ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES, LEATHERWORK

INTEGRATION OF DIGITAL LIBRARIES IN CONTEMPORARY FASHION DESIGN

FLOREA-BURDUJA Elena[1], CANGAŞ Svetlana[2], OVCEARENCO Cristina[3]

[1, 2, 3] Technical University of Moldova, Faculty of Design, 4 Sergiu Radautan Street, Chisinau, Republic of Moldova

Corresponding author: Florea-Burduja Elena, E-mail: elena.florea@dtt.utm.md

Abstract: *The digital transformation of the fashion industry is creating the conditions for a more sustainable production model, based on reducing resource consumption and optimizing design processes. In this context, digital libraries of textile materials are gaining a central role, not only as storage tools but as active components of an interconnected digital ecosystem. Recent studies show that the integration of 3D simulation, the use of the "digital twin" concept, and the development of collaborative platforms significantly reduce the need for physical prototypes and improve process efficiency. At the same time, the use of digital material libraries in ecodesign supports informed decision-making and accelerates product development. Materials can be tested, adjusted, and reused quickly, without additional physical resources, offering a clear advantage over traditional methods. This article analyzes the role of digital libraries in shaping a digital ecosystem in fashion, highlighting the need for standardization and interoperability between platforms. The aim of the research is to define a conceptual model for integrating digital libraries into contemporary design workflows, with a focus on their impact on sustainability. The development of these structures is an essential condition for the transition from fragmented digitalization to a coherent and functional system in the fashion industry.*

Key words: *sustainability, digital ecosystem, digital textile materials, 3D simulation, interoperability*

1. INTRODUCTION

The fashion industry is undergoing a period of profound transformation, driven by increasing pressure related to sustainability and resource efficiency. The traditional model, based on repetitive physical prototyping and intensive material consumption, is increasingly being challenged, making innovative solutions necessary to reduce environmental impact. In this context, the digitalization of design and production processes is becoming a strategic direction, supported by the development of 3D simulation technologies and collaborative digital platforms [1, 2].

Recent research highlights that the transition to digital fashion does not only involve the use of advanced technological tools, but also the development of a digital ecosystem in which various actors, resources, and technologies interact in an integrated manner. Thus, studies on sustainability in the context of the metaverse emphasize the importance of platform interconnectivity and collaboration among stakeholders for value creation and waste reduction [3]. At the same time, the specialized literature on digital ecosystems points to the need for open and scalable architectures, based on common standards that enable interoperability of data and processes [4].

In this framework, digital libraries of textile materials become essential components of the digital ecosystem, facilitating the storage, reuse, and transfer of information regarding material

properties. Studies in the field show that the use of such libraries significantly contributes to reducing physical prototypes and optimizing the decision-making process in design [5, 6]. However, a major issue remains the lack of standardization of digital materials, which limits interoperability between different platforms and industrial actors.

In this context, the aim of this paper is to analyze the role of digital textile material libraries within the digital ecosystem of the fashion industry and to propose a conceptual model for their integration into contemporary design workflows.

2. STANDARDIZATION OF DIGITAL MATERIALS AS THE FOUNDATION OF A SUSTAINABLE DIGITAL FASHION ECOSYSTEM

The standardization of digital materials can be seen as a natural next step in the evolution of digital fashion. In practice, the field is still quite fragmented, with design processes often tied to specific platforms. Without shared standards, digital materials are hard to transfer between systems, which limits their broader use and slows down their integration into industrial workflows.

A digital textile material should be understood as more than just a visual surface. It is, in fact, a set of parameters that define how the material behaves, how it looks, and how it interacts in a virtual environment. This way of thinking places the material at the center of the design process, similar to how physical materials function in traditional fashion. Still, without standardization, these digital materials remain incompatible, leading to repeated work and inefficient processes.

By introducing standardization, a common language for digital materials begins to take shape. This makes it possible for different software platforms and industry actors to work more easily together. In this context, digital material libraries become essential, as they allow materials to be stored, reused, and shared across projects. This not only reduces duplication but also speeds up both design and prototyping.

