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3D Printer- Manufacturing of Complex Geometry Elements

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Abstract. In the last 5-10 years the process of 3D printing has an incredible advanced in all the fields with a tremendous number of applications. Plastic materials exhibit highly beneficial mechanical properties while delivering complex designs impossible to achieve using conventional manufacturing. In this article the printing process (filling degree, time, complications and details finesse) of few plastic elements with complicated geometry and fine details was analyzed and comment. 3D printing offers many of the thermoplastics and industrial materials found in conventional manufacturing. The advantages and disadvantages of 3D printing for plastic parts are discussed. Time of production for an element with complex geometry, from the design to final cut, was evaluated.

1. Introduction

Learning-reading devices that are currently on the market are rather difficult to be manipulate, do not allow the word to be correlated with a visual representation of the graphic representation of the word, and there is also the possibility of making misspelled words by wrong choice of letters, or the combination of letters is difficult for pre-school and unattractive children [1]. The technical problem solved by the patent [2, 3] consists in bringing together, in a single apparatus, both the function of viewing a letter, a word, and the graphical representation of the meaning of the word being formed, and the possibility of writing letters on a built-in tablet. With this device, the visual perception of the letter or word image is correlated with the auditory perception of the phonemes. On the basis of an invention patent [2, 4, 5] it has been proposed to provide a read-write device made up of plastic elements. In order to establish the main dimensions of the component elements for the market implementation of this product, the 3D printer was used for the design and physical realization of the component elements.

3D printing or additive manufacturing is a process of manufacturing three-dimensional solids by adding layer by layer. Physical objects are produced using the data of a digital model, a 3D model or other sources such as an additive manufacturing file (AMF) [6]. By using 3D printing, you can create products in almost any form. Several technologies and materials for 3D printing are currently being used. Recently, 3D printing equipment is available for both industrial and household users [7]. 3D printing allows the creation of complex structures and parts that cannot be produced by conventional production methods. Easy complex geometries can be created, providing great freedom in design [8-

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10]. Complex models can be 3D printed as a single piece, eliminating the need to assemble component parts. 3D printing makes it very easy to customize at no additional cost. If it is necessary to change the design of an object, only the digital file needs to be modified without the need for expensive production processes or tools and additional devices [11].

The prototype of this device was made using a 3D printer to determine the optimal functional features. This article briefly presents the steps of making an element, a button with a grip and motion role in the final shape from the concept to the actual object using the 3D printing technique.

2. Materials and methods

For printing the plastic parts was used a Smart Rap 3D Printer. As active wire we use PLA - Verbatim (thermoplastic), 1.75 mm diameter. PLA is appreciated as the most important of all bio based polyesters at this moment. PLA it is made from sugar (sugar beets, sugarcanes, corn). Through fermentation, with the help of micro-organisms, lactic acid is produced. This is a highly efficient process. From a sugar molecule, two molecules of lactic acid are produced, without any residual products. Work temperature is 200-230 ˚C. The printing rate (wire alimentation) was of 2.5 mm/s. Beside the work temperature we have a table work temperature of 70 ˚C. The nozzle diameter was of 0.4 mm. The entire line to obtain a plastic product summarize: 3D design, 2D drawing, 3D printer program, printing process and element cleaning (post-processing) if necessary. The design plastic part is a roll with the purpose of moving a band of draws with specific dimensions and a gripping system.

3. Results and discussions

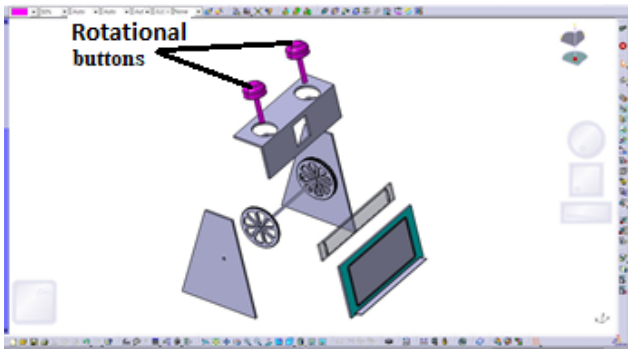
The results present the obtaining of a final product, a rotational button, made from the design idea to the actual product using 3D printer. The design part was realized using Catia software. The button is presented in Figure 1 a) as a part of the entire equipment proposed for the read-write learning stage. The advantages of this device are: the upper part of the device allows you to place the attention on the illuminated image, the visual perception of the image and the word, in connection with its name; the auditory perception of phoneme, together with the visual perception of the corresponding letters; the choice of letters to form syllables and word words; easy and attractive handling for children; allows users to create mobile, flexible and creative thinking; determine the formation and development of an active lexical stock [12, 13]. The device is designed for the writing-reading learning phase, used by both preschool children and those with speech deficiency.

