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## ALTERNATIVE METHODS OF THE ARTIFICIAL FISH LURES MANUFACTURING – CASE STUDY

**Abstract:** In this paper alternative methods of the artificial lures manufacturing are presented. Proposed approach is based on application of various contemporary techniques it is reverse engineering rapid prototyping and manufacturing and middle-end CAD modeler. It is proposed to use reverse engineering not only for gathering of existing parts 3D geometry but also for acquiring it just from fish. Moreover if there is a possibility to gather information about fish skin texture, with high end 3D scanners, the real-looking fishing lures would be produced. These scanned models are usually sufficiently good for production with rapid prototyping apparatus. In order to meet a client needs application of the middle-end CAD modeler – Inventor is proposed. It allows modeling a product geometry which is well matched to a client needs and requirements. Finally vacuum casting rapid manufacturing method for a small batch production of soft fishing lures is suggested. This paper gives an application example of each above mentioned methods.

### 1. Introduction

Currently there are the two basic manufacturing techniques used in a mass production of artificial lures. The first is a highly developed technique of the injection moulding of the polymers materials used in case of manufacturing of soft baits lures (see the figure 1). The second most popular manufacturing technique is stamping used for manufacturing of the artificial lures such as inline spinner baits and spoon lures (see the figure 3). The last considered in the paper type of hard-bodied fishing lures is wobbler. It can have a solid or hollow body made out of a light weight material such as plastic or balsa. In some designs a wobbler body is separated into two pieces joined by a small flexible link to improve the impression of a fish whipping its tail fin. Wobbler is manufactured, depending on type of the raw material, with combination of removal and gluing techniques.

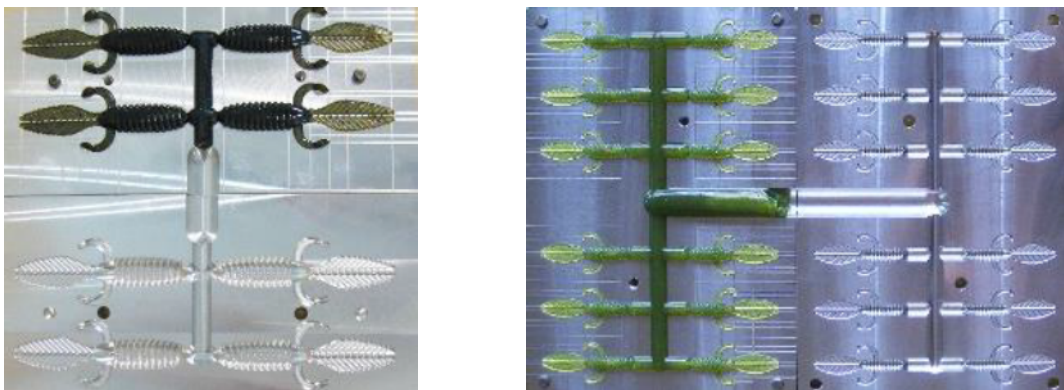
Injection moulding is generally used for manufacturing of soft bait lures such as rippers and twister tail fishing lures. The manufacturing process is being realised cyclically with injection moulding machine. During the injection process the raw material it is granulated or powder material is heated to required temperature and next extruded into an injection mould.

The most expensive part of the injection moulding machine is a mould mostly because of high mould raw materials cost and need of mould manufacturing with CNC controlled machine.



*Fig. 1. Exemplary soft artificial lures*

The input product of the injection moulding process is a moulded piece which is additionally treated by removing flashes and runners [4].



*Fig. 2. Aluminium injection moulds used for a cavity moulding of the soft lures [9]*

As it has been previously mentioned the second group of the fishing lures consists of inline spinner baits and spoon lures. The characteristic feature of this kind of baits is that the main part of each, it is a spoon or blade respectively, is made of steel brass or copper shaped by stamping. This process is being carried out in the three steps as follows (see the figure 3).



*Fig. 3. Stages of the spoon lures manufacturing process [9]*

In the first stage a press presses down a sheet brass to a die block in order to make a company trade-mark and drawing: size, a slot in the middle and a hole in the lower part of the

spoon lure. During the second stage the spoon outer contour is marked out, in the third stage of the manufacturing process the desired shape is obtained by cutting. The manufacturing cost in case of stamping is relatively low in comparison to other manufacturing methods [1, 4].

