



HEI MAKERS

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Technical creativity in 3D printing
module



Co-funded by the
Erasmus+ Programme
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2017-1-LT01-KA203-035231



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LESSON #5 3D PRINTING PARTS DEFECTS ANALYSIS

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OUTLINE OF THE LESSON #5

- Topic 5.1 Causes of defects in 3DP
 - Topic 5.2 3DP defects - Case studies
 - Further learning
 - Tasks for reflection
- 

5.1. CAUSES OF DEFECTS IN 3DP

- In this lesson you will learn about the causes of the defects encountered in FDM 3D printing.
- Expected learning outcomes: basic knowledge needed to obtain good quality parts from a FDM 3D printer.

Duration	1 academic hrs
Author / Lecturer	Doru Cantemir, Ludor Engineering
Delivery methods	Individual
Evaluation methods	Test / Report / Feedback / Exam etc.

INTRODUCTION

- Creating a good quality object with a FDM 3D printer is part art and part science. There are so many factors to take in consideration: the object design, the dozens of print settings to tweak, the filaments that usually display different properties in function of not only the type but also the color, the printers characteristics, etc.
- On the bright side, you're a maker and there is a lot of fun to play with all these variables. Most of the FDM 3D printers allows you to experiment and to improve your print quality and your knowledge about 3D printing in general and your 3D printer in particular.



Figure 5.1.1. Some 3DP defects. Source: Ludor Engineering

INTRODUCTION

- Unexpected challenges may arise when printing and they must be resolved in order to complete a successful print. Many times, the solution is not immediately apparent, especially if your experience with 3D printing is limited.
- Luckily, the 3D printing community is a very active one and several comprehensive and helpful guides were made available on Internet. Also, there are many forums and a lot of people willing to help. So, the solution is somewhere there, you just need to look for it.



Figure 5.1.2. Some 3DP defects. Source: Ludor Engineering

CAUSES OF 3DP DEFECTS

- The printing defects can be caused mainly by the following issues:
 - The nozzle distance relative to the build platform is not correct
 - Build platform is not level
 - The nozzle is partially or totally clogged
 - Filament problems: incorrect diameter, contamination, broken, finished, tangled, poor quality, etc.
 - Lack or loss of adhesion to the build platform
 - Shock or vibrations (from the printer or another source)
 - Incorrect printer settings

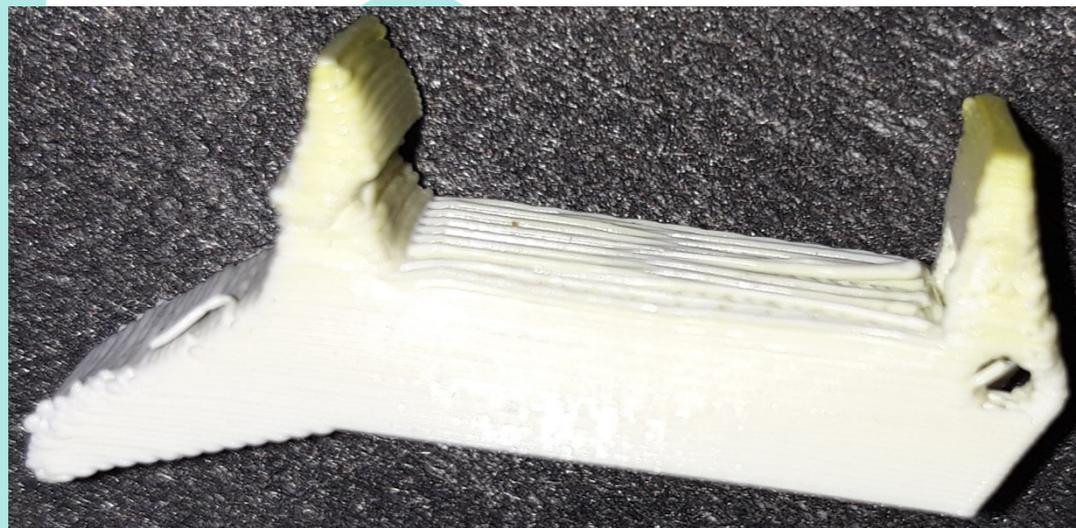


Figure 5.1.3. Some 3DP defects. Source: Ludor Engineering

NOZZLE OFFSET

- The extruder should be located at the perfect distance from the build plate in order to correctly extrude and bond the first layer.
- If the nozzle is too close to the build platform, there is not enough room for plastic to come out from extruder. If it's too far, the plastic will not stick to the plate.

