uniforms are generally based on blended-fibre fabrics (most commonly cotton-polyester or cotton-nylon blends), reinforced fabric structures and modular clothing systems.

Military field uniforms must demonstrate exceptional mechanical performance under conditions that conventional civilian clothing would be unable to withstand. Among the most critical mechanical properties are tensile strength, tear resistance, abrasion resistance and dimensional stability, all of which are essential to maintaining functionality [2]. Cotton-polyester blends (65/35 or 80/20) improve tensile strength, wear resistance and moisture management [4]. The cotton component provides breathability and comfort, while synthetic fibres (polyester or nylon) contribute to durability and rapid drying in wet or demanding field conditions.

The optimisation of fabric structure, including parameters such as weave density, fibre thickness and overlap ratios, is also a fundamental factor in uniform performance [5]. Compared with traditional two-dimensional fabrics, three-dimensional textile structures demonstrate improved resistance to deformation and enhanced energy absorption capabilities [6]. These properties largely determine the service life of military uniforms and their ability to retain protective and functional characteristics over time.

Operational requirements further necessitate flame resistance, antistatic behaviour and multispectral camouflage capabilities. Military uniforms must address the threat posed by infrared detection systems; consequently, effective multispectral protection requires material compositions and fabric structures capable of reducing thermal emissions [7]. Recent developments have therefore expanded the functional scope of military textiles to include thermal regulation through phase-change materials, advanced moisture-management systems enabled by specialised fibre technologies, and even integrated sensing capabilities that allow real-time monitoring of soldiers' physiological parameters [8]. Such smart materials enable uniforms to respond to environmental conditions, transmit tactical information and monitor physiological signals while maintaining acceptable levels of comfort and functionality [8].

These multifunctional systems represent a departure from traditional uniform concepts, in which protective and functional characteristics were incorporated passively through material technologies. Instead, they embody active technological systems capable of responding in real time to environmental and operational demands.

Concealment is of critical importance in military uniforms; consequently, the camouflage function of contemporary uniforms is far more complex than traditional visual concealment alone. With the development of modern multispectral detection technologies, visual camouflage is no longer sufficient in itself, and uniforms must provide protection across a broad range of the electromagnetic spectrum [9]. The evolution of military camouflage systems reflects broader changes in military technology and strategies designed to counter visual detection [10]. During the Cold War, most camouflage patterns were optimised for specific regional environments. Over the past decade, several armed forces have replaced analogue patterns with digital camouflage systems in order to improve effectiveness across a wider range of operational environments. Conceptually, digital camouflage patterns are based on fractal-like structures that complicate visual processing across multiple spatial scales [11]. Pixelated or grid-based structures are deliberate design choices, and the resulting patterns often do not directly replicate the forms found in natural vegetation. Field-testing results indicate that universal camouflage patterns may provide performance improvements of 20–30 per cent compared with terrain-specific designs [10].

NATO standardisation plays an important role in shaping the uniform specifications of member states. Standardised testing methods ensure consistent evaluation across different military forces, facilitating interoperability and enabling direct comparison of textile systems employed by allied partners [3]. These standards address critical parameters, including mechanical strength, thermal properties, moisture-management characteristics and resistance to environmental degradation.

3. EVOLUTION OF HUNGARIAN AND GERMAN MILITARY UNIFORMS

Hungarian military field uniforms have undergone substantial development over the past century. The colourful uniforms of the nineteenth century were gradually replaced during the early twentieth century by grey, then khaki, and eventually camouflage-patterned uniforms, initially manufactured from wool and later from cotton canvas following Soviet practice [12] [13].

One of the most iconic elements of Hungarian military uniform history, the 1965M green field uniform introduced after the Second World War, remained in service well beyond the political transition of the 1990s. In line with twenty-first-century requirements, the 2000M uniform introduced a three-colour camouflage pattern, followed by a four-colour variant. The 2004M adopted a desert colour scheme and was based on the cut of the American BDU field uniform, incorporating numerous American design elements. At the same time, as a distinctively Hungarian feature, it was produced in both heavier and lighter versions in order to accommodate different climatic conditions [1]. These twenty-first-century uniforms all incorporated camouflage patterns and were manufactured from lighter, more breathable ripstop fabrics, providing greater comfort than their twentieth-century predecessors. However, limitations in material durability were reported under certain operational conditions [1].

The 15M uniform was developed to address these shortcomings. Designed in accordance with the digital requirements of the twenty-first century, it complies with the clothing material standards employed by NATO armed forces. It is manufactured using a ripstop weave and consists of 64 per cent Lenzing FR (flame-resistant viscose), 24 per cent para-aramid, 10 per cent polyamide and 2 per cent antistatic fibres. The blended textile (surface density: 210 g/m^2) provides good breathability, moisture absorption and oil repellence, while also exhibiting high tensile strength (900/800 N on a 50 × 200 mm specimen), excellent abrasion resistance (≥ 3,500 cycles), strong colour fastness (grade 5), and antistatic properties. As a result, the fabric does not accumulate electrostatic charge, minimising spark generation and meeting infrared reflectance requirements [14] [15].

The 15M HunCam pattern is composed of seven colours and features a base layer transitioning from brown to light tan, overlaid with gradients of dark green, olive green, and lime green, and finished with irregular opaque shapes in dark brown and cream tones distributed across the surface. This layered structure enables the visual appearance to shift between predominantly green and predominantly brown across different sections of the fabric, while smaller disruptive elements break up the larger background areas to enhance concealment [16].

