SOME ASPECTS REGARDING 3D PRINTING
OF DENTAL PROSTHESIS

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Abstract: *This paper presents how to import STL models, simulate the models before they are printed and print them. Depending on the choice of printing parameters, the quality of the parts surfaces is obtained. The material used to print the models is PLA, and they were printed on an Anycubic i3 Mega printer.The printed models have only a didactic and theoretical role.*

Keywords: 3D printing, STL file, dentures

1. Introduction

Rapid Prototyping (RP) is the rapid manufacture of a part, model or physical assembly using a CAD (3D Computer Aided) design. The creation of the part, model or assembly is usually analyzed using additive manufacturing or more commonly known as 3D printing. To be able to create a prototype in terms of making dental prostheses, rapid prototyping combines the knowledge of three specialists: a dentist, a dental technician and a design engineer. Also, special CAD, CAM programs and a 3D printer are required. The part prototype can be used as a concept model for visualization and analysis [1], [2], [3] and [4].

These papers specify that "Model" is a term often used in rapid prototyping technologies. The model represents what the manufacturer wants to achieve when using rapid prototyping technologies. A prototype allows designers to perform some functional tests and modifications. Models prototype reduces design costs, mass product release time based on early stage detection of possible mistakes, widens the dialogue between designers and technicians and dentists, reduces product time to market if we refer to industry products. There is a wide spectrum of materials for prototyping on the market, depending on the field of use of the final product, materials that differ according to: the quality of the formed surface, the level of precision, the field of use, etc.

Depending on the process, basic materials such as: polystyrene, thermoplastic, polycarbonate, nylon, ABS, synthetic resins, paper are used in rapid prototyping [5].

In this paper presents the import of 3D models, of STL type, the simulation of printing and the realization of the printing of these models [6].

The models were also studied in papers [7] and [8], in these papers the method of obtaining the quality of the surfaces of the printed parts was also analyzed according to the selected printing parameters.

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2. Importing stl models and simulating models

After entering the parameters in each settings window, we will import the STL model, position it on the 3 axes X/Y/Z to set the reference (fig.1), set the scale 1:1 (fig.2) and check the positioning on the axes of rotation so that the model is correctly placed on the plane.

After positioning we perform a simulation to see the duration of the part's execution (the simulation time is quite long, in our case it was 1 hour 41 minutes) and we see the amount of material used in this way correctly determining the cost of material used. The amount of material used for the model under study was 7 grams or, if we refer to the length of the filament, 2.49m of filament.
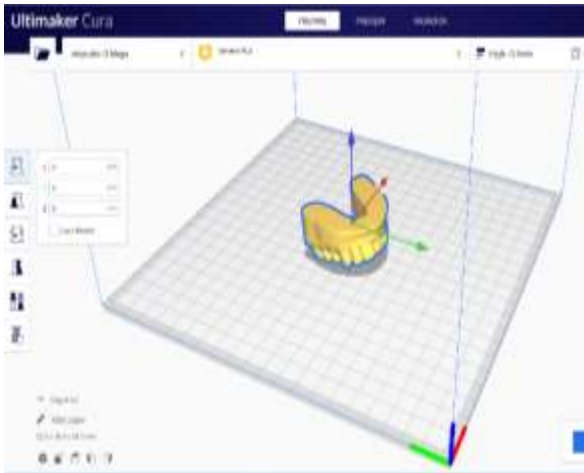

Fig. 1. Positioning the model on the reference axes, reference three-dimensional system
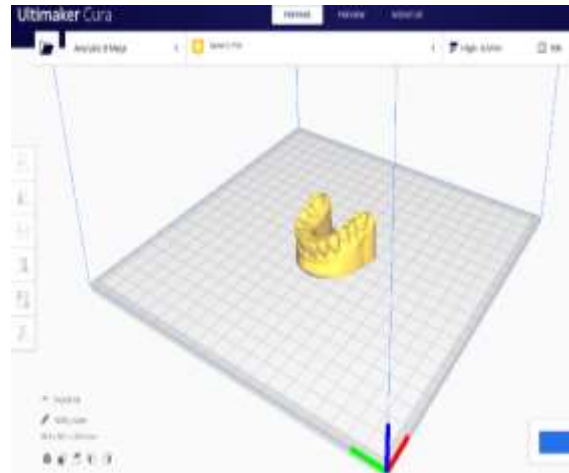