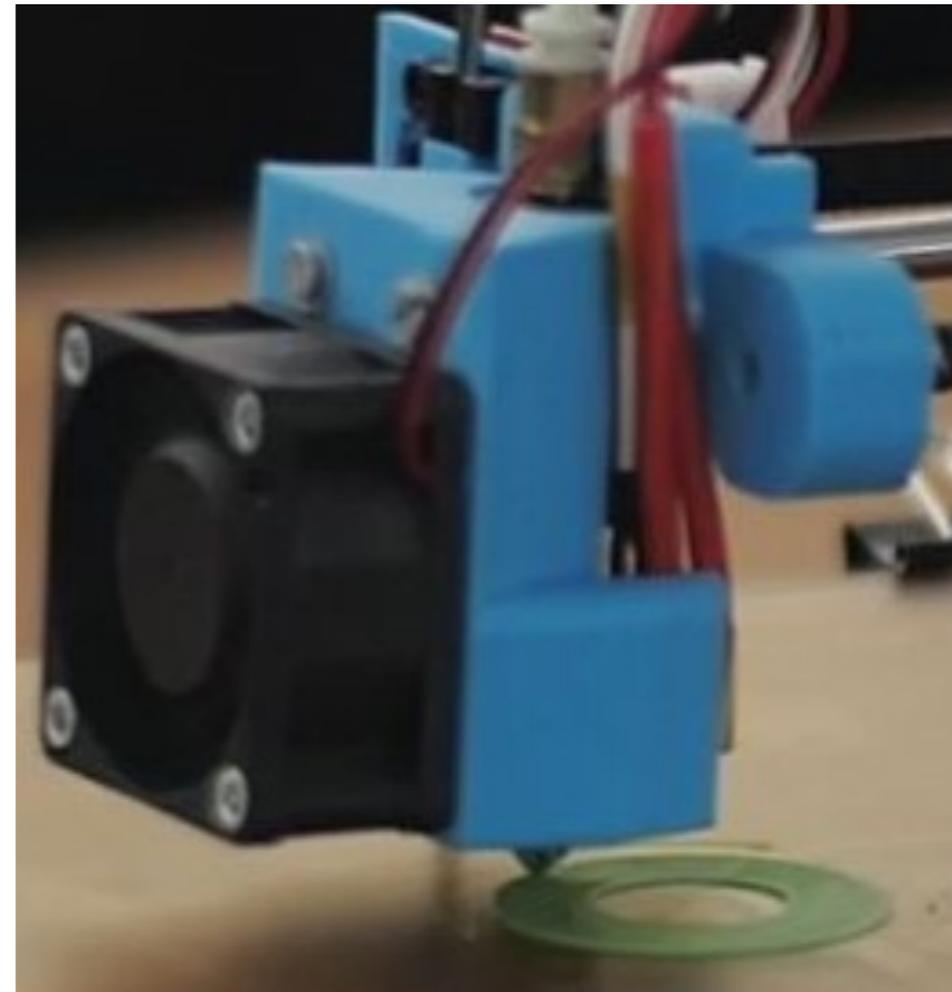


Figure 5.1.4. Nozzle distance. Source: Ludor Engineering

UNLEVEL BUILD PLATFORM

- If the platform is uneven, the nozzle will be at different distances from it in different parts of the print – sometimes this could mean too close (no plastic come out or worst –scratched plate, destroyed nozzle) or too far (poor adhesion).