The 15M was developed over several years and was influenced by foreign design concepts, particularly through the adaptation of the MultiCam pattern. Its purpose was to meet the challenges of twenty-first-century military operations as part of the Digital Soldier Programme, through which the Hungarian Defence Forces modernised personal equipment, tactical gear and individual communication systems [1].

The development of German military uniforms followed a different trajectory. Following the grey uniforms of the Imperial German Army during the First World War, which were broadly similar to their Hungarian counterparts, Germany became one of the principal pioneers of military camouflage design [17]. Yet relatively limited progress was made in camouflage uniform design until the German Army initiated uniform trials in 1976. These trials resulted in several experimental patterns, including the Sägezahnmuster (sawtooth pattern), Punktmuster (dot pattern), and three variants of Flecktarn (spot pattern). The Flecktarn designs were categorized as A (small spots), B (large spots), and C (shadow variant). Among these, the Flecktarn B pattern proved to be the most effective and was subsequently adopted by the German Army in the mid-1980s under the name Flecktarnmuster, with additional adaptations for tropical and desert environments [17]. German Flecktarn is widely regarded as one of the most effective camouflage systems globally [18].

The Flecktarn pattern consisted of a five-colour spotted structure combining light green (15 per cent), dark green (35 per cent), olive green (20 per cent), reddish-brown (20 per cent) and black (10 per cent) shades [16], and became one of the most recognisable military designs in Europe. For a long period, it served as the standard camouflage pattern of the Bundeswehr following its nationwide adoption after German reunification in 1990. It was specifically optimised for Central European woodland environments. The pattern was designed to imitate the visual noise of natural vegetation. It was manufactured using a dithering technique that generates a randomized, non-repetitive distribution of colours [16]. The pattern eliminated hard boundaries between colours, making Flecktarn effective in temperate woodland environments. It also provided effective masking in the near-infrared spectrum.

Changes in the operational environment during the twenty-first century, particularly the increasing importance of urban and mixed-terrain settings, created a demand for further development. As a result, the Bundeswehr launched a new development programme in the early 2010s aimed at creating a more universal camouflage pattern. The programme was conducted by the Wehrwissenschaftliches Institut für Werk- und Betriebsstoffe, with the objective of developing a camouflage system capable of functioning effectively across multiple environments [19].

The new system, Multitarn, employs six colours and is based on the structural principles of Flecktarn, but incorporates a more complex visual logic. The pattern began to be introduced from 2016 within German special operations units, including the Kommando Spezialkräfte. The aim of Multitarn was not to create a compromise solution, but rather a system capable of providing acceptable camouflage performance across a range of terrain types, including woodland, open and urban environments. According to current Bundeswehr plans, Multitarn is expected to replace Flecktarn progressively across the entire force between 2026 and 2029 [19] [20].
Unlike the Hungarian 15M, the introduction of Multitarn did not involve the development of an entirely new uniform system. Whereas the Hungarian 2004M and 15M differ in terms of cut, material composition and consequently properties such as durability, the primary change in the case of Multitarn occurred at the level of the camouflage pattern. The fundamental construction, garment design and textile-technological characteristics of the uniform largely remained consistent with the previous system. Multitarn therefore represents an evolutionary development of the Flecktarn system, focusing primarily on the modernisation of visual camouflage logic.
Both the Hungarian and German development trajectories demonstrate that the evolution of camouflage patterns is driven by changes in military technology and operational requirements, with increasing emphasis placed on universal solutions capable of functioning effectively across multiple environments.

4. VISUAL MODERNITY AND TECHNOLOGICAL PERCEPTION

In addition to their functional role, military uniforms exert a significant perceptual influence through their visual appearance. Research on visual material perception suggests that people infer a product's technological sophistication or durability on the basis of surface texture, pattern and structural characteristics.
The sophisticated mechanisms underlying the visual perception of material properties are characterised by the fact that the visual system does not perform direct optical calculations to estimate the physical parameters of a material. Instead, it constructs statistical generative models that encode variations in material appearance across different viewing conditions, lighting environments and surface configurations [21]. This perceptual approach enables rapid and generally accurate material identification despite the considerable variability in visual appearance.
According to Filip et al. [22], human judgements regarding the appearance and similarity of materials can be accurately predicted from only two standardised images of a material. This suggests that perceptual attributes are organised along predictable dimensions that are largely independent of the specific material category.
Texture perception represents a particularly important dimension of material evaluation, combining both visual and tactile information processing [23]. However, visual appearance does not necessarily convey tactile properties such as comfort, flexibility or elasticity [24], potentially creating perceptual discrepancies between appearance-based evaluations and actual user experience.
Research on camouflage effectiveness highlights the complex interactions between camouflage pattern characteristics, observer perceptual mechanisms and environmental context [25]. According to an eye-tracking study by Yang et al. [25] investigating the detection of camouflaged targets, disruptive colour patterns significantly affected target recognition. In complex woodland environments, they resulted in longer detection times than non-disruptive patterns and reduced detection rates by approximately 15 per cent.
The visual design of camouflage patterns fundamentally shapes their perceptual effectiveness across different terrain environments [10]. Pattern designs incorporating disruptive elements and adaptive colour gradients that mimic natural texture variation demonstrate substantially better camouflage performance in complex environments.
Perceived technological sophistication does not necessarily correspond to actual performance [1]. Digital camouflage patterns often appear more sophisticated and technologically advanced to observers than traditional patterns, even when differences in field performance are not statistically significant. Non-expert civilian observers may systematically favour patterns and materials that appear technologically advanced [1]. This visual bias suggests that human perception remains deeply rooted in appearance-based judgements and does not always reflect the underlying engineering characteristics of a system, making such evaluations potentially unreliable.

