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EMPOWERING ETHNIC FOOTWEAR ARTISANS THROUGH CO-DESIGN: A CASE STUDY ON TRADITIONAL QIANG FOOTWEAR

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EMPOWERING ETHNIC FOOTWEAR ARTISANS THROUGH CO-DESIGN: A CASE STUDY ON TRADITIONAL QIANG FOOTWEAR

ABSTRACT. Co-design is one of the effective ways to support the innovation of ethnic footwear artisans. Taking the design of traditional shoes and boots of Qiang ethnic group as an example, this study collected field data through observation method and semi-structured interview method, explored the innovation dilemma of ethnic artisans by thematic analysis method. The research reveals a triple dilemma in the innovation of ethnic footwear artisans characterized by suppressed aesthetic self-determination, frozen cultural consciousness, and constrained technological autonomy. To address these challenges, three co-design principles are proposed in this study with ethnic footwear artisans—"Aesthetic Equity", "Cultural Liberation", "Technological Replenishment" and six related action steps to guide designers, ethnic footwear artisans, and other stakeholders towards a clear direction in co-design.

KEY WORDS: ethnic footwear artisans; co-design innovation dilemmas; co-design principles; traditional Qiang footwear

ÎMPUTERNICIREA MEȘTEȘUGARILOR ETNICI DE ÎNCĂLȚĂMINTE PRIN CO-DESIGN: UN STUDIU DE CAZ DESPRE ÎNCĂLȚĂMINTEA TRADIȚIONALĂ QIANG

REZUMAT. Co-designul este una dintre modalitățile eficiente de a sprijini inovația meșteșugarilor etnici de încălțăminte. Luând ca exemplu designul pantofilor și cizmelor tradiționale ale grupului etnic Qiang, acest studiu a colectat date prin metoda de observare și metoda interviului semistructurat, a explorat dilema inovației a meșteșugarilor etnici prin metoda analizei tematice. Cercetarea dezvăluie o triplă dilemă în ceea ce privește inovarea în cazul meșteșugarilor etnici de încălțăminte, caracterizată prin autodeterminare estetică suprimată, conștiință culturală blocată și autonomie tehnologică restrânsă. Pentru a aborda aceste provocări, în acest studiu sunt propuse trei principii de co-design în cazul meșteșugarilor etnici de încălțăminte — „Echitate estetică", „Eliberare culturală", „Reaprovizionare tehnologică" și șase etape de acțiune aferente pentru a ghida designerii, meșteșugarii etnici de încălțăminte și alte părți interesate spre o direcție clară în co-design.

CUVINTE CHEIE: meșteșugari etnici de încălțăminte; dileme de inovare în co-design; principii de co-design; încălțăminte tradițională Qiang

RENFORCER LES ARTISANS DE CHAUSSURES ETHNIQUES PAR LA CO-CONCEPTION : UNE ÉTUDE DE CAS SUR LES CHAUSSURES TRADITIONNELLES QIANG

RÉSUMÉ. La co-conception est l'un des moyens efficaces de soutenir l'innovation des artisans de chaussures ethniques. Prenant comme exemple la conception de chaussures et de bottes traditionnelles du groupe ethnique Qiang, cette étude a recueilli des données par la méthode d'observation et la méthode d'entretien semi-structuré, et a exploré le dilemme d'innovation des artisans ethniques par la méthode d'analyse thématique. La recherche révèle un triple dilemme dans l'innovation des artisans de chaussures ethniques caractérisé par une autodétermination esthétique supprimée, une conscience culturelle bloquée et une autonomie technologique limitée. Pour relever ces défis, trois principes de co-conception sont proposés dans cette étude avec des artisans de chaussures ethniques : « Équité esthétique », « Libération culturelle », « Réapprovisionnement technologique » et six étapes d'action connexes pour guider les concepteurs, les artisans de chaussures ethniques et d'autres parties prenantes vers une direction claire dans la co-conception.

MOTS CLÉS : artisans de chaussures ethniques ; dilemmes d'innovation en co-conception ; principes de co-conception ; chaussures traditionnelles Qiang

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INTRODUCTION

The development of ethnic attire owes much to the key role of ethnic artisans and their innovative practices. An increasing number of ethnic artisans are collaborating with external partners, such as designers, fashion companies and cultural institutions, to modernize ethnic clothing. The collaboration between tradition and modernity has revitalized ethnic clothing and empowered artisans by providing them with new platforms and opportunities to display their work. In the relevant practice and theoretical research, the co-design of ethnic artisans and designers has achieved rapid development. For example, Tung [1] investigated the co-design process between designers and artisan groups, suggesting that their collaboration facilitates the mutual acquisition of new knowledge. Liao, Liu and Li [2] analysed the collaborative behaviors and practices between ethnic artisans and fashion designers, elucidating the mechanisms underlying their co-design. Wang and Zhang [3] focused on the co-design processes and outcomes, exploring the empowerment and disempowerment dynamics of ethnic artisans in co-design. All the above research studies emphasize the observation and exploration of the existing co-design process. However, before entering into collaboration, it is unclear how the two sides will define the direction of co-design.

While co-design holds great promise, the process of building a shared vision and mutual understanding is often fraught with challenges. Research shows that in many collaborative projects, the direction of co-design is usually determined by the more authoritative designer. These designers often have greater resources and influence and can mask the voices of minority artisans, leading to the challenges and needs of these artisans being ignored. Input and demand from ethnic artisans were marginalized, preferring to meet the needs of mainstream designers to produce more commercially viable products. However, co-design emphasizes meeting the needs of all stakeholders [4], but this process can lead to the dilution of cultural authenticity and the exploitation of traditional knowledge without proper recognition. The contributions and expectations of all parties may not be fully reflected in the final product. While such collaborations may succeed in the market, they often fail to truly represent the rich heritage and intricate craftsmanship of indigenous communities.

To address these issues, it is essential to implement co-design theories that ensure equitable participation. This includes establishing clear communication channels, setting shared goals, and creating feedback mechanisms throughout the project. By fostering an inclusive and respectful design environment, collaboration can genuinely honor tradition while driving innovation.

This paper uses the traditional footwear design of the Qiang ethnic group in Maoxian, Sichuan, as a case study. By understanding the challenges and needs faced by Qiang footwear artisans, it proposes co-design principles centered on the artisan community. These principles provide practical guidelines for designers, helping all stakeholders clearly define the direction of co-design.

THEORY

The definition of co-design emphasizes the active involvement of all stakeholders in the design process. To achieve this, co-design methodologies have evolved from participatory design to generative design, developing various theories. At their core, these theories focus on collaboration to meet the needs of different projects [5, 6], thereby improving the quality of design outcomes [7]. Additionally, these theories align with social innovation frameworks, highlighting design as a tool for social change, particularly in using innovative approaches to improve the conditions of marginalized groups [8]. As a result, contemporary design not only explores the development of methods and tools but also addresses issues of social equity, cultural preservation, and innovation, with greater emphasis on supporting disadvantaged communities through design [9].

In the context of globalization, people are more concerned than ever about the

preservation and dissemination of cultural heritage and how to adapt it to the needs of modern society [10]. Ethnic artisans, though often in a weak position in history, played a crucial role in this process. They are the inheritors of traditional culture and the promoters of cultural innovation [11]. Recognizing this, governments and non-governmental organizations are increasingly providing policy support and funding, including community engagement, rural revitalization and design intervention, to promote the development of jointly designed projects aimed at preserving and enhancing ethnic cultures [12].

Under the framework of co-design, what designers should do is support the innovative needs of ethnic artisans and ensure that the creative process is truly collaborative and inclusive. This shift requires designers to have not only technical expertise, but also cultural sensitivity and the ability to harness and respect the rich cultural context of artisan work. Correspondingly, the active involvement of ethnic artisans fosters a deeper sense of belonging and pride in the final product, which in turn helps to preserve and develop traditional craftsmanship.

Therefore, co-design has great potential to support innovative design practices of disadvantaged groups, especially for ethnic artisans. As both theory and practice continue to develop, co-design methods are becoming vital tools for promoting social equity and cultural preservation. Moving forward, with further research and practical application, co-design is poised to play a unique role in a broader range of fields.

METHODS

Case Study

Due to the widespread distribution and large number of ethnic artisan communities, obtaining a comprehensive overview presents challenges. Therefore, this study conducted in-depth case studies [13] focusing on the ethnic footwear artisan community in Qiang ethnic regions. Between May 2023 and November 2023, our research team conducted three field surveys in the Qiang ethnic region of Maoxian County, Sichuan Province. First-hand data were collected through observational methods (with observation periods totaling over 15 hours) and semi-structured interviews (with over 20 participants and recordings exceeding 650 minutes) [13]. Thematic analysis [14] was employed to identify concepts beneficial to the research. Analysis of the interview texts revealed six codes and three categories, serving as evidence to understand the innovation dilemmas faced by ethnic footwear artisans.

Case Description

Case studies emphasize the typicality of cases and their relevance to the research questions. Following this principle, this study selected four sources of interviewees (Figure 1): (a) the Qiang footwear market on Qiangxing Avenue. This is the only place in Maoxian County where Qiang footwear are sold in bulk, catering to surrounding towns and villages. Respondents P1 to P5, P19, and P20 were sourced from this scene; (b) the Ancient Qiang City on Wutai Road. Hundreds of Qiang villagers work here wearing Qiang footwear, gathering in rest areas during breaks to embroider and make traditional Qiang clothing. It serves as a dynamic display of Qiang clothing culture and craftsmanship. Respondents P6 to P14 were sourced from this scene; (c) the West Qiang Embroidery Workshop in Qingtawan. Hundreds of Qiang embroiderers are employed here, with a personal collection and exhibition room of Qiang footwear and boots. Respondent P15 was sourced from this scene; (d) the Qiang Embroidery Training Center on Wutai Road. This center, part of the Maoxian Intangible Cultural Heritage Training Center, has respondents P16 to P18. Among the respondents, P5 is a provincial-level inheritor of intangible cultural heritage, while P15 and P18 are national-level inheritors. These three respondents have a high demand for innovative ethnic footwear products and several years of co-design creative experience. In summary, the aforementioned research

scenes possess the following advantages: they are closely related to the research subject, exhibiting strong typicality; they provide a large number of observable research samples closely related to the research topic; and by sampling interviews within a limited space and scope, the research can be streamlined while still providing a relatively comprehensive reflection of the challenges faced by Qiang artisans within these scenes.

(a) (b) (c) (d)

Figure 1. (a) Qiang footwear market; (b) The Ancient Qiang City of China; (c) Xiqiang Embroidery Workshop; (d) Qiang Embroidery Transmission Centre. Photo credit: The author.

In this study, we consulted several provincial and national intangible cultural heritage inheritors from China, who are highly respected in traditional embroidery and handmade footwear, with decades of exceptional experience. These experts participated as consultants, providing unique cultural insights that informed the development of the co-design principles. Their involvement ensured the cultural authenticity and continuity of craftsmanship throughout the research process. By combining interviews, collaborative workshops, and feedback sessions, we gathered expert opinions that added significant depth to our findings, ensuring that the proposed solutions were well-grounded in both theory and practice, and tailored to the specific needs of ethnic footwear artisans.

Case Analysis

The specific steps undertaken in this study are as follows: (1) Referring to relevant domestic and international research, designing interview outlines, conducting pre-interviews, and refining semi-structured interview outlines; (2) Drawing research maps to determine sources of interviewees and research scenes; (3) Engaging in extensive conversations with individuals of different age groups within the research scenes, selecting suitable interviewees for subsequent research; (4) Conducting semi-structured interviews with 20 selected interviewees, collecting data with their consent through recordings, videos, photographs, and notes, and supplementing the required information through targeted group interviews (two group interviews were conducted separately for interviewees P1 to P2 and P6 to P9); (5) Employing a three-tier coding system to analyze it, as illustrated in Figure 2; (6) Assessing the saturation of the coding scheme, followed by conducting semi-structured interviews with three randomly selected interviewees, which did not reveal any new codes, categories, or relationships.

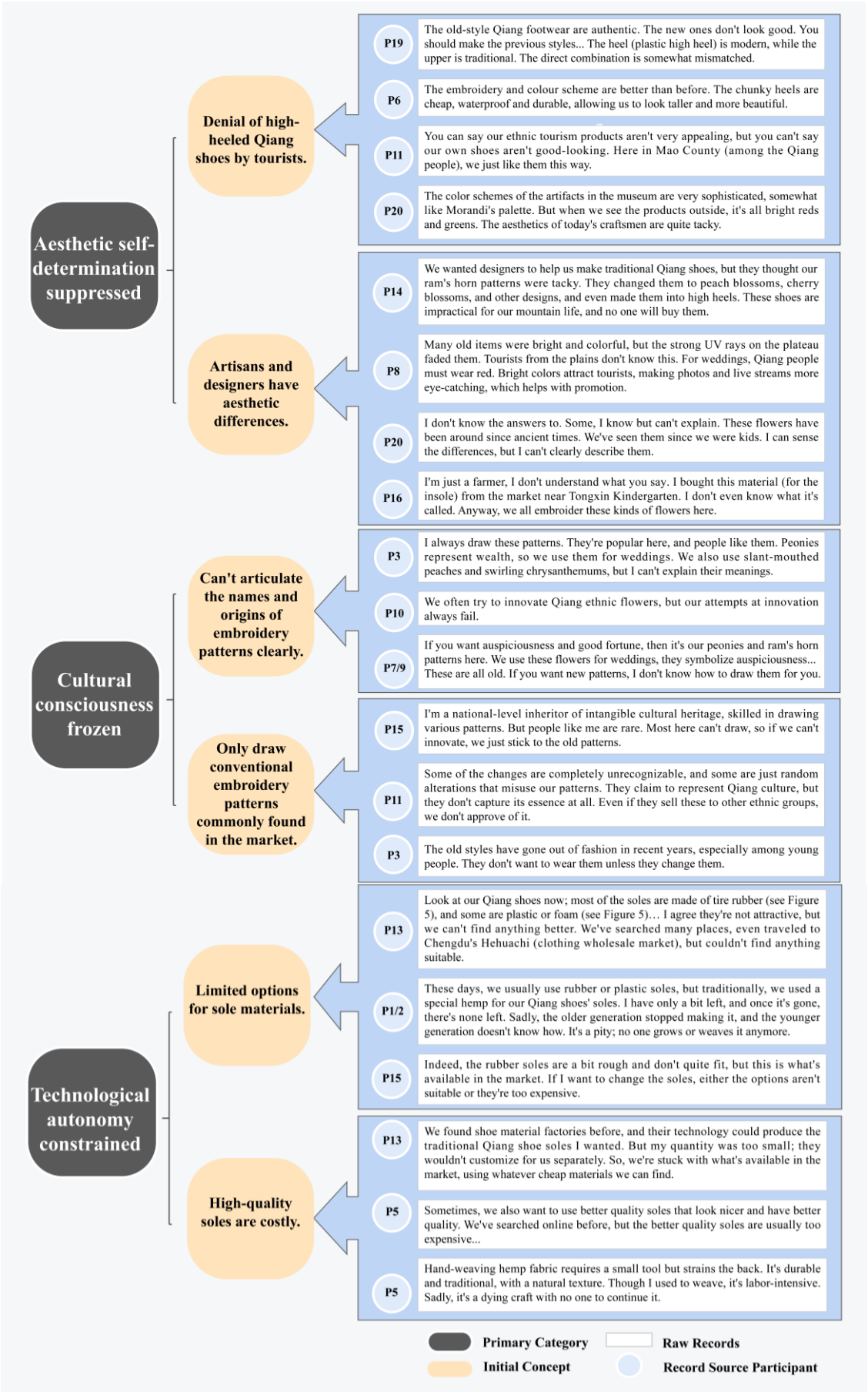

Figure 2. Coding process

FINGDINGS

Dilemma 1: Aesthetic Self-Determination Suppressed

The thematic analysis results reveal that one of the innovation dilemmas faced by ethnic footwear artisans is the "aesthetic self-determination suppressed". This refers to the situation where ethnic footwear artisans, in innovating their traditional ethnic attire, are subject to aesthetic judgments from external ethnic groups, thereby diminishing their autonomy in aesthetic decision-making regarding their own ethnic attire. In this study, this dilemma is primarily manifested through two codes: denial of high-heeled Qiang footwear by tourists and aesthetic disagreements between artisans and designers.

With the development of tourism and improvement in living standards in Qiang ethnic regions, Qiang people have increasingly been exposed to foreign cultures and information, leading to shifts in their demands and aesthetics concerning traditional attire [15]. To address these changes, ethnic footwear artisans in Maoxian County have modified traditional Qiang footwear, such as replacing the traditional hemp soles with plastic high heels. However, these changes have faced rejection from outsiders, with some even suggesting a return to the old styles. For instance, in the Ancient Qiang City, when a Qiang footwear artisan (P4) showcased high-heeled Qiang wedding footwear made for her daughter, a tourist (P19) raised doubts, stating, "The old-style Qiang footwear are authentic. The new ones don't look good. You should make the previous styles... The heel (plastic high heel) is modern, while the upper is traditional. The direct combination is somewhat mismatched." The Qiang footwear artisan (P4) later remarked, "The old styles are outdated here, especially among the younger generation who resist them. They are unwilling to wear them." Additionally, a footwear artisan (P6) mentioned, "The embroidery and color matching of the new high-heeled footwear are more refined than before. These thick high heels are cheap and durable, waterproof, and can make us look tall and beautiful." Similar situations occur frequently. The subjective aesthetic judgments of foreign tourists towards Qiang ethnic attire often leave Qiang artisans feeling helpless. An artisan (P11) stated, "You can say that our tourist products are not beautiful, but you cannot say that the footwear we wear are not beautiful. We (Qiang people in Maoxian County) just like them this way."

Moreover, there exist aesthetic disagreements between artisans and designers regarding the innovation of traditional Qiang attire. Some designers insist that ethnic attire should maintain the traditional forms they envision. For example, a designer (P20) told the research team, "The color schemes of the artifacts in the museum are very sophisticated, somewhat like Morandi's palette. But when we see the products outside, it's all bright reds and greens. The aesthetics of today's craftsmen are quite tacky." In contrast, an artisan (P8) voiced opposition, stating, "Many old items were bright at that time. The strong ultraviolet rays on the plateau fade colors, but tourists living on the plains don't know that. Now, considering wedding ceremonies, we Qiang people must wear red, and bright colors can also attract tourists. Wearing them makes it easier for them to take photos and live broadcasts, attracting more attention for publicity."

Figure 3. Traditional Qiang footwear and modern Qiang footwear (high-heeled). Photo credit: The author

The aforementioned situation is pervasive in ethnic regions, where external individuals often presumptuously assert that ethnic attire should adhere to traditional paradigms and remain unaffected by external cultures or contemporary trends. Indeed, the value of ethnic attire largely stems from its preservation of the cultural heritage and distinctive aesthetic symbols of the ethnic group accumulated over a long period. However, aesthetics is dynamic, and current traditional ethnic attire has undergone extensive evolution and innovation. Attire carrying historical and cultural significance can be preserved and displayed in museums, while the aesthetic autonomy of ethnic attire reflecting contemporary life needs should be entrusted to the people living in ethnic regions today. The external "aesthetic gaze" described above effectively excludes ethnic footwear artisans from the realm of aesthetic freedom and diversity, leaving them feeling powerless in the process of innovation.

Dilemma 2: Cultural Consciousness Frozen

The second innovation dilemma faced by ethnic footwear artisans is the "cultural consciousness frozen". This term refers to the situation where many ethnic footwear artisans, in their innovative practices of ethnic attire, are unable to accurately discern and utilize the cultural context of the inherited skills. This dilemma is evident from the coding of inability to clarify the names and origins of embroidery patterns and only drawing conventional embroidery patterns for market circulation.

In this study, several ethnic embroidery footwear artisans were interviewed at the square of the Ancient Qiang City in China, revealing that most of them were unable to clearly identify the names of the embroidered patterns they were working on, let alone explain the significance of these patterns in Qiang culture. When asked about these issues, one respondent (P7) stated, "I bought this (shoe pad) material from the market near Tongxin Kindergarten. I don't know what it's called. Anyway, we embroider these kinds of flowers here." Similar responses were observed in multiple interviews. Inspired by this, the research team visited the Qiang footwear market near Tongxin Kindergarten, observing and interviewing several artisans specialized in drawing and selling embroidery patterns. Through observation and comparison, it was found that the embroidered patterns sold at the booths of these pattern artisans were essentially similar to those embroidered by artisans in the Ancient Qiang City. However, when asked about the origin and names of the embroidered patterns, few pattern artisans could provide clear answers. For instance, when faced with this question, one respondent (P3) stated, "I have always been drawing these (embroidery patterns). Anyway, these are popular here, and the customers also like them... Peonies symbolize prosperity, and we use peonies for weddings here... Crooked-mouthed peaches (peach patterns with one side pointing upwards) and rotating chrysanthemums (abstract chrysanthemum patterns with rotating petals) are also frequently used. If you ask about the meanings, I can't explain."

