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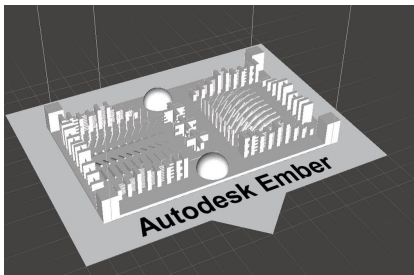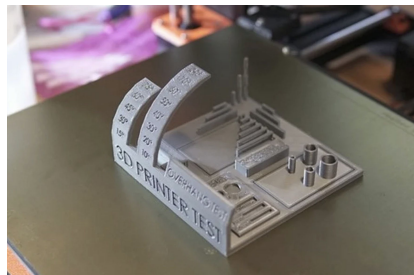
**Faculty
of Informatics**

Computational Fabrication (Spring 2024)

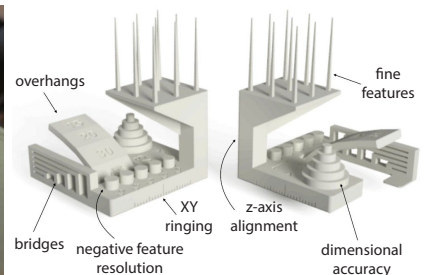## Assignment 2: Testing 3D Printer Capabilities March 22, 2024

Source: Autodesk
Source: juan438 / Thingivers
Soruce: Kickstarter Autodesk 3D Printer Evaluation

In this assignment you will be testing capabilities of one of our 3D printers (Ultimaker S5). To this end, you will first design a testing pattern/geometry, similar to those above, using constructive solid geometry tool (OpenSCAD). Then, you will print and investigate the resulting quality. Finally, you will create a short report describing the capabilities of the printer.

Designing the Test Patterns (5 points)

For designing your testing pattern use OpenSCAD (http://www.openscad.org/). The dimensions of the testing pattern should not exceed 50x42x30mm (LxWxH). Please keep in mind you should not waste printing material.

You should design a pattern that tests at least:

- resolution of the printer, e.g., the smallest gap and feature it can print,
- ability to print thin and tall structures,
- ability to print sharp and smooth features ,
- the amount of slant and overhang that can be printed without supporting structures.

Use the procedural capabilities of the OpenSCAD software to print features with different parameters (thickness, height, etc). The resulting geometry should be exported to one STL file. To simplify the printing process, assume that one unit in the OpenSCAD correspond to one millimetre in the real world.

Tips:

- Make sure that once you print you know the dimensions of the features and the angles of slanted parts.
- Before designing the patterns, consider the parameters we will use for printing. The default parameters are nozzle size: 0.4 mm, layer height: 0.1 mm.
- In case you want to preview your print in Cura software[1] you will be asked to provide materials we will use for printing. In our case, Extruder 1 is loaded with Black PLA and the print core is AA 0.4
- In case of additional questions, you can check our FAQ at the end of the document.

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[1] https://ultimaker.com/software/ultimaker-cura

Printing the Patterns

We print the samples for you with default parameters using the STL files you provide and we bring them on the lecture (Monday 9th).

Report (5 points)

You report should include:

- pictures of the designed test geometry,
- pictures of printed testing patterns,
- description of tested capabilities,
- description of the results,
- description of any problems that you had,
- any further comments and observations regarding the assignment.

Submission Instructions

Please submit the solution for the assignment in two parts:

PART I (until March 30 2024):

- OpenSCAD file that generates your test geometry
- generated STL file containing the geometry
- in the comment to the submission, mention how you want to proceed with printing

PART II (until April 19 2024):

- the report

Each part should be submitted as a separate ZIP file.

Remember, this assignment is to be done on your own. Please do not share code or implementation details with other students.

Deadline for the assignment: March 30 2024(PART I)
April 19 2024(PART II)

Frequently asked questions:

- **Can I use a downloaded model?**
  No. The assignment is about designing your own using OpenSCAD. However, you can get inspired by what you find online. Please remember that we want you to submit the OpenSCAD source code for generating the full model.

- **Can I use online code if the credits are given?**
  Yes, you can reuse the code if the credits are given but limit the amount of reused online code to 50

- **What are the dimensions mentioned in the assignment (LxWxH)?**
  The dimensions are length, width, and height. They correspond to the final size of the test pattern you would like to print. In OpenSCAD, you can assume that L and W correspond to X and Y axis, while H is Z.

- **What are the units in OpenSCAD?**
  The OpenScad does not have defined units; neither does the STL format. You should assume some, e.g., millimeters. The printing software will interpret 1 unit in the STL file as 1 millimeter by default, but this can be changed by uniformly scaling the object inside the printing software.

- **What is the thickness of the plate on which I can place my testing patterns?**
  The printer is capable of printing sub-millimeters layers, but to make the base stable, we suggest using 2-3mm.

- **What printer parameters should I assume?**
  We will be printing with black PLA material. The nozzle we will use has a size of 0.4mm. Therefore, the width of a single line the printer will print is approximately 0.4mm. For the layer thickness, we will use 0.1mm. Note that the goal of the exercise is to test the printer capabilities given the above settings. Therefore, it is okay and even desired if some of your features won't get printed.

- **What is a negative feature?**
  It is a gap/space between two different parts of the model. The resolution of the negative feature defines how small are the gaps that the printer can reproduce. The higher the resolution, the smaller gaps can be printed. This property is essential for printing moving mechanisms. Imagine printing a chain. The question you may ask is how small can be the chain so each link can move separately.

- **What is an overhang, and how can we measure it?**
  Overhangs are structures/parts of the print which do not have a direct connection to the base, e.g., an arch is an overhang. Depending on the process, printers can print overhangs with different angles with respect to the horizontal direction. Therefore, one possible way of measuring overhang is by using the angle of the printed surface forms with the horizontal or vertical direction.

- **What is XY ringing?**
  It is an artifact caused by the misalignment of consecutive layers of a 3D printed model.