QUICK PROTOTYPING METHODS

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Abstract: the present work is meant to introduce the "door handle" prototyping modern method by using a 3D-printer quick prototyping method

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1. INTRODUCTION

The technologies for quick production of prototypes are the result of intense research and progress in various domains: from fine mechanics to numerical commands, from laser technologies to tri-dimensional geometric modelling programming suites, from computers to science of materials. At the beginning of years '90, these determined the appearance of a new type of technologies, known in literature and industrial practice as *Rapid Prototyping* (RP).

Briefly, the required products can be obtained by three types of technology:

1) **working technologies by material removal,** which start from a greater quantity of raw material and cut away the excess by means of conventional or nonconventional methods;
2) **working technologies by material redistribution,** which start from the correct quantity of raw material and adequately redistribute it into the required shape by deformation in solid state deformation (forging, stamping, drawing etc) or liquid/semi-liquid state (casting, injection etc);
3) **quick prototype fabrication technologies,** which make the part by adding material in adequate quantities and in adequate places.

These new technologies, named as "*Rapid Prototyping*", became more and more important because of the producers' requirements for shortening of the time from conception to marketing, and for lowering of the costs for new products assimilation and fabrication.

It is very important to have very good and complete information, in order to take right decisions as early as possible when a new product is developing. The decision depends directly on the information level and quality. Fig.1 shows the differences between the classical development of a product and the one that uses RP technologies.

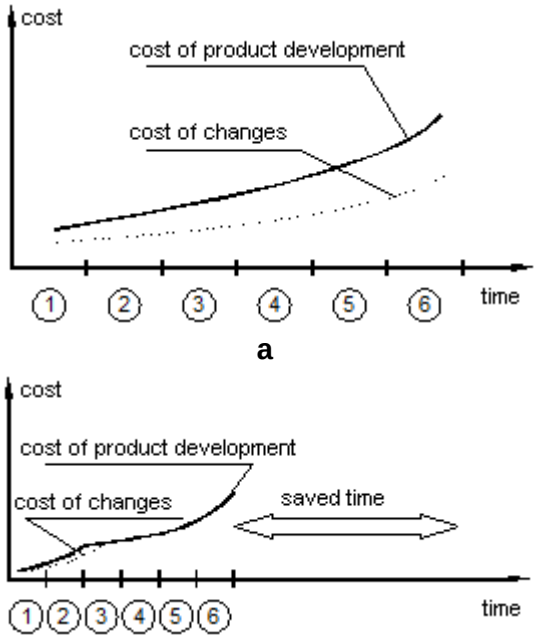

Fig.1. Comparison between the classic development of a product (a) and use of RP technologies (b); 1 – idea, 2 – conception, 3 – finishing, 4 – elaboration of documentation, 5 – realization of verification tools and devices, 6 – production.

By selective laser sintering (SLS) of plastic mass powders, prototypes of products can be easily obtained, which replicate the original only geometrically, but not its nature. Because of this reason, because larger series of prototype products are required or because the quality system allows testing only on the real material, new technologies have been developed, which allow the elaboration of prototypes by SLS on metal powders. The

active parts of thermoplastic materials injection moulds can be obtained directly by means of this new technology. Tab.1 shows a comparison between the classical method and the metal powder SLS method of thermoplastic materials injection mould construction.

Tab.1. Comparison between classical method and SLS.

Classical execution of moulds	*SLS execution of moulds*
Over 80 years of evolution	Under 15 years of commercial use
Each operation requires specialized machines (milling, EDM working, rectifying etc.)	All operations are made in one step.
Each operation requires highly-qualified operators	Automatic production, without operators, which exclude the human errors
Tools are required and used in every execution step.	No tools are necessary
All operations are executed sequentially on one element	Single operation
Every element is produced separately	All elements are produced in a single step
Complex logistic organizing	Simple organizing
Special control operations during execution process	An accurate replica of the virtual 3D geometrical model is made
Long execution time	Extremely rapid execution

Lately, the plastic powder 3D printing has become more and more popular, because the 3D printers are smaller and easier to use. The 3D quick prototyping systems represent a revolutionary solution by means of which three-dimensional physical objects or models of the designed objects may be performed starting directly from the CAD electronic format.

Special additives dust prototyping technology using the 3D colour Zprinter 450 shall be used.

The present work introduces the "door handle" prototyping modern method by using a 3D-printer.

A first stage shall consist of the CAD performance of the item construction drawing.

Once constructed, it shall be saved with an extension compatible with the 3D-printer soft. The image shall be opened afterwards by means of such soft, ZPrint. This soft allows the item construction simulation. In the image below, the item to be constructed may be observed, as well as the its placing manner in the printer box.