Furthermore, when the research team assigned the task of creating a Qiang embroidery representing auspicious wishes to a friend moving into a new home and invited a pattern artisan (P3) to combine traditional Qiang embroidery patterns to create a new embroidery pattern, the artisan (P3) responded, “If you want auspicious wishes, then it’s our peonies and horns of the sheep. We use these flowers for weddings here, and they symbolize auspiciousness... These are all old patterns. I don’t know how to draw new ones for you."

Figure 4. Ethnic footwear artisan with painted insole. Photo credit: The author

The main reason for the aforementioned dilemma is the self-identification of ethnic footwear artisans as “half-farmers and half-workers.” Several respondents (P12, P13, P18) stated that they were merely farmers earning a living with their skills. During busy farming seasons, they need to harvest economic crops such as peppercorns and fruits in the fields and hillsides, and only set up stalls or take on work during agricultural downtime. In their view, making Qiang footwear is only for livelihood purposes; they do not see themselves as Qiang ethnic footwear artisans and lack a conscious cultural interpretation of Qiang ethnic attire. Indeed, in recent years, the government and some civil organizations have invested considerable funds in establishing learning classes to promote the inheritance and development of ethnic attire skills and culture among ethnic artisans. However, research has found that the participants in these classes are mainly teachers, designers, and individuals recognized by the government as inheritors of intangible cultural heritage, with limited participation from a larger base of ordinary ethnic artisans. Even if they participate, their most immediate demand is to learn a skill that can support their families, thus showing little interest in the cultural theory courses offered by these classes. In conclusion, the cultural consciousness of ethnic footwear artisans is frozen in their self-identification as “half-farmers and half-workers”.

Dilemma 3: Technological Autonomy Constrained

In addition to the aforementioned two dilemmas, the research results indicate that the “technological autonomy constrained” is also a significant challenge faced by ethnic footwear artisans in innovation. The term “Technological autonomy constrained” refers to the passive abandonment of ethnic footwear artisans’ desire to enrich their creations with modern technology due to various limiting conditions. In this case, this dilemma is primarily analyzed from the coding of limited choice of sole materials and high cost of quality sole materials.

The commonly used materials for making traditional Qiang footwear soles, such as red hemp and yellow hemp woven fabrics, possess excellent breathability and unique texture due to their natural properties. However, influenced by

economic factors, the cultivation area of these crops has sharply decreased, and the manual production costs far exceed those of industrial materials, leading to the gradual decline of related traditional weaving techniques. During the interviews, respondents P14 and P15 showed the researchers their collected hand-woven hemp fabrics, stating, "I only have this bit of fabric left now. Once it's used up, there won't be any more. Nowadays, the elderly no longer make this kind of fabric, and the younger generation doesn't know how to make it." Faced with this situation, the Qiang footwear artisans have turned to seek alternative footwear materials. Respondents (P1, P2) stated, "Look at most of our Qiang footwear now; the majority of the soles are made of tire soles (made from discarded car rubber tires, see Figure 5 left), and some are made of plastic (Figure 5 center) and foam (Figure 5 right)... I also think they don't look good, but we can't find anything better. We've searched many places before, and even went to Chengdu Hehuachi (a clothing wholesale market), but we couldn't find anything suitable." In addition to limited choices of materials, the cost of sole materials is also a factor considered by ethnic footwear artisans. A Qiang footwear artisan (P5) mentioned, "Sometimes we want to use better-quality soles, which look nicer and have better quality. We searched online before, but the better-quality sole prices were too high. Here, even if footwear are ten yuan more expensive, no one buys them... We found a shoe material factory before, and their technology could completely produce what I wanted (soles), but my quantity was too small, and they wouldn't customize for us separately, so we could only do this; whatever is available (cheap materials) on the market, we use." It can be said that due to the niche market demand, ethnic footwear artisans have very limited technological elements to autonomously choose from in the innovation process of ethnic attire.

Figure 5. Qiang footwear with three different soles (left: tire sole; middle: plastic sole; right: foam sole). Photo credit: The author

DISCUSSION

In delving deeper into the academic discourse surrounding the challenges faced by ethnic footwear artisans, particularly in the context of traditional Qiang footwear design, it is imperative to engage with theoretical frameworks that can provide insight into the complexities of cultural preservation and innovation. The aforementioned dilemmas faced by these artisans are not merely practical but are deeply rooted in the interplay of cultural identity, creative expression, and technological adaptation. Addressing the aforementioned challenges faced by ethnic footwear artisans in innovation—namely, the "aesthetic self-determination suppressed", "cultural consciousness frozen", and "technological autonomy constrained"—this paper proposes a co-design principle comprising three aspects: Aesthetic equity (A), Cultural liberation (C), and Technical replenishment (T). This article hereby names this co-design principle as ACT (Figure 6). Based on the ACT co-design principle, expert opinions (Chinese intangible cultural heritage inheritors, scholars, craftsmen) were

gathered through a combination of interviews, collaborative workshops, and feedback sessions. This study proposes six actions—namely, aesthetic listening, aesthetic coordination, cultural bridging, cultural catalysis, technical matching, and technical integration— to assist designers in clarifying the direction of co-design. This study also validated the effectiveness of the ACT co-design principles through practical application, with part of the process illustrated in Figure 7. It demonstrates how craft specialists, cultural experts, and students collaborated in practice to apply the ACT co-design principles.

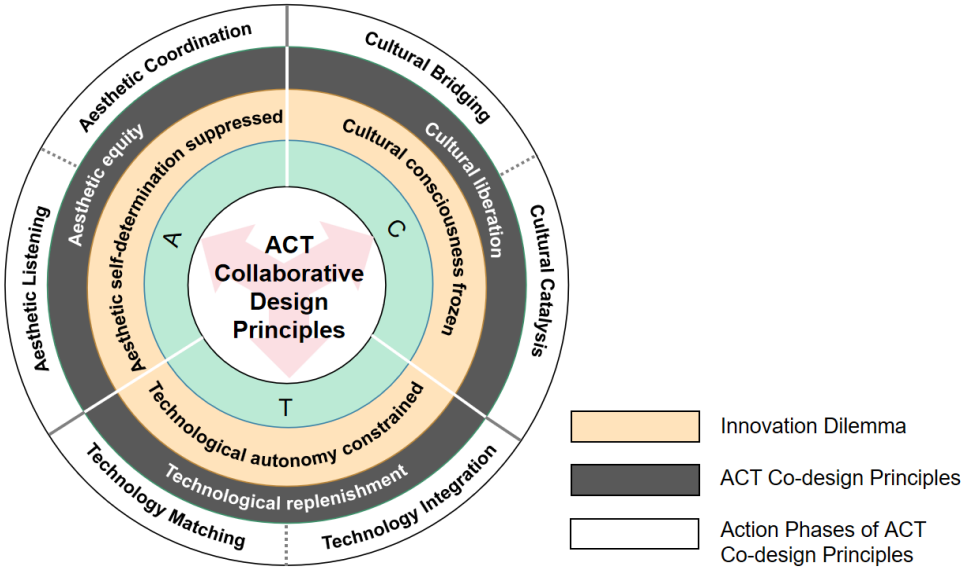

Figure 6. ACT Co-design Principles

Figure 7. ACT Co-design Principles Practice (Craft specialists, cultural experts, and students collaborated in applying the ACT principles in practice). Photo credit: The author

Aesthetic Equity

Addressing the dilemma of aesthetic self-determination suppressed faced by ethnic footwear artisans, this paper proposes the co-design principle of "Aesthetic Equity". This principle emphasizes the shift in the role of designers in co-design processes. In traditional design paradigms, designers often lead design directions based on their individual aesthetic preferences. However, the designer's 'parachuting' into projects do not grow or develop [16]. This approach has led to numerous controversies involving major fashion brands, which have faced accusations of appropriation, and other practices that unfairly target marginalized communities [17]. To address this, in co-design based on ethnic cultures, this study

suggests a role transformation for designers—from past aesthetic leaders to aesthetic listeners and mediators—to create a free, fair co-design environment, offering ethnic footwear artisans diverse possibilities and gradually returning the aesthetic decision-making power in traditional ethnic costume design to them. By prioritizing cultural sensitivity and inclusivity, this approach aligns with a broader push for ethical practices within the fashion industry, as exemplified by the recent responsible design and sustainable production movements.

The principle of Aesthetic equity comprises two actions: aesthetic listening and aesthetic coordination. When collaborating with external designers, ethnic footwear artisans often habitually assume that designers' aesthetic experiences outweigh their own local experiences, thus feeling reluctant to share their true opinions and thoughts. Therefore, this study proposes the action of aesthetic listening, urging designers to empathize during collaboration, pay attention to the language, past experiences, aesthetic preferences, and other factors of ethnic footwear artisans, use familiar terminology to bridge the gap, create a relaxed atmosphere, and encourage them to boldly express aesthetic viewpoints and voice authentic opinions. Furthermore, to resolve the contradiction between ethnic footwear artisans' aesthetic experiences and external aesthetic experiences, this study proposes the action of aesthetic coordination. Aesthetic coordination entails designers acting as mediators, focusing on finding inclusive solutions, providing ethnic footwear artisans with diversified options, and enriching their autonomy in choices. Taking the co-design of traditional Qiang footwear as an example, designers can conduct pattern design workshops with artisans who draw Qiang footwear embroidery patterns, jointly explore recombination schemes for traditional Qiang embroidery patterns (such as lupine flowers, ram horns, etc.), or fusion schemes of commonly used Sino-Tibetan patterns in Qiang areas (such as phoenixes with peonies, fish playing with lotuses, etc.), and produce economically feasible finished embroidery patterns, available for local ethnic footwear artisans to freely choose. Through the actions of aesthetic listening and aesthetic coordination, designers can assist ethnic footwear artisans in integrating their local aesthetic experiences into co-design processes, achieving aesthetic equity.

Cultural Liberation

To address the dilemma of cultural consciousness frozen, this paper proposes the co-design principle of "Cultural liberation". The concept of Cultural liberation refers to the process through which the cultural self-awareness of ethnic footwear artisans is awakened by designers through co-design. In the traditional concept, designers are accused of cultural appropriation, and other kinds of lack of concern for others' feelings towards powerless and vulnerable groups [18], ethnic footwear artisans are often regarded as "backward small producers" and "processing workers", resulting in their inherent ethnic cultural vitality is often ignored. In addition, scholars suggest that artisans should be empowered from a cultural perspective (heritage, know-how) and be equipped with the ability to independently develop future projects. The collaboration between designers and artisans should not result in the latter becoming subordinate to the former, in order to achieve true artisans' empowerment [19]. This view fits well with the principle of cultural liberation. Therefore, in the co-design principles, this study suggests that designers play the role of intermediary and catalyst to activate ethnic footwear artisans' understanding and interpretation of their own national culture.

The principle of Cultural liberation covers two actions: cultural bridging and cultural catalysis. First, cultural bridge requires designers to step out of the traditional designer identity and play the role of cross-border intermediary. This role requires the designer to have a wealth of design experience and the ability to integrate

and manage multicultural resources [20]. For example, designers can coordinate and connect the human resources of ethnic culture Xianda for Qiang footwear artisans, including Qiang research scholars, Qiang museum staff, Qiang Shibi (A highly respected member of the ethnic group) and other roles, plan and implement a series of interactive activities to promote knowledge exchange between them and ethnic craftsmen, and arouse the cultural vitality of ethnic artisans. An illustrative example of cultural bridging in design practice can be observed in the collaborative project between designers and local communities, such as the "Qi2He" cultural product innovation project in China [21]. In this project, the design process emerged from a vibrant co-creation between cultures, where the craftspeople took the lead in influencing the patterns, showcasing a true fusion of creative inputs.

Secondly, cultural catalysis involves designers acting as "catalysts" to trigger a cultural catalytic effect [22] during the co-design process, thereby stimulating ethnic footwear artisans' cultural self-awareness. For example, after the co-design process, designers can organize a series of reflective activities with ethnic footwear artisans to jointly analyze and reflect on the cultural dynamics and shifts during co-design, assisting ethnic footwear artisans in recognizing and understanding the role of their own culture in co-design, thereby enhancing their flexibility and accuracy in cultural application. The theory of cultural protection and innovation emphasizes the balance between cultural inheritance and modernization, and focuses on how to innovate while protecting culture, which is consistent with the concept of cultural liberation in co-design theory.

Technical Replenishment

To address the dilemma of technological autonomy constrained, this study proposes the co-design principle of "Technical Replenishment". This principle emphasizes the role of designers in augmenting the technological innovation resources of ethnic footwear artisans during co-design, thereby expanding their range of technical choices. In traditional design models, designers often perceive ethnic footwear artisans solely as sources of traditional techniques to complement their own design strategies [23]. However, in co-design tasks aimed at innovating traditional ethnic attire, this study suggests that designers adopt the role of technology brokers, prioritizing the technological needs of ethnic footwear artisans and assisting them in identifying and integrating relevant technological resources to achieve technological upgrades and innovations.

The principle of Technical Replenishment comprises two actions: technology matching and technology integration. Firstly, technology matching involves designers searching for feasible technological resources that align with the characteristics of ethnic attire techniques and the needs of ethnic footwear artisans, based on assessments of traditional ethnic attire techniques and the technological requirements of ethnic footwear artisans. In regions where technological and informational resources are relatively scarce, this action serves as the foundation for technological innovation among ethnic footwear artisans. Field surveys indicate that users of traditional Qiang footwear are highly sensitive to prices, with affordability being one of the significant factors influencing artisans' choice of footwear sole materials. For example, by upskilling and elevating the expertise of artisan communities, designers introduced contemporary techniques to produce jewelry that meet the demands of today's international market [24]. This approach aligns with the ACT co-design principles, as it emphasizes the vital role that artisans play in guiding and shaping the design process, reinforcing the importance of enhancing their skills and contributions in co-design projects.

In light of this, designers can collaborate with ethnic footwear artisans,

footwear sole material manufacturers, research institutions, etc., to develop new sole material technologies that not only meet economic needs but also convey aesthetic and cultural requirements of ethnic attire. If technology matching serves as the foundational action, then technology integration represents the progressive action in addressing technological innovation among ethnic footwear artisans. Technology integration entails designers assisting ethnic footwear artisans in reorganizing and integrating matched new and old technologies to generate executable technological implementation plans. For instance, in co-design tasks for traditional Qiang footwear, designers can organize footwear sole stitching workshops with ethnic footwear artisans to explore the assembly techniques of new sole materials with traditional uppers, documenting the process in both text and visuals, and making it accessible to local footwear artisans, thus facilitating their technological upgrades.

Summary

The significant barriers to innovation faced by ethnic footwear artisans in the traditional Qiang footwear co-design are multifaceted and deeply entrenched in cultural, economic, and technological factors. Previous research has shown that top-down, one-size-fits-all services and strategies often fail to meet the diverse needs of local communities effectively [16]. In this context, the 'designers' transition theory highlights the limitations in designers' mindsets, suggesting that a shift in perspective could lead to better collaboration and design outcomes [25]. Additionally, Qiang culture in western China faces threats due to assimilation with the dominant ethnic cultures, leading to a decline in participation in traditional rituals and the gradual loss of cultural skills and knowledge transmission [26]. Therefore, it is crucial to establish a platform for dialogue between Qiang artisans and the design community to promote cultural diversity and enhance understanding and appreciation of the unique aspects of Qiang culture. In conclusion, the barriers to innovation for Qiang shoemaking artisans in traditional design stem from deep-rooted cultural, economic, and technological factors. By engaging with theories that emphasize the importance of aesthetic autonomy, cultural consciousness, and technological autonomy, and by promoting a designers mindset transition, it is possible to create an environment that nurtures innovation while preserving the cultural essence of the Qiang and similar ethnic communities. This approach not only honors the past but also ensures the vibrancy and relevance of their cultural practices in the contemporary world.

CONCLUSION AND IMPLICATIONS

Through the detailed case analysis of the traditional footwear design of Qiang, it highlights the three difficulties faced by Qiang footwear artisans in the process of innovation: aesthetic self-determination suppressed, cultural consciousness frozen and technological autonomy constrained. These dilemmas underscore the significant barriers to innovation that artisans encounter when their creative freedoms and cultural expressions are constrained.

In response to these dilemmas, this study proposes that designers adopt ACT co-design principles, including Aesthetic equity, Cultural liberation, and Technological replenishment. These principles aim to assist ethnic footwear artisans in overcoming the aforementioned challenges and achieving genuine innovation. Unlike mass-oriented ethnic cultural product design, the co-design principles discussed in this paper are tailored to the innovation practices of traditional ethnic attire and are specifically targeted towards internal minority groups. Consequently, these principles emphasize ethnic footwear artisans as the primary actors, with designers serving as facilitators who supplement the various resources needed for ethnic artisan innovation.

By implementing these principles, designers ensure that aesthetic strategies in co-design reflect the true perspective of ethnic artisans and that the cultural narrative is vivid, helping it to promote technological development. This practice will return the innovation right of ethnic clothing to the national artisans themselves, and empower the ethnic footwear artisans to speak in co-design. While respecting the cultural heritage and creativity of ethnic artisans, it also promotes a more equitable and collaborative environment for innovation.

Theoretical and Practical Implications

In summary, the ACT Co-design Principles redefine the role of ethnic footwear artisans and designers in the collaborative process, and the adoption of the ACT co-design principles promotes a more balanced and dynamic partnership. Compared with traditional co-design practices, both parties have undergone a significant identity shift. Designers no longer play the role of decision makers, but flexibly adjust their roles according to the needs of ethnic footwear artisans, acting as promoters and assistants, mobilizing various resources, providing more choice space and participation opportunities, and supporting the innovation needs of ethnic footwear artisans. The ethnic footwear artisans are no longer just the executor of the plan, but has become the leader of the creative process.

By adopting the ACT co-design principle, designers and craftsmen learn from each other, exchange their own knowledge in the collaborative process, and produce new skills, such as new aesthetic experience, cultural application ability and technical integration ability, which are the necessary conditions for the innovation of national costumes in the new era. With the deeper participation of artisans in co-design, ethnic footwear artisans, with the assistance of designers, reinterpret traditional aesthetics, accumulate co-design experience, enrich the individual works of artisans, and enhance the modernity and connotation of ethnic clothing. This produces results that resonate with different groups of people. This collaborative process could ultimately lead to a sustainable model of innovation that respects and revitalizes cultural heritage while embracing contemporary progress, ensuring that national costumes remain alive and relevant.

Limitations and Future Research

Due to limitations in research samples and sampling space, this study focuses on the single case of traditional Qiang footwear design in Mao County, Sichuan Province. Future research could expand to include more ethnic groups and types of attire, employing multi-case studies to further enrich the theory of co-design between ethnic artisans and designers. Additionally, this study primarily proposed the co-design principles and related actions, and conducted preliminary practical tests to validate and refine the effectiveness and applicability of these principles. However, due to space limitations, this study does not elaborate on these practical cases in detail. Future research can further validate and refine these principles through more in-depth and extensive co-design cases, thereby exploring their potential application in various cultural and technological contexts more comprehensively.

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VALORIZATION OF COLLAGEN AND KERATIN BY-PRODUCTS FROM LEATHER INDUSTRY TO INCREASE THE QUALITY OF PRODUCTION FROM A CHERRY ORCHARD

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VALORIZATION OF COLLAGEN AND KERATIN BY-PRODUCTS FROM LEATHER INDUSTRY TO INCREASE THE QUALITY OF PRODUCTION FROM A CHERRY ORCHARD

ABSTRACT. This paper presents the results of valorization of the protein by-products recovered from the leather processing industry in the horticultural field. Collagen and keratin extracts were the starting point for protein combinations containing nanometric particles that indicate the presence of amino acids and oligopeptides, recognized for the effects of biostimulation, nutrition and systemic protection of plants. The protein extracts associated with plant extracts for the development of a biofungicidal product, with the double action of antifungal protection of plants and stimulation of agricultural production, were tested in a cherry orchard. The test results of two of the variants of the biofungicidal product show better fruit quality indicators and increased production, both compared to a standard treatment and compared to a variant to which no specific treatment was applied.

KEY WORDS: byproducts, collagen, keratin, orchard production

VALORIZAREA SUBPRODUSELOR DE COLAGEN ȘI CHERATINĂ DIN INDUSTRIA DE PIELĂRIE PENTRU CREȘTEREA CALITĂȚII PRODUCȚIEI DINTR-O LIVADĂ DE CIREȘI

REZUMAT. Această lucrare prezintă rezultate ale valorificării în domeniul horticol a sub-produselor proteice recuperate din industria de prelucrare a pielii. S-au realizat extracte de colagen și cheratină din care s-au obținut combinații proteice cu conținut de particule nanometrice care indică prezența aminoacizilor și a oligopeptidelor, recunoscute pentru efectele de biostimulare, nutriție și protecție sistemică a plantelor. Extractele proteice asociate cu extracte vegetale pentru dezvoltarea unui produs biofungicid, cu dublă acțiune de protecție antifungică a plantelor și de stimulare a producției agricole, au fost testate într-o livadă de cireși. Rezultatele testelor a două dintre variantele de produs biofungicid prezintă indicatori de calitate a fructelor mai buni și producții sporite, atât comparativ cu un tratament standard, cât și comparativ cu o variantă la care nu s-a aplicat un tratament specific.