ISSN 1584 – 2665 (printed version); ISSN 2601 – 2332 (online); ISSN-L 1584 – 2665

5. VISUAL PERCEPTION OF FIELD UNIFORM MODERNISATION

Within military uniform research, technological and perceptual approaches are often treated as separate fields of investigation. Textile engineering studies primarily focus on material and structural properties, whereas perception-based research tends to examine the effects of design and visual impressions.

Relatively few studies have addressed military uniform development generations from the perspective of how readily they can be recognised through visual appearance alone. This is particularly relevant when military uniform systems evolve within similar operational environments yet adopt different design solutions. The present study examines this question through the comparison of two Hungarian and two German military uniforms.

The aim of the research was to explore the extent to which differences arising from the technological and design evolution of military field uniforms can be recognised solely on the basis of visual appearance. The study sought to determine whether observers are able to identify generational development in military uniforms and whether visually more modern-looking systems are automatically perceived as technologically more advanced. The proposed hypothesis was that observers would be capable of distinguishing between different generations of military uniforms using visual information alone and that uniforms perceived as visually more modern would also be evaluated as technologically more advanced, regardless of the actual engineering differences between the systems.

The study was conducted as an image-based perception experiment comparing two Hungarian uniforms (2004M and 15M) with two generations of German uniforms (Flecktarn and Multitarn). This structure made it possible to investigate the extent to which observers could identify generational changes within a given uniform system and how visual differences between development generations influence perception. A total of 20 soldiers, 20 civilians and 10 fashion designers participated anonymously. The soldier group included both active and former service personnel, all of whom possessed field experience and familiarity with different military uniforms. The civilian group represented general societal perceptions, having no military background. The fashion designers constituted an expert sample due to their experience in clothing or textile design, enabling them to interpret visual systems in a more complex manner.

Participants were presented with images of four military uniforms shown in identical poses, photographed from the same camera angle and displayed against a neutral background. All identifying features referring to a specific country or organisation, such as flags or insignia, were removed.

The uniforms were presented without their original designations, and the order of presentation was randomised for each participant in order to minimise order effects. Separate questionnaires were prepared for the three participant groups. Respondents evaluated the uniforms using seven-point Likert scales across several perceptual dimensions and also completed comparative and open-ended questions.

During the evaluation process, participants assessed the uniforms across several perceptual dimensions. The principal variables examined were:

- perceived modernity
- perceived technological sophistication
- perceived durability
- perceived professionalism
- perceived functional suitability
- perceived camouflage effectiveness
- perceived generational advancement

In addition to the Likert-scale evaluations, forced-choice tasks were used to enable the relative ranking of the uniforms in terms of perceived modernity, age, durability, suitability for field use and camouflage effectiveness. The Likert-scale assessments and forced-choice tasks were further complemented by open-ended questions, through which participants were able to share their own experiences and observations.

The data analysis began with descriptive statistical procedures, which were used to determine the mean ratings of each uniform across the different variables. This was followed by the ranking of the uniforms based on the forced-choice tasks and subsequent comparisons between participant groups.

ISSN 1584 – 2665 (printed version); ISSN 2601 – 2332 (online); ISSN-L 1584 – 2665

As the study was exploratory in nature, the sample size was limited and therefore not representative. Nevertheless, it was considered sufficient for exploring the visual perception of technological development in military uniforms and for identifying potential perceptual biases across different observer groups. This is particularly relevant given the increasing recognition that military uniforms function not only as protective equipment but also as instruments of visual communication and carriers of symbolic meaning [1] [26].

6. PERCEIVED TECHNOLOGICAL AND GENERATIONAL DIFFERENCES

The results revealed a clear and coherent pattern across the different observer groups. Despite the anonymised presentation of the uniforms, participants were able to distinguish between older and newer development generations with a high degree of consistency. Across all three groups, Multitarn emerged as the most modern system, whereas the 2004M was almost invariably perceived as the oldest. The 15M and Flecktarn occupied intermediate positions, although their evaluation varied between observer groups.

The Likert-scale ratings indicated a strong relationship between perceived modernity and perceived technological sophistication, particularly among civilians. Multitarn received the highest scores across all major dimensions, especially in terms of perceived modernity, technological sophistication and camouflage effectiveness. The 15M also received consistently high evaluations, suggesting that participants identified it as a modern system, although generally at a lower level than Multitarn. By contrast, the 2004M received the lowest scores across all dimensions, particularly in perceived modernity and generational advancement. Nevertheless, its perceived camouflage effectiveness lagged less markedly behind the other uniforms than did its ratings in the remaining dimensions.