The first step in the additive manufacturing process is the realization of the digital model. For this, Computer Aided Design (CAD) is used [14]. Reverse engineering can be used to generate a digital model through 3D scanning. After the design of the button the 2D draw was realized at real quotas using AutoCad software, Figure 1 b). Based on the 2D draw using 3D printer we realize the buttons using PLA filament.

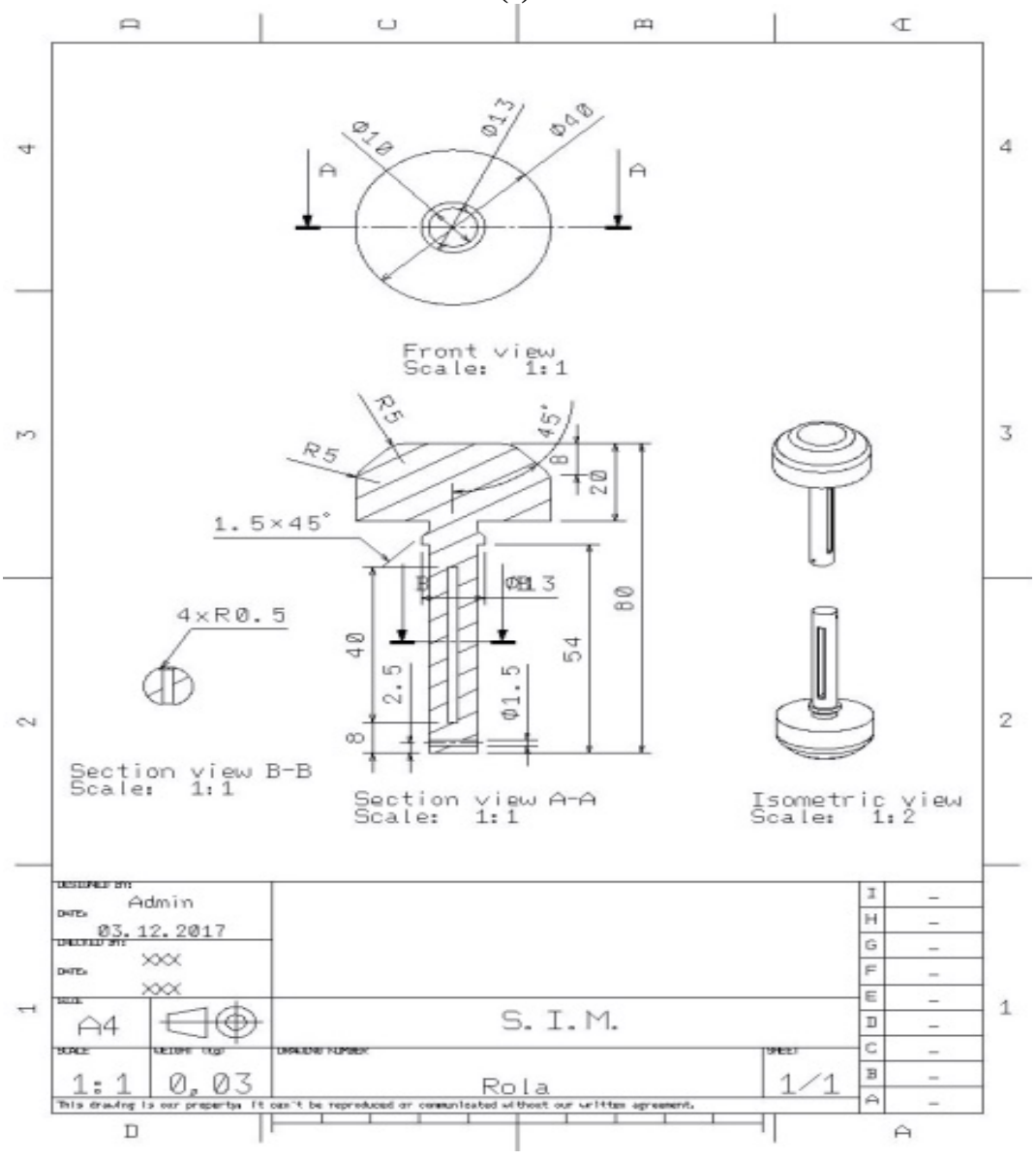
In Figure 2 are present print screens of the Pronterface program interface (which controls the SmartRap + 3D printer) and the possibility of editing a Gcode program directly from Pronterface in a) and b) and the Cura program that makes slicing and generates the Gcode program of the printer [15, 16]. The most important parameters are visible in the left panel in (c). The elements made with 3D printer are build layer by layer. This making process present many advantages like the element density (the filling degree), useful to obtain very light pieces or very resistant pieces.