CUVINTE CHEIE: produse secundare, colagen, cheratină, producția livezii

LA VALORISATION DES SOUS-PRODUITS DE COLLAGÈNE ET DE KÉRATINE DE L'INDUSTRIE DU CUIR POUR AUGMENTER LA QUALITÉ DE LA PRODUCTION D'UN VERGER DE CERISIER

RÉSUMÉ. Ce travail présente les résultats de la valorisation dans le domaine horticole des sous-produits protéiques récupérés de l'industrie de transformation du cuir. Des extraits de collagène et de kératine ont été réalisés à partir desquels des combinaisons de protéines ont été obtenues avec une teneur en particules nanométriques indiquant la présence d'acides aminés et d'oligopeptides, reconnus pour les effets de biostimulation, de nutrition et de protection systémique des plantes. Les extraits protéiques associés à des extraits de plantes pour l'élaboration d'un produit biofongicide, à double action de protection antifongique des plantes et de stimulation de la production agricole, ont été testés dans la cerisaie. Les résultats des tests de deux des variantes du produit biofongicide montrent de meilleurs indicateurs de qualité des fruits et une production accrue, tant par rapport à un traitement standard que par rapport à une variante à laquelle aucun traitement spécifique n'a été appliqué.

MOTS CLÉS : produits secondaires, collagène, kératine, production fruitière

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INTRODUCTION

The BIO-PLANT-Protect project as presented in a previous work [1] is a European cooperation between Romania and Poland to capitalize animal and vegetable waste in circular agriculture and to develop new bio-fungicidal compositions with bivalent activity: protection against pathogens and bio-stimulation of germination and growth of plants.

The increasingly intensive promotion of organic agriculture keeps up-to-date research for the recovery of proteins (primarily nitrogen carriers) from various secondary sources and their validation for use in plant culture [2].

The natural leather processing industry, through the specificity of its processes, is an important source of protein by-products, collagen and keratin, which can be exploited for agricultural use [3], due to the high nitrogen content and the wide spectrum of amino acids with potential of protection against abiotic stress and stimulation of plant growth [4].

Many research studies are still in progress, both for improving the processes of obtaining hydrolysates of collagen and keratin [5, 6], and those related to the use of these hydrolysates to increase the yields of agricultural crops [7, 8]. The extraction of collagen as gelatin is also currently being studied [9].

The previous results of the BIO-PLANT-Protect project demonstrated the antifungal effect of the developed products and the ability to bio-stimulate the germination of horticultural plant seeds [10, 11].

In the present research protein combinations based on gelatin, collagen hydrolysates and keratin hydrolysate dedicated to association with plant extracts with fungicidal effects, were tested in the orchard on fruit of the cherry species, to evaluate the nutritional potential of the protein components.

This paper presents the protein extracts made from leather byproducts such as gelatin, collagen hydrolyzate and keratin hydrolysate, and the effects of treatments in the cherry orchard with the protein combinations recovered from the leather industry.

The cherry orchard tests were carried out with two types of protein combinations recovered from the leather industry, a treatment with a protein combination consisting of gelatin and collagen hydrolyzate extracted from untanned leather and a treatment with a protein combination consisting from gelatin, collagen hydrolyzate extracted from tanned leather and keratin hydrolyzate extracted from sheep wool.

The cherry orchard tests have shown that treatment with the experimental version with keratin content has determined the highest values of fruit weight, firmness, pH and of the total soluble substance content, compared to an untreated control and with Standard treatment. Significantly higher productions, compared to an untreated control and with Standard treatment, were obtained with both experimental treatments.

EXPERIMENTAL

Materials and Methods

Materials

Bovine leather and sheep wool by-products have been used for collagen and keratin extracts as gelatin and collagen and keratin hydrolysates: residual semi-processed bovine leather for collagen extraction was collected from the leather processing pilot station of INCDTP – Division: Leather and Footwear Research Institute, chopped, and preserved by freezing; wool for keratin extraction was purchased from sheep farmers and degreased at the INCDTP – Division: Leather and Footwear Research Institute.

Analytical grade chemical reagents: hydrated calcium oxide (CaO CaOH, MW = 81.371 g/mol) was purchased from Cristal R Chim SRL (Bucharest, Romania); ammonia potassium hydroxide and oxalic acid were purchased from Chimreactiv SRL (Bucharest, Romania); propionic acid was purchased from Sigma-Aldrich (Bucharest, Romania).

Enzymes: for collagen hydrolysis, Alcalase 2.4 L (protease from *Bacillus*

licheniformis with 2.4 U/g activity); for keratin hydrolysis, Protamex® (an endo-protease from *Bacillus* spp. with 1.5 U/g activity) was purchased from Novozymes (Atasehir, Turkey).

Methods

Gelatin and collagen hydrolysates from residual untanned leather by-products were prepared by thermal and enzymatic hydrolysis. Also, collagen hydrolysate was prepared by alkaline and enzymatic hydrolysis of residual bovine-tanned leather. Keratin hydrolysate was prepared by alkaline and enzymatic hydrolysis from degreased residual sheep wool. For pH adjustment propionic acid was used in collagen extraction and oxalic acid in keratin extraction. The protein extraction processes are shown in Figure 1.

The protein extracts and their combinations were analyzed physico-chemically to evaluate the most significant characteristics, for applications in the agricultural field: molecular weight, nanometric particle size distribution, amino acid content profile.

Methods for Characterizing Protein Extracts and Their Combinations

The average molecular mass of gelatin was determined by SDS Page electrophoresis in Mini-PROTEAN ® Tetra Cell 4 gel handcasting system (Tank, hand casting stand and accessories), with processing on the Gel Documentation Imaging Bio-Print XT4 which includes a scientific CCD camera with a Super Resolution of 5.5 megapixels; HPLC for the amino acid composition of gelatin, collagen, and keratin hydrolysates by using an Amino Acid Analyzer LC 3000 (Sykam GmbH, Eresig, Germany), equipped with a polymeric cation exchanger column, post-column ninhydrin derivatization at 125°C, and photometric measurement at 570 nm, with monitoring the results by Chromatography-Software ChromStar 6.0 (SCPA GmbH, Bremen, Germany); Dynamic Light Scattering (DLS) using a ZetaSizer Nano ZS (Malvern, UK) for the analysis of nanometric particle size and their distribution.

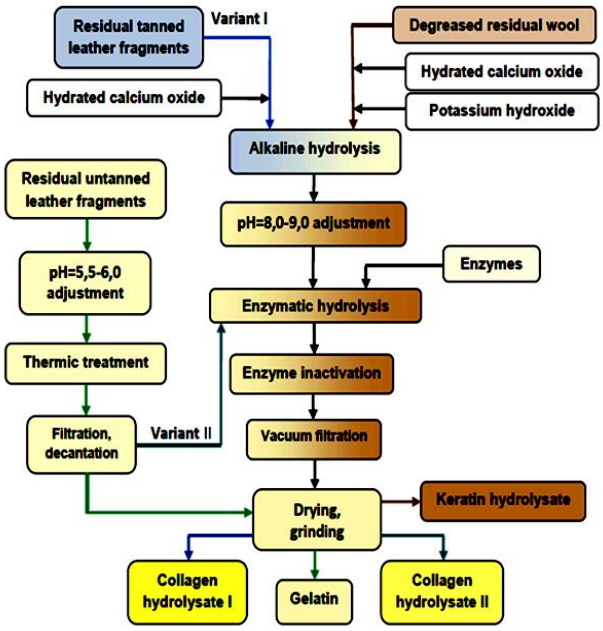

Figure 1. Protein extraction processes

The combined protein extracts, as part of a biopesticide prototype, were tested in the orchard on fruit of the cherry species, the Skeena variety, at Research and Development Institute for Fruit Growing, Mărăcineni, Pitești, Romania, to follow the effect of the

application of biopesticides with ambivalent activity, antifungal and fertilization, on the production and quality of the fruits.

The experiment was carried out with 3 repetitions in a completely randomized block, with 5 trees/repetition, to which the following treatments were applied: (1) untreated control; (2) treatment with the biopesticide prototype containing gelatin and collagen hydrolysate extracted from untanned leather; (3) treatment with the biopesticide prototype containing gelatin extracted from untanned leather, collagen hydrolysate extracted from tanned leather and keratin hydrolysate; (4) treatment with a standard product (Serenade® ASO).

Finally, the following indicators were analyzed: mass, pulp firmness, pH, total soluble matter content and fruit production. The observations were of a numerical type, with the aim of obtaining data and characteristic parameters for the objective evaluation of the fruiting processes.

The statistical method used to evaluate the differences between the averages of the determined indicators was the analysis of variance, and the differences between the variants were highlighted using the Duncan test for a confidence level α=0.05. The data were processed using the SPSS 14.0.0 program. The effect of the tested products was represented graphically.

RESULTS AND DISCUSSIONS

The average molecular mass of gelatin was determined by SDS Page electrophoresis with processing of the migration gel on the viewing camera. Figure 2 shows the migration gel, with the gelatin sample on line 12, the buffer on line 14 and the marker on line 15, detected automatically, as well as the details recorded by the viewing camera for the gelatin sample on line 12.

After processing the data recorded by the viewing camera, an average molecular weight of gelatin of 127 kDa was obtained, in accordance with the amino nitrogen content (< 0.2% of total nitrogen).

The amino acid profile and content in protein extracts determined by HPLC is shown in Figure 3.

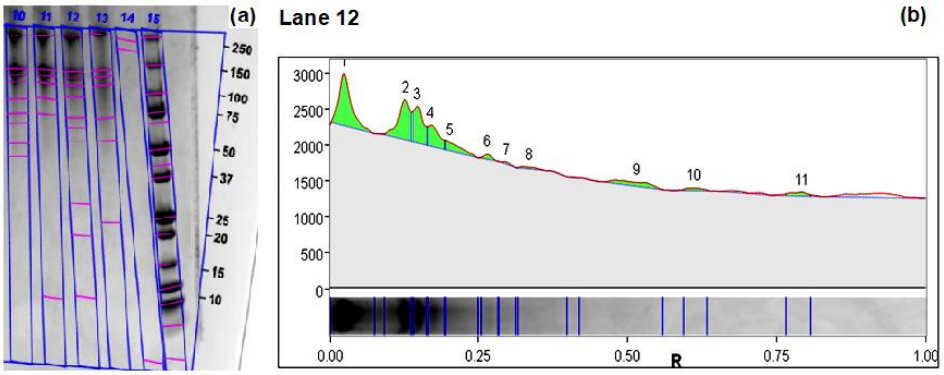

Figure 2. SDS Page electrophoresis of gelatin: (a) the gel after decolorization, (b) the molecular mass profile of the peptides, shown by the viewing camera

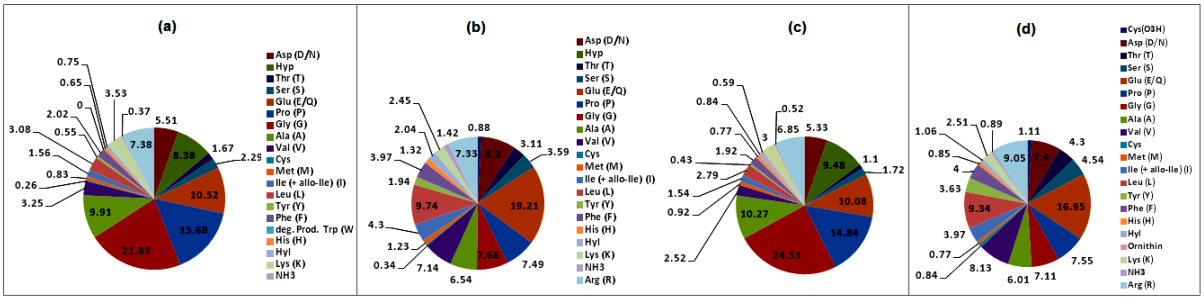

Figure 3. Amino acid profile of protein extracts: (a) gelatin extracted from untanned leather, collagen hydrolysate extracted from tanned leather, (c) collagen hydrolysate extracted from untanned leather, (d) keratin hydrolysate

A very wide profile of amino acids, including essential ones, capable of penetrating cell membranes is observed.

Figure 3 shows as a characteristic the presence of hydroxyproline in the collagen extracts, while the keratin extract is characterized by the presence of cysteine, which through the supply of sulfur (phytonutrient) can improve the yield and quality of crops.

The presence of traces of cysteine in gelatin and collagen hydrolyzate obtained from the same skin resource, is the result of the fact that the skin from which they were extracted, being a by-product, had processing deficiencies in the repair stage and therefore traces of hair remained which were degraded in the hydrolytic processes.

Moreover, it is observed that collagen extracts, obtained from different processes or sources, have significantly different compositions for certain amino acids because the fractured peptide chains were different, depending on the processing stage of the hides. The differences between the gelatin and the collagen hydrolyzate resulting from the residues left after gelatin extraction were recorded, in the content of threonine, serine, proline, valine, tyrosine. Also, the differences between the collagen hydrolyzate extracted from tanned leather and the collagen hydrolyzate resulting from the residues left after gelatin extraction were recorded, in the content of threonine, serine, tyrosine.

The two combinations of protein extracts, made for the biopesticide prototype, were analyzed by DLS confirming the content of nanometric particles, Figure 4.

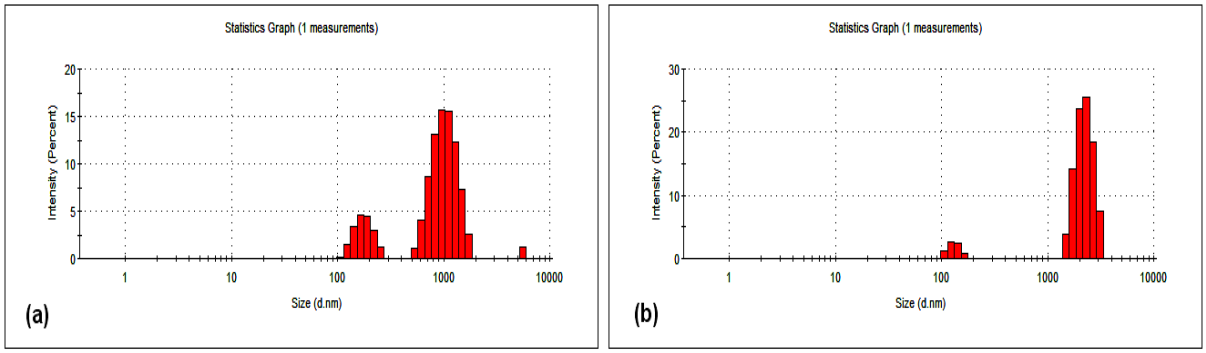

Figure 4. Particle size distribution in protein combinations: (a) gelatin and collagen hydrolysate; (b) gelatin, collagen hydrolysate and keratin hydrolysate

Figure 4 presents the histograms of the average results of three measurements performed for each of the two protein combinations tested.

The reflected light intensity measurements indicate the existence of both small and medium particle populations (100-1000 nm), as well as particle populations larger than 1000 nm. In the protein combination (a) we find a population of 14% particles of 100-200 nm, a population of 85% particles of 500-1500 nm and 1% particles of 5560 nm, which differentiates it from protein combination (b) in which we find a population of 7% particles of 100-200 nm and a population of 93% particles of 1500-3000 nm.

The content of nanometric particles is associated with the presence of amino acids and oligopeptides recognized for the effects of biostimulation, nutrition and systemic protection of plants.

The favorable effect of treatments in the orchard with protein components recovered from the leather industry was confirmed by the results of the tests initiated in the cherry orchard. Figure 5 presents the histograms of the measurements of the main quality indicators of the fruits harvested from the experimental lots.

The analysis of the histograms in Figure 5 indicated that the values respected the condition of normality of distribution for the indicators of fruit weight, pulp firmness, total soluble substance content and fruit production. In the case of pH, a slight positive asymmetry was observed, due to the

presence of very high values, present in small numbers, as well as a vaulting generated by the accumulation of most of the values in the central area.

According to the Multiple Comparative Test Duncan, the largest fruit weight, 9.2 g, was recorded for the variant (2), treatment with the biopesticide prototype containing gelatin and collagen hydrolysate extracted from untanned leather, followed by (4), treatment with a standard product (Serenade® ASO) and variant (3), treatment with the biopesticide prototype containing gelatin extracted from untanned leather, collagen hydrolysate extracted from tanned leather and keratin hydrolysate, to which a fruit weight of 9.0 g was recorded. The lowest fruit weight of 8.4 g was recorded for (1) untreated control.

The firmest fruits were those harvested from variants (3) and (2), respectively 72.9 units and 72.1 units (tissue test Shore HPE II Fff Bareiss). A significantly smaller firmness than those in variant (2) and variant (3), similar to the untreated control, was found in the resulting fruits after the standard treatment.

The least acidic fruits, with a pH of 3.8, were harvested from treatment variants (3) and (2), while the fruits harvested after the standard treatment (4) and those of the untreated control (1) presented more acidic fruits.

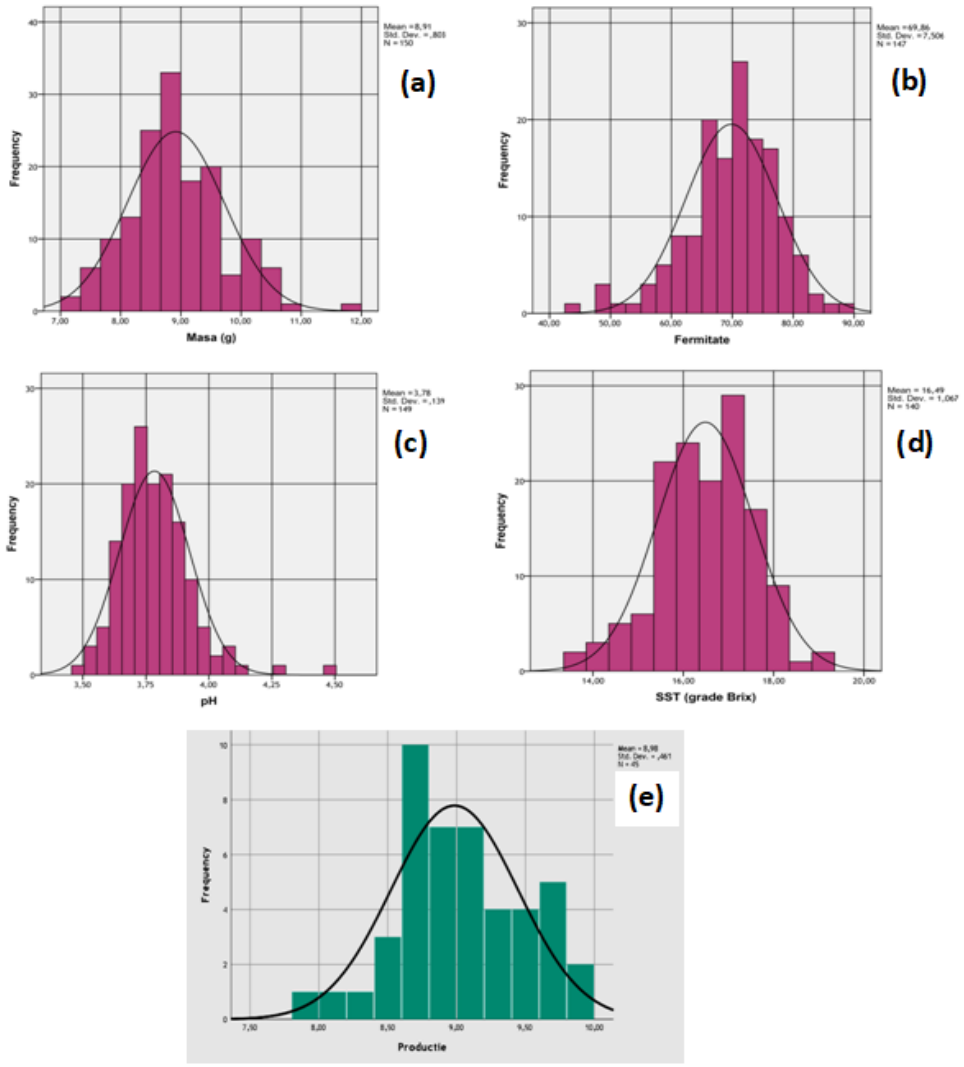

Figure 5. Histograms of recorded values for: (a) fruit mass; (b) pulp firmness; (c) the pH of the juice; (d) the total soluble matter content of the fruit; (e) fruit production

Both variants of experimental treatments (2) and (3) have significantly and similarly increased the total soluble substance content.