Within the military group (Figure 1), the difference between the 15M and Multitarn was minimal, suggesting that the designers of the 15M successfully adopted the multi-terrain design concept in the development of the pattern. In perceived modernity, the difference amounted to only 0.3 points (6.1 versus 6.4), while perceived technological sophistication also differed by just 0.3 points (6.0 versus 6.3). For functional suitability, the difference was merely 0.2 points (6.1 versus 6.3). By contrast, civilian participants perceived substantially larger differences between the two systems and regarded Multitarn as clearly more advanced. Flecktarn occupied a distinctive intermediate position. As it remains in active service, it appeared almost as modern as Multitarn to many civilian respondents.

The findings indicate that visual appearance alone is sufficient for recognising generational differences, while visually modern designs strongly influence perceptions of technological sophistication. At the same time, the interpretation of these visual cues is highly dependent on the observer's level of expertise.

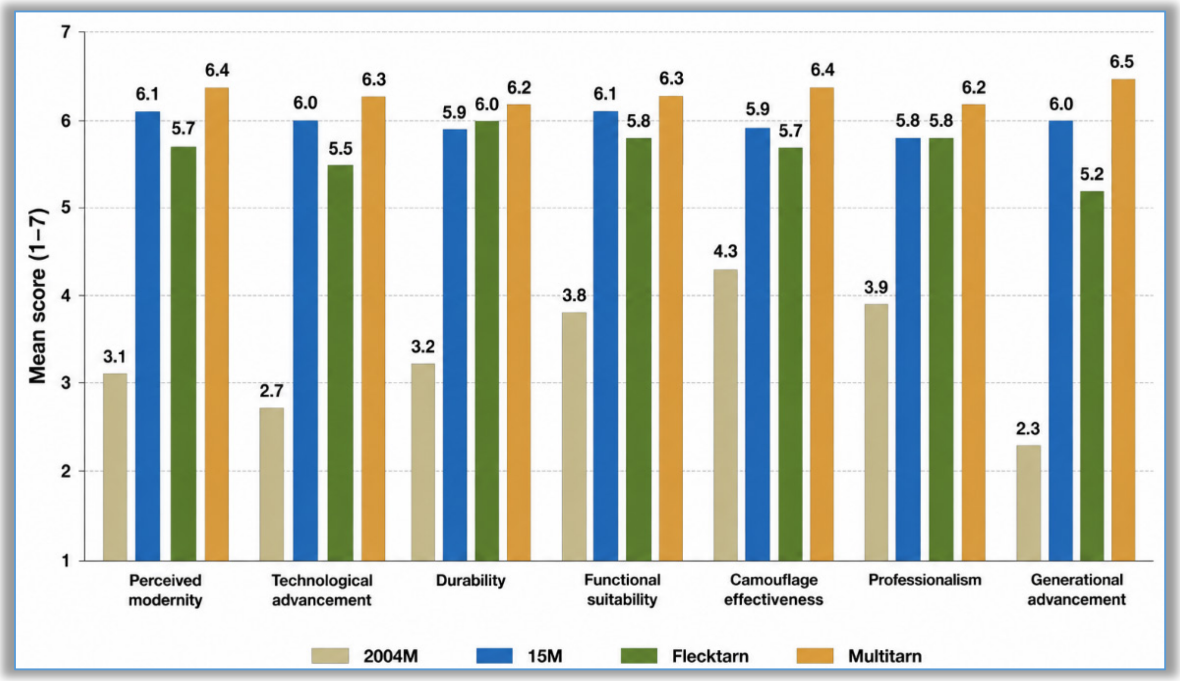

Figure 1: Perceived Uniform Characteristics – Soldiers

The responses provided by military participants revealed a balanced and professionally differentiated perspective. Although Multitarn also emerged as the most modern system within this group, the ratings assigned to the 15M were very similar. Both the 15M and Multitarn were identified as modern systems, and participants did not draw a sharp distinction between them in functional terms. The three more advanced systems (15M, Flecktarn and Multitarn) received highly comparable ratings in the dimensions of durability, field suitability and camouflage effectiveness. Military participants displayed a balanced and professionally differentiated evaluation pattern. Although Multitarn was also perceived as the most modern system within this group, the 15M received similarly high evaluations. Both the 15M and Multitarn were identified as modern systems and were not sharply differentiated in terms of functionality. For durability, the three advanced systems (15M, Flecktarn and Multitarn) received scores ranging from 5.9 to 6.2; for functional suitability, from 5.8 to 6.3; and for camouflage effectiveness, from 5.7 to 6.4. These findings were reinforced by the forced-choice results, in which Multitarn was most frequently selected as the most modern system, being chosen by 55 per cent of respondents, while the 15M was also selected by a substantial proportion of participants (40 per cent).

The evaluation of Flecktarn within this group is particularly noteworthy. Although participants were aware that the pattern represents an older generation, it continued to be perceived as a reliable and functionally effective system. It received relatively high ratings for durability (6.0), field suitability (5.8) and camouflage effectiveness (5.7).

Among civilian participants (Figure 2), a strong relationship was observed between visual appearance and perceived technological sophistication. Multitarn clearly emerged as the most modern and technologically advanced system, achieving scores of 6.7 for perceived modernity, 6.8 for technological sophistication, 6.5 for functional suitability, 6.7 for camouflage effectiveness and 6.9 for generational advancement. The 15M consistently occupied second place across these dimensions. Civilians perceived a considerably larger difference between the two systems than military participants. Whereas civilians rated Multitarn as 1.2 points more modern (6.7 versus 5.5) and 1.2 points more technologically advanced (6.8 versus 5.6) than the 15M, the corresponding differences among military participants were only 0.3 points in both dimensions (6.4 versus 6.1 and 6.3 versus 6.0, respectively).