The 3D printing process is largely automatic. Depending on the size of the object, materials, and printer, the procedure may take from a few hours to a few days. It must be checked, from time to time, that there are no errors.

Many geometrical complex parts can be realized layer by layer reaching by one operation an 95% percentage of the final element. All programs used for 3D printing are open source. The 3D printing parameters are presented in Table 1. The time to obtain an element is 3 hours without using any additional elements that will increase the production costs. The filling degree was of 20% fact that will give the element a sufficient integrity and also a reduce mass [17].



(a)



(b)

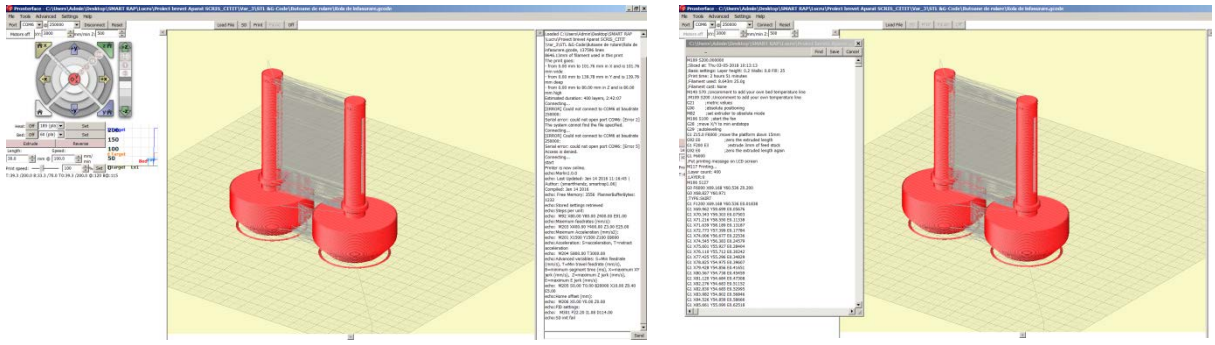
Figure 1. Design of the equipment (a) component parts including the rotational buttons and (b) 2D draw of the superior rotational button.

Table 1. Button printing parameters.

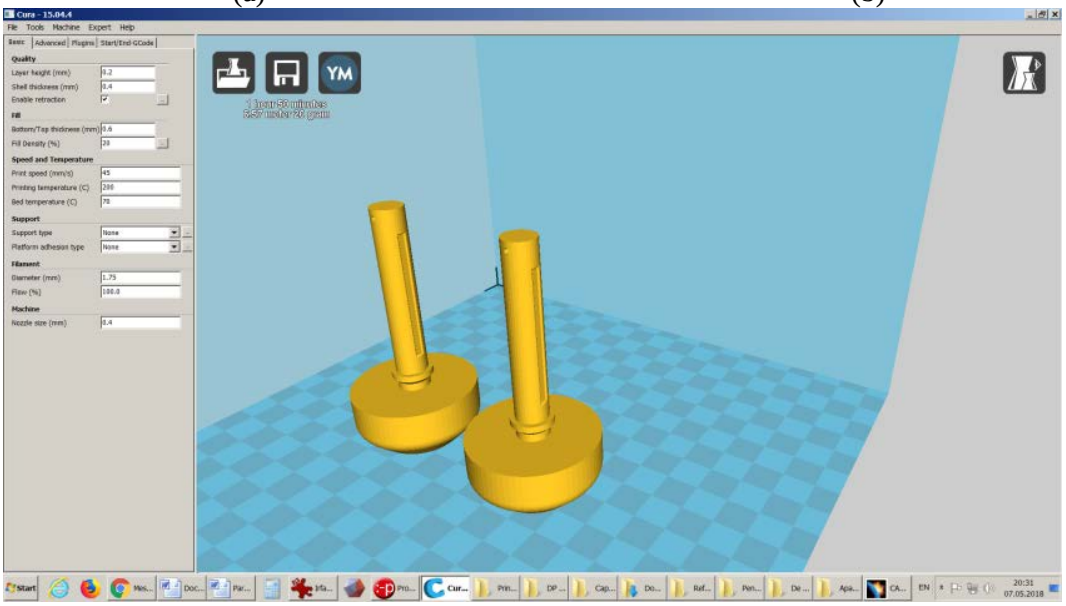
Element	pieces	Time/piece [h]	Layer [mm]	Shell [mm]	Bottom [mm]	Infill [%]	Support [tip]	Adhesion [tip]
Rotational button	2	3	0.2	0.4	0.6	20	none	none