2. WORKING WITH 3D PRINTER

The working space is divided in three windows, two of them providing a 2D view on the X-Y co-ordinates, Z-X, respectively, and the third a three-dimensional image of the designed object. Each of the three windows is interconnected with the other two, so that regardless of the modification made in one of them, it shall appear in the other two as well.

The first step consists in importing the file from the CAD used. In this case, the drawing of the item to be executed, which was performed in AutoCAD, was imported. Once we have opened the drawing in ZPrint we may place the product in the position envisaged. If by any chance, we exceed the borders of the working space we shall be warned by a message. The increase or the decrease of the model in order to fit within the dimensions envisaged shall be made by means of SCALE function, which allows us to set the size of a parameter both in metric system and in inch.

The system checks whether the printer is connected to the computer and whether we have sufficient material as to successfully complete the work. If the model is prepared for print, we may use the Print preview option in order to obtain estimation of the materials used and of the period for the completion of the model.

The advantages of the ZPrint soft:

- it is able to capture the drawings performed in most CAD programmes (Autocad, Katia,etc)
- it allows the arrangement of the product in the printer box in the positions we desire, so that a material economy is achieved.
- it calculates the material consumption so that an estimate of the prototype price can be established
- it calculates the item performance time and the item cooling time

After that, the soft transfers this information to the 3D-printer that commences to process the product layer by layer, upwards, keeping us informed regarding the printing evolution.

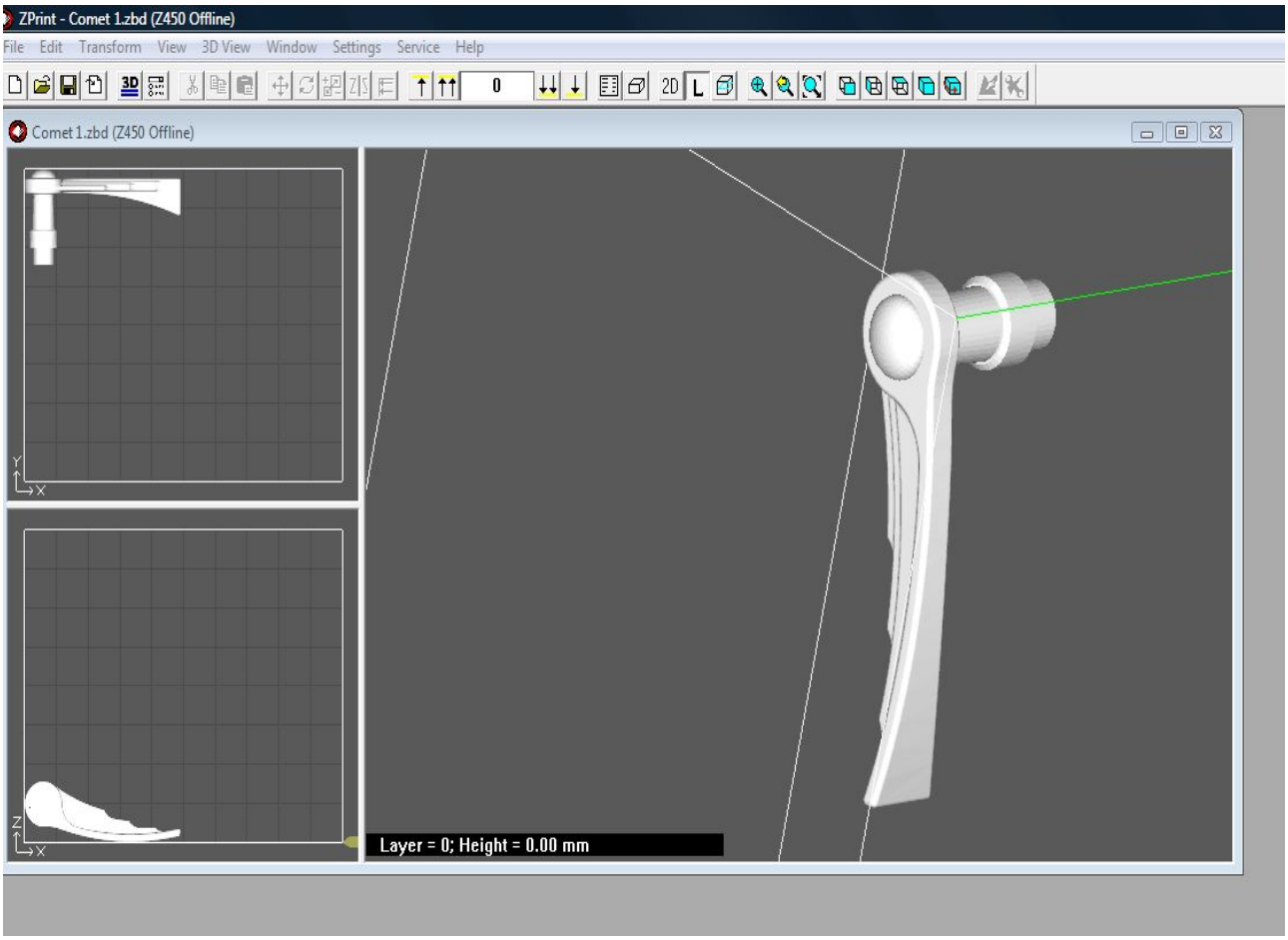

Fig.2. CAD project of the "door handle" product.