In Figure 6, the fruit production is presented for the tested treatment variants: 1 – the untreated control, 2 – treatment with the biopesticide prototype containing a protein combination consisting of gelatin and collagen hydrolysate extracted from untanned leather, 3 – treatment with the biopesticide prototype containing a protein combination consisting of gelatin extracted from untanned leather, collagen hydrolysate extracted from tanned leather and keratin hydrolysate, 4 – treatment with a standard product (Serenade® ASO).

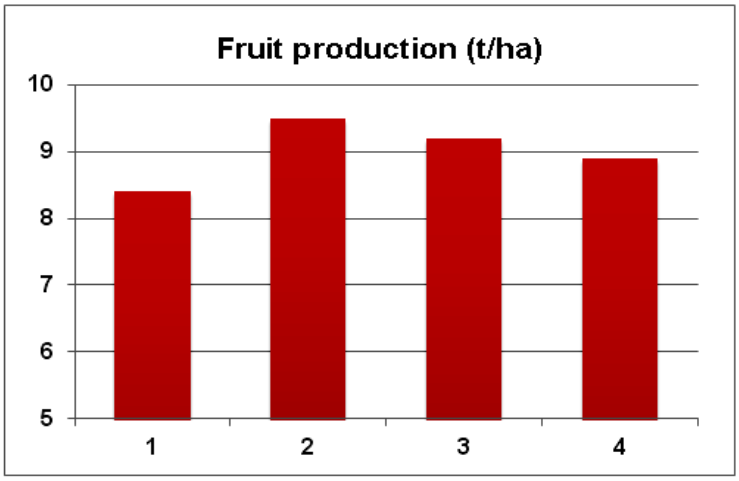

Figure 6. The influence of treatments on fruit production: 1) untreated control; 2) gelatin and collagen hydrolysate extracted from untanned leather; 3) gelatin, collagen hydrolysate extracted from tanned leather and keratin hydrolysate; 4) standard product (Serenade® ASO)

Cherry orchard tests have shown that treatment with experimental version (2) has determined the highest values of fruit weight (at 9.2 g), firmness (at 72.1 units), pH (3.8) and of the total soluble substance content (16.7˚Brix). However, the effects produced by the treatment with the experimental version (3) on the weight of the fruit were similar. Productions close to the maximum 9.5 t/ha, obtained with treatment (2) were also obtained in (3) fertilization version, 9.2 t/ha, both being significantly higher, compared to the untreated witness and with Standard treatment.

In order to establish the reproducibility of the results obtained in last season in the cherry orchard, a new set of tests is underway in the present season, and the results will be presented in subsequent publications.

CONCLUSIONS

The composites based on protein hydrolysates and gelatins have amino acids and polypeptides suitable for the immediate and delayed release of organic nitrogen necessary for plant stimulation and nutrition.

The treatments containing protein combinations was shown to increase fruit quality parameters as well fruit production level compared to both the untreated control and the standard treatment.

The use of collagen and keratin from the by-products of the leather industry for agricultural applications is a viable alternative to synthetic products.

Acknowledgements

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COMPOSITIONAL SOLUTIONS AND ASSIMILATION OF NEW TECHNICAL ELEMENTS WITH APPLICATIONS OF DESIGN IN FOOTWEAR MANUFACTURING

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COMPOSITIONAL SOLUTIONS AND ASSIMILATION OF NEW TECHNICAL ELEMENTS WITH APPLICATIONS OF DESIGN IN FOOTWEAR MANUFACTURING

ABSTRACT. Creativity and performance, as well as esthetical, artistic, psychological and marketing knowledge define the world of high-class design in the footwear industry. Beauty captured in the design of footwear and leather goods, personal design or computerized graphics are defining elements that bring high quality modernism through balance, harmony, clarity and order. In recent years, the leather industry has changed a lot, from low-cost mass production to serving customers consisting of small retail chains, where orders are small and models are varied. In order to cope with these changes, the footwear industry started investing in technological solutions. However, even today, due to the limited capacity of design software, designers frequently resort to traditional methods and techniques, often making use of their manual craftsmanship to design and make footwear components. The new technologies and the increasing involvement of the "fashion customer" lead to the emergence of new architectures in the esthetic and emotional expression of the wearer. Therefore, the article studies and analyzes the design-technology-image relationship as a scientific tool for generating ideas that define the personality of a high-class product.

KEY WORDS: footwear, fashion, innovative technologies

SOLUȚII COMPOZIȚIONALE ȘI ASIMILAREA DE NOI ELEMENTE TEHNICE CU APLICAȚII ALE DESIGNULUI ÎN FABRICAREA ÎNCĂLȚĂMINTEI

REZUMAT. Creativitatea și performanța, cunoștințele estetice, artistice, psihologice și de marketing definesc lumea designului de clasă din industria încălțămintei. Frumosul salvat în designul încălțămintei și marochinăriei, personal designul sau grafica computerizată sunt elemente definitorii care aduc prin echilibru, armonie, claritate și ordine, modernism de bună calitate. În ultimii ani, în industria de încălțăminte s-au schimbat multe, de la producția de masă low-cost la deservirea clienților formați din mici lanțuri de retail, unde comenzile sunt mici și modelele sunt variate. Pentru a face față unor astfel de modificări, industria încălțămintei a început să investească în soluții tehnologice. Cu toate astea, chiar și astăzi, din cauza capacităților limitate ale software-lor de proiectare, frecvent, designerii recurg la metode și tehnici tradiționale, folosind adesea măiestria manuală, pentru proiectarea și fabricarea componentelor de încălțăminte. Noile tehnologii și implicarea tot mai mare a „clientului de modă" duc la apariția de noi arhitecturi în expresia estetică și emoțională a purtătorului. Prin urmare, articolul studiază și analizează relația design-tehnologie-imagine ca instrument științific destinat producerii de idei care definesc personalitatea unui produs de clasă.

CUVINTE CHEIE: încălțăminte, modă, tehnologii inovative

SOLUTIONS DE COMPOSITION ET ASSIMILATION DE NOUVEAUX ÉLÉMENTS TECHNIQUES AVEC DES APPLICATIONS DE CONCEPTION DANS LA FABRICATION DE CHAUSSURES

RÉSUMÉ. La créativité et la performance, les connaissances esthétiques, artistiques, psychologiques et de marketing définissent le monde du design de classe dans l'industrie de la chaussure. La beauté conservée dans la conception de chaussures et de maroquinerie, le design personnel ou l'infographie sont des éléments déterminants qui apportent un modernisme de haute qualité par l'équilibre, l'harmonie, la clarté et l'ordre. Ces dernières années, beaucoup de choses ont changé dans l'industrie de la chaussure, passant d'une production de masse à faible coût à une clientèle composée de petites chaînes de vente au détail, où les commandes sont petites et les modèles variés. Pour faire face à ces changements, l'industrie de la chaussure a commencé à investir dans des solutions technologiques. Cependant, même aujourd'hui, en raison des capacités limitées des logiciels de conception, les concepteurs ont fréquemment recours à des méthodes et techniques traditionnelles, faisant souvent appel à un savoir-faire manuel, pour concevoir et fabriquer des composants de chaussures. Les nouvelles technologies et l'implication croissante du « client mode » conduisent à l'émergence de nouvelles architectures dans l'expression esthétique et émotionnelle de celui qui les porte. Par conséquent, l'article étudie et analyse la relation design-technologie-image comme outil scientifique pour la production d'idées qui définissent la personnalité d'un produit de classe.

MOTS CLÉS : chaussure, mode, technologies innovantes

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INTRODUCTION

The 21st century is deemed a century of new technologies and materials that have radically changed the objective world created by mankind. Currently, when unprecedented technical-scientific development takes place, the application of new technologies causes the phenomenon of technological substitution. The emergence of new technologies leads to partial or total disappearance of entire areas of industry; for instance, the development of synthetic adhesives, ecological leather, computer-assisted equipment are some of the factors that have led to a reduction or disappearance of areas that once existed in the market.

In recent years a lot has changed in the footwear industry, from low-cost mass production to serving customers consisting of small retail chains, where orders are small and models are varied. In order to cope with such changes, the footwear industry started investing in technological solutions. However, even today, due to the limited capacity of design software, designers frequently resort to traditional methods and techniques, often making use of their manual craftsmanship to design and make footwear components [1].

Creativity and performance, as well as esthetical, artistic, psychological and marketing knowledge define the world of high-class design in the footwear industry. Beauty captured in the design of footwear and leather goods, personal design or computerized graphics are defining elements that bring high quality modernism through balance, harmony, clarity and order.

The concept of personal design has rapidly evolved and is complementary to mass production [2]. Elements of innovation and performance are not just a set of new knowledge in the field, but also a real instrument for correctly assessing creative opportunities for footwear companies, to develop product strategies. Idea or concept sketches are a graphic illustration of the product, a mandatory work tool in all design stages and in all its manifestations.

The new technologies and the increasing involvement of the "fashion customer" lead to the emergence of new architectures in the esthetic and emotional expression of the wearer.

DEVELOPMENT OF MODERN FOOTWEAR

The need to reduce production time, costs and use of materials, as well as to make waste management more efficient, forces the adoption of modern and efficient methods of production. Consumers increasingly want to be actively involved in the shoe design process, which determines changes in design practices. Traditional design methodologies have long been the basis of footwear production, but evolving design trends, combined with the necessity for a greater adaptability to consumers' preferences, lead to adopting algorithmic design techniques [3].

This approach not only overcomes many constraints of traditional design, improving both geometric details of footwear shape, but also increases opportunities for personalized design solutions, for specific requests (for instance, product sizes, colour options, morphological shape, depending on the physical characteristics of the user).

The future of footwear manufacturing is deeply influenced by the integration of advanced technologies (such as 3D printing, 3D scanning, V-Ray rendering, 3D knitting and sensor technology) in different stages of design and fabrication [4-10].

DESIGN

Computational Design uses algorithms and computational tools to optimize process design, facilitating rapid prototyping and iteration.

Computer-Aided Design revolutionizes the footwear design process by providing designers with instruments to create, visualize and perfect footwear designs.

Although the contribution of Strategy, Financing, Human Resource Management, Purchasing, Logistics and Marketing cannot be ignored, Design is the heart of product development [11].

Design has five stages: conceptualization, screening concept, preliminary design, assessment and improvement, prototyping and final design.

Although there is design software available, designers resort to traditional methods and techniques, often using manual craftsmanship, to design and manufacture footwear components [1].

A good designer has remarkable flair in combining materials and colours, in constructing shapes as well as merging fashion with functionality (fashion without functionality becomes ridiculous, functionality without fashion is a wasted opportunity). Attractive visual effects are worthless if the footwear is uncomfortable during wear or if it fails to fulfill its functions. A successful product must be well designed, and its design must appropriately cover three aspects: functional, structural and decorative, in this order of importance. The most successful footwear and leather goods on the market are those that effectively combine these three aspects, so well that they naturally appear as a unit, and that each aspect develops in such a way as to complement the others.

Starting from zero, which involves documentation, competitive market analysis and user needs analysis, conclusions that determine the new concept, idea sketches, experimental studies and testing instruments to choose the best solution, the designer will use IT tools (computers), design software, 3D printers, scanners) that meet the principles of ecologic design and that pose a minimum risk for the environment [12].

DIGITAL MANUFACTURING TECHNOLOGIES

3D Printing enables the production of footwear components with unlimited final geometries. The technology that influences the footwear industry the most is that of 3D printers. The use of this tool has facilitated many of the design and fabrication processes.

This technology is used to a greater extent to develop prototypes to validate the design. What previously required a fabrication process can now be automated, reducing expenses with resources and manufacturing time. This, in its turn, enables testing a greater number of models and materials.

On the other hand, although to a lesser extent, 3D printing has also started to be used in production. Its use enables not only process automation, but also saving materials. In addition, due to digitization of various models, their modification is much easier.

3D Scanning is a technology that offers precision by digitizing physical models, facilitating construction processes and quality control.

3D Knitting emerges as an innovative technique, strengthening the textile sector by enabling complex and customized designs.

Sensors are integrated into footwear components in order to take measurements that provide valuable information to users, improving functionality and footwear utilization capacity.

Virtual and Augmented Reality offer experiences to users through virtual media they can interact with, virtual models in real time, improving their online shopping experience.

Innovative Technologies – Synthetic Materials in the Footwear Industry – Idea Sketches

Technological development often causes a new fashion trend. Considerable efforts are made to develop new materials, different from the traditional ones in terms of appearance and properties.

Synthetic materials with the appearance of natural ones, but having improved qualities in terms of resistance, wearability and maintenance, make their presence known in recent creations.

An important role and at the same time a clear trend of the next decade is that of synthetic materials, characterized by different textures, colours and prints; combined or not, they will offer the possibility of achieving unique esthetic effects.

To all these are added High-tech materials that have already seduced millions of customers; fantasy prompts creators to play with shapes and colours. It must not be forgotten that fashion is addressed to

potential buyers, wearers of creators' proposals, in concrete life circumstances. What defines the creation more is the originality of the proposals and functionality of solutions.

Less preferred by most designers, synthetic materials can be accepted in a new creative key. Regardless of the esthetic-emotional presentation, the first objective is that they are no longer monocellular from a technological point of view, as in the case of by-products or imitations, but polycellular, which means they can be recycled.

It is a clear message for industrialization that destroys beauty and for the lack of respect towards the environment.

The imaginative transfer towards a state that will become reality in the process of composing an object, regardless of its destination (through the excellence of fashion design) becomes an artistic composition using the means offered by modern, classic and artisanal technologies. Stylists have the task of intuiting and showing the shortest path to success. The mixture of images becomes a challenge both for specialists in the field and for receivers. Examples of synthetic materials that can be used in the footwear industry: synthetic leather with laser engravings and prints, with exterior effects used in 3D technology, to which high-tech textile materials are added, as well as plastic materials and rubber, are presented in Figures 1-4. Innovative technologies allow manufacturers to offer a wide range of leather samples to designers who choose, not lightly, to design a collection. The choice of shapes, volumes, materials and accessories that will be components of the concept collection will be part of the data obtained as a result of the fashion designer's artistic approach.

Figure 1. PRINT IMAGE – Prints have varied themes: nature, arts, city, movie stars, letters... Source: design research project, author dsg. Traian Foiasi

Figure 2. 3D EFFECT – Three-dimensional materials – innovative technologies lead to exaggerated three-dimension. Drawings with three-dimensional optical transmission, embossed and granular materials constitute an architecture with pronounced 3D connotations.
Source: design research project, author dsg. Traian Foiasi

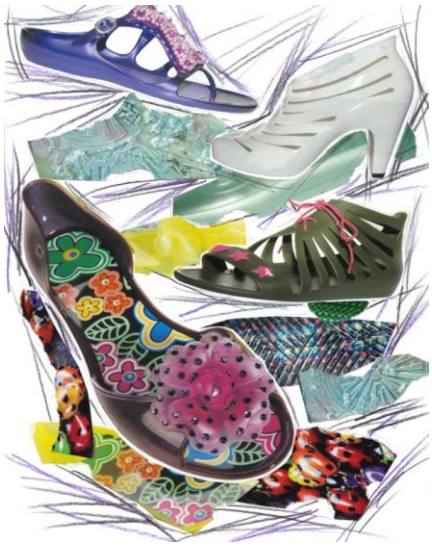

Figure 3. PLASTIC FASHION – Plastics are ever more present in the industry. The colour play and computer-designed shapes, the speed of adaptation to consumers' requests lead to a rapid development of this sector.
Source: design research project, author dsg. Traian Foiasi

Figure 4. RUBBER STEP – Unparalleled for the rainy season and not only, rubber footwear was developed due to 3D technologies.
Source: design research project, author dsg. Traian Foiasi

Idea Sketches, Generators of Modern Aesthetic Concepts in Fashion

Idea sketches or concept sketches are a graphic form that illustrates the product, a mandatory tool in all design stages and in all its manifestations. The new technologies and the increasing involvement of the fashion customer lead to the emergence of new architectures in the aesthetic and emotional expression of the wearer.

Innovative technologies enable the launch of models with sophisticated and futuristic appearance. The perceptible space is an area of excellence of designers who, with the help of 3D technology, can create a show of footwear creations (Figures 5-8).

Figure 5. High-class technologies impose themselves more and more through the production of protective materials that are highlighted by the application of films (elastomers) that give a nonconformist and particular aspect
Source: design research project, author, dsg. Traian Foiasi

Figure 6. Laces and perforations made with the help of the laser give elegance and preciousness to the models
Source: design research project, author dsg. Traian Foiasi

Figure 7. Innovative technologies enable launching models made of carboard fiber with sophisticated and futuristic aspect
Source: design research project, author dsg. Traian Foiasi

Figure 8. The perceptible space is an area of excellence for designers who, using 3D technology, have created a show of footwear creations
Source: design research project, author dsg. Traian Foiasi

The materials in the 2025-2026 trends are biodegradable and have an aesthetic expression according to the trends that the designers in the field offer as an artistic-technical suggestion to the companies of excellence in the fashion industry.

The materials that will be used for 3D printing by the FDM (Fused Deposition

Modeling) method are biocomposites based on thermoplastic polymers (such as TR-SBS, TPU, PLA) and natural fiber waste functionalized by the melt mixing method.

Dsg. Traian Foiasi made and presented some idea sketches for footwear components (sole, heel), which can be obtained by 3D printing (Figure 9) and can be then assembled into the finished footwear (Figure 10).

A finished footwear model sketch is also presented (Figure 11), which can be made completely by 3D printing.

Technology has the potential to transform any process, but the final success depends on the people involved. Access to knowledge and making the right decisions, both supported by solid training is of utmost importance [13].

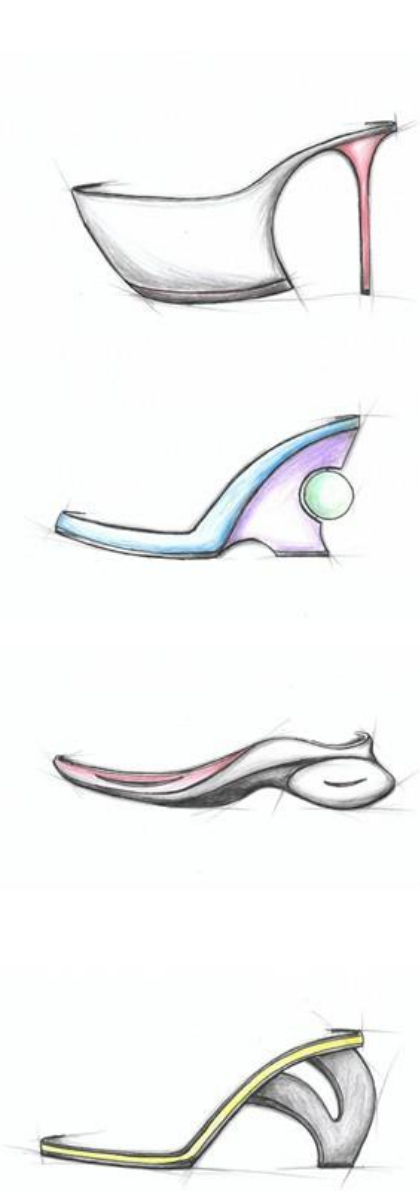

Figure 9. Idea sketches for footwear components

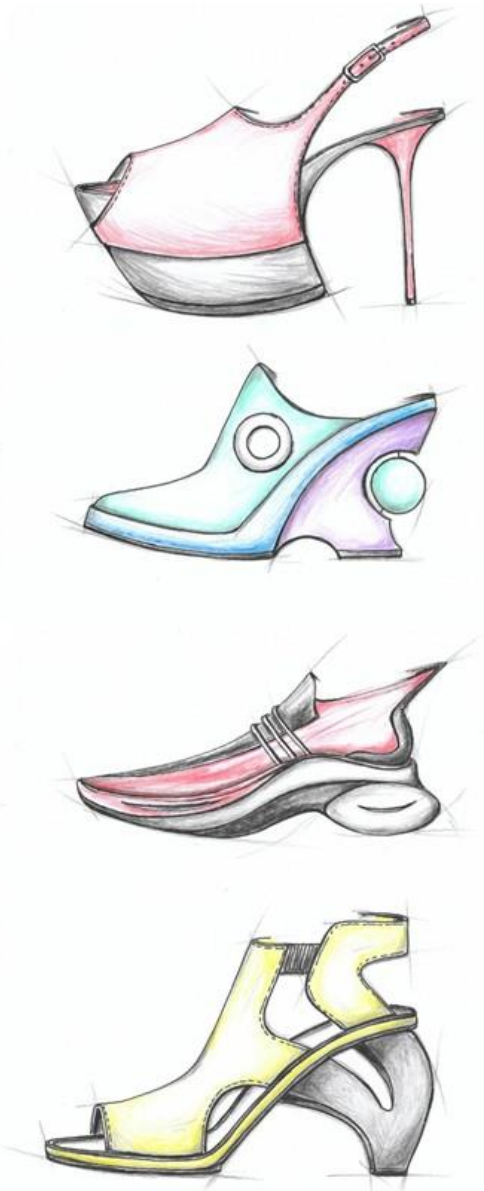

Figure 10. Idea sketches for finished footwear

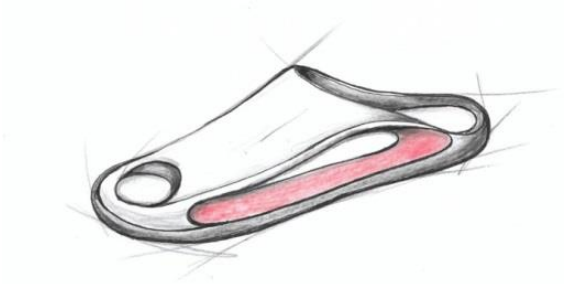

Figure 11. Idea sketch for 3D printed finished footwear

SIMULATION CONTROL METHODS

Finite Element Analysis (FEA) involves analysis methods using finite elements, conducting virtual tests from which valuable information is extracted regarding durability, comfort and lifetime of footwear components. These simulations allow researchers to evaluate the structural integrity and performance of various footwear components in different conditions.