The perception of Flecktarn within this group is particularly interesting, as civilian evaluations often broadly followed the same pattern as those of the soldiers, although civilians tended to perceive larger differences between the systems.

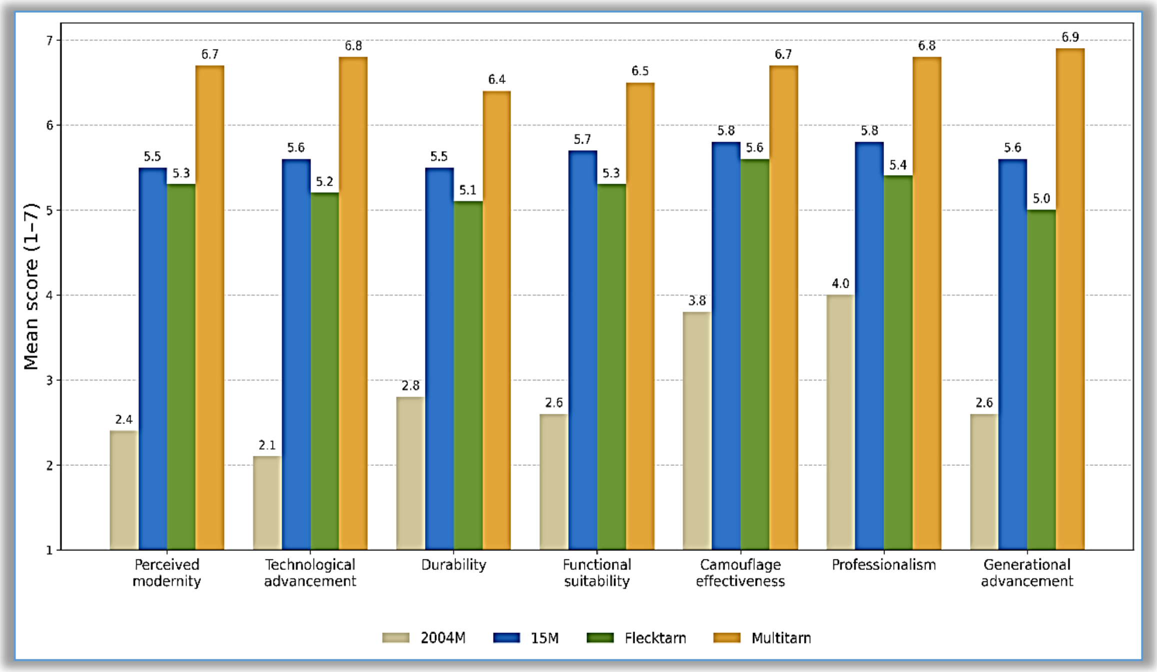

Figure 2: Perceived Uniform Characteristics – Civilians

Responses to the open-ended questions suggest that participants viewed Flecktarn as a classic military pattern that served as a familiar visual reference. This interpretation is also supported by the moderately high scores it received across several functional dimensions. It is noteworthy that

Flecktarn consistently received lower ratings than the 15M among civilians, whereas the distinction was less pronounced among soldiers. Civilian respondents rated Flecktarn at 5.1 for durability, 5.3 for functional suitability, 5.6 for camouflage effectiveness and 5.4 for professionalism, values that only slightly lagged behind the corresponding ratings of the 15M. This suggests that civilian evaluations were influenced not only by visual complexity but also by previous experience and cultural references, in this case the fact that most respondents were Hungarian. At the same time, the results indicate that non-expert observers rely heavily on visual impressions when evaluating technological systems. This may explain why civilians consistently assigned higher ratings to the newest Multitarn system than soldiers did. The difference is particularly evident in perceived technological sophistication (6.8 vs. 6.3), professionalism (6.8 vs. 6.2) and generational advancement (6.9 vs. 6.5).
Among the fashion designers, visual system coherence and the relationship between form and function played a central role in the evaluation process (Figure 3). At the same time, it is noteworthy that the overall evaluation pattern closely resembled that observed among civilians. Multitarn received the highest ratings in both visual coherence (6.3) and design innovation (6.4), whereas Flecktarn was perceived as representing an earlier but internally consistent design language, receiving a mean score of 5.1 for visual coherence and 5.0 for form–function balance. The 2004M received low ratings across all visual dimensions (3.4 for visual coherence, 3.0 for design innovation and 2.9 for generational modernity), reinforcing its perception as an outdated system. This is particularly interesting given that Flecktarn is, in overall terms, the older system, although it has undergone continuous generational development over time. Previous research comparing Hungarian field uniform generations similarly demonstrated that the 15M was evaluated more favourably by fashion designers in the desert colourway context [1]. The present study produced a comparable pattern, with the 15M receiving the second-highest ratings across most dimensions (5.8 for visual coherence, 5.9 for design innovation and 6.1 for generational modernity), surpassing Flecktarn. Responses to the open-ended questions suggest that design experts also considered the internal logic of the visual system, as well as its relationship to everyday military practice, when forming their evaluations.

