TECHNICAL UNIVERSITY OF CLUJ-NAPOCA

ACTA TECHNICA NAPOCENSIS

Series: Applied Mathematics, Mechanics, and Engineering
Vol. 67, Issue Special II, April, 2024

THE APPLICATION OF SPECIALIZED SOFTWARE IN DESIGN FOR OBTAINING DERIVED SHAPES OF THE HUMAN BODY

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Abstract: *In years digital software has revolutionized how designers generate and visualize their ideas showcasing the potential of these tools across industries. This highlights their role, in fostering innovation and enhancing efficiency within the creation process. The creation of complex design objects is a process in which digital software, mechanical machinery and manual skills can be combined. This paper explores the collaboration between software, mechanical machinery and manual experience in creating forms inspired by the human body. The study focuses on the fusion of art, technology and craftsmanship, that examines software programs, machines and tools employed to produce these shapes. It includes analysis of 3D modelling software, computer aided design (CAD) and digital fabrication techniques. Moreover, it investigates methodologies for transforming three models into tangible objects. The practical outcomes of this study encompass the process of obtaining body inspired shapes.*
Key words: *CAD/CAM systems, digital body, scanning process, laser cutting, assembling process*

1. INTRODUCTION

Creating complex design objects is a multifaceted endeavour that necessitates the harmonious fusion of digital software, mechanical machinery, and manual skills.

One of the driving forces behind this research is dispelling the misconception that the fashion industry is a narrow field confined by rigid standards. In actuality, it constitutes a multidisciplinary realm that extends far beyond clothing and trends, interweaving diverse disciplines and encompassing a wide spectrum of creative and technical facets.

A novel approach to attaining synergy between digital software, mechanical machinery, and manual craftsmanship is by seamlessly integrating these disparate disciplines, it enables the creation of highly detailed designs that would be unattainable through any single method in isolation.

Another pivotal motivation is the exploration of human perceptions of the body. The fashion industry often perpetuates unrealistic body ideals, resulting in adverse effects on self-esteem.

These distinctive attributes position this research at the forefront of innovation within the fashion and design landscape.

2. INFORMATION

Browsing through various sources, several examples were discovered that combine art and technology. Some of these have been exemplified below.

2.1 "Sculpture Factory"

The Sculpture Factory (figure 1) project combines classical sculpture with robotic technology to explore the relationship between form and matter, reality and artificiality, and traditional and contemporary. The installation uses a large industrial robot to repeatedly sculpt variations of different masterpieces. The fact that the figure is never completed, but each attempt reveals new aspects and articulations of matter, emphasizes the endless potential of the material and the possibilities of achieving an ideal form. The use of algorithms and models unknown to the robot gives it an autonomous and unconventional approach to the sculpting process, opening up new perspectives on artistic creation. [1-3]

Fig. 1. The Sculpture Factory, example

2.2 "The Art of the Mannequin" exhibition

Through this exhibit, "The Art of the Mannequin," (figure 2) we see Pucci push beyond conventional boundaries by treating mannequins as pieces of art rather than mere models. Mannequins created through collaboration now serve beyond displaying clothing; they challenge traditional limitations. [1-3,7]

Fig. 2. "The Art of the Mannequin" exhibition

Another big insight in the world of digital software, mechanical machinery, and manual skills is the book „Digital Fashion Innovations Advances in Design, Simulation, and Industry” [8] that offers a thorough exploration of the connection between tech and fashion unfolds inside this book. The main focus are digital technologies transforming the fashion sector and customer engagement, including supply chain management, electronic commerce platforms, blockchain innovations, large datasets, and AI applications that mutually enhance corporate performance and end user satisfaction.

3. METHODS AND TECHNIQUES

For this research paper it was decided to analyse 2 methods: 3D scanning and 3D modelling.

3.1. 3D Scanning

3D scanning involves analysing the visual characteristics of an object or environment to collect data. This data is then used to generate a 3D digital representation that can be reproduced with a 3D printer, CNC milling machine or digitally displayed. Professional 3D scanning can be classified as contact or non-contact. Contact scanning requires placing the object on an exact surface and physically scanning it. Active non-contact scanning uses light to scan the object, while passive non-contact scanning detects environmental radiation. These scanning methods often require expensive hardware and software. However, a more affordable alternative is photogrammetry, which uses smartphone apps and captures multiple images from different angles.