Other Control Methods focus on methods aiming to optimize the design by wear testing. By incorporating feedback from wearers, these methods seek to improve the general design of the footwear, making sure that it meets the needs and preferences of the consumers. This approach allows for iterative improvements based on scenarios of use in the real world.

TARGET GROUP

Target groups for footwear are identified based on consumers' preferences and needs. Consumers choose footwear based on different criteria, including functionality, style, comfort and performance. In addition, there is a growing tendency towards customized products, adapted to the preferences and individual requirements of customers.

Professional – The footwear industry focuses on creating footwear that meet the specific needs and preferences of people in many industries and occupations.

Medical - The footwear industry also focuses on designing, manufacturing and prescribing medical footwear adapted to various foot conditions, and improving foot health in general.

ADVANTAGES OF APPLYING INNOVATIVE TECHNOLOGIES IN THE FOOTWEAR SECTOR

The new technologies not only make possible the improvement of existing processes, but also finding new ways of application in order to provide better services, as well as various benefits that make it impossible to compete with traditional methods:

- Higher resource savings due to more efficient processes.
- Shorter production time due to automated systems.
- Higher versatility and flexibility in making modifications.
- Better services for the user and suppliers due to the possibility to share useful information through these technologies.

CONCLUSIONS

Innovation in fashion is essential for commercial value and longevity. It is essential for the way in which we model the industry. Innovation in fashion will allow us to function and interact in a digital world.

The pragmatic approach of the relationship between design, technology and image becomes a scientific tool for generating ideas that define the personality of a high-class product, its demand on the market and chances of success compared to other products.

The esthetic design of a new product involves a creative spirit and artistic talent, the designer needs to find the optimal shape

of the new product. But this shape must correspond to the improved functionality of the product.

To perfect the designed product in terms of functionality, results from different areas of science and technology are to be implemented.

The new technologies help footwear designers transform design ideas more conveniently, they greatly improve the efficiency of product design, extend the creative space of footwear design and rapidly create prototypes of products with shapes and structures difficult to make using traditional methods. With the help of new technologies, the footwear industry will also undergo significant changes through original methods of design, development and production, as well as developing customization services. They will help enterprises adapt to current consumption models and fast fashion market trends, customization, small batches and diversification.

Acknowledgements

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EXTRACTION OF PERCEPTUAL FACTORS OF SHU EMBROIDERY PATTERNS AND INNOVATIVE APPLICATION IN WOMEN'S SHOES DESIGN

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EXTRACTION OF PERCEPTUAL FACTORS OF SHU EMBROIDERY PATTERNS AND INNOVATIVE APPLICATION IN WOMEN'S SHOES DESIGN

ABSTRACT. Shu embroidery, an important intangible cultural heritage of China, boasts a long history and exquisite needlework techniques. As the times have progressed, consumers' demand for personalization of women's shoes has increased, and women's shoe design has shown shortcomings such as insufficient innovation and lack of traditional Chinese cultural characteristics. As the core carrier of embroidery to express the theme and aesthetics, Shu embroidery pattern reflects the deep heritage of traditional Chinese culture, and its innovative fusion with women's shoe design gives women's shoe products a unique style and charm. This paper proposes a design process based on the principles of Kansei Engineering and Shape Grammar to explore the perceptual cognitive expressiveness of Shu embroidery patterns, by selecting representative patterns favored by consumers, deconstruct and reorganize them in combination with shape grammar, and innovatively apply them to the design of women's leather shoes. The study indicates that: using Kansei Engineering principles to quantify consumers' perceptual evaluation of Shu embroidery patterns can provide scientific theoretical and data support for the extraction of the perceptual factors; the innovative application of Shu embroidery patterns in women's leather shoes design can improve the personalization level of products, enhance market competitiveness and provide a paradigm for the women's shoe brands and designers to apply.

KEY WORDS: Shu embroidery; pattern; perceptual engineering; shape grammar; women's leather shoes

EXTRAGEREA FACTORILOR DE PERCEPȚIE DIN MODELELE DE BRODERIE SHU ȘI APLICAREA INOVATOARE A ACSETORA ÎN DESIGNUL ÎNCĂLȚĂMINTEI PENTRU FEMEI

REZUMAT. Broderia Shu, un important patrimoniu cultural imaterial al Chinei, se mândrește cu o istorie îndelungată și tehnici de cusut rafinate. Odată cu trecerea timpului, cererea consumatorilor pentru personalizarea pantofilor de damă a crescut, iar designul încălțămintei pentru femei a prezentat deficiențe, cum ar fi inovația insuficientă și lipsa caracteristicilor culturale tradiționale chinezești. Ca suport de baz[care exprimă tematica și estetica, modelul de broderie Shu reflectă moștenirea profundă a culturii tradiționale chineze, iar fuziunea sa inovatoare cu designul încălțămintei de damă conferă produselor un stil și un farmec unice. Această lucrare propune un proces de design bazat pe principiile ingineriei Kansei și ale gramaticilor formelor pentru a explora expresivitatea cognitiv-perceptuală a modelelor de broderie Shu, selectând modele reprezentative preferate de consumatori, deconstruindu-le și reorganizându-le în combinație cu gramatica formelor și aplicându-le inovator în designul încălțămintei de piele pentru femei. Studiul indică faptul că: utilizarea principiilor ingineriei Kansei pentru a cuantifica evaluarea perceptuală a consumatorilor asupra modelelor de broderie Shu poate oferi suport teoretic și științific bazat pe date pentru extragerea factorilor de percepție; aplicarea inovatoare a modelelor de broderie Shu în designul încălțămintei de piele pentru femei poate îmbunătăți nivelul de personalizare al produselor, spori competitivitatea pe piață și oferi un model pentru brandurile și designerii de pantofi de damă.

CUVINTE CHEIE: broderie Shu; model; inginerie perceptuală; gramatica formelor; pantofi din piele pentru femei

L'EXTRACTION DES FACTEURS PERCEPTUELS DES MOTIFS DE BRODERIE SHU ET LEUR APPLICATION INNOVANTE DANS LA CONCEPTION DES CHAUSSURES POUR FEMMES

RÉSUMÉ. La broderie Shu, un important patrimoine culturel immatériel de la Chine, se distingue par une longue histoire et des techniques de broderie exquises. Avec le temps, la demande des consommateurs pour la personnalisation des chaussures pour femmes a augmenté, et la conception des chaussures pour femmes a montré des lacunes telles que l'innovation insuffisante et le manque de caractéristiques culturelles traditionnelles chinoises. En tant que support principal de la broderie pour exprimer le thème et l'esthétique, le motif de broderie Shu reflète l'héritage profond de la culture traditionnelle chinoise, et sa fusion innovante avec la conception des chaussures pour femmes confère aux produits une touche unique et un charme distinctif. Cet article propose un processus de conception basé sur les principes de l'ingénierie Kansei et de la grammaire des formes pour explorer l'expressivité cognitive et perceptuelle des motifs de broderie Shu. En sélectionnant des motifs représentatifs appréciés par les consommateurs, en les décomposant et en les réorganisant en combinaison avec la grammaire des formes, ces motifs sont appliqués de manière innovante à la conception de chaussures en cuir pour femmes. L'étude indique que l'utilisation des principes de l'ingénierie Kansei pour quantifier l'évaluation perceptuelle des consommateurs des motifs de broderie Shu peut fournir un soutien théorique et scientifique basé sur des données pour l'extraction des facteurs perceptuels ; l'application innovante des motifs de broderie Shu dans la conception de chaussures en cuir pour femmes peut améliorer le niveau de personnalisation des produits, accroître la compétitivité sur le marché et offrir un modèle pour les marques et les concepteurs de chaussures pour femmes.

MOTS CLÉS : broderie Shu ; motif ; ingénierie perceptuelle ; grammaire des formes ; chaussures en cuir pour femmes

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INTRODUCTION

Shu embroidery, also known as "Chuan embroidery," is a traditional Chinese embroidery craft, recognized as one of the four great embroideries of China. It is also one of the oldest forms of embroidery in China, with a history dating back over 2,000 years [1]. Shu embroidery was included in China's national intangible cultural heritage list in 2006, which indicates that it has extremely important value for the protection and development of China's rich cultural heritage [2]. Shu embroidery is not only a handicraft, it also contains rich cultural connotations, creating extremely delicate and vivid patterns through different combinations of stitches. The themes of Shu embroidery works are expressed through the content and subject matter of the patterns. Many creations are rooted in traditional Chinese culture and folklore, showcasing exquisite folk craftsmanship and conveying profound cultural and educational significance.

The composition of Shu embroidery patterns determines the artistic style and characteristics of the embroidery works [3] with their intricate and exquisite visual effects offering significant artistic and design value. Innovatively transforming Shu embroidery patterns and incorporating them into the design of women's leather shoes is an effective approach for the modern application of traditional elements. Scholars have conducted research on the innovative application of traditional elements in footwear: Ho Sun Lim [4] explores the innovative use of traditional Korean muntin patterns in the design of 3D printed shoes. The study aims to create customized shoe designs that are unique and different from existing products by integrating traditional patterns with modern 3D printing technology. A. Karaseva *et al*. [5] research on traditional Mongolian costumes in modern footwear design shows high market demand for ethnic-style designs. The study highlights the integration of ethnic themes and designers' creative interpretations, recommending new footwear models with traditional Mongolian elements to enhance competitiveness. Zhonghua Cao *et al*. [6] incorporated traditional Chinese cultural elements, such as Confucianism and Taoism, into parent-child shoe designs. Using panda imagery and traditional ink painting techniques, they created unique panda-themed designs, which were applied to various shoe styles for toddlers and women, combining both functional and aesthetic elements. Traditional patterns feature diverse color combinations, rich curves, and strong regional cultural significance, providing abundant inspiration for contemporary art and design [7]. Using Kansei Engineering methods, the study quantitatively analyzes consumers' emotional perceptions of Shu embroidery patterns, offering a crucial basis for innovative design. Additionally, combining shape grammar facilitates the derivation and regeneration of fundamental factors in Shu embroidery patterns, applied to women's leather shoes as a medium. This innovative design process enables designers to better understand and meet market and consumer demands, effectively merging consumers' emotional expectations with the inheritance and development of traditional art.

RESEARCH METHODS AND PROGRAM DEVELOPMENT

Principles of Kansei Engineering

Kansei engineering, as a representative method in emotional design, captures and quantifies users' emotional responses to specific product attributes. This establishes a connection that provides clear guidance for the formulation and evaluation of design schemes [8]. It encompasses various research methods, including semantic differential analysis [9], surveys, factor analysis, aiming to deeply understand individuals' perceptions of products, specifically their psychological expectations and emotional responses. Kansei images reflect the emotional connection humans have with objects, representing the deeper expression of emotional reactions [10].

Shape Grammar Principle

Shape grammar is a design reasoning method primarily based on shape operations. It generates new shapes by arranging and combining one or more basic shapes according to grammatical relationships and rules of the shapes [11]. Shape grammar has the ability to transform initial shapes into new shapes following specific rules, while ensuring the new shapes retain the properties of the initial shapes. This characteristic offers good inheritance. Shape grammar is represented by a four-tuple formula, which includes: $\mathrm{SG} = (\mathrm{S}, \mathrm{L}, \mathrm{R}, \mathrm{I})$. In this formula, SG represents the set of shapes derived from shape S through operations such as scaling and rotation; S denotes a finite set of shapes; L represents a finite set of labels; R stands for a finite set of inference rules; and I indicates the initial shape [12].

Research Programming

The article proposes a design methodology that integrates Kansei Engineering with shape grammar. Initially, Shu embroidery patterns are selected as the research subject. Patterns are collected and depicted in stimulus images, while relevant affective words are identified. Next, an evaluation experiment of affective semantics is conducted, with results organized and analyzed for factors and grey relational analysis to identify Shu embroidery samples for innovative design. Selected samples are then deconstructed and reorganized into basic units, transformed using shape grammar rules to generate regenerative elements, and experimented with in various color styles. Finally, these regenerative elements are applied in “dot, line, surface” forms in the integrated design of women’s leather shoes. The design process is illustrated in Figure 1.

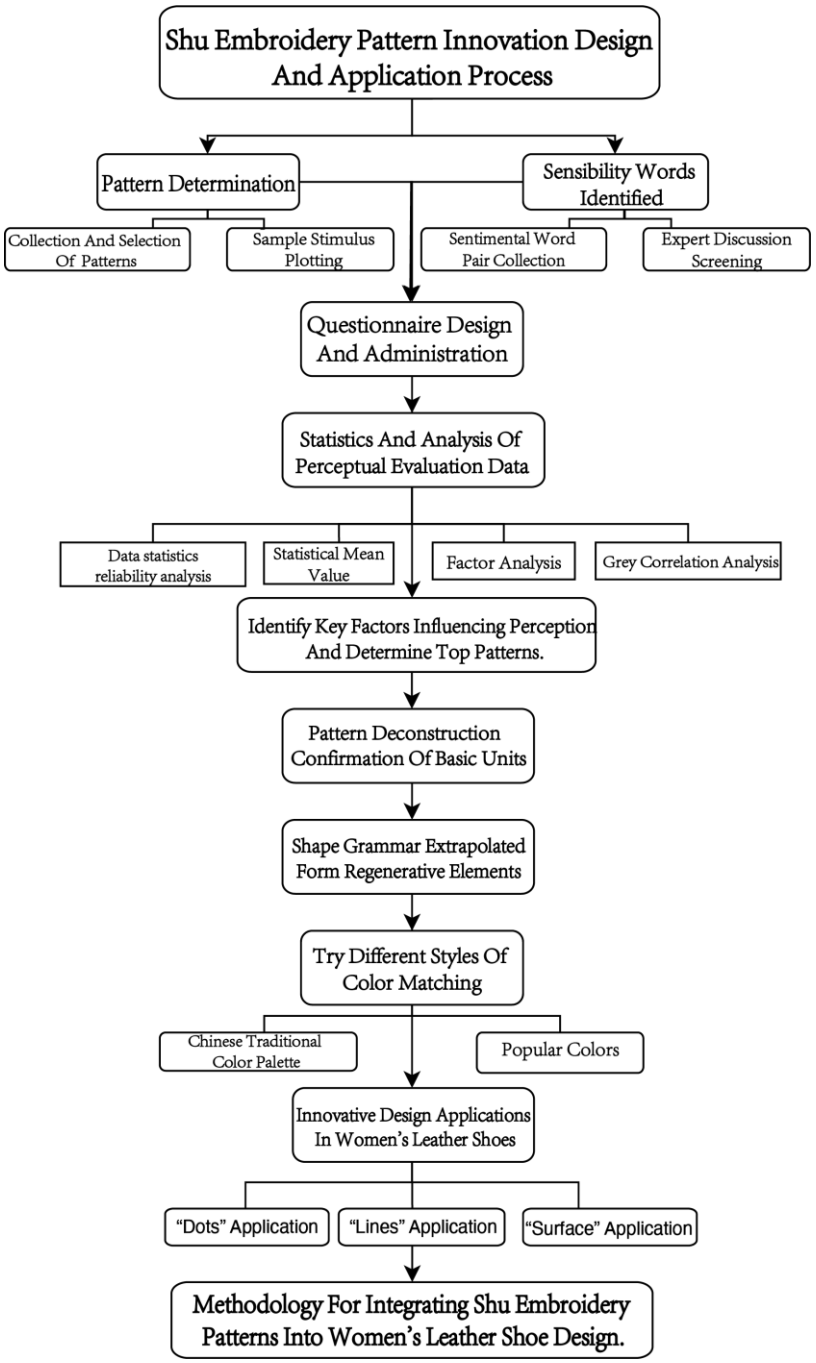

Figure 1. Shu embroidery pattern innovation design flow chart

RESEARCH PROCESS

Selection and Stimulation Pattern Design of Shu Embroidery

Focusing on Shu embroidery patterns as the research subject, pattern materials were collected from literature and field investigations. Through, organizing and summarizing the literature, Shu embroidery patterns can be broadly classified into five categories: animals, plants, humanities, artifacts, and geometric patterns. Four representative samples were selected from each category, resulting in a total of 20 patterns. To minimize the influence of color, texture, and stitching techniques on consumers' perceptual evaluations, black-and-white line drawings were created using Adobe Illustrator. In designing the questionnaire, the order of the stimulus images was randomized to enhance clarity and effectiveness. As shown

in Figure 1, the random order of the Shu embroidery pattern stimulus images is as follows: patterns 01, 06, 11, and 16 belong to the animal category; patterns 04, 07, 12, and 17 belong to the plant category; patterns 03, 10, 15, and 20 belong to the humanities category; patterns 02, 08, 14, and 19 belong to the artifact category; and patterns 05, 09, 13, and 18 belong to the geometric pattern category.

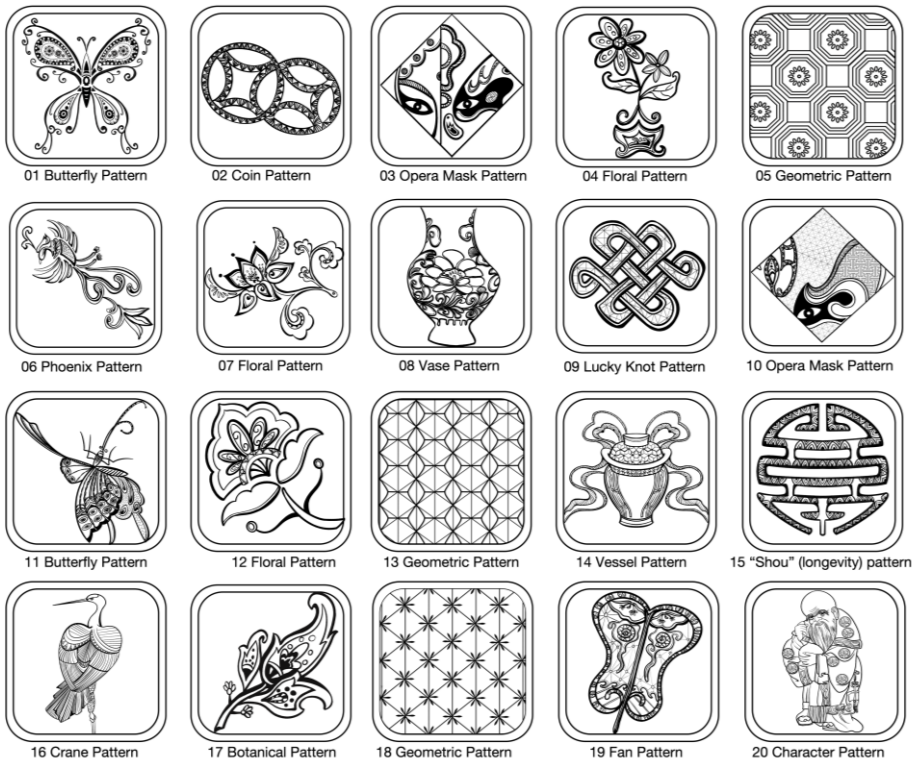

Figure 2. Shu embroidery sample stimulus images and number

Perceptual Word Pair Selection

We adopted a combined online and offline strategy to collect adjective pairs. Online collection was mainly conducted by reviewing literature and browsing relevant websites. Offline collection was achieved through gathering opinions and evaluations from relevant experts, including professors, Shu embroidery masters, industry professionals, design students, and designers. In total, more than 60 pairs of patterns were collected. Using the Semantic Differential (SD) method, which quantifies people's attitudes and emotional responses toward an object, we eventually identified nine pairs of Kansei adjectives: concrete-abstract, simple-complex, graceful-lively, traditional-modern, dynamic-static, gentle-harsh, elegant-vulgar, boring-interesting, and dislike-like [13].