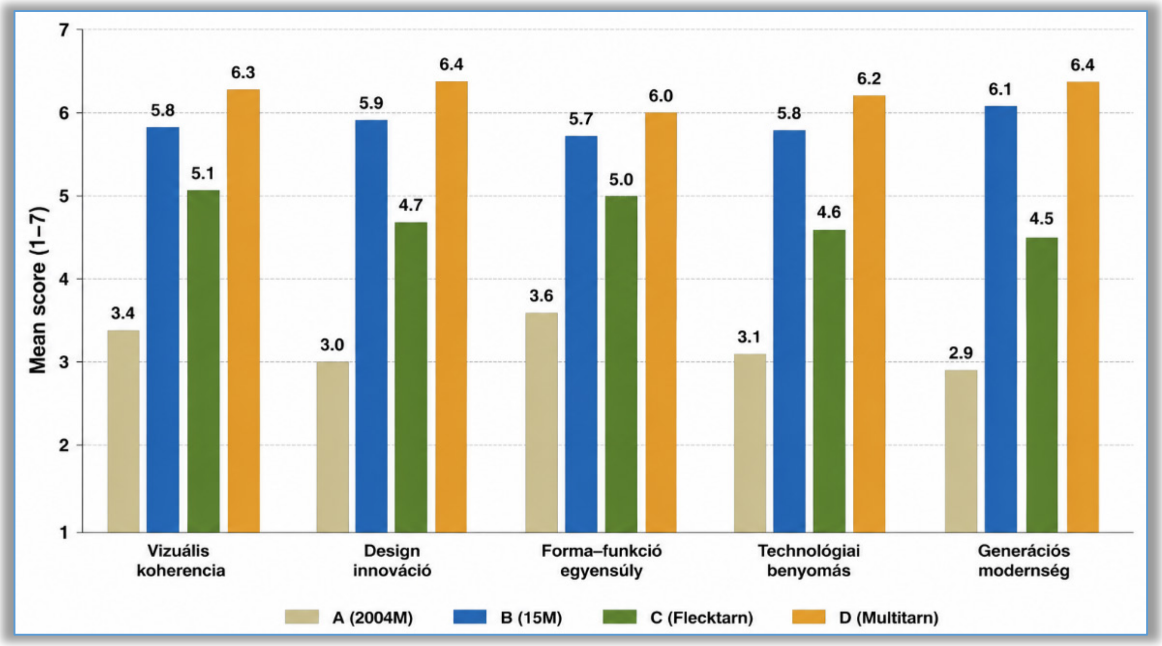

Figure 3: Perceived Uniform Characteristics – Fashion Designers

The forced-choice tasks (Figure 4) reinforced the patterns observed in the Likert-scale evaluations. Across all three groups, Multitarn was the system most frequently identified as the most modern. Both soldiers and civilians selected it as the most modern uniform in 55% of cases, while half of the fashion designers also chose it. In the oldest category, the 2004M clearly dominated, with soldiers and civilians again showing remarkably similar responses, as 75% of both groups identified it as the oldest system. In the categories of perceived durability and suitability for field use, responses were distributed across the 15M, Flecktarn and Multitarn, particularly among the soldiers, where approximately one-third of respondents selected each of the three uniforms. The parallel patterns observed between the civilian and military groups are particularly noteworthy. Despite differences in professional background, both groups showed a high degree of agreement in identifying the oldest and most modern systems, suggesting that the visual cues associated with generational development were widely recognisable regardless of military experience.

