

FEATURES OF 3D MATERIAL DESIGN FOR CLOTHES

Denys BORYSENKO^{1*}, Nataliia MAKSYMENKOVA²

¹*Light Industry and Design Department, PhD, Associate Professor of Food Technology, Innovative Technologies Faculty, Ukrainian Engineering Pedagogics Academy, Kharkiv, Ukraine*

²*Light Industry and Design Department, 3rd year student, Innovative Technologies Faculty, Ukrainian Engineering Pedagogics Academy, Kharkiv, Ukraine*

*Corresponding author: BORYSENKO Denys, e-mail: denisuipa@gmail.com

Abstract. *The article considers the modern direction of development of light industry - clothing design based on 3D material. The importance of each stage of design and influence of additive production on the production of practical models is analyzed. The perspective role of attracting this innovative material for clothing and the peculiarities of its development are emphasized.*

Keywords: *additive production, 3D material, 3D model, clothing, design.*

Introduction

Modern technologies are increasingly opening up new practical possibilities for everyday things. One of the most interesting areas is the use of 3D technologies, which create unique three-dimensional things. In general, 3D technology is a much broader area of development, which can be divided into virtual and material positioning. In the first case, the creation of non-existent objects, which are developed virtually in special software. This is a well-known 3D modeling. The second is no less well-known and practically implemented today in many industries - the creation of ready-made material objects based on developed virtual 3D models. A separate area of the manufacture of models is called additive production with its well-known technical device, which caused a sensation in the manufacture of material things - 3D printer. Its appearance also initiated the ability to start implementing the idea of making parametric structures, 3D material for clothing, development of futuristic formations and practical effective structures [1].

Discussion

3D technology impresses with its breadth of coverage: from top-secret projects to the creation of conventional toys today. Additive production as one of the promising technologies of the next decade is rapidly entering our lives today, overcoming the boundaries of complex technologies and programming. Even children can join state-of-the-art technologies by simply choosing 3D models from a wide range of model bases and printing on conventional portable 3D printers. The latter is also already available today in budget versions and are becoming available to the masses. Of course, this is just the beginning. These breakthrough technologies make it easier for researchers to work together, combining the broader experience of predecessors, including the average user. Most importantly, these technologies allow you to experiment, create unique new solutions from the incompatible, find new approaches to solve problems.

In addition, additive printing currently has a problem area with raw materials, technologies that already need innovation, as well as updating the technical base. All this causes the inability to fully use 3D printing in the production process. To date, restrictions on the number or individual prototypes of clothing models have been developed, which surprise with the design of solutions, but have significant shortcomings. This causes a lack of widespread use of 3D technology for the manufacture of casual wear. This problem field is gradually being solved by attracting new materials - nylon and light-sensitive resins, as well as new concepts of forms, which previously simply were not considered on the basis of traditional textiles [2].

An important emphasis in the clothing design on the basis of modern technology is to focus on the peculiarities of the manufacture of material for it. Changing approaches to developing and focusing on creating 3D material is the impetus for global change. 3D material is a modern textile substitute that can eliminate the need for a sewing machine and special sewing equipment, including the need for wet heat treatment. A large number of technological operations in the manufacture of products, not to mention the procedure of textile production, is nullified simply by the appearance of 3D material. This is not just a material for clothing, but a material-product. It can be completely made and represent the final design product - clothing. On the other hand, 3D material can remain only a part of the finished product - to combine the use of traditional textiles with innovative technological material.

The main advantage of 3D-material is the parameter, which includes the ability to create unique surfaces and take into account even more unique shapes of future clothing users, thus maximizing the personalization of the design. It is not just individual production - it is a personalized design in mass production with a well-balanced use of resources. This is a more convenient, unique and personalized approach to the client [3]. Already technological progress allows to reorient production to the maximum satisfaction of needs of the final consumer, and for production - the organization of flexible parametric production which is almost completely automated. Also, in the process of creating modern material will be used as much raw material as needed to produce a sample - this is almost the motto of 3D printing and 3D clothing material, respectively, with constantly declining resources on Earth.

Stages of 3D material design

3D material design is a completely parametric process based on clear algorithmic principles and takes into account the generalized features of the 3D model. In turn, this includes the following sequence of steps: idea generation, 3D modeling, model verification and 3D printing. These steps are conditional and it all depends on the plan of the developer and the project. During the design you can use a ready-made model or on the basis of a ready-made model to develop your own, use an avatar, template, or develop from the so-called "zero", which is longer and more expensive, but will be unique and clearly consider all parameters.

The initial step of any design is the formation of an ideological solution. Each new model is built conditionally on a compromise - a combination of existing models and new tasks, on the basis of which the implementation of the solution of the problem is built. In the first stage, it can be just a description of the problem and its solution on a sheet or a graphic sketch. After the generalized presentation of the idea, its analysis is performed and the practical side - the need for a solution. In most ideas, these are just futuristic solutions that have no basis for solution. This is not a problem, especially for the fashion industry, which is on the verge of shocking innovation and technological opportunities. Everything that is not directly related to mass production, forms conceptual solutions for the future. Therefore, with the involvement of additive production, these concepts can be realistically presented through innovative forms and structures.

One of the modern trends that has moved from the computer industry and is mastered in the light industry - 3D modeling. This is a radically different approach to the design of material and clothing, where the material itself becomes more constructively complex and requires consideration of the peculiarities of the situation not only on the surface of the user of clothing, but also in space. This complicates the structure of the material and its texture, and the overgrown view of the 3D material is the finished product.