Questionnaire Design and Implementation

The survey questionnaire employed a 5-point Likert scale, with scores ranging from 1 to 5. To minimize page-turning time for respondents, a matrix format was used to arrange the nine pairs of adjectives. Each pair of adjectives was placed at the ends of a scale, with scores closer to the ends indicating a stronger feeling towards that adjective. For example, for "concrete—abstract," 1 indicates very concrete, 2 indicates somewhat concrete, 3 indicates neutral, 4 indicates somewhat abstract, and 5 indicates very abstract.

The survey was distributed using the online platform Questionnaire Star. Each questionnaire included an introduction explaining the survey's purpose, instructions, length, and estimated completion time. Respondents were asked to view 20 stimulus images and rate them using the 12 adjective pairs, with the images presented in random order.

DATA STATISTICS AND ANALYSIS

Data Statistics and Reliability Analysis

A total of 160 questionnaires were distributed and collected online. Among the respondents, 85.62% were familiar with Shu embroidery and its patterns. Specifically, 68.13% (109 individuals) learned about Shu embroidery through social media platforms, while nearly half were informed through films, museum visits, and literature. The respondents' familiarity with Shu embroidery ensured the reliability of the data.

Reliability analysis using SPSS 26.0 showed that the Cronbach's α coefficient for the eight pairs of affective adjectives was 0.975, and for preference ratings, it was 0.945, both exceeding 0.900, indicating excellent reliability of the questionnaire.

Mean Statistical Analysis

Each pattern stimulus map obtained 1440 scores (160 questionnaires * 9 pairs of perceptual adjectives), and the questionnaire results were mean-valued statistically using SPSS software. To analyze the emotional tendencies of the 20 Shu embroidery patterns, the "origin method" was used, with scores ranging from 1 to 5 and 3 as the origin. Scores less than 3 indicate a tendency towards the left adjective, while scores greater than 3 indicate a tendency towards the right adjective. The greater the deviation from 3, the more pronounced the affective tendency. For example, for pattern 01, the adjective pair "elegant—vulgar" had a mean score of 2.09, indicating a stronger inclination towards "elegant". The mean scores of the 20 patterns were ranked by the strength of their tendencies, with the top three adjectives for each pattern listed in Table 1. The adjectives shown in the table represent the primary feelings elicited by each pattern, such as pattern 01 being perceived mainly as elegant, gentle, and concrete.

Table 1: The main emotional and psychological vocabulary and scores of Sichuan embroidery pattern samples

Pattern number	Adjectives	Score	Pattern Number	Adjectives	Score	Pattern Number	Adjectives	Score
	elegant	2.09		elegant	2.4		abstract	3.46
1	gentle	2.17	8	traditional	2.46	15	elegant	2.64
	concrete	2.28		concrete	2.47		complex	3.34
	traditional	2.51		elegant	2.34		concrete	2.14
2	elegant	2.51	9	interesting	3.25	16	dynamic	2.19
	simple	2.59		concrete	2.77		elegant	2.23
	elegant	1.97		dynamic	2.16		elegant	2.48
3	dynamic	2.14	10	elegant	2.21	17	gentle	2.51
	interesting	3.76		abstract	3.7		dynamic	2.59
	dynamic	2.28		dynamic	2.28		simple	2.54
4	elegant	2.37	11	interesting	3.61	18	elegant	2.79
	gentle	2.41		elegant	2.41		graceful	2.83
	elegant	2.59		dynamic	2.39		elegant	2.31
5	graceful	2.66	12	gentle	2.39	19	dynamic	2.41
	simple	2.69		elegant	2.44		gentle	2.43
	elegant	2.08		abstract	3.46		concrete	1.93
6	dynamic	2.23	13	harsh	3.38	20	traditional	2.12
	gentle	2.26		static	3.31		complex	3.82
	gentle	2.15		dynamic	2.59			
7	elegant	2.16	14	traditional	2.6			
	dynamic	2.16		gentle	2.62			

The mean score of adjective pair "like - dislike" reflects the degree of favoritism of the 20 Shu embroidery patterns, the higher the value is, the higher the degree of favoritism, and the lower the value is, the relative degree of favoritism is lower. The favorability scores of each sample are shown in Table 2, from which it can be seen that the samples with higher favorability are mostly humanities, plants and animals.

Table 2: The popularity score of each Shu embroidery pattern sample

Pattern number	Favoritism	Pattern number	Favoritism
1	3.92	11	3.75
2	3.46	12	3.66
3	4.16	13	3.16
4	3.76	14	3.67
5	3.39	15	3.42
6	3.96	16	3.89
7	4	17	3.59
8	3.61	18	3.53
9	3.63	19	3.63
10	4.07	20	3.76

Factor Analysis

The eight adjective pairs (excluding the "like—dislike" pair, which was only used to evaluate the preference for the 20 Shu embroidery patterns and was not included in the factor analysis) were subjected to KMO and Bartlett's sphericity tests. The KMO value was 0.677, greater than 0.600, and the Bartlett's sphericity test significance was 0.000, indicating strong correlations among the data, making them suitable for factor analysis [14]. The adjective pairs were categorized and the perceptual factors were extracted through factor analysis, firstly, the Shu embroidery pattern stimulus images were downgraded and interpreted through principal component analysis to find out the number of common factors that could reflect more original data. Factor eigenvalue greater than 1 is considered to be able to be used as the main factor [15], as shown in Table 3, of total variance interpretation, the eigenvalue of factor 1 is 4.105, and the eigenvalue of factor 2 is 1.893, the eigenvalue of the 2 factors is greater than 1, and the cumulative contribution rate is 74.973%, which is more representative of the original variables, so these 2 factors can explain most of the perceptual information of the Shu-embroidery patterns better.

Table 3: Eigenvalues and variance contribution rate

Factor	Initial Eigenvalues			Sums of Squared Loadings		
	Total	Variance / %	Cumulative /%	Total	Variance / %	Cumulative /%
1	4.105	51.316	51.316	4.105	51.316	51.316
2	1.893	23.657	74.973	1.893	23.657	74.973
3	0.863	10.791	85.764			
4	0.697	8.709	94.474			
5	0.276	3.446	97.919			
6	0.096	1.199	99.119			
7	0.04	0.496	99.615			
8	0.031	0.385	100			

The factor loading matrix was rotated using the maximum variance method to make the factors interpretive [16]. The adjective pairs were categorized according to the rotated component matrix, and the main factors were named according to the grouping content. To clearly display the relationship between factors and adjective pairs, coefficients less than 0.3 were ignored. As shown in Table 4, the adjective pairs "dynamic—static," "boring—interesting," "gentle—harsh," "elegant—vulgar," and "simple—complex" had high absolute loadings on Factor 1, indicating that they primarily explain Factor 1. This set of adjective pairs describes the elegant yet dynamic and interesting characteristics of Shu embroidery patterns; therefore, Factor 1 was named the "Temperament Factor." The adjective pairs "traditional—modern," "graceful—lively," and "concrete—abstract" had high absolute loadings on Factor 2,

indicating that they primarily explain Factor 2. This set of adjective pairs describes the stylistic features of Shu embroidery patterns; thus, Factor 2 was named the "Style Factor."

Table 4: Rotated component matrix

Adjective Pairs	Component	
	Factor 1	Factor 2
dynamic—static	0.967	—
boring—interesting	-0.962	—
gentle—harsh	0.922	—
elegant—vulgar	0.916	—
simple—complex	-0.622	—
traditional—modern	—	0.898
graceful—lively	—	0.825
concrete—abstract	—	0.607

Gray Relational Analysis

Gray relational analysis is a method used to assess the degree of correlation between two sets of factor sequences as they vary with a certain variable. If the degree of variation is consistent, it indicates a strong correlation between the two sets of factors; conversely, if the degree of variation is inconsistent, the correlation is weak [17]. To determine the degree of correlation between the two main factors of Shu embroidery pattern design and consumer preference, an evaluation matrix was established, and gray relational analysis was conducted. The specific steps are as follows.

Determination of the Evaluation Matrix

The mean scores of the affective evaluations for the five adjective pairs in the Temperament Factor and the three adjective pairs in the Style Factor were used as the indicator sequences $\{X_i(k),\ i=1,\ 2,\ k=1,\ 2,\ \ldots,\ 20\}$.

Here, $X_i(k)$ represents the mean affective evaluation score of the i-th stimulus image for the k-th adjective pair in each factor. The mean preference scores for the 20 Shu embroidery patterns were used as the reference sequence, $\{X_0(k),\ k=1,\ 2,\ \ldots,\ 20\}$, where, $X_0(k)$ represents the mean preference score of the k-th stimulus image. To display the matrix clearly, it was transposed, generating the following matrix:

$$(X_0,\cdots,X_2)^T = \begin{Bmatrix} 3.92 & 3.46 & \cdots & 3.63 & 3.76 \\ 2.62 & 2.83 & \cdots & 2.79 & 2.97 \\ 2.51 & 2.68 & \cdots & 2.50 & 2.30 \end{Bmatrix} \quad (1)$$

Normalization of Original Data

Due to the presence of multiple factors in the gray relational system, and the differences in units and meanings of the data for each factor, the resulting dimensions are also different. To facilitate data analysis and calculation, and to ensure the reliability of the analysis results, data are typically dimensionless [18]. This paper uses mean normalization for data processing. The normalization formula is as follows:

$$X_i'(k)=\frac{x_i(k)}{\bar{x_i}} \quad (2)$$

In the formula, $x_i(k)$ represents the original data of the i-th indicator for the k-th sample; $\bar{x_i}$ denotes the mean value of the i-th indicator; $x_i'(k)$ represents the normalized data of the i-th indicator for the k-th sample. Here, $(i=0,\ 1,\ 2,\ k=1,\ 2,\ \ldots,\ 20)$. The resulting matrix is as follows:

$$(X_0',\cdots,X_2')^T = \begin{Bmatrix} 1.059 & 0.935 & \cdots & 0.981 & 1.016 \\ 0.938 & 1.012 & \cdots & 1.000 & 1.064 \\ 0.895 & 0.954 & \cdots & 0.891 & 0.818 \end{Bmatrix} \quad (3)$$

Calculation of Absolute Differences Between Sequences

The absolute differences between the indicator series for the 20 stimulus images (the two principal factor mean score series) and the

reference series (the preference mean score series) were calculated. The formula (4) is:

$$\Delta i(k)=|X_0'(k)-X_i'(k)| \quad (4)$$

In the formula, $\Delta i(k)$ represents the absolute difference, $X_0'(k)$ is the normalized reference series, and $X_i'(k)$ is the normalized indicator series. After calculating the absolute differences, the resulting matrix is as follows:

$$\begin{Bmatrix} 0.121 & 0.077 & 0.155 & \cdots & 0.019 & 0.048 \\ 0.164 & 0.019 & 0.030 & \cdots & 0.090 & 0.198 \end{Bmatrix} \quad (5)$$

Determination of the Range

Identify the minimum and maximum differences in the absolute difference matrix. From the matrix, it is evident that the minimum difference is 0.013, and the maximum difference is 0.257.

$$\min_i \min_k |X_0'(k)-X_i'(k)| = 0.013 \quad (6)$$

$$\max_i \max_k |X_0'(k)-X_i'(k)| = 0.257 \quad (7)$$

Calculation of the Gray Relational Coefficients

Using the absolute differences from the matrix series and the maximum and minimum differences, the gray relational coefficients between the two principal factors and the preference levels are calculated. The calculation formula is:

$$\gamma_i(k) = \frac{\min_i \min_k |X_0'(k)-X_i'(k)| + \rho * \max_i \max_k |X_0'(k)-X_i'(k)|}{|X_0'(k)-X_i'(k)| + \rho * \max_i \max_k |X_0'(k)-X_i'(k)|} \quad (8)$$

In the formula, $\gamma_i(k)$ represents the gray relational coefficient for the i-th stimulus image's k-th principal factor and the preference level, and ρ is the distinguishing coefficient, which is typically set to 0.5 [19]. The resulting gray relational coefficient matrix is as follows:

$$\begin{Bmatrix} 0.567 & 0.689 & 0.499 & \cdots & 0.753 & 0.957 & 0.802 \\ 0.483 & 0.959 & 0.893 & \cdots & 0.589 & 0.648 & 0.434 \end{Bmatrix} \quad (9)$$

Calculation of the Gray Relational Degree

Using the gray relational coefficients obtained in the previous step, the degree of association between the two principal factors and the preference level is calculated. The formula is as follows:

$$\omega_i = \frac{1}{m}\sum_{k=1}^{m}\gamma_i(k) \quad (10)$$

In the formula, ω_i represents the average gray relational degree between the i-th principal factor and the preference level, and the magnitude of this value is directly proportional to the degree of association. Here, m is the total number of stimulus image samples.

Through calculation, the Temperament Factor : $\omega_1 = 0.717$, and for the Style Factor: $\omega_2 = 0.673$, Thus, the degree of association with the preference level is ranked as: $\omega_1 > \omega_2$, indicating that the Temperament Factor has a stronger association with the preference level.

Based on the principal component analysis of the Temperament and Style Factors, and combined with the scores of the main affective psychological words for each pattern sample in Table 1, it can be concluded that whether the pattern theme is lively and interesting, and whether the composition is simple yet smooth and unadorned, are the primary concerns of consumers. Shu embroidery patterns with lively and interesting themes, cultural flavor of the Sichuan-Chongqing region, and soft and elegant presentations are more likely to be favored by consumers. According to Table 1, patterns 03, 04, 05, 06, 07, 11, 12, 17, and 19 reflect the most characteristics of the Temperament Factor, making them more likely to be favored by consumers.

INNOVATIVE DESIGN OF SHU EMBROIDERY PATTERNS

Based on the above analysis, the patterns that align with the temperament characteristics favored by consumers were ranked according to their preference scores in Table 2. Pattern 03 ranked highest, indicating that the opera mask pattern possesses unique characteristics in terms of theme and composition, making it more likely to be favored by consumers. Therefore, the opera mask pattern was used for innovative design and extraction. The opera mask pattern is an innovative form that integrates Sichuan opera elements into Shu embroidery, being novel and vibrant, and highly accepted among younger

consumers. Sichuan opera, as a significant cultural symbol of the Southwest region, endows Shu embroidery with regional characteristics and cultural depth. This integration helps deepen consumers' geographical impression of Shu embroidery art and improves the recognition and acceptance of Shu embroidery patterns.

Extraction of Basic Factors

Sichuan opera facial masks consist of abstract and geometric shapes made up of dots, lines, and surfaces, with the lines mostly being curves, offering fluidity and richness [20]. By using the deconstruction and reorganization method, the elements of the Sichuan opera mask patterns were disassembled and optimized. Some new elements were combined to derive deformed basic units that retain the details and characteristics of the original patterns, as shown in Figure 3.

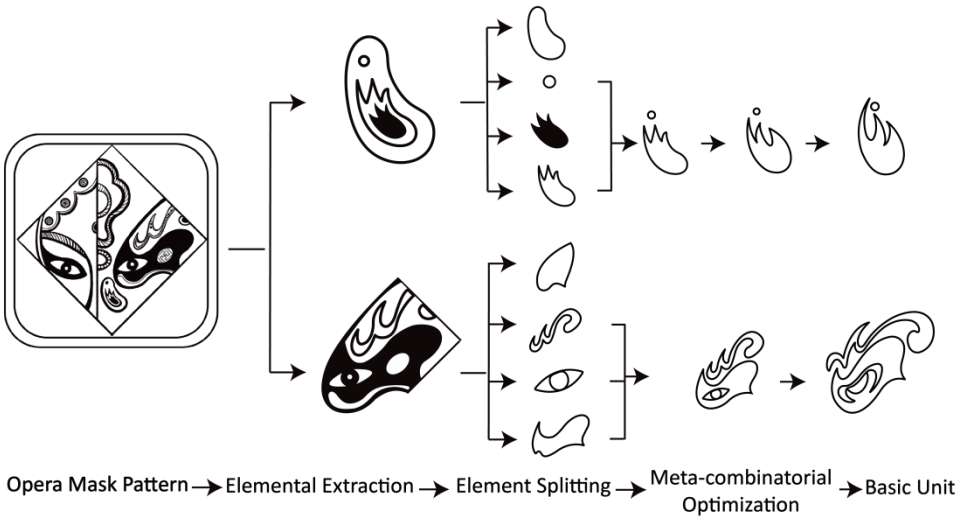

Figure 3. The Process of Deconstructing and Recombining Shu Embroidery Facial Patterns

Shape Grammar Derivation Process

The deconstructed and reorganized basic units were evolved according to shape grammar rules. The evolution rules are denoted by R, with R1 representing the horizontal mirroring rule, R2 the vertical mirroring rule, R3 the point rotation rule, R4 the central rotation rule, R5 the horizontal displacement rule, R6 the vertical displacement rule, R7 the reduction rule, R8 the enlargement rule, and R9 the addition and deletion rule. The deconstructed and reorganized basic units were used as the fundamental patterns for the derivation process, as shown in Figure 4.

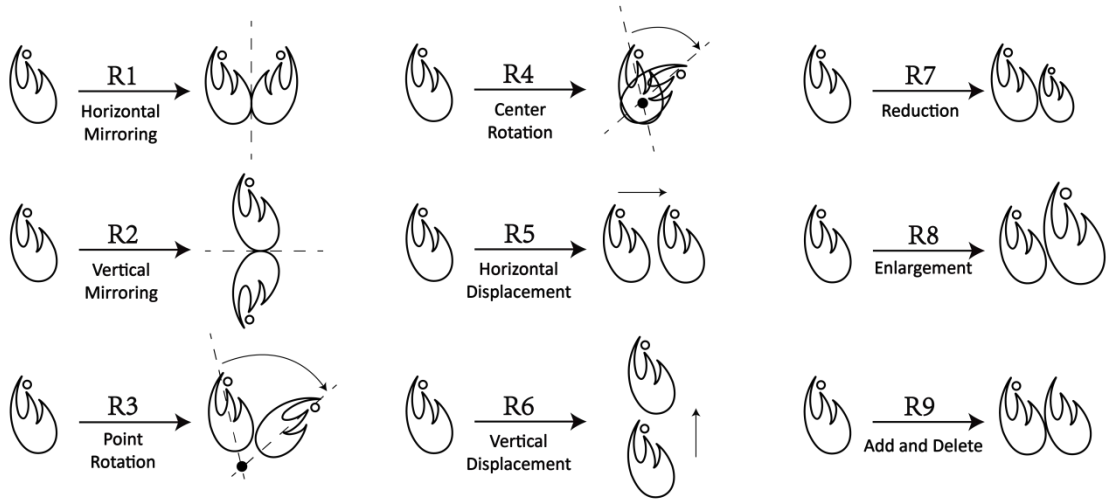

Figure 4. Schematic evolution diagram of basic patterns

The two basic units formed from the deconstructed and reorganized opera mask pattern underwent the first round of evolution according to the aforementioned rules, resulting in more complex regenerative elements, as shown in Figure 5. Basic unit A, after minor adjustments with the R4 rotation rule, underwent R1 horizontal mirroring, R2 vertical mirroring, and R9 addition and deletion rules to form regenerative element A1. Basic unit A, after R4 rotation adjustment and R9 addition rule for increased complexity, used the R3 rotation rule twice to form regenerative element A2. Basic unit B, after three R3 rotations, was reduced using the R7 rule to facilitate subsequent combinations, resulting in regenerative element B1. These regenerative elements serve as the foundational elements for further pattern design, facilitating their application in women's shoe design.

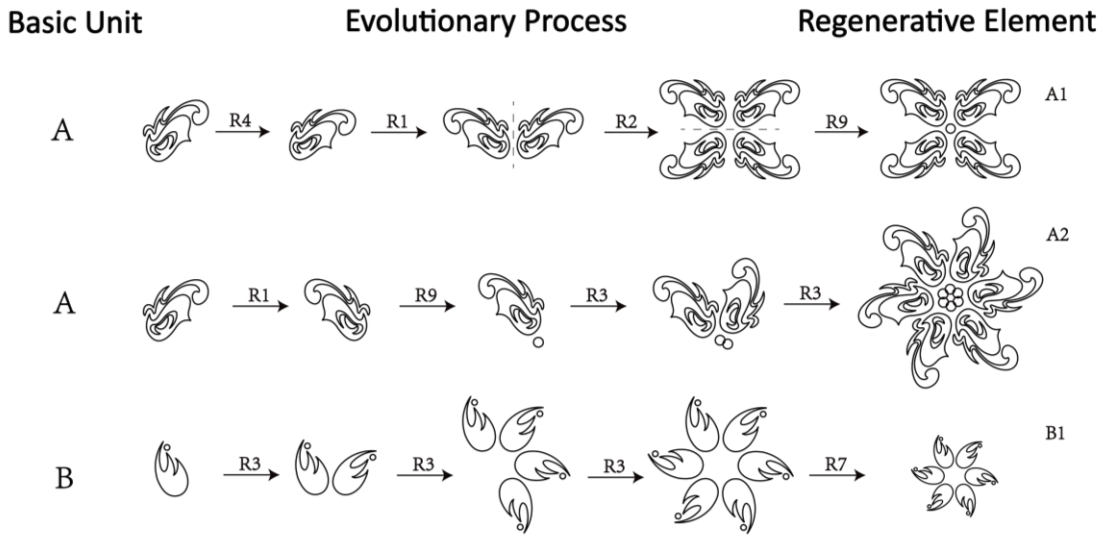

Figure 5. Schematic evolution of the basic unit

Color is an essential visible factor in design, with unique associative and emotional expression abilities that bring patterns to life [21]. Appropriate color combinations can guide consumer sensory experiences, reinforce the theme of the pattern, and create a specific

design atmosphere. Initially, Photoshop was used to correct and extract colors from traditional Sichuan opera masks, resulting in a five-color palette, as shown in Figure 6.