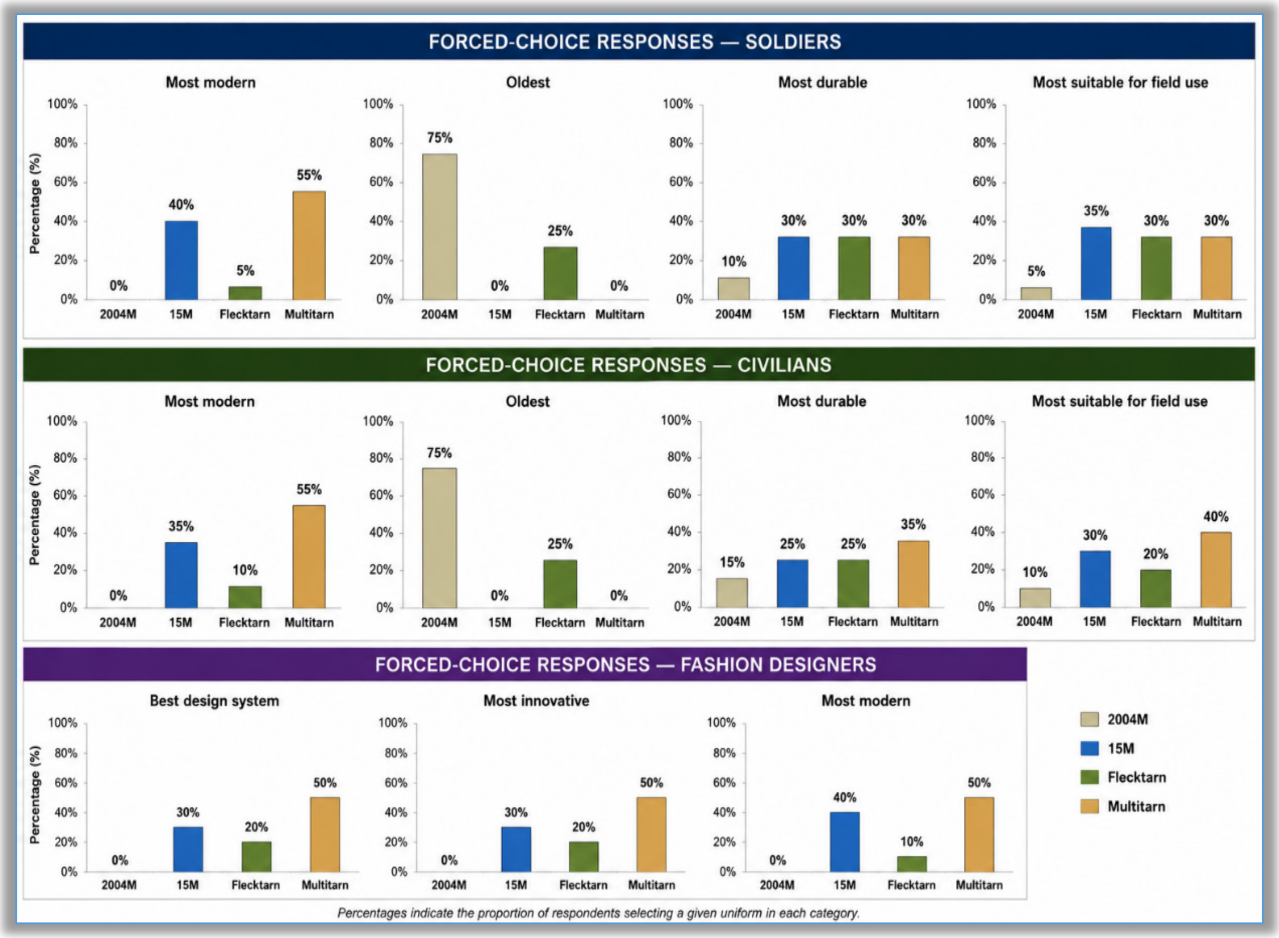

Figure 4: Forced Choice Responses Among Different Groups

Based on these findings, it is clear that participants were generally able to recognise the direction of uniform development, although the manner in which they interpreted these developments differed between groups. Responses to the open-ended questions suggest that civilians tended to interpret the differences in binary terms (old versus new), whereas soldiers perceived a more gradual process of development. Fashion designers primarily differentiated between generations on the basis of the complexity of the visual system. It is also noteworthy that the German developments received higher evaluations than the Hungarian ones, with German systems accounting for 60% of the votes in the most modern category among both soldiers and fashion designers, and 65% among civilians.

7. CONCLUSION

The findings of the study demonstrate that successive generations of military uniforms are visually recognisable in a consistent manner, even when presented in an anonymised context. Participants across all three groups were able to identify older and more modern systems, suggesting that the evolution of military design creates perceptible patterns that can be recognised by a wide range of observers. This finding is consistent with the literature on perception, which suggests that the human visual system is capable of inferring material and system properties from complex visual patterns [21]. The present study extends this principle to military textile systems.

The results also clearly indicate a close relationship between perceived visual modernity and perceived technological sophistication, particularly among non-expert observers. Within the civilian group, visually more complex and digitally inspired camouflage patterns consistently received higher ratings for technological advancement, supporting the assumption that observers draw implicit technological conclusions from formal visual characteristics. This finding is consistent with the observations of Filip et al. [22], who argued that the visual appearance of materials and surfaces strongly influences the attributes associated with them. The results obtained from the military group, however, suggest that this relationship is not universal. Among soldiers, the difference between the 15M and Multitarn was minimal, indicating that professional experience moderates the influence of visual bias. With regard to Flecktarn, it may be characterised as a classic and well-established military pattern that is perceived as a stable and reliable system largely because of its familiarity among respondents.

The development of Hungarian field uniforms has, in every generation, been influenced by some form of international design precedent. The findings suggest that respondents often evaluated the foreign uniforms more favourably in direct comparisons. At the same time, among soldiers, the 15M achieved ratings very close to those of Multitarn across several dimensions, and Flecktarn did not consistently outperform the 15M. This indicates that visual perception is shaped not only by formal design characteristics but also by cultural and experiential factors.

Overall, the interpretation of field uniforms appears to be strongly dependent on the observer's expertise. Soldiers tend to evaluate uniforms primarily on the basis of functional considerations, whereas civilians rely more heavily on visual impressions and are more likely to interpret a modern appearance as evidence of technological superiority. Fashion designers, by contrast, focus primarily on the coherence of the visual system. These differences are further complicated by cultural embeddedness. Nevertheless, the variation in responses demonstrates that military uniforms are not merely functional artefacts but also visual systems open to multiple interpretations, carrying different meanings for different observers. Further investigation through larger-scale studies, potentially conducted in dynamic environments, is required to explore these phenomena in greater depth. The findings suggest that visual design functions as an independent carrier of meaning and does not necessarily reflect underlying functional performance. As military uniforms increasingly assume a role as deliberate instruments of communication in the context of expanding international conflicts, it becomes important to understand the signals they convey to observers, particularly those that may influence perceptions of trustworthiness, competence and power [1]. The present study further demonstrated that non-expert groups tend to place greater emphasis on visual appearance than on actual technological sophistication, reinforcing the significance of the communicative role of military uniforms.

References

[1] Gondan–Jancso, O. (2026). The Interplay of Form, Function and Perception: Technolocical and Visual Assessments of Hungarian Military Field Uniforms. Annals of Faculty Engineering Hunedoara, 24(1).