Fig.3. Plastic prototype of product, made by 3D printing.

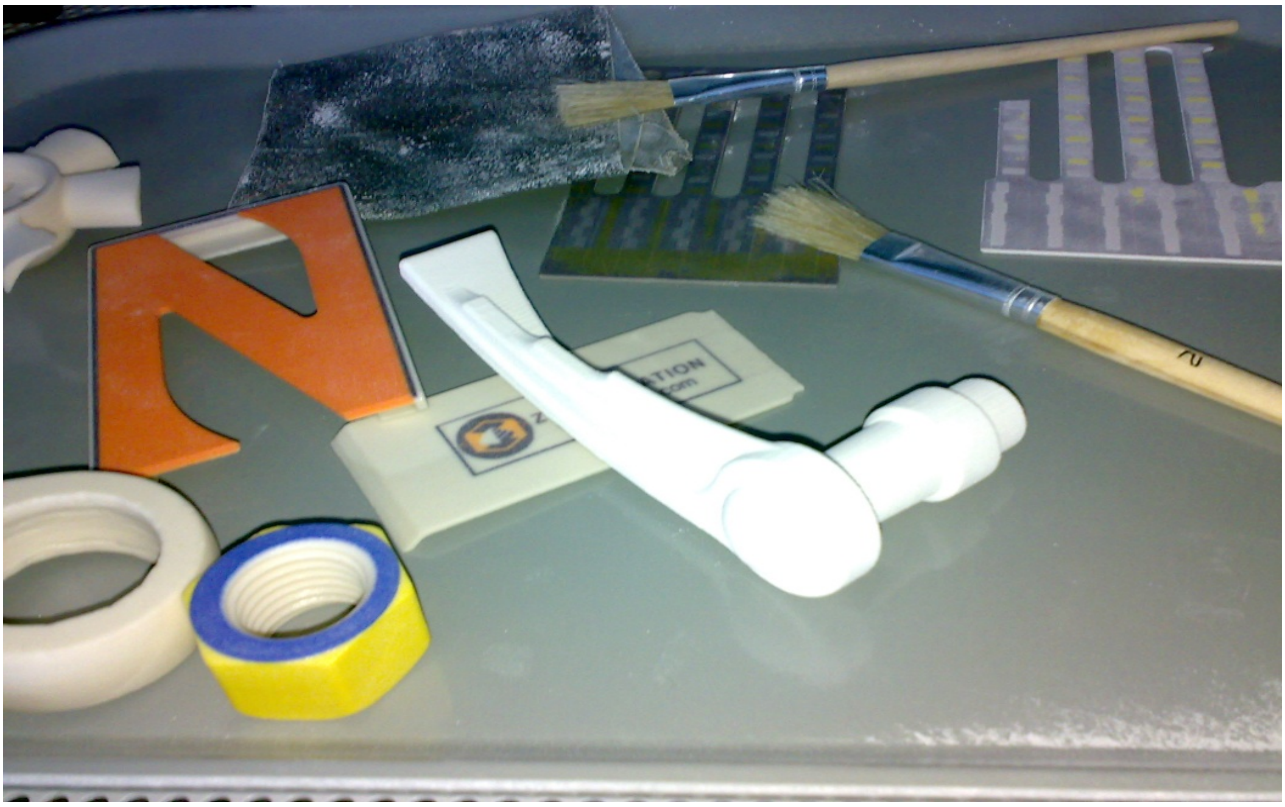

Fig.4. Plastic prototype of designed product, along with other Rapid-Prototyped products.

Once the item is completed it is dried at the temperature and the time calculated. The dried item shall be treated with a resin or a varnish in order to enhance its hardness. The advantages of this processing method:

- ✓ the geometry of the product can be easily modified
- ✓ the prototype is completed in a very short period of time (8 hours and 12 minutes) as compared to the other prototyping methods.
- ✓ the cost for the performance of the prototype is much smaller (60 Euro)

3. CONCLUSIONS

In conclusion, by using quick prototyping technologies, we may rapidly create the designed prototype., we may easily view the product envisaged, we may identify the form, the functionality and implicit the concept or design errors, in the sense of their correction for a quick product market launch.

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[2] Ivan N.V., *Sisteme CAD/CAPP/CAM*, Editura Tehnică, București 2004;
[3] *** Zprint