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Reproduction and Preservation of Albanian Handicraft Accessories Through Additive Manufacturing

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Abstract: *The development of craftsmanship of silver and gold ornaments and the minting of silver coins in the country have their origins in ancient times. The first objects made of precious metal in the form of ornaments from the Bronze Age were two gold balls made of spiral wire.*

The reproduction of traditional objects in 3D form has now become an urgent necessity for the creation of a new method of cataloging cultural heritage in Albania, ensuring its preservation for future generations.

This technology, with its innovative capabilities, provides new opportunities for studying and processing the acquisition and preservation of geometric forms of damaged museum objects in cultural institutes. It is a thrilling and important innovative technique in the restoration, documentation and preservation of the original objects.

This paper presents the approach of prototyping traditional accessories by scanning and modelling them with 3D software for the reproduction of realistic 3D models of folkloric objects for cataloging to be preserved for the future.

We worked with two methods, 3D scanning objects with a Konica Minolta Scanner and 3D modelling with Zbrush Software, to obtain 3D models with high resolution and real dimension. These models were then sent directly to the 3D printers for fabrication of the original object.

The software used was PET, for scanned objects to export the data in standard formats: DXF, STL, CAM, and CAT 3-D, and convert, save, or send for reproduction in 3D printers with real-dimension objects.

Comparing the two methods, it was obvious, that 3D objects can also be obtained through modeling, even though it requires more time to acquire the object in 3D. This shows that inexpensive desktop production equipment with suitable software can provide accurate data at a low cost in preserving folk accessories.

1. INTRODUCTION

Albanian folk costumes and accessories have played and continue to play an essential role in revealing the values and expressing the identity of our country's culture and history.

The primary objective of this study is to showcase the potential of 3D technologies. These technologies have the power to revolutionize the processes of conserving, storing, and cataloguing folk objects. 3D Additive manufacturing, commonly known as 3D printing, is a vital tool in this process, transforming digital forms of folk accessories, preserving the original object, and facilitating mass production. This potential is not just theoretical, but a beacon of hope for the future of cultural preservation.

3D scanners are devices that analyse objects in real time to collect data about their shape and appearance (Vilbrandt et al., 2011). The potential of 3D scanners is immense, as it is based on

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their ability to acquire many 3D points in a very short time, also called clouds (Addison, 2000; Scopigno et al., 2014). The use of large-scale 3D scanners to create virtual models with real dimensions is considered at the peak of its use of the fourth industrial revolution for the preservation and documentation of the cultural heritage, of 3D points (Vilbrandt et al., 2008; Stone & Wood, 2000). The collected data is then used to build virtual 3D models, which can be used for a variety of applications. Some of the fields of use of 3D scanning technology are medicine, science, engineering, gastronomy, fashion industry, etc. This step is not just a part of the process, but a crucial element in the journey of preserving cultural heritage.

Experiments on scanning, modelling, and 3D printing systems were carried out in the Laboratory of CAD/CAM and Clothing Technology at the Department of Textiles and Fashion at the Polytechnic University of Tirana (Universitatea Politehnica Timişoara, n.d.).

2. METHODOLOGY AND EXPERIMENTS

In this paper were shown two techniques for modelling 3-D objects and two different printers for fabrication to encourage practical and easy ways of moving between the virtual and physical world. This study aims to show the impact of 3D imaging software on modelling and design methods for the sculptural process of traditional accessories. The experiments have been conducted on scanning, reconstruction, and rapid prototyping (3D printing) of cultural heritage objects.

One aspect of the study delves into the practicality of 3-D modelling and printing. Due to its precise sizing, measuring, it was used the 3D Scanner, Zbrush and 3d Max software to obtain 3d real data. The 3D modelling includes two components: object scanned or modeled and object edited. The study falls into two distinct categories in this field. The first methods were by using the Konica Minolta Vivid 910 laser scanner, a system based on triangulation, and a 3D printer, available in the Laboratory of CAD/CAM Garment Production Technology, at the Polytechnic University of Tirana. The second method involved modelling the objects in software like Zbrush and 3D Max finding the most suitable solution. The case studies covered the entire process, from the initial stages to the final 3D printing model.

