Платформа 4
Актуальні питання підготовки фахівців для індустрії моди

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LILIIA CHERTENKO[1], EVRIDIKI PAPACHRISTOU[2], DARIIA KAPTIUROVA[1],
[1]Kyiv National University of Technologies and Design, Ukraine
[2]International Hellenic University, Greece

IMPLEMENTATION OF 3D DIGITAL TECHNOLOGIES IN HIGHER EDUCATION AND FASHION INDUSTRY WITHIN THE 3D4U PROJECT

Objectives. *The study aims to outline current trends in the digitalization of the fashion and footwear industries, determine the importance of 3D technologies in the process of training specialists, and present the goals and stages of the 3D4U projec entation. Particular attention is paid to substantiating the role of cr hubs as tools for the modernization of education and production. The main objectives of the project include: analysis of modern digital design and production methods in the fashion industry, assessment of the potential of 3D modeling for optimizing learning processes and practical tasks, as well as research into the effectiveness of international cooperation in improving the quality of educational programs. An important task is to analyze the features of using progressive, effective 3D software systems to solve various problems in the fashion industry.*

Key words*. 3d technologies, digital design.*

Introduction. The implementation of digital technologies into various sectors of the fashion industry is one of the main stages of the transition to sustainable production today. This is a long, multi-stage process aimed at achieving a set of goals:

1) Increasing the technical level of productions and the efficiency of their work,
2) Increasing the environmental friendliness of production by reducing the cost of material resources (at the development stage - by creating virtual prototypes and digital models),
3) Reducing the carbon footprint by using digital projects that can be implemented locally in any geographical region

4) Increasing the inclusivity of the industry by enabling to work locally when working with digital projects
5) The ability to quickly customize products.

Digital design has already firmly established itself as the main direction of the future fashion industry. But to date, the Ukrainian fashion industry is still skeptical about the global role of digital technologies. And one of the most effective ways to reboot the industry should be to train comprehensively trained young professionals, knowledgeable in modern progressive technologies and ways to effectively apply them.

Methodology. The analysis used methods of systematization and comparison of educational practices, generalization of international experience, as well as practical analysis of the structure and tasks of the 3D4U project. The main components of the methodology are:

• Creation of three 3D hubs on the basis of Kyiv National University of Technologies and Design, Khmelnytskyi National University and Lutsk National Technical University. The hubs are equipped with modern CAD and 3D technologies, including FLSUN FDM printers, portable 3D body scanners and sensory insoles for creating individualized prototypes.

• Implementation of educational programs using 3D design and additive technologies. The programs combine digital modeling, virtual prototyping and real production tasks, allowing students to go through the entire design cycle from idea to physical prototype;

• international cooperation with universities in Greece, Germany, Romania to exchange experience in methodologies and integrate European standards into the educational process;

• integration of student competitions and practical projects as platforms for testing digital solutions, developing teamwork skills and preparing students for real production conditions.

Research results. Analysis of sources showed that digital technologies open up broad prospects for the sustainable development of the fashion industry [1]. The 3D4U project aims to bridge the gap between education and production, increase the level of digital competence of students and teachers, and create an infrastructure for individualized and ecological production.

The project also contributes to the formation of a community of young professionals capable of implementing innovative technologies in the production of clothing and footwear, and partnerships with European universities strengthen the international positions of Ukrainian educational institutions and promote the development of academic mobility.

The digital transformation of the fashion industry is associated with the introduction of a large number of various programs for 3D modeling, 3D design, 2D design. All programs have different functionalities, different

interfaces, and different principles of operation. Having analyzed a number of 3d softwares installed in the 3D Hub of KNUTD within the framework of the 3D4U project, it is possible to formulate their basic principles of operation. The work aims to compare the approaches used for 3D modeling of various fashion industry products using the example of three programs, each of which offers the most typical principles of work and occupies a leading position in its sector:

- V-Stitcher - Browzwear (for 3D garment modelling)
- MindCAD 3D (for footwear 3d design)
-Rhinoceros (for designing accessories, shoe soles and orthopedic elements)