The element is build layer by layer, each of 200 µm thick, until the element is done. In Figure 3 the final button is presented. For round parts we need for an additional stage for finishing the surface. Final product processing can include manual or compressed air cleaning, polishing, colouring and other actions that prepare the product for final use. In most cases, in 3D non-industrial printing, removing the printed object is easy - separating the piece printed on the print table, Figure 2 (a).

In the last step the equipment is ready for printing. The process requires the proper setting and control of the 3D printer, workbench cleaning and raw material loading. A routine check of all the main print settings and control panel is also required. When the machine is ready, the 3D print file can be loaded.



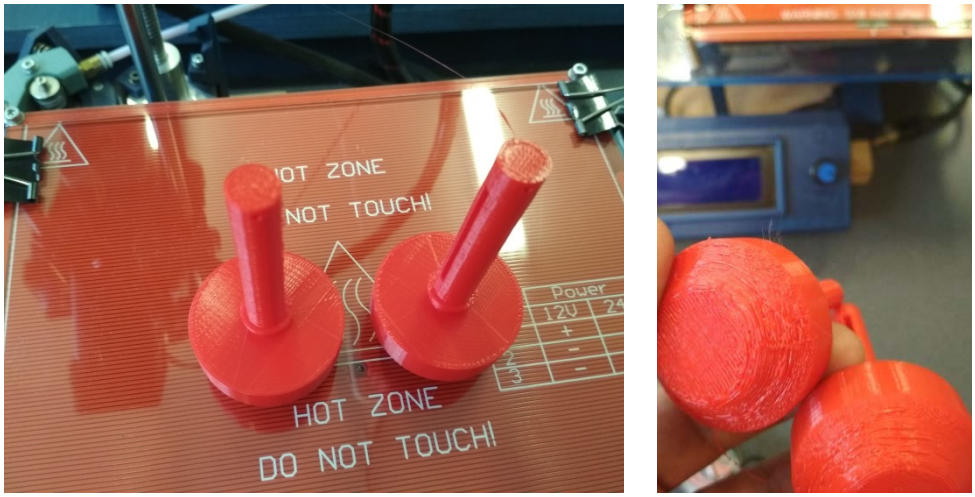
(a) (b)



(c)

Figure 2. (a) the Pronterface program interface (which controls the SmartRap + 3D printer) and the possibility of editing a Gcode program directly from Pronterface; (b) the Cura program that makes slicing and generates the Gcode program of the printer; (c) the most important parameters are visible in the left pane.

3D printing or layer-by-layer deposition is a process of making a three-dimensional object of any form digitally designed. The 3D object is accomplished by an additive process in which successive layers of material are deposited in different shapes. The difference between the 3D printing technique and the traditional method of making objects is that instead of eliminating the excess material, the material is deposited in the desired shape from the beginning without a special need for further processing.



(a) (b)

Figure 3. Button final product (a) two pieces and (b) the need for finishing the final surface of round parts.

4. Conclusions

Because models and parts can be produced in a short time, 3D printing is used to check and develop design ideas. It is cheaper to produce a 3D prototype than to recreate an existing one if needed. As a result, 3D printing is good for those who want to give life to a product idea, because marketing is faster and at lower risk. 3D printing can also reduce the risk of dangers associated with certain manual prototyping procedures. We use 3D printing to obtain plastic pieces with complicated geometries. The printing parameters present a 3 hours' time process with a very good final result concerning the accuracy of the details. Mechanical resistance versus the weight of the element can be choose by modifying the filling degree of the element between 5% to 100%. Round surfaces present areas that necessity a post printing processing.

5. References

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