At the stage of 3D modeling there is a construction of a virtual 3D model of clothing material. Any 3D model is a geometric shape that can be a simplified primitive or a combination of them into a more complex shape. The surface of the human body, which is covered with clothing, is much more complex than conventional primitives and requires in most cases complex designs to maintain the appropriate level of comfort for the user of the product and the goals of clothing, its features.

Therefore, the main task in the design of 3D material is to take into account the peculiarities of the formation, including atypical design features [1].

Upon completion of the 3D model of clothing material, developers must further test the model in automatic mode with the use of special software and manually, reviewing the basic parameters of the virtual 3D model of clothing material. The achievement of the task, the virtual implementation of the conceptual solution and the final stage - 3D printing of the material depend on the test. Software validation sees the opening of a saved design in a correspondingly saved file in 3D printing programs and, if necessary, the automatic correction of a design that can then be printed out on a 3D printer.

The final stage of 3D material design is its printing - making a practical sample. This stage of making a material model can take the form of prototyping, including reduced, enlarged or scaled. Involvement of one or another scale of printing depends on the requirements of demonstration and additional research after the production of the first sample. Therefore, in most cases, the design is not immediately implemented in mass batches due to the fact that it is, first, personalized 3D material - for a specific model, which is selected at the stage of idea design and considered parametrically at the stage of 3D modeling. Secondly, the direction of design of this innovative material is still at the stage of deployment and it is necessary to involve prototypes to study the obtained result before actively exploiting it.

In general, all stages of design are combined into a single continuous process, which can be joined remotely to developers. This is another important advantage of developing 3D material - the organization of remote production in accordance with Industry 4.0. In the design process it is possible to combine international experience, group activity of researchers from different countries, as well as to attract technical support from programmers and technical staff working directly with relevant 3D printers, including ordering 3D printing online from other companies.

Prospects for the development of 3D material for clothing

3D material is becoming increasingly popular among researchers and with the renewal of the raw material base of 3D printing. Today, a significant number of types of 3D printing are already known, the most popular of which are FDM, SLS, SLA and others. Each species is updated, new ones appear based on a combination of existing and the use of the latest technologies. Thus, promising directions for the development of 3D material, including:

- renewal of the raw material base and the emergence of new types of composites, which, accordingly, lead to the formation of a bridgehead for new research and technological future design products;
- increase in detail, which creates the preconditions for the emergence of mass production of nanotextiles;
- the emergence of new structures and forms, which is expressed in the creation of new formations;
- new opportunities, which launches an update of the functionality of ordinary clothing and the search for new tasks to solve, new horizons to master;
- development of 4D material - a new concept of material that changes over time or under the influence of appropriate influences [4].

Today the most actively developing direction is the inclusion of electronics in 3D material and the creation of smart clothes. Clothing material is already becoming more than a protective layer against the environment and an aesthetic product - it understands the information flows around us and responds to them. Another and important step in the future development of 3D material is the preservation of the environment and combating the negative effects of the so-called "fast" fashion, reducing the amount of garbage, waste from clothing production. Today, the use of safe biodegradable materials such as PLA plastic, which is made from corn and sugar beets, is being actively introduced. These may not be suitable materials for clothing, but this is a significant achievement for an eco-campaign. So, to create exquisite copies of super-fashionable exclusive prototype models and even wider disposable products, the use of these raw materials is simply irreplaceable.

Conclusions

3D clothing material is only in the early stages of widespread implementation. Despite the existing problems with raw materials, the duration of obtaining quality models and their cost of implementation, these unique materials should turn the traditional clothing industry. In the near future we will have amazing practical results of using 3D material, which will make clothes more personalized, will take into account any whims of the user and in general for the manufacture will no longer need to go to the store - it can be made at home. On the one hand, it resembles a return to the workshops at home, but that's another. Everyone will be able to join the production of ultra-sophisticated technological products, which will be our usual everyday clothes.

To date, a huge amount of research, development and existing working prototypes have been presented, which demonstrate the effective indicators of the ability of 3D material for clothing to approach and surpass traditional materials. The use of composite and biosoluble raw materials has been made, the search for unique combinations of material continues, which can also speed up the process of making the material. We must also not forget about the great accumulated positive experience from other industries in the direction of additive production, which gives impetus to new achievements and the generation of quality design products of the future.

References

1. JEONG, J., PARK, H., LEE, Y., KANQ, J., CHUN, J. Developing parametric design fashion products using 3D printing technology. In: *Fashion and Textiles*, 2021, 22, pp.1-25, doi: <https://doi.org/10.1186/s40691-021-00247-8>.
2. FANGLAN, Z., KAIFA, D. Innovative application of 3D printing technology in Fashion design. In: *Journal of Physics: Conference Series*, 2021, 1, pp. 1-8, doi: <https://doi.org/10.1088/1742-6596/1790/1/012030>.
3. JAFFERSON, J. M., SABAREESH, M. C., & SIDHARTH, B. S. (2021). 3D printed fabrics using generative and material Driven design. In: *Materials Today: Proceedings*, 2021, 46, pp. 1319-1327, doi: <https://doi.org/10.1016/j.matpr.2021.02.405>.
4. MALLAKPOUR, S., TABESH, F., HUSSAIN, C. M. 3D and 4D printing: From innovation to evolution. In: *Advances in Colloid and Interface Science*, 2021, 294, , doi: <https://doi.org/10.1016/j.cis.2021.102482>