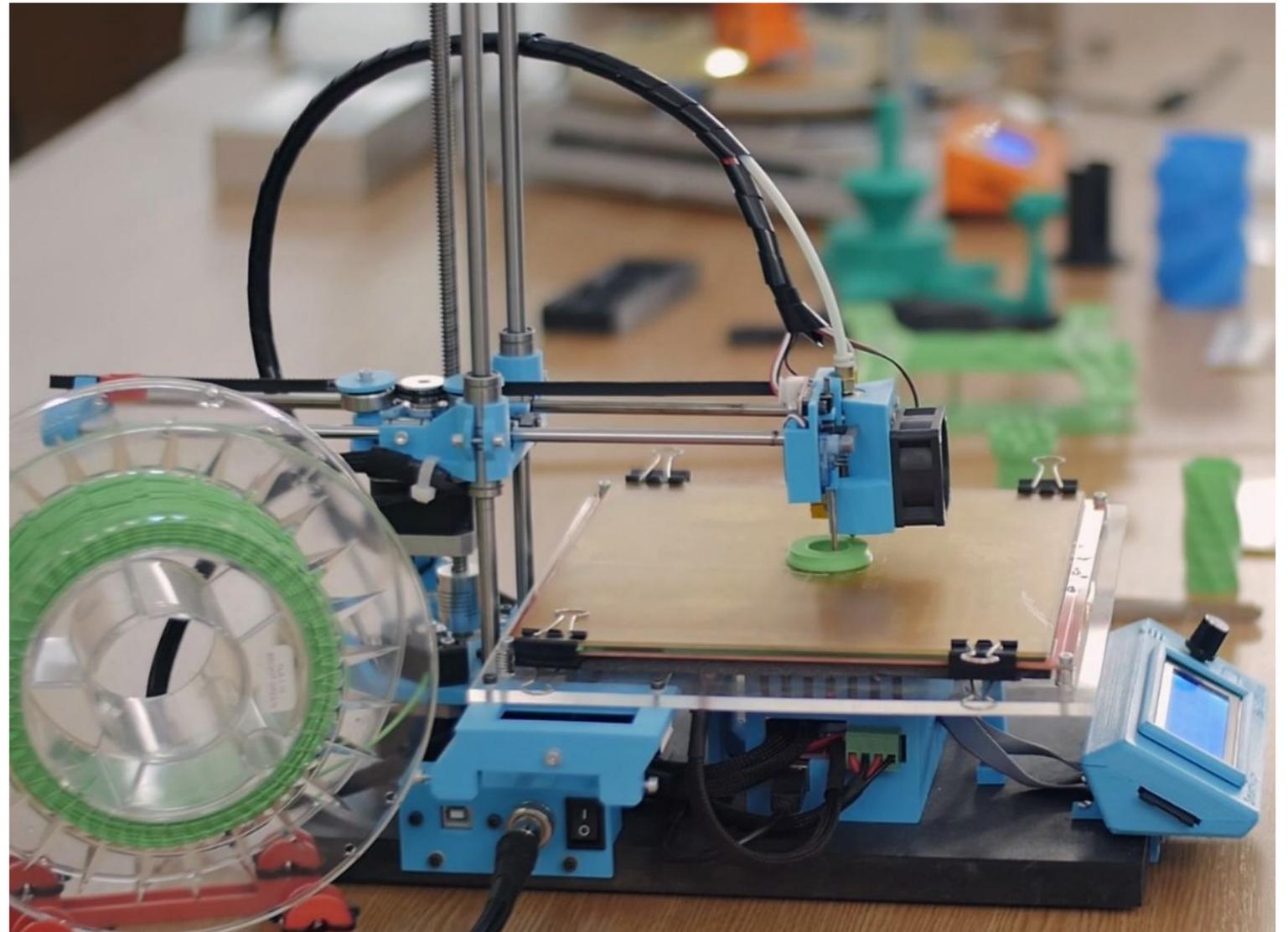


Figure 5.1.5. Level platform. Source: Ludor Engineering

CLOGGED NOZZLE

- A clogged nozzle cannot extrude the right amount of plastic or will not print at all. There are many causes (poor quality or dirty filament, incorrect print temperature, incorrect nozzle offset) and several solutions: pulling a piece of filament through the extruder (cold pull), using a needle, dismantling and cleaning the extruder, burning the nozzle.



Figure 5.1.6. Clogged nozzles. Source: Ludor Engineering

FILAMENT PROBLEMS

- The poor quality of the filament could be the cause of many catastrophic prints.
- A good quality filament but used with incorrect settings (diameter, temperature, cooling, printing speed) or contaminated (dust, dirt, humidity), broken, tangled, etc. will also cause problems.



Figure 5.1.7. Filament issues. Source: Ludor Engineering

ADHESION ISSUES

- Poor adhesion of the first printing layer to the bed creates many problems. To improve it, some materials can be applied on the bed, depending on the type of filament: different tapes, glue, hair spray, special sheets.
- Cleaning the printing surface, correct levelling and nozzle offset, suitable printing speed, temperatures and cooling could also help a lot.

