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Research paper

3D Technologies in the Production of Jewelry with Elements of Complicated Design

Kazachkova O. A. *, Zyabneva O. A. *, Mamedova I.Y. *, Kulishova E.A. *

**MIREA - Russian Technological University, Russia*

Abstract

The article analyzes the objects of complicated shapes and technologies of their exact reproduction in jewelry which allow creating elements of complicated design at the stage of creation of master-models. The possibilities of applying 3D technologies are correlated with the sizes of objects that are complicated in design. The technologies allowing to most accurately convey the shape and texture of objects of complex shape - forming on a small-sized object with a complex design, using a ductile metallic mass and using a scanned 3D model of an object of a large shape with a complicated design - are considered in detail.

Keywords:

1. Introduction

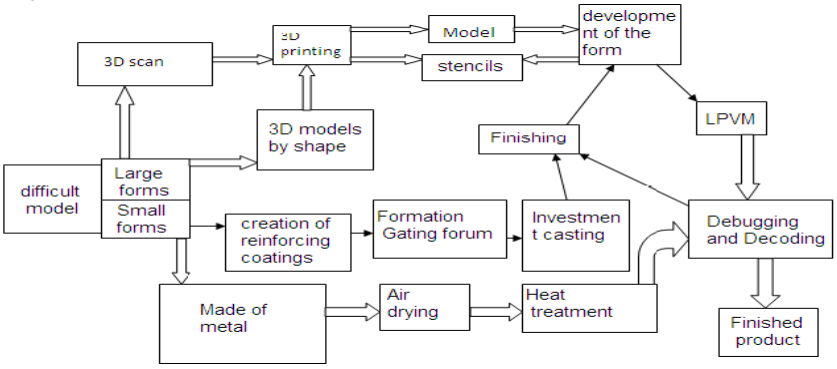
The modern world of jewelry constantly undergoes fundamental changes under the influence of fashion and technological progress. Complicated technologies are adapted for the production of jewelry, and new materials are being developed that simplify the production cycle, improve the quality of products, create new decorative effects.

The traditional scheme of creating jewelry involves the master-model making, taking off the shape, getting stencils, assembling the stencils in the model blocks, making the molds and casting the molds with metal. The use of modern technologies, including 3D technologies, allows to influence the efficiency of production and the quality of products at different stages of the production cycle.

One of the most critical stages on which the aesthetic appearance of the product depends is the stage of creating the master-model. 3D technologies allow you to create accurate master-models for sketching products obtained by creating 3D-models in graphics programs, photo processing or 3D scanning of complicated objects.

2. Technology Analysis

The scheme (Pic. 1) presents the technologies for manufacturing jewelry with complex elements of design using the example of natural objects. [1,3,7,8,9,12,15,16] Natural objects of complex shape in size can be conditionally divided into objects of large and small form. Objects whose dimensions are related to the size of the jewelry, that is, without changing the size can be used as their elements (leaves of bushes, bumps, etc.), refer to objects of small forms. Objects of large shapes, whose dimensions are several times larger than the size of the jewelry product in which they are used (leaves of chestnut, large fruit, etc.), belong to objects of large shapes. [11,13]



Picture 1. Scheme: Technologies for the exact reproduction of objects in the design of jewelry

Precise copies of objects with complicated design can be obtained by casting on burned models, where the model is the object itself (for example, easily burnt out natural objects). The casting method for burned-out models, considered in detail by Khrushcheva [8,9], has a number of drawbacks, among which, among others, are casting defects: cracks of various sizes, pores, small through holes, not spilled thin edges of plants, not spilled parts of plants. [8]

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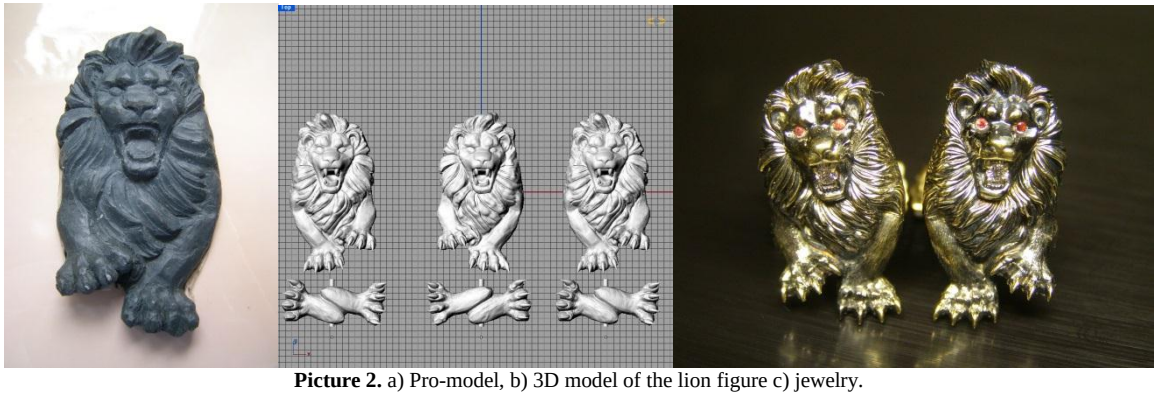
3. Results of the Analysis

3D scanning today allows you to get exact copies of any objects. This technology, as noted in the works by Dobrynina IG, when scanning natural objects has a number of limitations, the main one of which is the need for laborious revision of 3D models in editors (since small parts are not well conveyed). [10] "Information on the shape of the surface of the object is contained in distortions in the shape of the projected image. When scanning a small object (for example, a plant leaf), the resulting 3D model is very complex and contains redundant information about the coordinates with which CAD programs often fail to work correctly. The CAD form of objects, built on the STL data from the scanner, sometimes differs significantly from the actual surface, which is explained by the use of the mathematical approximation, smoothing and simplifying the surface in its construction. " [13] Scanning large-scale natural objects (as prototypes of models) allows you to obtain a more accurate detail of the object. Further reducing the size of the 3D model leads to an increase in its accuracy. Also noted the possibility of fine-tuning the images in CAD-programs. [11,13] The resulting models are printed on 3D printers. This technology allows you to receive accurate copies of large-sized complicated objects. Such objects can be attributed directly to natural objects: large fruits (pineapple, pear), animals, birds, busts of people and so on, and stylized volumetric copies of them, in the form of sculptures and models.