[2] Steffens, F., Gralha, S. E., Ferreira, I. L. S., & Oliveira, F. (2019). Military Textiles – An Overview of New Developments. Key Engineering Materials. 812, 120–126.

[3] Revaiah, R., Kotresh, T., & Kandasubramanian, B. (2020). Technical textiles for military applications. Journal of the Textile Institute. 111(2), 273–308.

[4] Saini, U., & Guru, R. (2025). Optimizing Fiber Blends: Impact on Handle and Mechanical Properties of Handloom Curtain Fabrics, Part – I. Journal of the Textile Association. 86(4), 432–437.

[5] Naglic, M. M., Petrak, S., & Tomljenovic, A. (2025). Analysis of Woven Fabric Mechanical Properties in the Context of Sustainable Clothing Development Process. Polymers. 17(15), 2013.

[6] Zhao, J., Peng, Y., Hu, P., Hu, X., Su, X., & Sun, F. (2025). Knot-Patterned Treble-Weaving Smart Electronic Textiles with Advanced Thermal and Moisture Regulation for Seamless Motion Monitoring. Advanced Functional Materials. 35(35), 2501912.

[7] Su, Y., Yu, B., & Zhao, X. (2023). Research status and development of infrared camouflage textile materials. Textile Research Journal. 93(21–22), 5047–5082.

[8] Lu, Q., Lei, T., Xu, J., Qin, J.–Y., & Hu, W. (2026). Smart Materials and Soldiers: Applications and Challenges – A Mini Review. Advanced Engineering Materials. 28(6), e202502320.

[9] Zhai, Z., Zhang, N., She, X., Li, S., Jin, X., & Jin, C. (2026). Nanoforest–like Metamaterials for VIS–IR Dual–Band Camouflage. ACS Applied Materials and Interfaces. 18(4), 7269–7280.

[10] Samarasinghe, W. r. c. i., Liyanage, P., & Wijerathne, D. S. (2024). Exploring the visual design of military camouflage patterns and developing Sri Lankan military's unique camouflage style. Proceedings of Integrated Design Research Conference 2024. 3.

[11] Nguyen, T., & Nguyen, D. P. (2025). A method for designing pixelated camouflage patterns for forest terrain backgrounds. Journal of Military Science and Technology. 106, 121–128.

[12] Kánya, A. (2019). Komfortérzet és tépőzár: A magyar fegyveres erők egyenruházata, https://honvedelem.hu/hirek/komforterzet–es–tepozar–a–magyar–fegyveres–erok egyenruhazata.html

[13] HM Hadtörténeti Intézet és Múzeum. (2020). Hallottál már róla? https://www.facebook.com/hadtorteneti.muzeum/posts/

[14] Romvári, L., Szajkó, Gy. and Pap, A. (2023). A Magyar Honvédség 15M gyakorló egyenruházat tervezésének környezetvédelmi aspektusai, 2. rész, Hadtudományi Szemle, 16(3), 25–38.

[15] Kutasi, Cs. (2022). Optimális infra–remissziót elősegítő textilszínezékek álcázáshoz. Magyar Kémikusok Lapja, 77(1), 9–13.
[16] UFPRO (2024). Europe's official camouflage patterns https://ufpro.com/blog/europes–official–camouflage–patterns
[17] Wharton, R. J. (2017). Barriers to Implementing a Single Joint Combat Camouflage. Uniform. Naval Postgraduate School.
[18] Brayley, M. J. (2009). Camouflage uniforms: International combat dress 1940–2010. Marlborough, Wiltshire: The Crowood Press.
[19] Defence and Aviatation (2025). Multitarn, the German Army camouflage to replace the famus Flecktarn of 1990 https://www.outono.net/elentir/2025/08/13/multitarn–the–german–army–camouflage–to–replace–the–famous–flecktarn–of–1990/
[20] UFPRO (2020). Flecktarn – the German way of playing hide and seek https://ufpro.com/blog/evolution–flecktarn–camouflage–pattern
[21] Fleming, R. (2014). Visual perception of materials and their properties. Vision Research, 94, 62–75.
[22] Filip, J., Dechterenko, F., Schmidt, F., Lukavsky, J., Kotera, J., Vilímovská, V., & Fleming, R. W. (2025). Material fingerprinting: predicting human perception of material appearance through psychophysical analysis and neural networks. Royal Society Open Science. 12(11) 250513.
[23] Han, X., Xiang, Q., Li, L., Yuan, J., Xiao, K., & Yu, L. (2026). Influence of Multisensory Attributes on Emotional Responses Across Fashion Fabrics: Integrating Color Visual and Material Tactile Perception. Color Research Application. 51(2), e70069.
[24] Bocancea, V., Marin, I., & Loghin, M. c. (2025). Subjective Evaluation of Digital Protective Materials. Archives of Metallurgy and Materials. 70(3) 1371–1381.
[25] Yang, X., Yan, S., Hao, B., Xu, W., & Yu, H. (2025). Efficiency Analysis of Disruptive Color in Military Camouflage Patterns Based on Eye Movement Data. Journal of Eye Movement Research. 18(4), 26.
[26] Wallin, M. (2015). Military Public Diplomacy: How the Military Influences Foreign Audiences. American Security Project. https://www.americansecurityproject.org/white–paper–military–public diplomacy/

ISSN 1584 – 2665 (printed version); ISSN 2601 – 2332 (online); ISSN-L 1584 – 2665