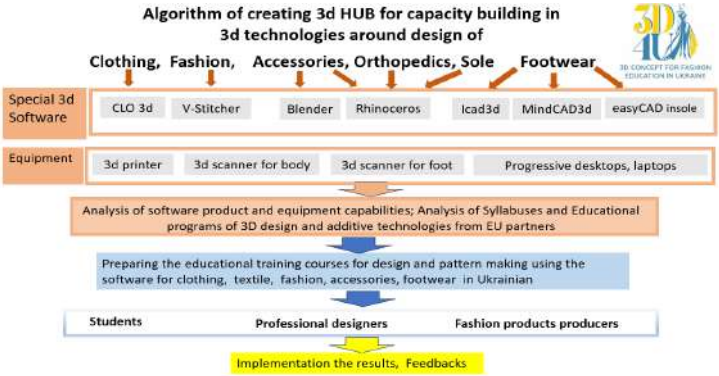


Fig. 1. **Capacity building in 3d design based on 3d HUB of 3D4U project in Ukraine**

The V-Stitcher program occupies one of the leading positions among prototyping software systems, and offers an approach that can be formulated as the adaptation of 2D patterns to the 3D shape of the avatar. It is mostly aiming pattern makers, cutters and technical designers since it requires a 2D pattern to perform the 3D visualization/3D sewing on the avatar body. Lotta solution is suitable for designers and Stylezone is a cloud platform for showcasing 3D designs on web and mobile. The initial information in V-Stitcher is represented by two objects: a 3D avatar and a 2D pattern. The parameters of the avatar shape can be edited as needed. At the same time, the program has a great amount of 3D design and visualization tools that can be applied to the 3D model being developed. However, the basis for developing a new project is 2D patterns, which must be modified in a flat format in accordance with the result of the model fitting in a spatial format. The program has virtually unlimited design capabilities, absolutely realistically reproducing both the properties of the fabric and all the visual effects of the design being developed. If the

software is supported by fabric digitizer hardware equipment like Browzwear's Fabric Analyzer (FAB), the users have the ability to determine all physical properties of any fabric, from its thickness to the stretch and bend (Papachristou & Anastassiu, 2022). Virtual prototyping contributes to the diminishing of the need for extensive physical sampling iterations, thereby restraining expenses related to raw materials and labor (Zhang, 2022). However, like all typical 3D fashion tools, when the user works with high-resolution fabrics, displacement/normal maps, multi-layer garments and so on, most probably will come across exceed GPU memory and force down-res textures, proxy assets, or crashes–undercutting "showcase-quality" output that brands increasingly expect (Stobrawe, 2024). Moreover, cloth simulation still clean heavily in CPU which when are unable to keep-up, creative teams resort to lower-quality sims (coarser meshes, fewer collision layers), reducing accuracy for fit/behavior previews–again compromising the "trust in 3D" (Hanson, 2024).

The MindCAD 3D for Footwear software is focused on designing a 3D shoe model directly on the surface of the shoe last. The initial information is a 3D model of the last. In this case, we start the development process with a 3D format, in which style lines, shoe details and their visual properties (color, texture, edge treatment) are created. Then additional visualization elements (stitching, edging, fittings, lacing) are created and edited. After developing the 3D model, the 3D shape is converted into a 2D flattening, on the basis of which 2D patterns are developed in a 2D footwear CAD. That is, such a CAD is used both for prototyping and design development, and for engineering a shoe elements. In addition, the MindCAD3d for Footwear has a part for designing the shape of the sole, which can be exported for further manufacturing on digital equipment. Thus, this CAD system has a completely practical purpose of application for footwear production, oriented both for designers and engineers. Allows you to use the shoe last model obtained as a result of 3D scanning, which increases the practical value of this software for shoe production. Has many opportunities for visualization of design solutions, but is not focused on reproducing the properties of the material, since the model is created exclusively on the surface of the shoe last. MindCAD 3D faces similar hardware-driven constraints to the most of 3D fashion tools. Recommended requirements for a smooth running of the software (ie Processor , RAM , GPU, Resolution and so on) are as demanding as the ones of 3D fashion prototyping tools (Mind, 2025).