The 3-D printing technology, also known as additive manufacturing is known for rapid prototyping and production. The printer used was, a 3d Cartesian coordinate system printer plastic filament fabrication (FFF) and ELEGOO Saturn 2- 3D printer resin. The model obtained was a 3D photo-realistic, which led to the realization of a hyper-realistic museum.

3. RESULTS AND DISCUSSION

This study is focused on 3D scanning, modelling, and 3D printing. The first experiments were made with Konica Minolta 3D Scanner and after there are used 3D software lowest-cost methods to obtain realistic objects. In Using these two methods, were analysed the specifics of each technique as mentioned below:

- 3D scanning operations through the Konica Minolta Vivid 910 I 3D scanner.
- 3D modelling accessories in Zbrush Software.

Experiments on scanning, modeling, reconstruction, and rapid prototyping (3D printing) of cultural heritage objects are presented below.

3.1. 3D Scanning Operations Through the Konica Minolta Vivid 910 I 3D Scanner

The first object of this study was a Silver plate folk object material by handicraft artisans. We used a Konica Minolta Vivid 910 laser scanner, a system based on triangulation. The number of scans for an object varies from 4 to 12, depending on the details of the object scanned. The objective of multiple scans is to have an accurate surface of the object scanned with no holes or gaps. The compatible software for the laser scanner during the surveying step was the Polygon Editing Tool (PET). It can be registered with multiple scans and merged into a poly mesh. We also used Mesh Lab and 3D Max for texture, material, and rendering.

Figure 1. Konica Minolta Vivid 910 I 3D scanner (a), Silver plate folk object (b)

Source: Own research

The Konica Minolta scanner's compatible software is the Polygon Editing Tool. The main window of the software linked with the scanner is presented in the figure below.

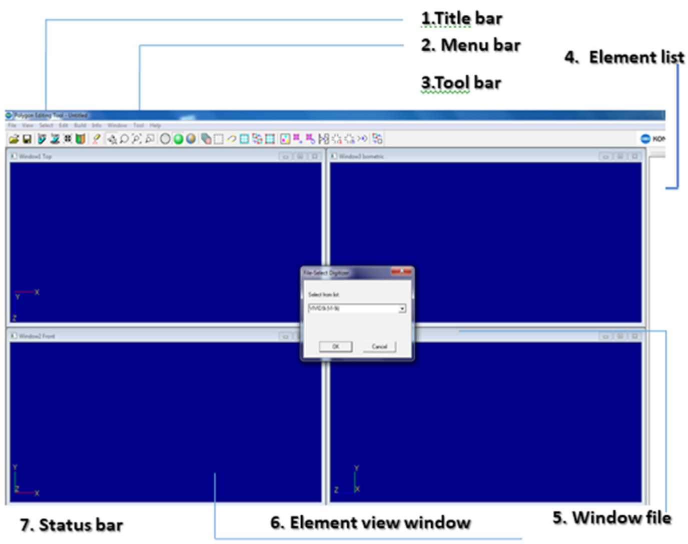


Figure 2. Polygon Editing Tool Software

Source: Own research

The figure below shows the scanned object from different angles (6 scans were done to obtain the 3D data) using the manual scan command File—Import—Digitizer—One Scan. Other steps were registration, filling holes, merging, and converting into a polygon mesh.

