**COURSE 12: ADDITIVE MANUFACTURING FOR INDUSTRY 4.0**

Student’s name: …………………………………………………………………………………………………………………………………

**Workshop 3 – Worksheet 3.1**

**Objective:** Test and calibrate your 3D printer.

This workshop will help you establish if the FDM 3D printer you are using for the duration of this AM course is working at its full potential. Each equipment is unique and sometimes the manufacturers’ calibration instructions are not enough.

In order to particularise your machines’ settings please undertake the following seven tasks. The first task will help you to get baseline adjustments and the rest will serve for fine tuning your prints.

1. **Task 01**: **Perform calibration with the Kickstart/Autodesk FDM test**

This first calibration print will show you the areas to focus on. When printing, be sure to use only one material as using different ones will ruin the analysis. However, you can change up the temperature or one setting at a time to adjust in between prints.

Start your baseline printing parameter settings test by accessing the guide and test part available here: <https://github.com/kickstarter/kickstarter-autodesk-3d/tree/master/FDM-protocol>.

Make sure you follow all instructions and perform the adjustments in accordance with your obtained result.

1. **Task 02: Perform the Benchy 3D printing test**

Benchy is recommended for testing out your 3D printer’s settings. It challenges your machine in almost every way and makes it easy for you to find problem areas. Follow the 3D printing recommendations given here: <http://www.3dbenchy.com/3d-print/> and make sure you pay attention to the main features of the test: <http://www.3dbenchy.com/features/>. Calibration is done using by checking the following dimensions: <http://www.3dbenchy.com/dimensions/>.

1. **Task 03: Perform the XYZ Calibration Cube test**

Apart from bed levelling, there are some other movements which need to be taken into consideration when calibrating your 3D printer. Linear X (left/right), Y (front/back), and Z (up/down) movements are just as important to the quality of your build job. The XYZ Calibration Cube from iDig 3D printing is a perfect way to test out these movements. This cube prints with letters indented into each side to show you which side is the X, Y, and Z. You can then see which sides are coming out sloppy and adjust your printer based on that. Download the model here: <https://www.thingiverse.com/thing:1278865> and start your test.

1. **Task 04: Perform the Quick Temperature Calibration Tower test**

Depending on your specific printer and the material you are using, the optimum temperature can vary quite a bit. The Quick Temperature Calibration Tower is an easy way to see what temperature works best with your printer. For each temperature setting you will have to repeat the print. Start with the manufacturers’ recommended temperature and try increasing and decreasing the temperature with 5oC. Compare between all parts you printed and set your printers’ optimum temperature. Make sure you use the same material for all prints. Find the temperature tower and the main print settings here: <https://www.thingiverse.com/thing:2729076>.

1. **Task 05: Perform the PolyPearl Tower 3D printing test**

The PolyPearl Tower test will help you adjust your printer settings if you are still struggling with overhangs, bridging, hanging, and curves. Follow the printing tips and guide available here: <https://polymaker.com/polypearl-tower-torture-test-model/> and download the model from here: <https://www.thingiverse.com/thing:2064029>.

1. **Task 06: Perform the Ultrafast and Economical Stringing Test**

Stringing and overhangs may appear not only due to bad temperature settings, but they might persist because of improper retraction settings. You might need just one test or several, depending on how bad your problem is. Each time you print, if you get strings, just adjust the temperature or retraction, and print it again until you finish string-free. The model is available on Thigiverse here: <https://www.thingiverse.com/thing:2219103>.

1. **Task 07: Perform the Bed Levelling Calibration Test**

This calibration test prints out a pattern of squares in just one layer on in six locations on your printing platform. You can easily see if your bed is level by looking at the squares and how they compare to each other. If your bed is level, you should not see a difference between the squares in different areas. If you still have problems run the manual or autocalibration from the machines’ main menu. Download the STL file from here: <https://www.thingiverse.com/thing:34558>.

**If throughout the semester you encounter difficulties in printing your parts, you can always come back to this workshop and use these calibration tests to figure out what your problem is. If the tests come out ok, them maybe it’s time to recheck your design rules for 3D printing and your CAD files.**

**Print away!**