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

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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

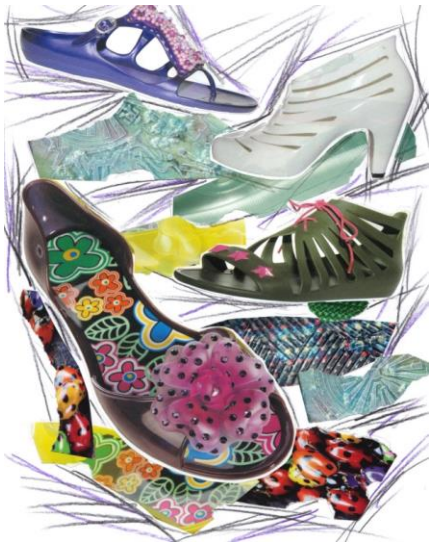

Figure 3. PLASTIC FASHION – Plastics are ever more present in the industry. The colour play and computer-designed shapes, the speed of adaptation to consumers' requests lead to a rapid development of this sector.
Source: design research project, author dsg. Traian Foiasi

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].

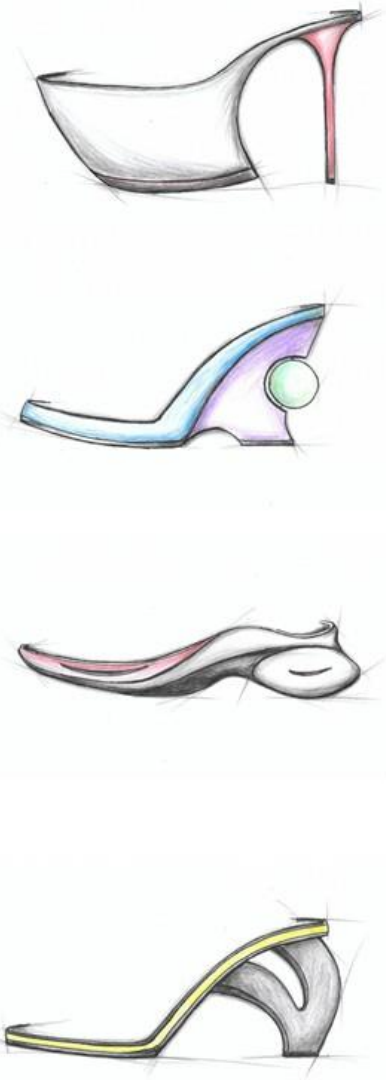

Figure 9. Idea sketches for footwear components

Figure 10. Idea sketches for finished footwear

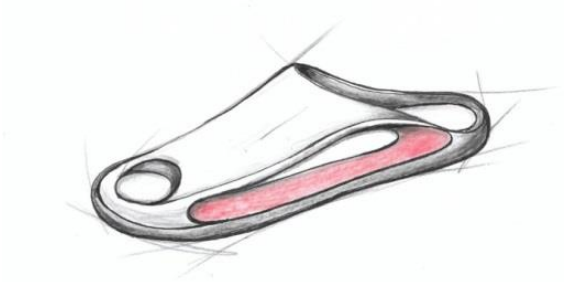

Figure 11. Idea sketch for 3D printed finished footwear

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.

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