4. Application of Technology

An example of this technology is the production of cufflinks "Lions" (Picture 2). Complicated design required a serious study of the model using 3D programs. In order to simplify the process, the main motif of the "lion" product was molded from sculptured plasticine on a 10: 1 scale. The resulting pro-model was a bas-relief image of a lion. But based on the scanned image of the figure, a 3D model of the cufflink decorative element was created and printed on a 3D printer from the model composition.



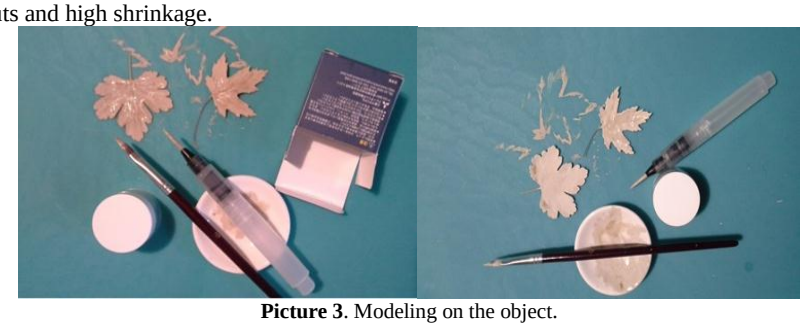
Picture 2. a) Pro-model, b) 3D model of the lion figure c) jewelry.

In the same way, you can create 3D models from photos.

Getting a 3D stamp stencil for master models is one of the inexpensive and cost-effective from an economic point of view. Currently, one of the promising technologies is considered the technology of 3D-printing with metal. For the manufacture of jewelry of complex shapes, 3D printing (on the FDM printer Mini Metal Maker) using metal plastic masses is used by extruding fine yarns from them. With sufficient fluidity for extrusion, the mass is fairly dense, so it retains its shape well as layers are applied. [17] After heat treatment, the printed objects can be bent, polished and drilled, they also have good wear resistance. [2,7,14] The quality of the products obtained by the present method is quite high, since new masses and more accurate printers have been developed, although a few years ago there was excessive surface roughness, poor accuracy of printouts and high shrinkage.

For the manufacture of small-sized jewelry, the technique of molding products from metal plastic mass on the basis of plant materials is widely used, which makes it possible to obtain original jewelry. For the manufacture of the "Gooseberry Leaf Leaf" suspension (Fig. 4) [11] from the silver plastic paste PMC3, produced by Mitsubishi Materials (Japan) [2,5], use a complex object - a leaf of gooseberry with pronounced veins and relief.

Modeling on a complex object is carried out layer by layer (the first layer - apply PMC3 paste, diluted to liquid state, on the entire surface of the object with a clearly expressed texture (Pic. 3); the main layer (Pic. 4) - apply undiluted PMC3 layer by layer to the thickness of the blank 1 mm), drying in air until complete drying, roasting, finishing and decorating. "[3,7,11,13]



Picture 3. Modeling on the object.

Before heat treatment, when the workpiece is still in the plastic state, it can be machined. To obtain a complex design, the workpieces can be glued together with each other by a diluted mass, fixing hardware, stones (whose properties do not change when exposed to high temperatures). [3,13,14]

The method of manufacturing products from plastic metal masses also makes it possible to use the finished product as a master model, for the subsequent removal of the rubber mold, the production of stencils by stamping, and replicating by investment casting.).



Picture 4. Finished products: pendant "Leaf of gooseberries", weight 3.79 g (a) and suspension "Maple leaf", weight 3.16 g (b) (works Kulishova E. A.)

This technology also can be used to make jewelry on large-sized objects of complex shapes. In this case, the metallic plastic mass is applied to the obtained stencils - mini copies of large-sized objects of complex shapes.

5. Conclusion

So, the industrial production of jewelry expands the possibility of manufacturing products with complex reliefs, natural structural surfaces. The relief created by nature and surface structure is very difficult to replicate, therefore, there are almost no jewelry pieces with unlisted floral elements designed using 3D programs.

The considered 3D technologies of manufacturing jewelry for objects of complex shape allow using in the design of jewelry items that are exact copies of objects of complex shape (in the case of large-sized objects - reduced copies). Currently, these technologies depend on the quality of the materials used, the accuracy of scanning objects and the quality of the surface obtained during printing. Currently, these technologies depend on the quality of the materials used, the accuracy of scanning objects and the quality of the surface obtained during printing.

With the development of new technologies, there are new opportunities for obtaining jewelry products that accurately repeat natural shapes and surface relief. 3D scanning technology and 3D printing are constantly being improved, which in the future will reduce the errors of the STL-model and improve the accuracy of printouts of 3D models. Manufacturers are also working to improve the composition of ductile metal masses, waxes, and to reduce the percentage shrinkage of materials during the solidification process.

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