The traditional Sichuan opera masks are brightly colored, with high saturation and strong visual tension, enriching the thematic effects and visual styles of the patterns. To provide designers with diverse color options, a fresh and natural trendy color, "Mint Mambo," was also selected for color matching. Trendy colors reflect consumers' fashion pursuits and current aesthetic elements [22]. The name "Mint Mambo" combines two concepts: "mint" (*mentha*), representing the freshest green of spring in ancient Greek, and "mambo," a dance originating from South America known for its lively and free characteristics. At the 2024 Spring/Summer Fashion Week, international brands such as Versace, Louis Vuitton, and Chanel used "Mint Mambo" as the theme color for their collections, resulting in a five-color palette extracted from these designs, as shown in the color factor library.

Figure 6. Shu embroidery innovative pattern color factor library

APPLICATION OF INNOVATIVE PATTERNS IN WOMEN'S SHOES

The base shoe model selected for this innovative design is a pair of light-colored genuine leather pointed-toe high heels, featuring a fresh and elegant color palette, with a minimalist yet refined design. This classic style is highly versatile, suitable for women of various age groups and style preferences. As a timeless icon in the fashion industry, pointed-toe heels have remained popular for many years, as they visually elongate the legs and exude an air of elegance, making them a staple for both daily and formal wear [23]. In recent years, pointed-toe heels have been frequently featured on international fashion week runways, with designers blending traditional pointed-toe elements with modern design concepts, further cementing their status as a global classic. Notable brands such as Prada, Givenchy, and Loewe prominently showcased this iconic style in their 2023 collections, highlighting its enduring influence in the fashion world. By incorporating the evolved traditional facial pattern designs into pointed-toe high heels, this innovation not only enhances the artistic value of the footwear but also caters to the growing demand for personalized fashion among women.

In this study, the renderings of the application of innovative Shu embroidery facial mask on women's shoes were created using the image processing software Adobe Illustrator. Correspondingly, the innovative patterns developed in this research can also be applied to 3D model of the shoes, demonstrating their versatility and potential for use in three-dimensional design. The specific application methods are categorized into three types: "dot" application, "line" application, and "surface" application [24].

“Dot” Application

The “dot” application focuses on individual patterns as concentrated visual elements, highlighting them clearly and concisely. Regenerative elements A2 and B1 were combined to form a single pattern with appropriate density and symmetrical harmony, as shown in Figure 7(a). The single pattern was colored using both traditional Sichuan opera mask colors and the “Mint Mambo” color scheme. The traditional color scheme is vibrant, while the trendy color scheme is fresh and natural, as shown in Figure 7(b). The pattern was used as a decorative element on the upper part of sandals, adding a delicate aesthetic touch, and placed on the heel to highlight the innovative design of women’s shoes, as shown in Figure 7(c).

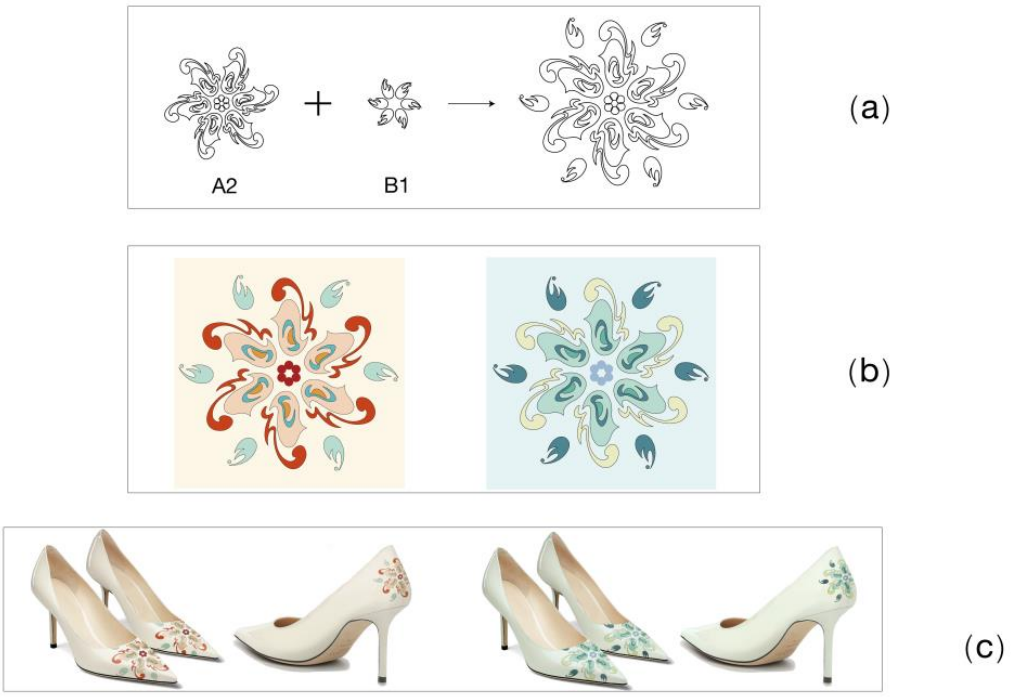

Figure 7. Individual pattern derivation process and its application in women’s shoes: (a) Individual pattern derivation process; (b) Individual pattern color matching; (c) The application of “dot” form

“Line” Application

The “line” application primarily uses continuous patterns, visually rich in rhythmic beauty, showcasing unity in repetition and harmonious aesthetics. Regenerative elements A1 and B1 were combined using the R5 horizontal displacement rule to form a continuous pattern, as shown in Figure 8(a). These patterns were colored using both traditional Sichuan opera mask colors and the “Mint Mambo” color scheme, creating two distinct styles, as shown in Figure 8(b). The pattern was scaled down and adjusted to an arc shape, delicately adorning the upper part of the shoe, giving a gentle and soft overall style. Alternatively, the pattern was placed around the shoe opening, highlighting a stylish and capable feminine temperament, as shown in Figure 8(c).

Figure 8. Bicubic Continuous pattern derivation process and its application in women's shoes: (a) Bicubic Continuous pattern derivation process; (b) Bicubic Continuous pattern color matching; (c) The application of "line" form

"Surface" Application

The "surface" application primarily uses four-way continuous patterns, featuring distinctive styles and intricate details. Regenerative elements A2 and B1 were combined using the R4 central rotation rule and R7 reduction rule, then arranged using the R5 and R6 displacement rules to form a four-way continuous pattern, as shown in Figure 9(a). These patterns were then colored, as shown in Figure 9(b).

Adjusting the pattern density changes the overall style: lower density results in a more spaced-out, simple, and elegant look, while higher density creates a luxurious and intricate appearance. Both applications enhance the visual impact, enriching the decorative details of the footwear and showcasing unique personalized styles, as shown in Figure 9(c).

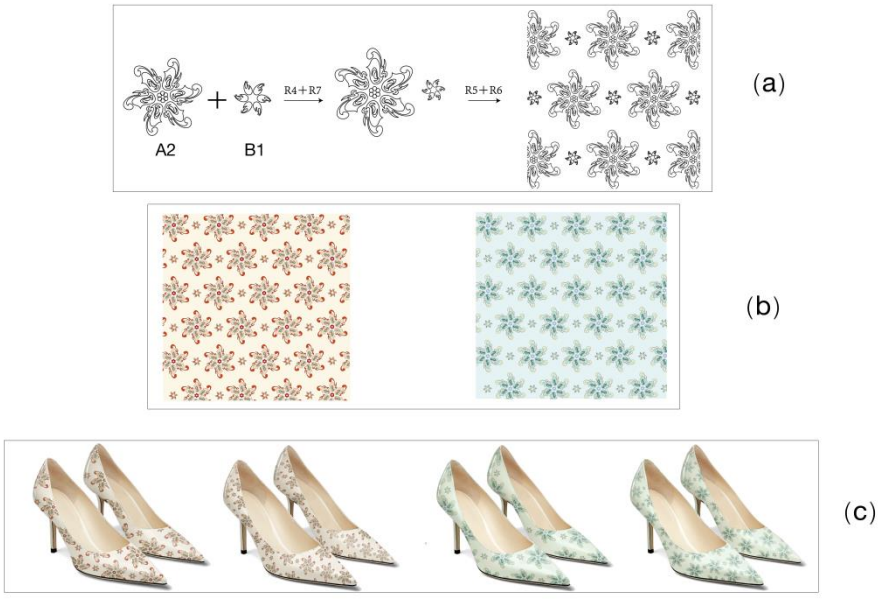

Figure 9. Fourth party continuous pattern derivation process and its application in women's shoes: (a) Fourth party Continuous pattern derivation process; (b) Fourth party continuous pattern color matching; (c) The application of "surface" form

CONCLUSION

Shu embroidery patterns encapsulate the essence and charm of Chinese culture, exhibiting high artistic value and creative potential in design. This study employs Kansei Engineering methods, utilizing mean statistics, factor analysis, and gray relational analysis to determine that the temperament factor of Shu embroidery patterns has the highest correlation with preference levels. The representative Shu embroidery pattern, the Sichuan opera mask, was selected based on its temperament characteristics.

The opera mask pattern was deconstructed, reorganized, and innovatively derived following shape grammar rules. It was colored using traditional Sichuan opera hues and the trendy "Mint Mambo" palette, and applied in women's shoe design in three forms: dot, line, and surface. This innovative integration of Shu embroidery patterns into women's shoe design provides a new pathway for the modern application of traditional elements, enhancing the innovation and unique appeal of women's footwear, thereby significantly improving market competitiveness. Furthermore, this design methodology offers a valuable reference for women's shoe brands and designers.

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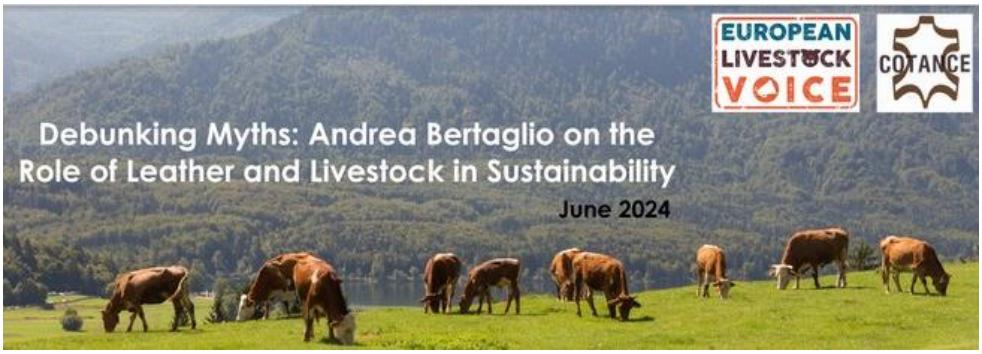
EUROPEAN RESEARCH AREA

COTANCE NEWSLETTERS

Starting with January 2019, the COTANCE Council has issued a monthly ***COTANCE Newsletter*** with the purpose of **promoting an improved image of leather** to relevant decision makers and domestic stakeholders including Members of the European and National Parliament, Governmental authorities, Ministerial officers, Customers of the leather industry, Brands, Retail chains, Relevant NGOs, Designers, etc. The monthly newsletters present topics that tell the truth about a controversial aspect or a fact that is not well known by the general public to bring about a better understanding of leather and the European leather industry, as well as a positive predisposition to legislate in favor of the leather industry. The newsletters are available in seven languages at https://www.euroleather.com/leather/newsletter, and were also published in the 2019-2023 issues of *Leather and Footwear Journal*. Newsletters 6 through 8 of 2024 are given below.



NEWS 6/2024

Debunking Myths: Andrea Bertaglio on the Role of Leather and Livestock in Sustainability

Andrea Bertaglio is an independent journalist, spokesperson for European Livestock Voice and author of the book "In defence of Meat". He is known for his in-depth knowledge of the meat industry and is therefore perfectly placed to give insight into the importance of livestock and leather sectors, their crucial roles in the circular economy, and their joint challenges in times of greenwashing.

Answering the question on the relationship between animal livestock and humans, Andrea Bertaglio said: *"Humankind and livestock have been proceeding together since the dawn of time. Meat made us humans. Without animal foods, we couldn't develop our brains as they are. Without hunting, we couldn't have organised our first ways of communication and our first kind of communities and societies. And if we speak about modern farming, we speak of nutrition, culture, traditions, know-how, economy, and hundreds of other things. Livestock is an incredibly important part of human life, and I hope it can still be like that for a very long time"*.

The same is true for leather, which has long been in the history of man. Findings from the archaeological site in Schöningen (Lower Saxony) show that it dates back 320 000 years. An engraving was found on the remains of a bear's skin, which evidences that hominids in northern Europe also hunted bears and skinned them to get meat and to use their hide to protect themselves from the cold. Leather features in human history.

Old Tannery in Pompeii
Photo credits: UNIC - Concerie Italiane

"We have leather because it is a by-product from meat production. And it has been like that since prehistorical times, I suppose. One of the best and oldest examples of "circular economy". It simply makes sense. Otherwise, it would be like picking a fruit only to keep the peel, which is absurd. Besides, leather is a great product: instead of being disposed of as waste, hides and skins are transformed into one of the most durable, enjoyable, and sustainable products ever", the journalist continued.

"Leather is the most bio-friendly in the car and is the most natural, sustainable, environmentally good by-product of the meat industry. The cows are not being grown for their leather", - says nutritionist Diana Rodgers

Furthermore, leather is a natural material that can be repaired, reused, and repurposed, highlighting its crucial role in the circular economy and establishing it as a prime choice for sustainable practices.

Despite these facts, both the leather and meat industries are facing a wave of unjustified accusations and manipulations from radical activist, vegan societies, whose deceptive narratives are likely to fall into the scope of the upcoming EU "Green Claims" Directive.

As an independent journalist, writing nearly two decades on environment and sustainability, Andrea Bertaglio has a mission: to crash the fake, dangerous, hypocritical narrative of the vegan world.

Reflecting on his daily motivation, he told VDL, the association for the German leather industry and COTANCE member: *"I am highly motivated by the fact that vegan/animal rights activism is one of the biggest frauds we have seen in many years: they paint in green and give an ethical message to things which are only and merely based on profit. I am disturbed by the good faith of many people in the hands of cunning corporations. Playing the victim while making loads of money is very trendy at the moment, and I try my best to fight this"*.

He says many people adopt a vegan lifestyle with noble intentions, seeking a holistic approach to improving the environment, animal welfare, and personal health. *"The vegan narrative is perfect because it puts environment, climate, animals, and health together, providing a prepacked, easy*

solution, emphasising the benefits of choosing plant-based options which may include some commercially processed alternatives. They fell into the trap of very clever marketing". However, he expresses concern that individuals might eventually reconsider their choices as they evaluate the long-term impacts of their dietary and lifestyle decisions on their health.

He further says: *"Not everyone knows that to grow synthetic meat, its cells must be in a soup of growth hormones and antibiotics (yes, those banned and extremely reduced in animal breeding!). Not only that, but according to some studies, lab-grown meat can impact up to 50 times more than livestock farming, and to be produced, it must be grown in extremely energy-intensive bioreactors. For now, it is just another way to generate audiences, debate and polarisation. It is no coincidence that many newspaper articles have been written about this product, but very few scientific papers"*.

The same can be said about "vegan leather", whose adverse impact on the environment starts to become visible. "Vegan leather," commonly known as "faux leather," is essentially plastic derived from fossil fuels, contributing significantly to climate change and ecosystem pollution. Attempts to reduce the amount of plastic, mixing it partly with agricultural produce or waste, resulted in a significant amount of these products becoming non-recyclable textile waste due to their reliance on polyurethane binders and coatings (plastic).

Such fakes quickly decompose into microplastic. Consumers need to know that more durable and sustainable options exist, like leather.

Remember: animals are not killed for leather. Their skins & hides represent on average just 1% of the animal's economic value. Leather is just the result of a by-product of the meat industry. European Tanners transform hides & skins into sustainable fashion materials, generating wealth and jobs in Europe. That means opting for leather helps upcycle a resource that would otherwise go to waste.

The world is not black and white. Don't become a victim of manipulating narratives that might make you feel neurotic and guilty. Make your own choices based on the evidence.

Regardless of your choice, the fact remains that leather is one of the smartest and most sustainable options a person should promote… even if you are vegan.

edited by

In cooperation with

If you want to go further:
European Livestock Voice | **Website**
"Can we imagine the world without livestock?" | **Article**
In Defence of Meat | **Book**

NEWS 7/2024

Dive into Leather: Summer Edition

Welcome to our Summer Edition! With the COTANCE July newsletter, we invite you to spend these summer holidays immersed in the world of leather.

*Explore the **UNESCO Sheep Value Chain in Millau,** France, a centre for leather production since the Middle Ages. Attend leather craftsmanship workshops, read about the leather, or consider joining upcoming leather-related events.*

Exploring the famous Sheep Value Chain

Millau has been a centre for leather production since the Middle Ages. Its historical significance in sheep farming and glove-making has shaped the region's identity over the centuries. The traditional craft of glove-making in Millau is particularly renowned, with techniques passed down through generations.

That is why its inclusion in the Intangible Cultural Heritage in France, followed by the ongoing process of its inclusion in UNESCO's prestigious World Heritage List, highlights the importance of the sheep value chain in Millau. This recognition celebrates the harmonious integration of sheep farming with leather production, emphasizing sustainable practices and artisanal skills. It acknowledges the role of local craftsmen and women in preserving traditional methods while adapting to modern demands.

Cultural Experiences and Attractions:

1. Millau Glove Museum:

- Visit the Millau Glove Museum to explore the history of glove-making. The museum features an impressive collection of gloves, historical artefacts, and exhibits on traditional crafting techniques.

2. Local Tanneries:

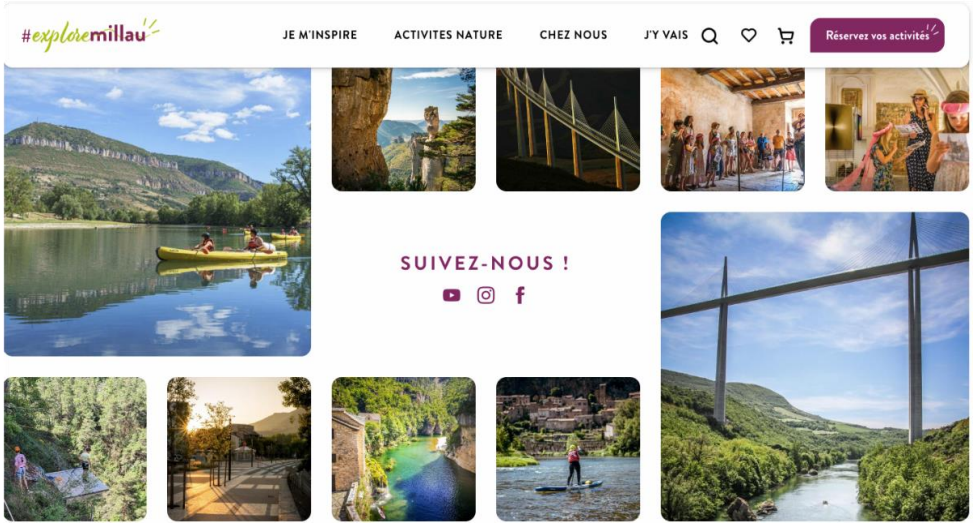
- Take a tour of local tanneries to see the traditional tanning process up close. Many tanneries in Millau offer guided tours where visitors can learn about the craftsmanship and methods used to produce high-quality leather.

3. Sheep Farming Tours:

- Experience the region's sheep farming firsthand. Tours often include visits to local farms, where you can learn about sheep breeds, wool production, and the integral role of sheep in the local economy.

4. Cultural Festivals:

- Millau hosts various cultural festivals throughout the year that celebrate its leather and sheep farming heritage. These events feature artisan markets, live demonstrations, and traditional performances.

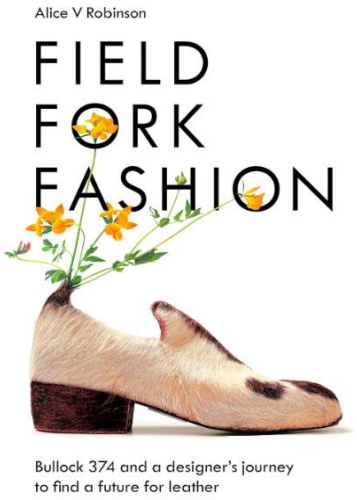


Visit Millau!