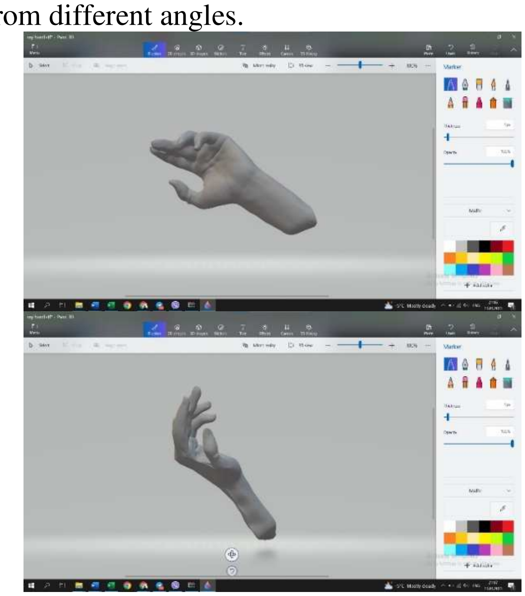

Fig. 3. The Polycam scan results of example 1

An example of the application of this method is presented below (figure 3, 4). As the author describes [7], for testing it was decided to use the Polycam application to scan a part of the body. The selected body part was placed on a white background. The scan was performed with the help of a third party to obtain the most accurate results. The software captures multiple images; therefore, it is very important to take as many pictures as possible from different perspectives. At the end, the 3D object is generated and can be shared in USDZ file format. To convert to an STL file, the Aspose online converter was used. [7]

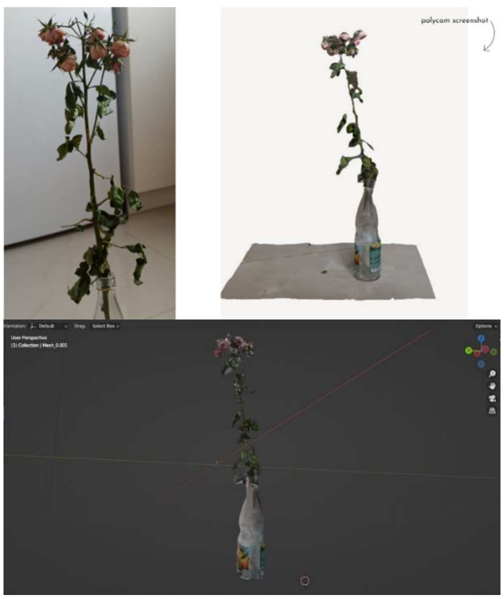

Fig. 4. The Polycam scan results of example 2

3.2 3D modelling

In order to create various objects of diverse complexity several applications were used such as Makehuman, Clo3D, Slicer for Fusion 360, Rhinoceros and Grasshopper .

Makehuman is a free and open-source 3D computer graphics program that specializes in creating realistic humanoid characters for prototyping purposes. By using Makehuman, a digital representation of the human body can be generated (figure 5). The software provides a number of adjustable parameters for 3D modelling, such as gender, positions, textures and various other features. [4-7]

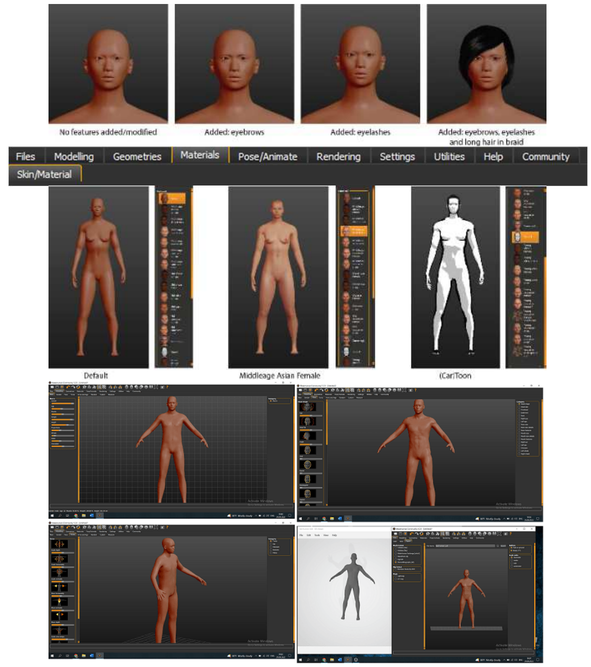

Fig. 5. Example of the Makehuman program

Although CLO3D is primarily known for its applications in the fashion industry, its capabilities extend beyond clothing design. The software can be used in a variety of other areas where it visualizes and simulates 3D objects. It allows designers and engineers to validate and refine their concepts before physical fabrication, reducing the costs and time associated with traditional prototyping.

Also, it can be used in the design of non-apparel products such as accessories, footwear, bags and other consumer goods. Designers can create virtual prototypes, simulate materials and visualize how products will look and function in 3D.