The sustainability benefits are also important. Reusing standardized materials reduces the need for physical samples, improves production efficiency, and lowers material waste. In this sense, sustainability is not just an added goal, but a direct result of how the digital system is structured.

Figure 1 shows the main stages of this standardization process within a sustainable digital fashion ecosystem.

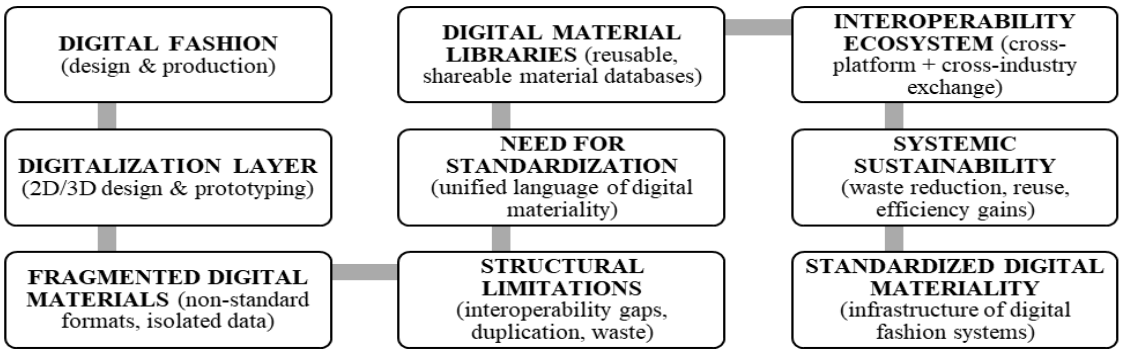

Fig. 1: *Stages of Digital Material Standardization*

Figure 1 describes a structural transition in the evolution of digital fashion: from the isolated use of digital tools toward the formation of a coherent system based on standardized infrastructures of digital materiality.

In an initial stage, digital fashion develops through the digitization of design processes, particularly through the use of 2D and 3D tools for sketching, simulation and virtual prototyping. This stage is predominantly operational in nature, where technology functions as a support for the creative process without fundamentally altering the structure of the industrial system. In other words, digitalization improves the design process but does not reorganize how materials are defined and circulated.

As the digital ecosystem expands, structural fragmentation emerges, driven by the diversity of software platforms and the lack of interoperability between them. Digital materials become dependent on specific systems, are difficult to transfer and cannot be consistently reused across different working environments. This situation generates redundancy, duplication of resources, and limited efficiency at a global level, even if processes are locally optimized. In this context, the need for standardization of digital materials becomes evident. Standardization is not merely a matter of technical uniformity, but of defining a common language of digital materiality that enables the consistent description, storage and use of materials across different platforms and applications. Thus, the digital material is redefined as a structural unit with parameterized properties, capable of circulating within an interoperable ecosystem.

With the emergence of standardization, digital material libraries develop as essential infrastructures of the ecosystem. These enable the storage, organization, and reuse of digital materials, transforming them into a shared resource at the industrial level. In this way, digital materials acquire a status similar to raw materials in the physical industry, but within a virtual environment. Standardization also facilitates interoperability between platforms, software systems and industrial actors, leading to the formation of an integrated digital ecosystem. Within this ecosystem, materials are no longer isolated entities, but circulating components of a global system of digital design and production. The figure shows that the real transformation in digital fashion does not come solely from going digital, but from establishing standards for digital materials, which enable a unified, connected and sustainable system of work.

3. INITIAL RESEARCH

This paper presents only the initial stage of digital material standardization. At this stage, the same type of digital material (Woven_Denim) was selected from different platforms (Table 1).