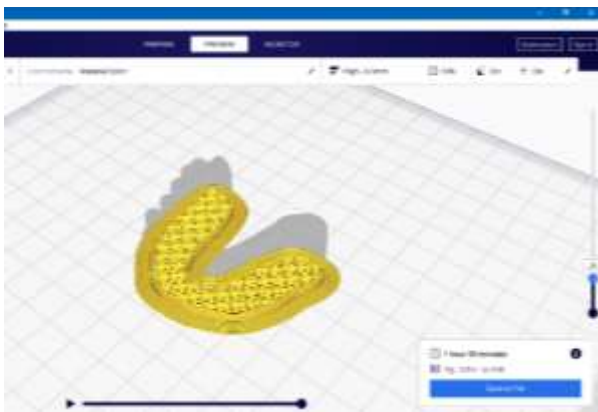Fig.2. Repositioning the model on the axes, three-dimensional system

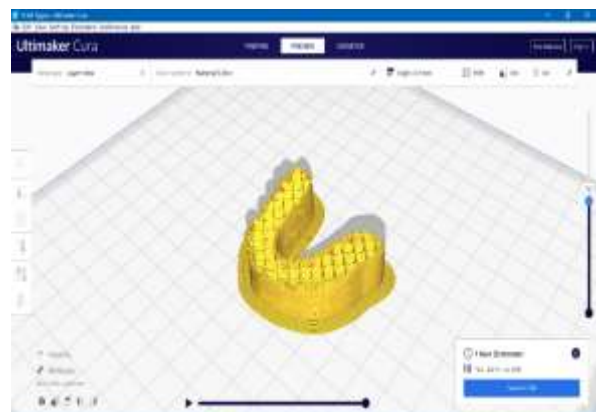Fig. 3. Z-axis simulation after depositing only a few layers

Fig. 4. Z-axis simulation after multiple layers are deposited

Also in this simulation we can section the part on the 3 axes, the most important one, in our case it was the simulation on the Z axis to check the defects that could appear during the printing process. This simulation is shown in Figures 3, 4 and 5.

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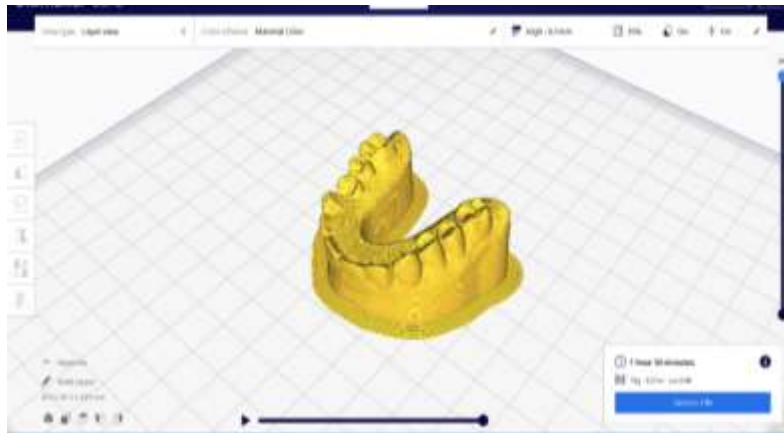*Editura "Academica Brâncuşi" , Târgu Jiu, ISSN 1844 – 640X*

Fig. 5. End of model simulation.

3. Exporting programs and initializing printing

The programs are copied to the memory card (fig. 6), the place of connection between the computer and the machine. The content of the program can be viewed using a text editor, we have a part of the program below as an example, the other programs are attached in annexes 1, 2 and 3.

Fig. 6. The connection between the computer and the printer

Schedules cannot be attached to the paper because they run on thousands of pages. We will attach to the paper only the first and last pages of the appendices:

```
;FLAVOR:Marlin
;TIME:6082
;Filament used: 2.49193m
;Layer height: 0.1
;MINX:76.05
;MINY:78.615
;MINZ:0.1
;MAXX:133.949
;MAXY:130.792
;MAXZ:17.8
;Generated with Cura_SteamEngine 4.7.1
```