It is flexible tools and simulation functions allow it to be used as a versatile solution for various design-related tasks in different sectors.

In this case Clo3D was used as an option to create and adjust the human body to base on the needs and desire (figure 6). [4-6]

Initially the desired avatar was selected, after which the body was adjusted according to size and appearance. All auxiliary parts such as shoes, hair, etc. were removed. The next step is to export the avatar in either .obj or .stl format depending on which software is preferred for use.

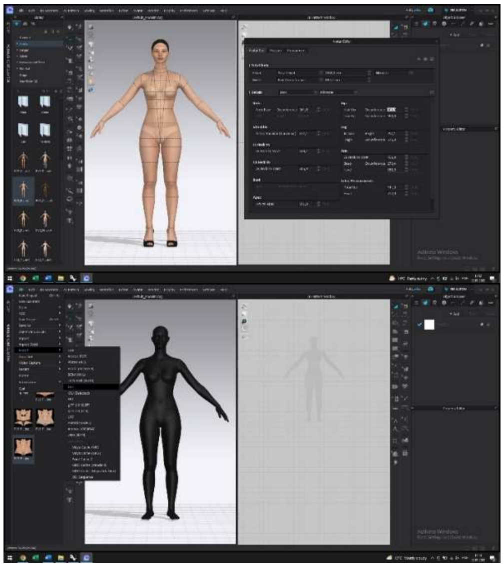

Fig. 6. Example of the Clo3D program

Since the next step requires the use of Rhinoceros it is necessary to export the avatar in .stl format. [4-7]

Rhinoceros, known as Rhino, is a software application used for 3D graphics and computer-aided design (CAD). It offers a wide range of tools and functionality for creating, manipulating and analysing complex 3D geometry. Rhinoceros finds extensive application in various industries.

Overall, Rhinoceros is a powerful and versatile software application used in a wide range of industries for various design and visualization purposes, benefiting professionals in architecture, industrial design, product design and more (figure 7). [4-7]

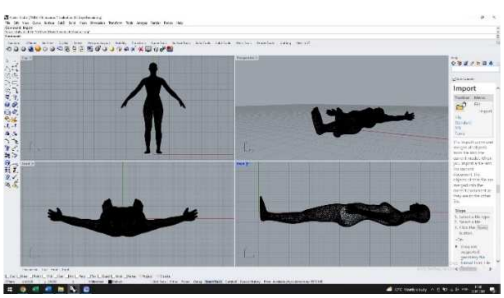

Fig. 7. Example of the Rhino program use

Once the Makehuman/CLO3D avatar is imported into Rhinoceros (Rhino), manipulation can begin using a variety of tools available in Rhino's 3D modelling software. These tools, such as line, polyline, rotate, cut and cap, allow the necessary changes to be made to achieve the desired avatar shape. With the line and polyline tools, curves can be created or modified to define the contour or outline of the 3-D model. With these tools it is possible to sketch or modify the shape of the model's body (figure 8).

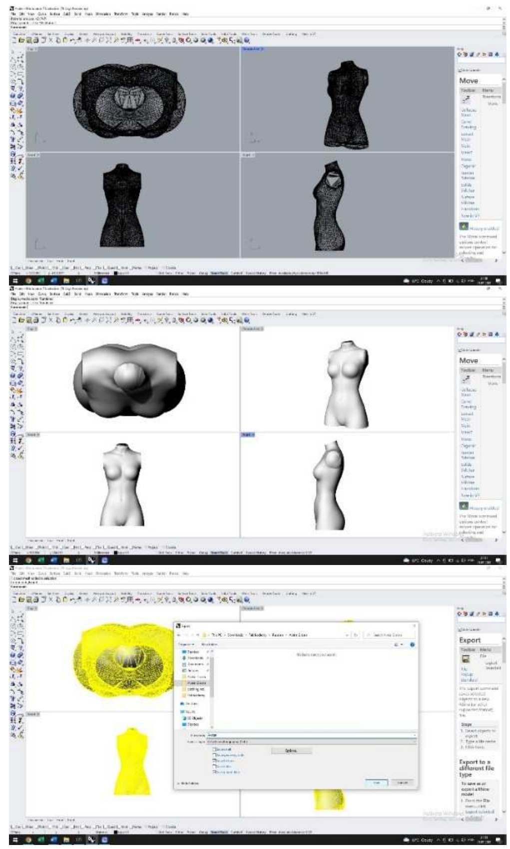

Fig. 8. The use of Rhino tools to create complex body

Rhino's rotate tool allows rotation of selected objects or components around a specified axis. This can be useful for adjusting the orientation or position of certain parts of the avatar. The trim tool is useful for removing unwanted or excess geometry from the model. It allows defining the cutting limits and trimming any unnecessary portions of the avatar to create the desired shape of the figure.