## 2. Alternative method of the artificial fishing lures manufacturing

In the proposed solution the alternative method of the artificial fishing lures manufacturing is based on application of the following contemporary techniques such as inverse engineering, rapid prototyping and vacuum casting [2, 3, 4, 7, 8, 11]. The reverse engineering process was used for gathering geometrical information. Reverse engineering process was carried out with application of the non-contact scanning method. As a subject of the scanning process a wobbler made of balsa was chosen (fig. 4). The process was performed with SMARTTECH 3D dual volume scanner.



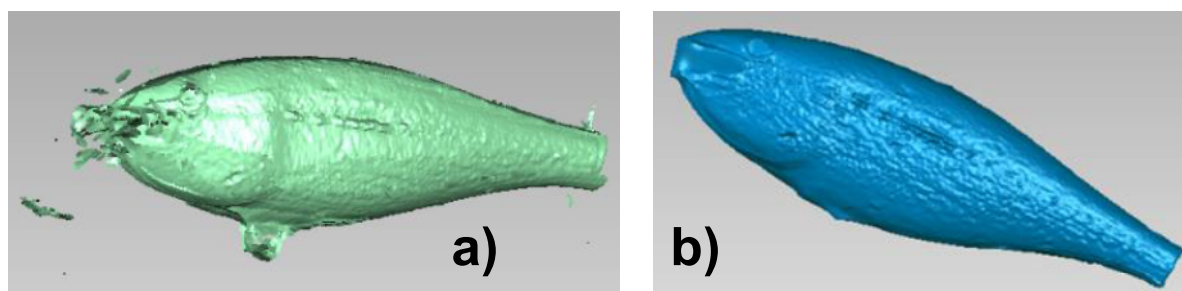
Fig. 4. The wobbler model [11]

For the scanning process purpose from the wobbler model treble hooks and rings were removed. During the scanning process the wobbler model was scanned from the 8 directions, it is the front, back, left and right sides of the model and the four model diagonals.



Fig. 5. The scanning process of the wobbler model, a) the wobbler model fixed in the handle, b) the appearance of the wobbler model in 3D Mesh software

As a result the 8 points' clouds were obtained. These points' clouds were next processed with 3D Mesh and Geomagic Studio respectively. During the post processing the following imperfections such as noise, handle elements and random objects from clouds' points were removed. After completing the post processing stage the 3D CAD model of the scanned product was automatically prepared in Geomagic Studio (see the fig. 6).



*Fig. 6. The scanning process of the wobbler model, a) the appearance of the wobbler model after joining points' clouds together, b) the appearance of the wobbler 3D CAD model [10]*

The wobbler CAD model was next sent to the NX 8.5 Siemens environment in order to prepare its STL model.

Having this model prepared it was possible to set about choosing the manufacturing technique. In the considered case selection of the manufacturing methods was limited, according to laboratory potential to the two; it is fused deposition modelling and 3D printing. Finally fused deposition modelling process was selected taking into account material characteristic of models manufactured with it. The wobbler model was made with Stratasys FDM 360 MC machine. The final product in the picture 7 is shown.



*Fig. 7. The wobbler model made with fused deposition modelling on FDM 360 MC machine [10]*

Taking into account the model surface quality it is appearance of staircase effect characteristic for RP manufactured parts it was necessary to apply additional finishing treatment [4, 5]. There are several methods of fused deposition modelling manufactured parts finishing but the most often used are abrasive machining and chemical treatment with acetone. The choice of treatment method is determined by the final product surface requirements.

In case when the part surface should be smooth it is recommended to apply acetone bath (acetone liquid bath or acetone fumes bath). If a product surface painting is needed then abrasive machining and primer painting ought to be applied. Taking into consideration above in presented case the second treatment method was chosen.

## 2.1. Application of a CAD modeler in custom fit fishing lures and vacuum casting

In the presented work Inventor CAD modeler was applied for modelling of custom fit fishing lures which are the best fitted to a client needs and requirements as it is only possible. During research the following models were made (see the figure 8): a twister and rippers. These models were next transformed into STL files and manufactured with FDM 360 MC apparatus.