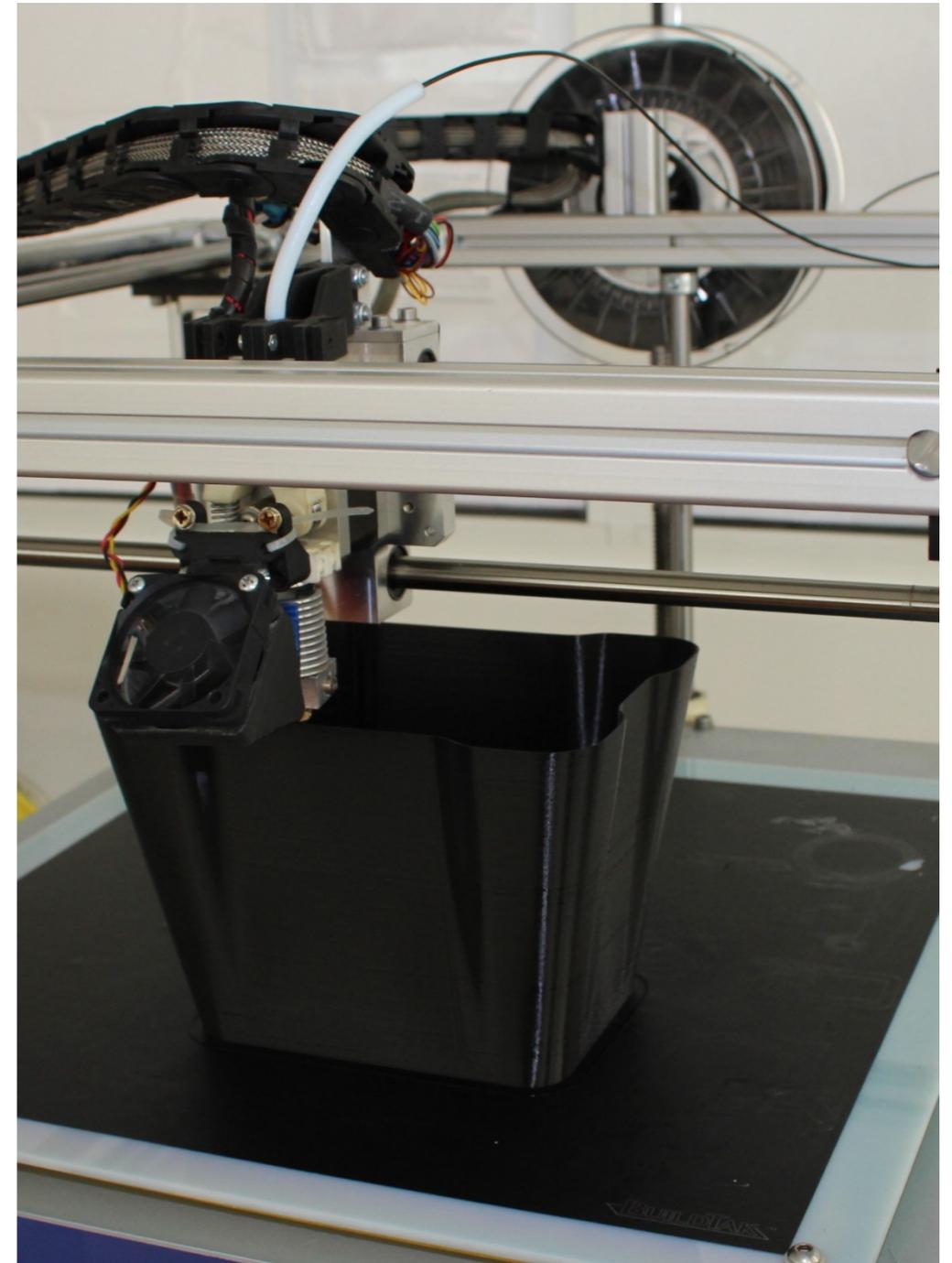


Figure 5.1.8. 3D printing on a special sheet to improve adhesion. Source: Ludor Engineering

SHOCK OR VIBRATIONS

- Printer vibrations can definitely ruin a print. Causes of vibrations: printing too fast, incorrect accelerations settings, mechanical issues (loose screws, broken parts).