Table 1: *Characteristics of the digital material (Woven_Denim)*

Software	Visual characteristics					Physical characteristics							
	Base Color	Normal Map	Displacement Map	Roughness	Metalness Map	GSM	Thickness	Stretch	Bending	Bending Buckling Ratio	Bending Buckling Stiffness	Dynamic Friction	Stastc Friction
	.png	.png	.png	.png	.png	g/m2	mm	g/s2	g*mm2/s2	[0-1]	[0-1]	-	[0-1]
CLO3D						280	0,7	4 values	4 values	4 values	4 values	-	1 value
	.jpg	.jpg	-	-	-	g/m2	mm	g/s2	g*mm2/s2/rad	[0-100]	[0-100]	[0-1]	[0-1]
Style3D			-	-	-	281	0,71	3 values	3 values	3 values	3 values	1 value	1 value

Table 1 presents a comparison of how the CLO3D and Style3D platforms define digital textile materials. Both visual and physical characteristics of the materials are analyzed, highlighting variations in file formats, the number of parameters, and the way material properties are described.

4. CONCLUSIONS

The analysis of the table clearly highlights the fragmented nature of digital materials in the absence of standardization. The differences observed between platforms such as CLO3D and Style3D, both at the visual level (types of maps used) and at the physical level (number and type of parameters), confirm the lack of a unified system for defining materials.

This variation demonstrates that digital materials cannot be transferred or reused coherently, which limits interoperability and the efficiency of design processes. At the same time, defining the material as a parameterized object shows that a clear structuring of properties can form the basis of a standardized model. Therefore, the results support the idea that the standardization of digital materials is not only necessary, but essential for building a coherent digital ecosystem, in which materials become reusable and comparable resources across platforms.

In the following studies, the analysis will be extended to a larger number of digital materials and platforms in order to validate the general nature of the identified fragmentation. A standardization model for digital materials will be proposed and tested, based on defining a unified set of parameters. Additionally, a digital material library structured according to this model will be developed. Finally, the level of interoperability and the possibility of reusing materials across different software environments will be evaluated.

REFERENCES

[1] Daria Casciani, Olga Chkanikova & Rudrajeet Pal, "*Exploring the nature of digital transformation in the fashion industry: opportunities for supply chains, business models, and sustainability-oriented innovations*", Sustainability: Science, Practice and Policy, Volume 18, 2022 - Issue 1. Available: https://doi.org/10.1080/15487733.2022.2125640

[2] Florea-Burduja E., Cangas S., Burduja V, "*Digital fashion – a sustainable alternative for the future*", In: Journal "Annals of University of Oradea. Fascicle of Textiles, Leatherwork", Vol. 26, No.2, pp. 39-42. ISSN 1843-813X. Romania, 2025. Available: https://textile.webhost.uoradea.ro/Annals/Vol%2026%20no%202-2025/Art%20621%20pag%2039-42.pdf

[3] Baogui Xin, Yaping Song, Hui Tan & Wei Peng, "*Sustainable digital fashion in a metaverse ecosystem*", Journal of Retailing and Consumer Services,Volume 82, 2024. Available: https://doi.org/10.1016/j.jretconser.2024.104099

[4] Gerard Briscoe, Suzanne Sadedin,Philippe De Wilde, "*Digital ecosystems: ecosystem-oriented architectures*", Natural Computing. 2011. Available: https://doi.org/10.48550/arXiv.1112.0204

[5] Flavia Papile, Barbara Del Curto,*"Ecodesign-driven material selection in fashion design: a methodological proposal and a mock-up tool",* Frontiers in Sustainability, Volume 7, 2026. Available: https://doi.org/10.3389/frsus.2026.1773542

[6] Hardabkhadze, I., Bereznenko, S., Kyselova, K., Bilotska, L., & Vodzinska, O, "*Fashion industry: exploring the stages of digitalization, innovative potential and prospects of transformation into an environmentally sustainable ecosystem*", Eastern-European Journal of Enterprise Technologies, 1(13(121)), 86–101, 2023. Available: https://doi.org/10.15587/1729-4061.2023.273630