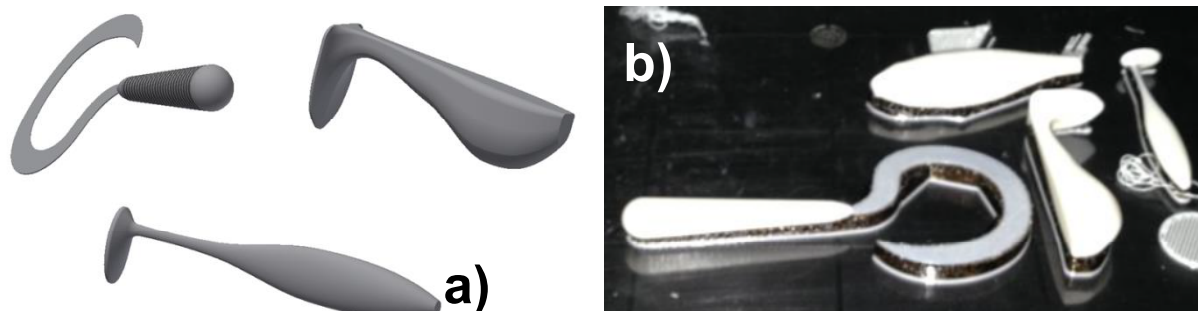


Fig. 8. The fishing lures CAD models (a), models manufactured with fused deposition modelling technique on the FDM 360 MC apparatus (b) [10]

Having fishing lures models manufactured (used next as master models) it was possible to set about choosing a small batch production method. There several rapid manufacturing methods for instance HSM machining, HSC cutting or casting. It was decided to apply vacuum casting method. Manufacturing process was carried out in the following steps: a moulding box preparation, supporting scaffold design, gating system and degassing system design, silicone mould fabrication, silicone mould cutting, mould heating, mould casting (see the figure 9).

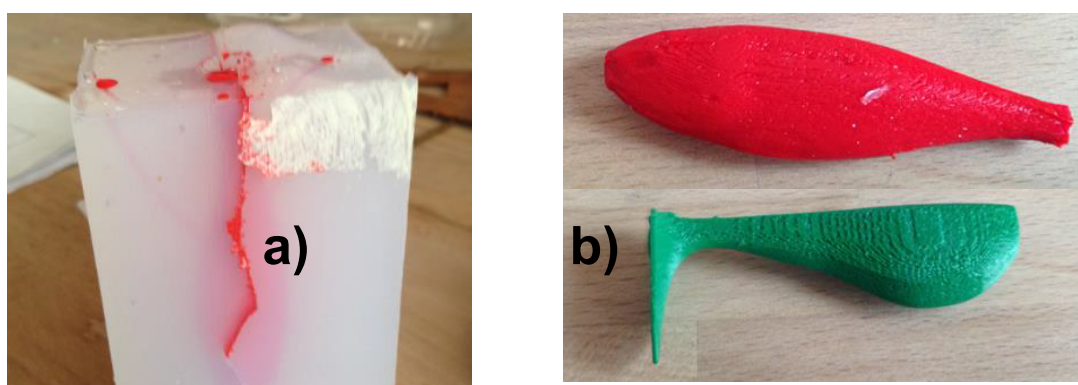


Fig. 9. The silicone mould with the casted part (a), final casted parts (b) [10]

## 3. Conclusion

Basis on the conducted research the following conclusions were drawn. Proposed alternative methods of artificial fishing lures manufacturing appeared to be time and labour-consuming because of the great number of manual work. It means that they are not the best choice in case of mass or series production but good in small batch production or custom fit

production. Vacuum casting methods is especially sensitive to correct selection of the following process parameters: components ratio, pigments amount, process' temperatures such as soaking heat and fluidization temperature, overall processing time. Moreover this method allows making parts with dimensions limited to the size of the working chamber. In case of casting of small and precise parts there is a danger of appearing of the final model geometry imperfections. Silicone moulds in vacuum casting technology have a limited life-span so the number of parts that can be casted with a particular mould equals to maximum dozens. In series or mass production it is suggested to use an alternative technology such as pressure die casting or injection moulding. Reverse engineering process is expensive mostly because of the high application cost of FDM. However it allows getting a product CAD model from the real object fast and makes the process of a design reconstruction relatively easy. Proposed in the paper approach can be used in prototyping, model verification and small or batch production.

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