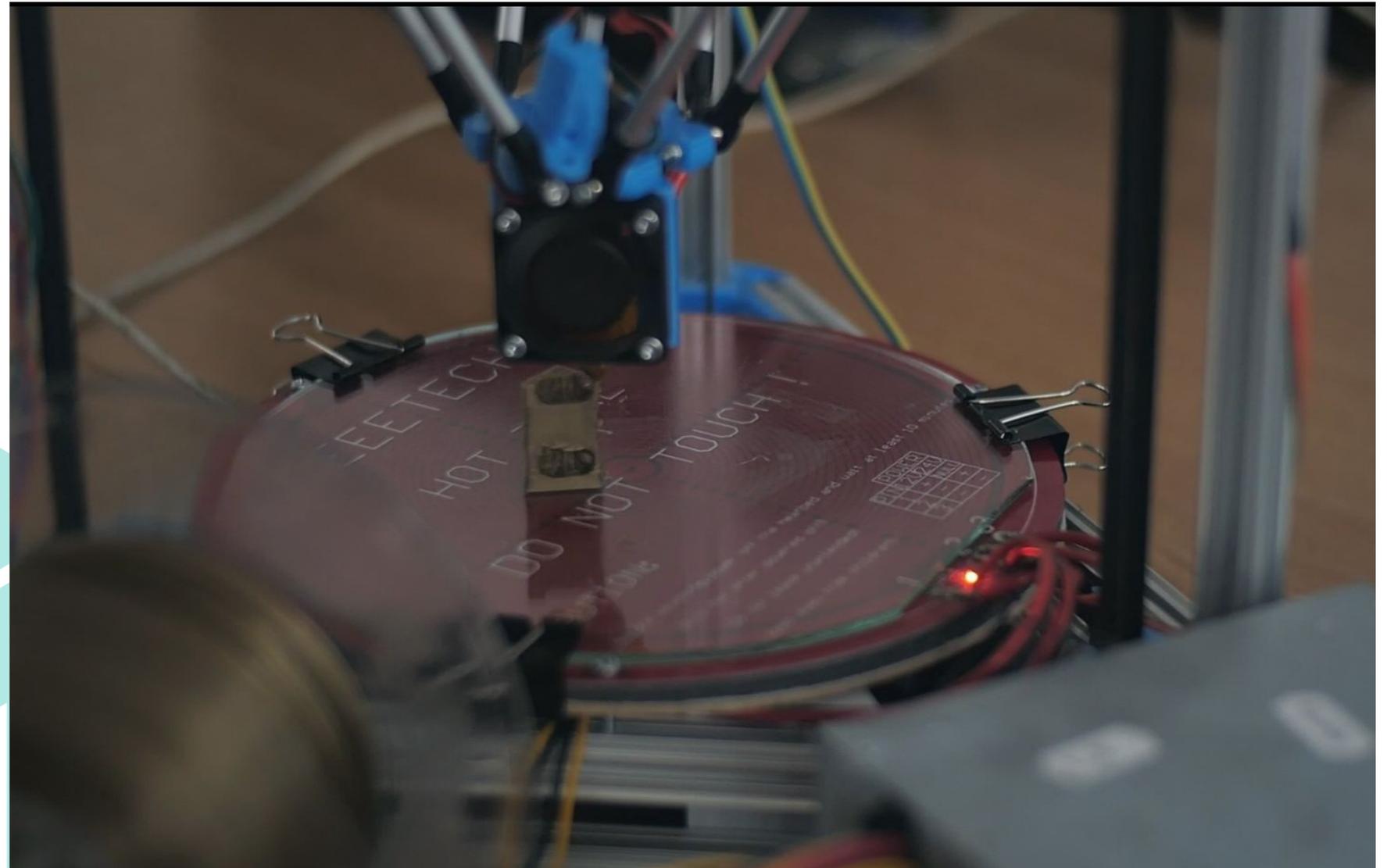


Figure 5.1.9. Delta 3D printer. Source: Ludor Engineering

PRINTER SETTINGS

- Depending on the 3D printer and on software used, there are dozens of settings that can make or break a print job. You need to learn about them, to test, to gain experience.

