Lamar University
Department of Computer Science

3D Printing

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I. Introduction

The introduction to 3D printing has become an advantageous tool in the classroom. Many college subjects, such as computer science, have abstract concepts which can be difficult to illustrate. By using modeling software and a 3D printer however, abstract ideas can be physically represented and printed to become real-world learning aids. There are many software options available that are sufficient to achieve our goal of creating digital models. The purpose of this project is to design and develop digital 3D models for teaching abstract concepts for classroom use.

II. About 3D Printers and 3D models

A 3D printer is a machine that constructs 3D objects from digitally created 3D models. The type of 3D printers we have are melt plastic based filament and extrude it through a nozzle while moving according to the digital 3D model's file. Building the 3D object layer by layer. Most 3D printers use a plastic filament to produce models.

Polylactic Acid (PLA) or polylactide is the most commonly used plastic followed by Acrylonitrile butadiene styrene(ABS). PLA is a biodegradable plastic made from corn starch and has a low melting-point which is useful for 3D printing. ABS is a stronger plastic that has a glass transition zone of 105^{o} F, but shrinks slightly when it cools possibly causing cracks, splits, or issues with sticking to the print bed.

To print a model using a 3D printer, one must use 3D modeling software to design and create the structure to be printed. The 3D model is then oriented in most logical position for printing and if needed support scaffolding can be designed or generated to

the model to help the printing process. Supports are generally needed for projects that include overhangs

The model is then converted into a file in Standard Tessellation Language (STL) which is the most common file type for 3D polygonal CAD models. STL is the standard format for 3D printing applications and contain the vertex information of the model. The file is then uploaded into a 3D printer slicing application, such as Cura, to slice each individual layer for printing and converts the STL file into G-Code, a language that tells computerized machine tools how to make something [1, 2].

Maintenance are care for 3D printers should always be a priority. Firmware updates should be checked for before each project. Cleaning Filament, made often from Nylon, should be used after large prints and when switching materials or colors to prevent the extruder from clogging and materials from mixing [3]. Most Cura based slicing software have presets already set for commonly used materials and should be used for the printer in question. The time to print a model depends on the size, material, and complexity of the model. With personal experience within the department, we have had prints that go from 30 minutes to 36 hours.

III. Methodology

The following procedure is the current practice for the 3D printing Lab within the Department of Computer Science of Lamar University. It has proven itself to be worthwhile as there has not been any complications since its implementation

STEP 1: Design

- Requests are accepted and requirements evaluated
- Model support systems are planned
- A 3D digital model is created and sent for review
- Export approved 3D digital model into STL file format

STEP 2: Printing

- Load STL into the 3D printing software
- Upload to printer and start the print

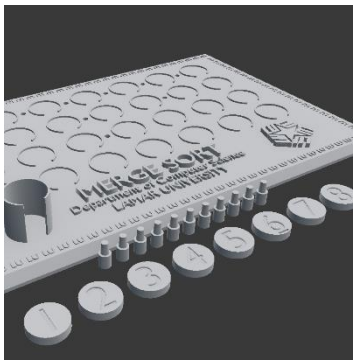
STEP 3: Refining

- Remove any support structure or other excess plastic
- Paint object, if necessary

STEP 4: Follow up

- Present the model for classroom use
- Store 3D Digital Model file for future modification/use

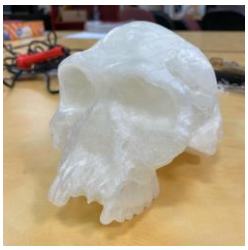
IV. Current Projects

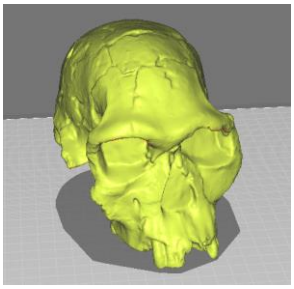


3D models for Computer Science Courses

3D models have been designed and printed to help students grasp the ideas of merge sort, bucket sort, Towers of Hanoi, scheduling algorithms and more. Students are also being challenged to come up with more models or to improve current models to be used in future classes.

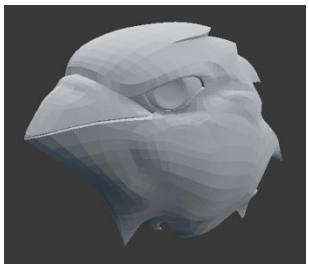
3D models for Other Courses





Professors from other departments have approached us about printing artifacts and figures to be used in their classrooms. The most recent being projects to print models of early human skulls that are used to study anthropology. We are still in the process of printing all the skulls in the collection of models shared with us, but students who are studying them have even gone to the lengths of painting the skulls to mimic their true look for historical accuracy.

3D models for school spirit



One student created a 3D model of the Lamar University Cardinal. The Model has been used on keychains, figures, desktop backgrounds, and 3D printed trophies for Computer Science related events held by the Lamar University Chapter of the Association for Computing Machinery.

V. Future Projects

Photogrammetry

Photogrammetry is input of photos and the output of 3D models [4]. Recently, Lamar University students have become interested in photogrammetry to work on small projects such as scanning small objects to reprint them or using images to recreate buildings. The hope is increase interest and research different methods within photogrammetry to share with our student community.

3D model of Lamar University

The interest in photogrammetry stemmed from wanting to create a 3D representational map of the Lamar University campus. The idea is to use Aerial Photogrammetry using drone photography to gain all the photos needed to create the model. Obstacles of the project include gaining permissions to fly drones around campus, learning how to fly a drone, finding the right methods for rendering the models, and weather predictions in the South East Texas area

VI. References

[1] “Cura (Software).” Wikipedia. Wikimedia Foundation, March 7, 2020. https://en.wikipedia.org/wiki/Cura_(software).

[2]“G-Code.” Wikipedia. Wikimedia Foundation, March 20, 2020. https://en.wikipedia.org/wiki/G-code.

[3]“How to Use 3D Printer Cleaning Filament (& What Not to Do).” rigid.ink. Accessed April 2, 2020. https://rigid.ink/blogs/news/how-to-use-3d-printer-cleaning-filament.

[4]“Photogrammetry.” Photogrammetry. Accessed April 2, 2020. http://www.photogrammetry.com/.