The Rhinoceros software is a very powerful 3D modeler with a wide range of applications. It has unlimited possibilities for creating engineering 3D forms of any complexity, and this is its main purpose. It can be used for design visualization, but has a limited set of visual effect tools.The main

advantage of this 3d CAD is the ability to apply it to any shapes. Therefore, it is often used for designing orthopedic elements of complex shapes that are difficult to implement in specialized CAD systems. The Rhinoceros software is focused on direct design, creating a complex 3D form practically from scratch.

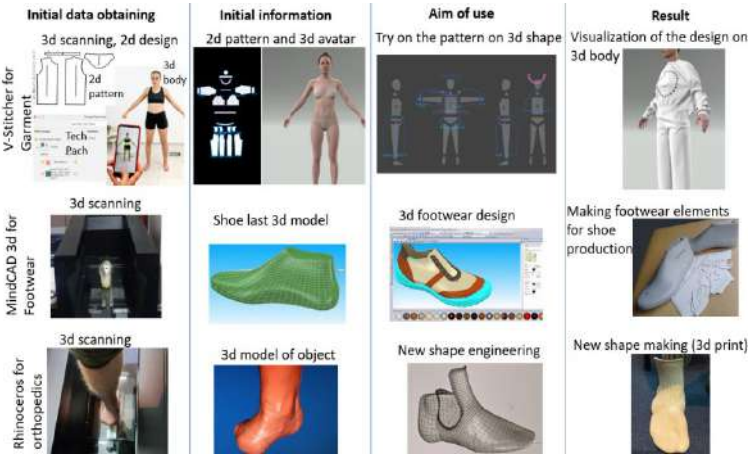


Fig. 2. **Analysis of the features of 3d design implementation for different products**

However, it is also useful for reverse engineering, having powerful functionality for mathematically describing 3D forms of any complexity by triangulation, quadriangulation, NURBs modeling and operating with all possible methods of 3D design (polygonal modeling, surface engineering, SubD design and solid 3D modeling). Modeling objects in the Rhinoceros environment based on the results of 3D scanning allows us to create ergonomic forms of high accuracy and functionality. The program is open source, which makes it capable of integrating various plugins, which expands its functionality. Rhino is one of the best 3D CAD for complex irregular 3D models, which include an orthopedic elements. However, this software has some limitations in the context of using for the specified purposes: Limited support for polygonal modeling (Rhino is focused on NURBS modeling); Lack of physical simulation (no built-in tools for: fabrics, flexible materials); Problems with parametricity (parametric modeling possible only with Grasshopper plugin); Basic functionality without plugins is limited (complex 3D modeling (shoes, orthopedics) requires third-party plugins (Shoemaster for shoes, Grasshopper for parametric modeling, etc.)

Conclusion. The implementation of the 3D4U project is of strategic importance for the development of the Ukrainian fashion industry and education. The creation of 3D hubs allows integrating advanced digital technologies into the educational process, contributes to the training of competitive specialists and the development of progressive approaches in design, and also inclusive and adaptive design. International partnership opens up new opportunities for academic mobility, exchange of experience and the formation of modern trends in the fashion industry, and also creates a platform for sustainable production and effective interaction between education and industry. Further development of training programs, practical cases, and research projects within the 3D hubs will ensure the sustainable development of an innovation platform for the Ukrainian fashion and footwear industry.

However, the success of implementing 3D technologies in the Ukrainian fashion industry is associated with the effective use of the potential of diverse 3D systems to solve various tasks and challenges in the production of fashion industry products. This, in turn, requires an in-depth study of the functionality and features of the entire spectrum of specialized 3d CAD systems in order to further use them, assess their capabilities, and promote their implementation in Ukrainian production conditions.

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