After trimming, the cap tool can be used to close any edges or open areas. This ensures that the avatar is a solid model with no holes or gaps. By using these tools and techniques in Rhino, one can manipulate the imported avatar to create the desired shape. The powerful 3D modelling capabilities in Rhino allow for precise and detailed adjustments, helping to achieve the desired result for the 3-D avatar design.

Depending on what kind of purpose the created object has it can be either 3D printed or cut out using the laser machine. For this research paper the second method using the laser cutting machine was chosen.

Once the file is finalized, the next step is to prepare the 3D model for cutting using Slicer for Fusion 360, a tool that converts 3D models into 2D cutting patterns (figure 9). [4-6]

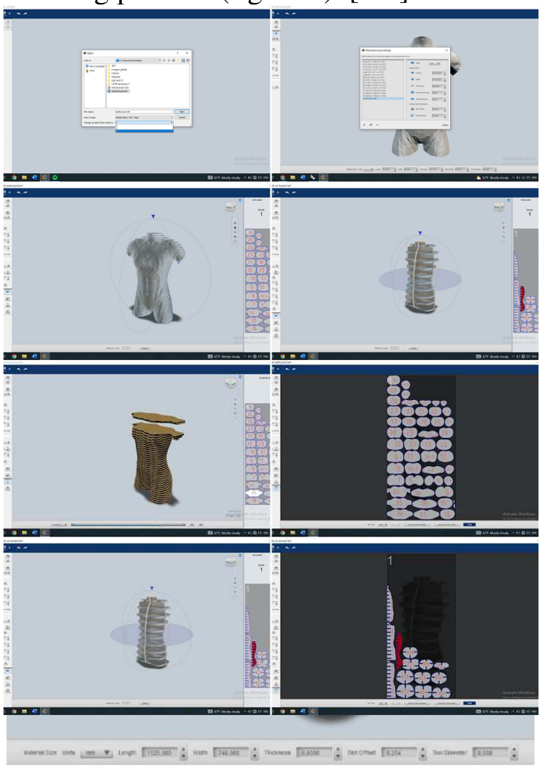

Fig. 9. The use of Slicer for Fusion 360 to create complex body

The following is a breakdown of the process: [4]

- Set the Board Size: In Slicer for Fusion 360, the dimensions of the cutting board can be specified. In this case, the used board had a size of 740mm x 1520mm with a height of 6mm.
- Choose Cutting Parameters: Select the desired cutting parameters, such as the type of cut, direction, and any other specific requirements. These settings will determine how the garment pieces are laid out on the cutting board.
- Generate the DXF File: Once the cutting parameters are configured, Slicer for Fusion 360 generates the final cutting pattern as a .dxf file (figure 10).

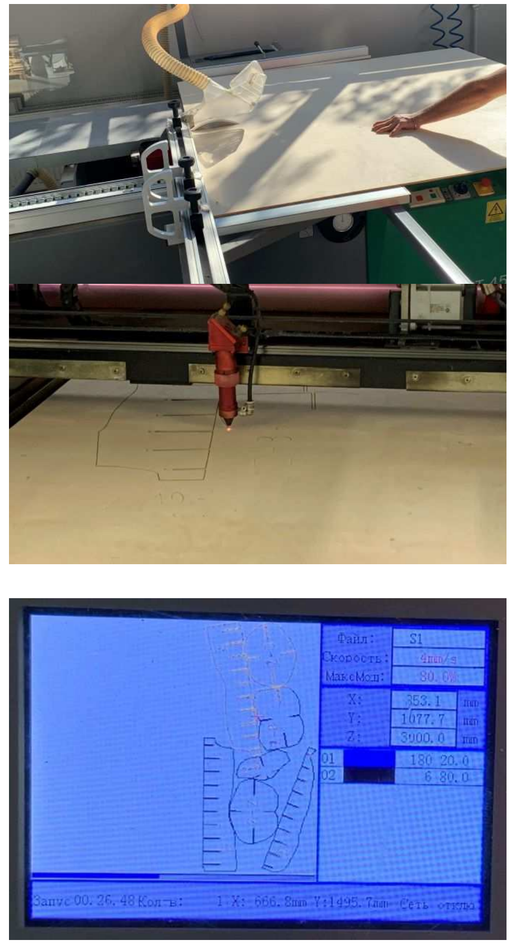

Fig. 10. The process of laser cutting the prepared files

Laser cutting is a precise and versatile manufacturing process that uses a high-powered laser beam to cut or engrave a variety of materials. It finds applications in industries such as manufacturing, fabrication, prototyping and crafts. [4-7]