Millau offers a unique opportunity to immerse yourself in a region where tradition meets craftsmanship. Whether you're interested in the art of leather-making, the history of sheep farming, or simply enjoying the beautiful French countryside, Millau provides an enriching experience.

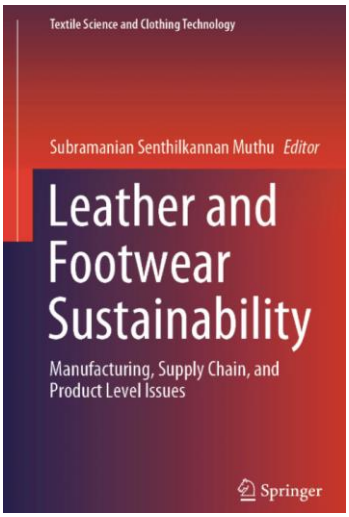
For more information and to plan your visit, check local tourism resources and heritage sites in Millau: https://www.explore-millau.com/

Summer Reading



"Field, Fork, Fashion" by Alice V Robinson

In this personal investigation into ethical and traceable leather, fashion designer Alice Robinson begins a ground-breaking journey into the origin story of leather and its connection to food and farming.



"Leather and Footwear Sustainability"

editor Subramanian Senthilkannan Muthu

This book examines the manufacturing, supply chain and product-level sustainability of leather and footwear products, also exploring interesting areas of leather and footwear sustainability, such as waste & the 3R's and their certification for sustainability.

Leather Events

Sustainable Leather Forum

9-10 September, Paris

The Sustainable Leather Forum (SLF) is the first international event dedicated to CSR in the leather industries, held in Paris, France. It gathers over 400 international participants, including major fashion corporations, SMEs, institutional bodies, and consultancies, to discuss social, environmental, and economic issues and share CSR best practices.

Lineapelle

17-19 September, Milan

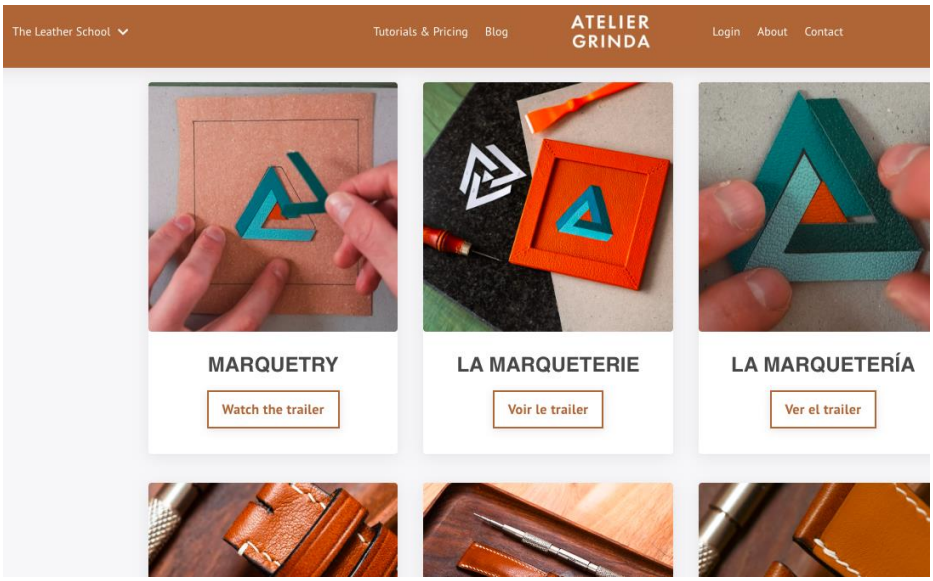
LINEAPELLE is the most important international exhibition dedicated to leather, accessories, components, synthetics and models for footwear, leather goods, garments and furniture.

🐂 **Leather Craft Workshops**: Various workshops across Europe are being held throughout the summer.

👉 **For France and Benelux countries: Find out more!**

Studio Leatherworking Training
(also available online)

Online Leatherworking Training (Bundle) | Online or Studio Craft Business Coaching (1 hour) | Studio Leatherworking Training (Bundle) | Studio Leatherworking Training (One Day Private



Atelier Grinda
leather school/tutorials

We wish you a pleasant summer holiday and hope you enjoy discovering the wonderful world of leather this summer!

Best Regards,
COTANCE Secretariat

If you want to go further:
Explore Millau - leather-related activities Website
Leatherbiz about Millau | Article
Intangible Cultural Heritage of the Pays de Millau | Website

NEWS 8/2024

European Leather Industry Provides Scientific Evidence in Support of Excluding Leather from the Scope of the EUDR

Leather is not the driver of deforestation—this is obvious to anyone involved in the leather supply chain, from livestock producers to fashion brands. Yet, with leather included in the scope of the European Deforestation Regulation (EUDR), it became essential to support this fact with comprehensive analysis.

With this September newsletter, we are proud to present scientific evidence supporting the European leather industry's position in the EUDR Review. The study, *"Socio-economic and Environmental Analysis of the Effects of Regulation 2023/1115/EU on the European Leather Sector,"* commissioned by UNIC and COTANCE and conducted by Sant'Anna School of Advanced Studies of the University of Pisa, was unveiled on September 18, 2024, at the Lineapelle Fair **to become a game-changer in defence of our industry.**

The study, structured into technical, socio-economic, and environmental assessments, reveals key findings that will be instrumental for the leather industry during the EUDR review process.

Executive Summary

- No Direct Link to Deforestation: The study, supported by an extensive technical analysis (94 million+ records, 29,200+ active serial titles, and 330,000+ books) and 28 stakeholder interviews, found no direct link between leather and deforestation. Leather is derived from cattle raised primarily for meat and dairy, and its production does not incentivise cattle farming.

The Study

- Severe Economic Impact: The EUDR's stringent traceability requirements could severely disrupt the European cattle hide supply chain, leaving European tanners without needed raw materials. This could force businesses to close and result in significant job losses across the industry's supply chain.
- Environmental Risks of Alternatives: The study warns that short-circuiting the European leather industry and replacing leather with synthetic alternatives like polyurethane leather-like materials (PU LLM) could increase environmental damage, in terms of higher emissions and resource use. Diverting cattle hides to landfills or to countries with weaker environmental standards would undermine the Green Deal's goals.

At the EUDR event in Lineapelle, a panel of **global industry experts unanimously agreed:** ***including leather in the EUDR is illogical and will not reduce cattle-related deforestation. Instead, it risks disrupting supply chains and shifting production to regions with lower environmental standards.***

Panel participants from left to right: Ricardo Andrade (CICB, Brazil), Toni Baltes (German Hide Association WHL, ICHSLTA), Max Engelke (A+B-hides), Micaela Topper (AHSLEA, Australia), Kevin Latner (LHCA, USA) and Dave Harrison (Beef+Lamb, New Zealand).

COTANCE stands firm in advocating for the removal of leather from the EUDR scope, presenting the Sant'Anna study in support of its argument. This academic investigation will be providing crucial intelligence in the context of the European Commission's review of the regulation.

Stay tuned for more updates as COTANCE continues to engage with policymakers and stakeholders to safeguard the interests of the European leather industry.

If you want to go further:

Socio-economic and Environmental Analysis of the Effects of Regulation 2023/1115/EU on the European Leather Sector | Study

"EPP demands delay of 'bureaucratic monster' deforestation law" | Article

"Deforestation in the leather supply chain takes centre stage in Milan and Paris" | Article

NEWS RELEASE FROM THE IULTCS

The IULTCS officers are very happy to announce the appointment of four new Commission Chairs.

Each Chairperson was selected due to their dedication, leadership, and vision for the IULTCS organization, these attributes stood out during the election process, and the officers are confident that each one will excel in their new role.

As Commission Chairs, they will play a crucial part in shaping the future initiatives, fostering collaborations, and driving positive change for IULTCS. The executive Committee and other Commission Chairs within the organisation, on behalf of all IULTCS members would like to offer a warm welcome to the new Commission Chairs and we look forward to working closely together to help achieve our shared goals.

The new IUC (Chemicals) Commission Chair is Tiziana Gambicorti.

Tiziana works as the Standardisation and Sustainability Manager at Biokimica SpA – Italy. In the roles she is responsible for the chemical analysis laboratory and project leader for "Measuring sustainability" of the company's products, to improve environmental performance.

Tiziana Gambicorti

The new IUE (Environmental) Commission Chair is Daniele Bacchi.

Daniele is the Environmental Division Manager at ITALPROGETTI. He is responsible for the company's general plant design, supervision of equipment construction, installation and startup projects, coordination of commercial activities and research and development.

Daniele Bacchi

The new IUS (Sustainability) Commission Chair is Kim A. de Sena.

Kim is the Sustainability Director for JBS SA. He is responsible for the sustainability department of the company's Leather Business Division. Among the main activities are the strategic planning, management of Life Cycle Assessments of materials, traceability and chain transparency projects.

Kim A. de Sena

The new IUR (Research) Commission Chair is Dr. Volker Rabe.

Dr. Volker is the head of wet end research and development for TFL Deutschland GmbH, in Leverkusen, Germany.

Dr. Volker Rabe

NEWS RELEASE FROM THE IULTCS

05 September 2024

IULTCS Young Leather Scientist Grant Programme 2025 Announced

IULTCS and the IUR Commission headed by Dr. Volker Rabe are extremely happy to announce that the IULTCS Young Scientist Grant Programme for 2025 is underway. The details are as follows and further information can be found on the IULTCS website https://iultcs.org/ or by contacting the IUR chair Dr. Volker Rabe (Volker.rabe@tfl.com).

Background

The IULTCS is committed to further intensifying co-operation between the individual member societies and to providing a platform to promote the latest innovations in the field of leather science and technology. For this reason, the latest findings in this field are shared with a broad public in the form of presentations at the global IULTCS congresses organized every two years by a regional member society.

In addition, the IULTCS would like to make a more direct contribution to leather research through its IUR Commission and at the same time provide additional support for younger scientists. For this reason, the Young Leather Scientist Grants were created to recognize outstanding achievements in three different categories by individual young scientists. The grant is freely available to the winners. Optionally, the winners are also given the opportunity to present their award-winning work at an IULTCS congress.

Award Categories

1) **Basic Leather Research Grant**– Sponsored by TYSON Leather (1500 €)
   - Basic research in collagen and/or leather.
   - Analytical method development
   - Innovative leather processing or new chemicals thereof
   - Hide/skin preservation.
   - Tannery waste treatment
   - Environmental studies applied to the tanneries

2) **Professor Mike Redwood Sustainability/Environmental Grant** sponsored by Leather Naturally (1000 €)
   - Innovative environmental techniques e.g. wastewater treatment, solid waste and emissions
   - Studies on sustainability leather processing
   - New chemicals for leather processing improving environmental impact e.g. carbon footprint and/or water management.

3) **Leather Machinery/Equipment Grant** sponsored by Italprogetti (1000 €)
   - Innovative new machinery for leather processing
   - Simplification and/or rationalization of leather production
   - Increased efficiency through e.g. energy savings

Admission Requirements for Applicants

- Not older than 35 years (date of submission)
- Student or Scientist on a university or a leather school
- Having an advisor at his/her institution

Application Procedure

The Document Form must be completed and saved as one PDF file only and identified as: *YLSG_year_applicantname*.

- Leave one empty page between the documents.
- Applications must be assigned to one of the categories.

The complete application form to be submitted to the IUR chair Dr. Volker Rabe (Volker.rabe@tfl.com) must have the following parts:

1) Application Form
2) Research Project Plan. Include Title, Introduction, Objectives, Methods, Hypothesis/Expected results, benefit for the local and/or global leather industry in one sentence and Literature. Maximum 3 pages.
3) Curriculum Vitae of the applicant (one page)
4) Curriculum Vitae of the advisor (one page)
5) Letter of recommendation from the advisor (one page)

Note: Applicants that do not follow the above rules will have their submission rejected.

Award Criteria & Selection

The application will be evaluated and ranked based on the following criteria:

1) Clear aim of the research
2) Methods
3) Expected results
4) Originality of the research
5) Correct citation
6) Global or local benefit of the research

The qualifications of the researcher and the advisor will also be evaluated. The Selection Committee has not been established; it will be made by renowned scientists on the field.

Timeline

- September 2, 2024, launch the YLSG 2025, with rules on the IULTCS web site and press release
- November 30, 2024, deadline for submissions
- January 30, 2025, winner selected and press release
- February 15, 2025, payment of the award and sending the IUR/IULTCS certificate

Report

The winners must complete a final project report which has to be submitted to the IUR Commission Chair by February 28, 2026.

The report should be accompanied by a one-page review of the project by the advisor and will be posted on the IULTCS/IUR web page.

INSTRUCTIONS FOR AUTHORS

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Leather and Footwear Journal publishes articles reviewed by two independent reviewers selected by the Editorial Board. The Publication Ethics and Malpractice Statement for *Leather and Footwear Journal*, based on COPE's Best Practice Guidelines for Journal Editors, clearly outlines standards of expected ethical behavior for all parties involved in the act of publishing (the author, the journal editor(s), the peer reviewer and the publisher) and is available on the journal's website, https://www.revistapielarieincaltaminte.ro.

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Presentation of Papers

The scientific papers should be presented for publishing in English only. The text of the article should be clear and precise, as short as possible to make it understandable. As a rule, the paper should not exceed fifteen pages, including figures, drawings and tables. The paper should be divided into heads and chapters in a logical sequence. Manuscripts must meet high scientific and technical standards. All manuscripts must be typewritten using MS Office facilities, single spaced on white A4 standard paper (210 x 297 mm) in 11-point Times New Roman (TNR) font.

Paper Format

Title. Title (Centered, 12 pt. TNR font) should be short and informative. It should describe the contents fully but concisely without the use of abbreviations.
Authors. The complete, unabbreviated names should be given (Centered, 10 pt. TNR font), along with the affiliation (institution), city, country and email address (Centered, 9 pt. TNR font). The author to whom the correspondence should be addressed should be indicated, as well as email and full postal address.
Abstract. A short abstract in a single paragraph of no more than 200-250 words must accompany each manuscript (8 pt. TNR font). The abstract should briefly describe the content and results of the paper and should not contain any references.
Keywords. Authors should give 3-5 keywords.

Text

Introduction. Should include the aims of the study and results from previous notable studies.
Materials and Methods. Experimental methods should be described clearly and briefly.
Results and Discussions. This section may be separated into two parts. Unnecessary repetition should be avoided.
Conclusions. The general results of the research are discussed in this section.
Acknowledgements. Should be as short as possible.
References. Must be numbered in the paper, and listed in the order in which they appear.

Diagrams, Figures and Photographs should be constructed so as to be easy to understand and should be named "Figures"; their titles should be given below the Figure itself. The figures should be placed immediately near (after or before) the reference that is being made to them in the text. Figures should be referred to by numbers, and not by the expressions “below” or “above”. The number of figures should be kept to minimum (maximum 10 figures per paper).
Tables. Should be numbered consecutively throughout the paper. Their titles must be centered at the top of the tables (10 pt. TNR font). The tables text should be 9 pt. TNR font. Their dimensions should correspond to the format of the Journal page. Tables will hold only the horizontal lines defining the row heading and the final table line. The tables should be placed immediately near (after or before) the reference that is being made to them in the text. Tables should be referred to by numbers, and not by the expressions “below” or “above”. The measure units (expressed in International Measuring Systems) must be explicitly presented.
Formulas, Equations and Chemical Reactions should be numbered by Arabic numbers in round brackets, in order of appearance, and should be aligned left. The literal part of formulas should be in Italics. Formulas should be referred to by Arabic numbers in round brackets.
Nomenclature. Should be adequate and consistent throughout the paper, should conform as much as possible to the rules for Chemistry nomenclature. It is preferable to use the name of the substances instead of the chemical formulas in the text.
References should be numbered consecutively throughout the paper in order of citation in square brackets; the references should list recent literature also. Footnotes are not allowed. If the cited literature is in other language than English, the English translation of the title should be provided, followed by the original language in round brackets. Example: Handbook of Chemical Engineer (in Romanian), vol. 2, Technical Press, Bucharest, **1951**, 87.
We strongly recommend that authors cite references using DOIs where possible. DOIs are persistent links to an object/entity and can be used to cite and link to any article existing online, even if full citation information is not yet available. DOIs should always be displayed as full links. Example: Onem, E., Cin, G., Alankus, A., Pehlivan, H., Mutlu, M.M., Utilization of Chestnut Shell Wastes as a Dyeing Agent for Leather Industry, *Leather and Footwear Journal*, **2016**, 16, 4, 257-264, https://doi.org/10.24264/lfj.16.4.1.
Citation of Journal Articles: all authors' names (surname, name initials), abbreviated journal title, year, volume number, issue number, full page reference, e.g.: Helissey, P., Giorgi–Renault, S., Renault, J., *Chem Pharm Bull*, **1989**, 37, 9, 2413-2425.
In case the reference is not cited in original, the author(s) should also list the original paper that has been consulted.
Citation of Books: authors' full name and name (initials), title of the book, issue number in Arabic numbers, publishing house, editors' names (if present), city where the book has been published, year of publication, the page(s) containing the text that has been cited.
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Paper template is available for download on the journal's website, https://www.revistapielarieincaltaminte.ro.

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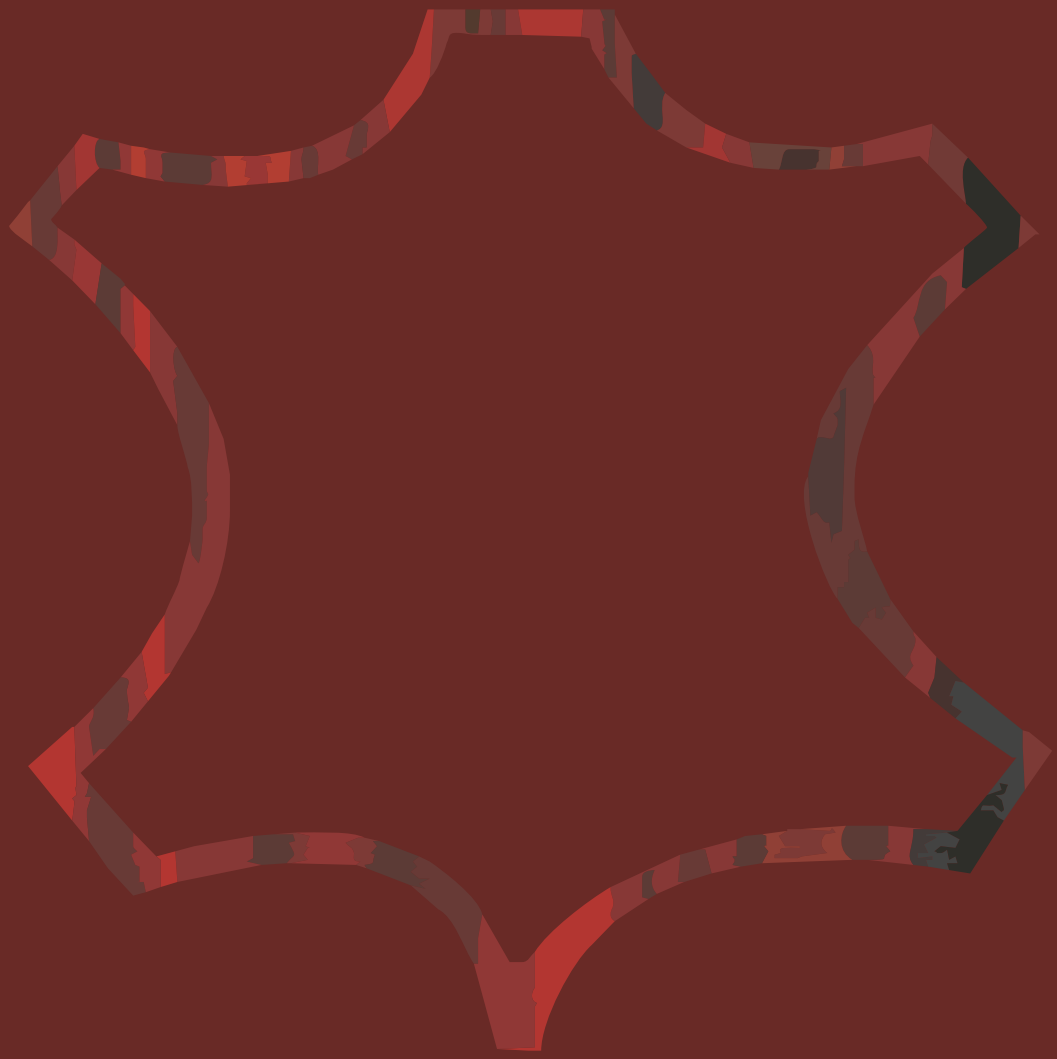

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