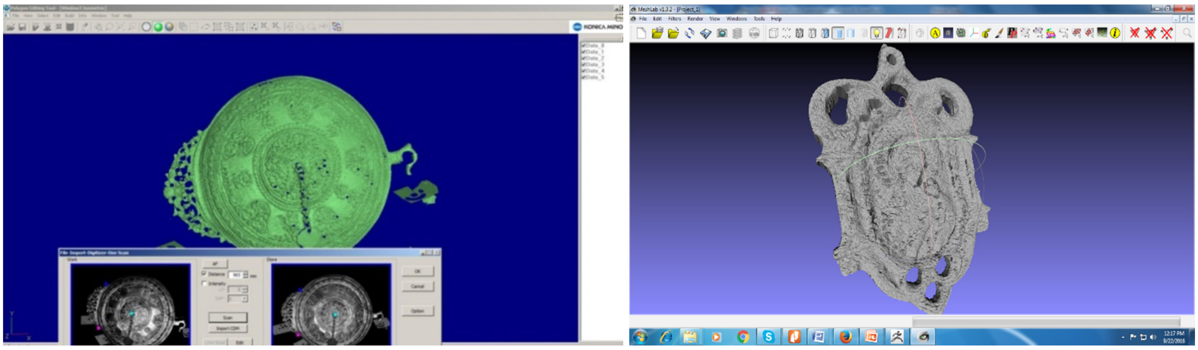
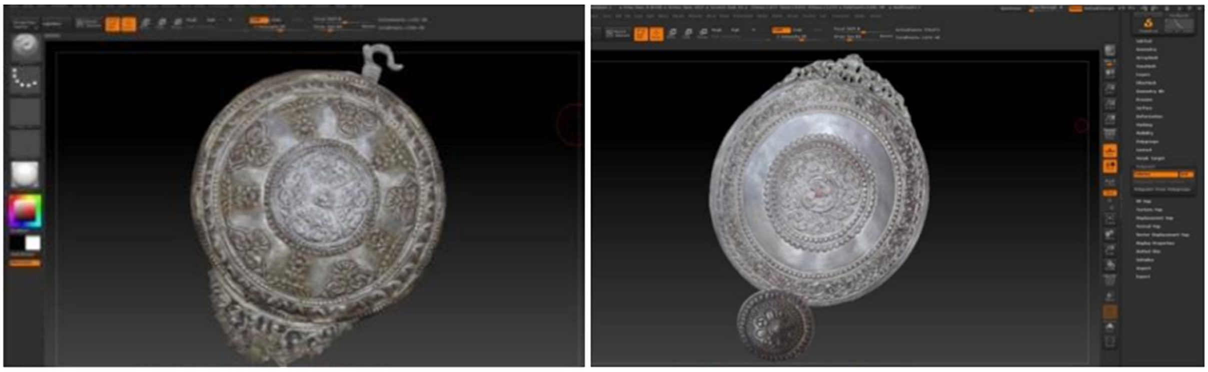


Figure 3. Scanned objects from different angles

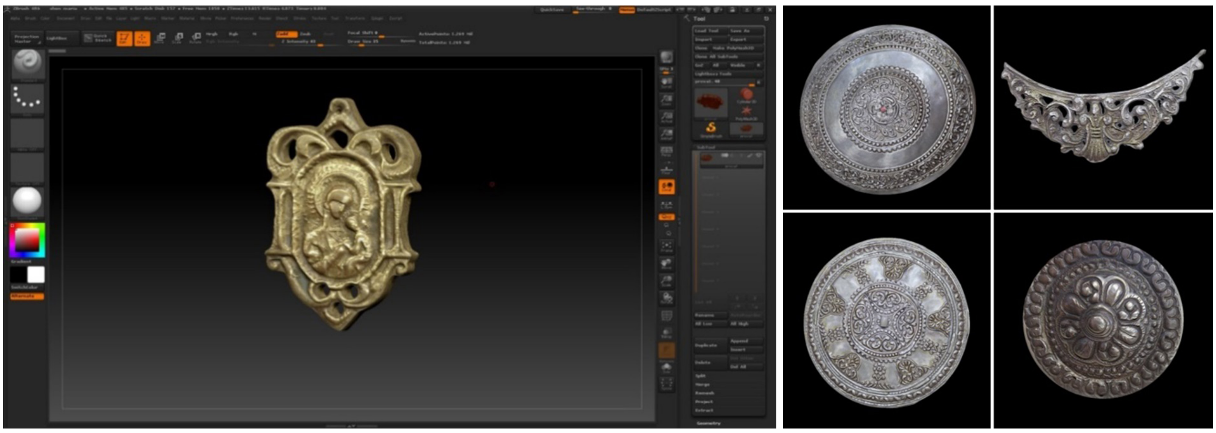
Source: Own research

3.2. Modelling Silver Plate Object in Zbrush 3D Software

The second method to obtain 3D realistic data on handicraft objects was modelling them by using Zbrush Software.