Firstly, it was decided to use the plywood as a base material for this project. Based on this the testing stated to determine the appropriate parameters. Through experimentation, it was found that a high speed of 6 mm/s did not cut plywood effectively. So, the optimal cutting speed was set at 4 mm/s. Once, the files needed for cutting were prepared the cutting process using the laser cutter began. Due to the thickness of the polyester wood (6 mm) and the chosen cutting speed (4 mm/s), the cutting process took about 40 minutes. In total, more than half a sheet of plywood was used to produce four vertical pieces and ten horizontal pieces. The speed of the laser cutting machine and the thickness of the polyester wood influenced the total cutting time and the need to adjust the size of the space. Then, the assembling process started (figure 11). [4]

Fig. 11. The assembling processes

4. RESULTS AND FURTHER RESEARCH

Based on all of the work carried out the following results were obtained (figure 12).

Based on the research in this article, in the future the focus should be on the following issues:

One approach is to optimize interlocking patterns for laser-cut parts, which can improve the structural integrity and fit of interlocking components. Exploring different design parameters such as gap size, tolerance, and joint geometry can contribute to this optimization process.

Another aspect to consider is the development of comprehensive safety guidelines and procedures for working with laser cutting equipment. This would involve identifying potential hazards and implementing best practices to ensure a safe working environment. Considering different laser power levels, materials, and safety measures is crucial in minimizing risks.

Fig. 12. The results

Integrating laser cutting with other advanced technologies, such as 3D scanning, computer-aided design (CAD), and automation, can also enhance the applicability of these technologies. Exploring the potential for these technologies to work together can streamline the design-to-production workflow, increasing production efficiency and accuracy.

In terms of future challenges, technical aspects such as size, speed, and structural integrity need to be addressed. Exploring new approaches, such as robotic 3D printing or the use of advanced materials, can help overcome these challenges. Additionally, the need to study methods like polishing, coating, annealing, and chemical treatments to improve the final quality of printed parts.

Further research and exploration in ethical challenges related to societal pressure and body ideals can also contribute to addressing these challenges and promoting a more inclusive and diverse approach to fashion and design.

Overall, by focusing on these future development perspectives, the applicability of these technologies can be enhanced, and both technical and ethical challenges can be addressed, adding depth and relevance to the discussion.

5. CONCLUSION

In conclusion, this paper has outlined the process of using 3D scanning, design software and laser cutting technology to transform a concept into a physical object.

Further, it provided insights into the combination of advanced technologies that enabled efficient prototyping and fabrication of physical objects.

This research paper also illustrated the power of modern digital tools and their applications in various industries, from fashion to product design and industrial design.

These technologies offer new possibilities for creativity, prototyping and production, enabling individuals and businesses to bring their ideas to life in a more efficient and affordable way.

Additionally, this document dispels the misconception that the fashion industry adheres to rigid standards, highlighting its multidisciplinary nature, encompassing creative and technical facets from different disciplines. It also emphasizes the importance of harmonizing digital software, mechanical machinery and manual craftsmanship.

Overall, this paper highlights the transformative potential of advanced technologies across industries and the need for interdisciplinary approaches and suggests the need for further research into design and assembly techniques, safety protocols and the exploration of innovative materials in the field of sculpture.

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Aplicarea softurilor specializate în design pentru obținerea de forme derivate ale corpului uman

În ultimii ani, software-ul digital a revoluționat modul în care designerii generează și vizualizează ideile lor, demonstrând potențialul acestor instrumente în toate industriile. Acest lucru evidențiază rolul lor în promovarea inovației și în creșterea eficienței în cadrul procesului de creație. Crearea de obiecte de design complexe este un proces în care se pot combina software-ul digital, mașinile mecanice și abilitățile manuale. Această lucrare explorează colaborarea dintre software, utilaje mecanice și experiența manuală în crearea de forme inspirate de corpul uman. Studiul se concentrează pe fuziunea dintre artă, tehnologie și măiestrie, care examinează programele software, mașinile și uneltele utilizate pentru a produce aceste forme. Acesta include analiza programelor de modelare 3D, a tehnicilor de proiectare asistată de calculator (CAD) și a tehnicilor de fabricare digitală. În plus, investighează metodologiile de transformare a trei modele în obiecte tangibile. Rezultatele practice ale acestui studiu cuprind procesul de obținere a formelor inspirate de corp.

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