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M140 S60
M105
M190 S60
M104 S200
M105
M109 S200
M82 ;absolute extrusion mode
G21 ;metric values
G90 ;absolute positioning
M82 ;set extruder to absolute mode
M107 ;start with the fan off
G28 X0 Y0 ;move X/Y to min endstops
G28 Z0 ;move Z to min endstops
G1 Z15.0 F50 ;move the platform down 15mm
G92 E0 ;zero the extruded length
G1 F200 E3 ;extrude 3mm of feed stock
G92 E0 ;zero the extruded length again
G1 F50
G0 Y20 F50
M117 Printing...…………………………
G5
G92 E0
G92 E0
G1 F2400 E-8
;LAYER_COUNT:179
;LAYER:0
M106 S255
M204 S3000
M205 X10 Y10
G1 F600 Z0.175
G0 F1500 X89.672 Y83.844 Z0.175
M204 S1800
M205 X8.
```

We insert the memory card into the slot intended for it to load the programs.

When starting the printer, Anycubic i3 Mega printer, we have the temperature of the head and the temperature of the print bed displayed on the screen at the top of the screen, in the middle we access the TOOLS command which will open a dialogue window where we find the HOME command.

We use this command for the machine to take it's X, Y and Z references by pressing Home all (fig.7).

We observe in fig.8 the positions of the printer's stroke ends.

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Fig. 7. Opening the initial window and
of the TOOLS window

Fig. 8. Printer stroke head positions

Also in the Tools menu we enter in Preheat, where we set Preheat PLA to bring the bed and the printhead to temperatures favorable for printing this type of material, the bed to 60ºC and the printhead to 200ºC. From the main screen we go to Print, where we find all the programs that are on the card. We select the first program with the name AI3M_Upper.gcode and press Print, the STATUS menu will appear on the screen (fig.9) where it shows us the name of the file, the printing speed expressed in percentages, the elapsed time, the progress of the program expressed in percentages, the temperature of the print head , the temperature of the bed and finally the position of the nozzle on X,Y and Z.

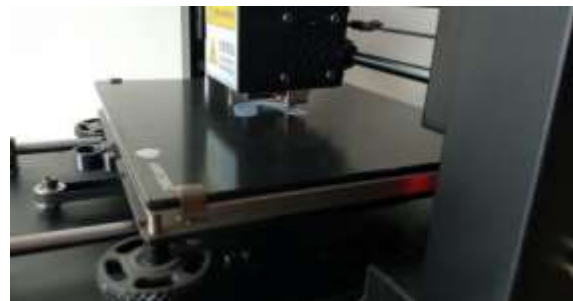

Fig. 9. STATUS menu

Fig. 10. Printing the first layer

Fig. 11. Printing several layers

Fig.12. Obtaining the final product

In fig. 10, 11 and 12 we can see the printing progress from the first to the last layer and the final model. Their position was obtained from several angles.

4. Conclusions

The printed models and their simulation were made for a material known as PLA, a material that is not used in the dental field, the printed models having only a didactic and theoretical role.

Rapid prototyping technologies deposit material layer by layer until the required shape is obtained, instead of removing material by chipping, they allow much greater flexibility than chipping (even CNC) because the complexity of the geometric shape of the model does not impose any limitations. Rapid prototyping technologies produce 3D models quickly and with good accuracy, thereby reducing the time required for the research and development phase of a new product, ultimately reducing the cost of the product.

References

[1]**Miran, R. -** *Rapid prototyping tehnologies a boon to mankind*- EPRA International Journal of Economic and Business Review- Aprilie 2014, Vol.II, ISSN 2347:9671.

[2]**G.S. Sahshidhara** - *Rapid prototyping* – this e-book is sponsored by project giedeeam solar www.giedeeamsilar.com and dowload free e-books on www.gajup.com

[3]**S.O.Onuh and Y.Y.YUSUF** - *Rapid prototyping technology: Applications and benefits for rapid product development*- January 1999 Journal of Intelligent Manufacturing 10(3):301-311, doi: 10.1023/A:1008956126775

[4]**Alin-Gabriel Gabor, ş.a.**- Digital Dentistry- *Digital Impression and CAD/CAM System Applications*- Journal of Interdisciplinary Medicine- 2017- DOI: 10.1515/jim-2017-0033

[5]**Constanța Rădulescu, Liviu Marius Cîrțînă, Radostin Dimitrov** -*Rapid prototyping technologies - advantages and disadvantages** -Annals of the „Constantin Brancusi" University of Targu Jiu, Engineering Series , No. 4/2022 ISSN 1842-4856 Annals 2, ,. Pg.136-142, nov. 2021

[6]https://dental.formlabs.com/eu/indications/surgical-guides/guide

[7]**C Rădulescu, L M Cîrțînă** - *Aspects regarding the necessary 3d printing stages to obtain complex models* - Annals of the „Constantin Brancusi" University of Targu Jiu, Engineering Series , No. 4/2022 ISSN 1842-4856 Annals 2, ,. Pg.157-162, 25.nov. 2022

[8]**C Rădulescu, L M Cîrțînă** - *Configurations of quality, shell and infail categories that influence the quality of printing 3d models*, Annals of the „Constantin Brancusi" University of Targu Jiu, Engineering Series , No. 4/2022 ISSN 1842-4856 Annals 2, ,. Pg.163-166, 25.nov. 2022

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