(a)



(b)

Figure 4. Plate in silver, icon necklet modelled in ZBrush

Source: Own research

3.3. 3D Printing of the Object

The 3D printers used were: ELEGOO Saturn 2, resin Printer and Cartesian PLA 3D Printer.

3.3.1. 3D Printing of the Object with ELEGOO Saturn 2

The ELEGOO Saturn 2, resin 3D printer offers enhanced toughness and resistance to impact, making it ideal for functional parts and prototypes.

ELEGOO Saturn 2 is perfectly suited for both professional designers and enthusiastic hobbyists alike. It offers limitless creative possibilities. This printer has high-resolution precision, printing time reduction, speed, and innovation to deliver exquisite prints with exceptional detail. This Equipment has a printing size of 219mm, 123mm, 250mm, to print larger models.

The ELEGOO Saturn 2 MSLA 3D Printer features a 10-inch 8K monochrome LCD COB screen, providing exceptional clarity and precision in every print, along with odour reduction.

This printer produces detailed prototypes that closely resemble the final product.

Figure 5. Preparing ELEGOO Saturn 2 for object printing

Source: Own research

The STL files are imported into the ChiTubox - Slicing software which plays a crucial role in 3D printing. It determines the layering and decides how each layer will be deposited while printing.

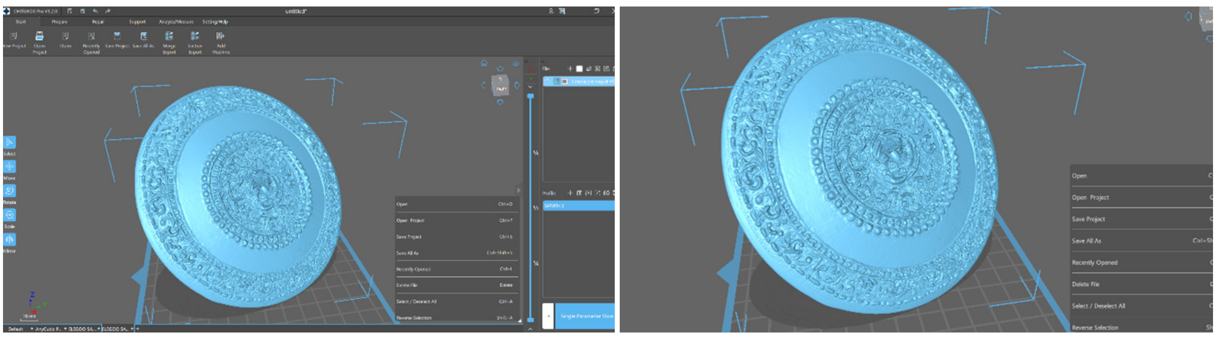


Figure 6. Stl files imported in ChiTubox - Slicing software

Source: Own research

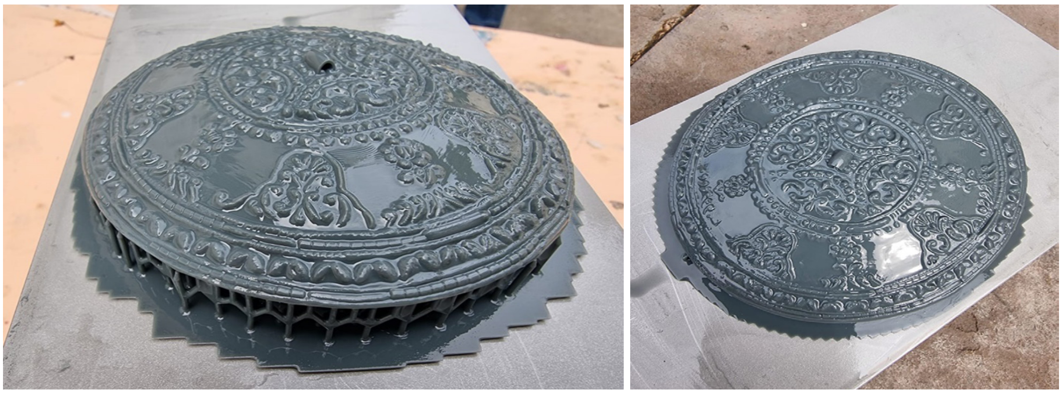


Figure 7. Object printed in Elegoo - Saturn 2
Source: Own research

3.3.2. Fused Dépositions Modelling (Fdm) or Fused Filament Fabrication (Fff) – Pla 3D Cartesian Printer

Plastic filament PLA is melted down and extruded through a nozzle. The nozzle and/or build platform move to print each layer. The material is heated to its melting point and deposited in layers. Cartesian printer (PLA) has a standard input in the form of the STL file.

The STL files are imported into the standard Cura 14.12 software package. The printer creates a 3D model by melting thermoplastic material and carefully layering it from the bottom up.

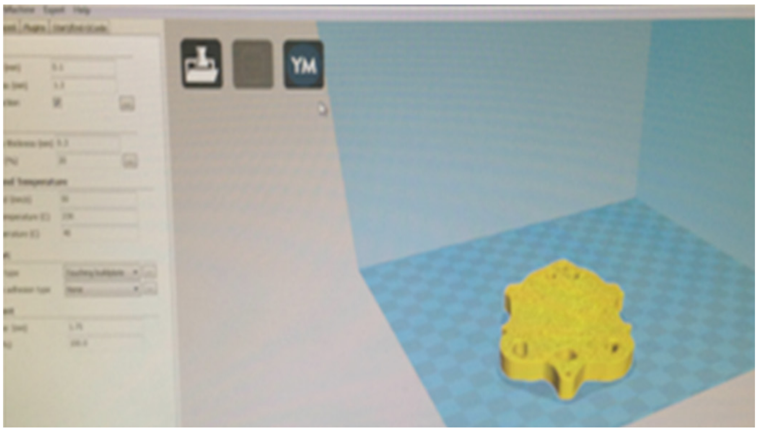


Figure 8. Stl files imported in Cura 14.12 software
Source: Own research

Figure 9. 3D Printed Objects in PLA 3D cartesian printer
Source: Own research

4. CONCLUSION

3D Scanning, modeling and 3D printing nowadays cover a wide range of uses such as in cultural heritage, various fields of industry, art, medicine, architecture, etc. for fabrication, reproduction, preservation, restoration and digitization.

Digital fabrication continues to gain attention moving beyond its traditional uses for prototyping and industrial manufacturing.

The purpose of this study was to obtain the 3D model by means of two scanning methods of the traditional object software modeling, as an efficient method with low cost and accurate reproduction.

The objects modeled in the 3D Zbrush software are as realistic and accurate as the polygon mesh object taken in the Konica Minolta scanner.

Another purpose was to compare ELEGOO SATURN 2 3D printer with a PLA 3D printer to determine the best fit, based on object structure, surface, and details.

In the experiments conducted with the two printers, it was noted that the ELEGOO Saturn 2, printer is more accurate in printing objects with tiny details.

ELEGOO 3D resin printer compared to PLA printer has these advantages and disadvantages:

Advantages:
- High-resolution printing for exceptional detail,
- Fast printing speed for improved efficiency,
- Odor reduction equipment for a pleasant working environment,
- Spacious printing size for larger-scale projects,
- Durable construction for long-lasting performance;

Disadvantages:
- Compared to entry-level 3D printers it has a relatively high initial investment,
- Requires technical knowledge for initial use,
- It has limited compatibility with file formats other than STL, OBJ, and AMF.

PLA (Polylactic acid) 3D Printer has the following advantages and disadvantages:

Advantages:
- Great for Beginners,
- Affordable,
- Environmentally friendly: composition from plant-based sources, making it a sustainable material,
- Biodegradable,
- Inexpensive: One of the cheapest 3D printing filaments,
- No Noxious Fumes;

Disadvantages
- Sensitivity to Heat: low melting point (between 180°C and 230°C),

- Brittle compared to ABS materials,
- Low Impact Resistance,
- Low Chemical Resistance.

With affordable desktops, it is possible to preserve the living traditions of crafts while providing new approaches to their design and production.

Acknowledgment

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