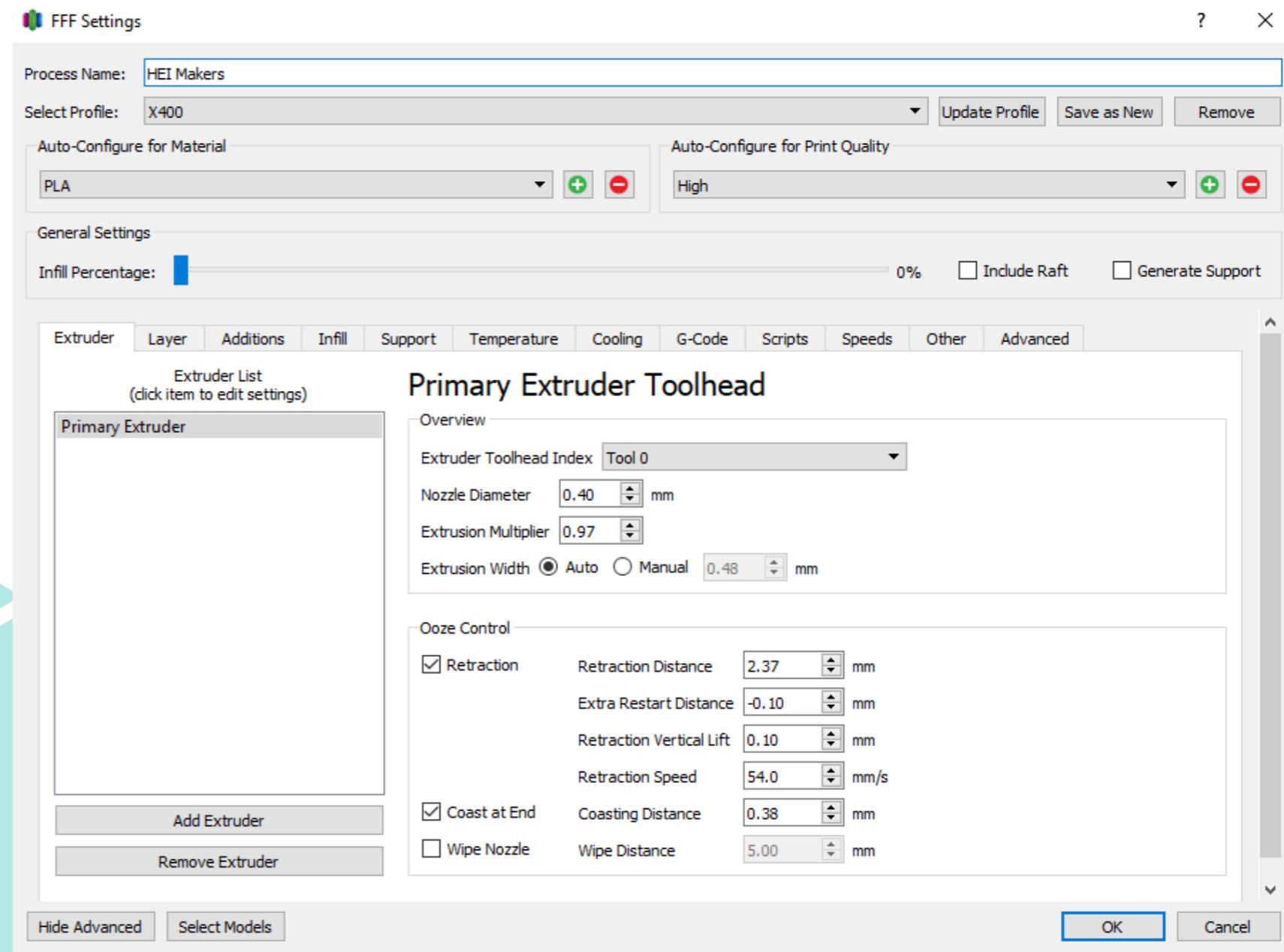


Figure 5.1.10. Printer settings. Source: Ludor Engineering

5.2. 3DP DEFECTS - CASE STUDIES

- In this lesson you will learn about the various defects encountered in FDM 3D printing.
- Expected learning outcomes: basic knowledge needed to obtain good quality parts from a FDM 3D printer.

Duration	1 academic hrs
Author / Lecturer	Doru Cantemir, Ludor Engineering
Delivery methods	Individual
Evaluation methods	Test / Report / Feedback / Exam etc.

PRINT NOT STICKING TO THE PRINTING SURFACE

- **The problem:** first layer is not sticking to the build platform and this cause warping or even part moving during printing.
- **Possible causes:** bed is not level, printing surface not clean, incorrect nozzle offset, unsuitable bed surface for the used filament, incorrect settings: speed, temperature, cooling
- **How to solve:**
 - calibrate printer, set the right nozzle distance from bed
 - prepare the printing surface: clean the print surface with isopropyl alcohol or other substances appropriate for your filament
 - use proper settings
 - decrease the printing speed

LAYER SHIFTING

- **The problem:** some of the layers shift from their designated position
- **Possible causes:** printing too fast, mechanical or electrical issues
- **How to solve:**
 - decrease the printing speed
 - check the printer's belts, make sure they are tight enough
 - make sure nothing is blocking the axis movement

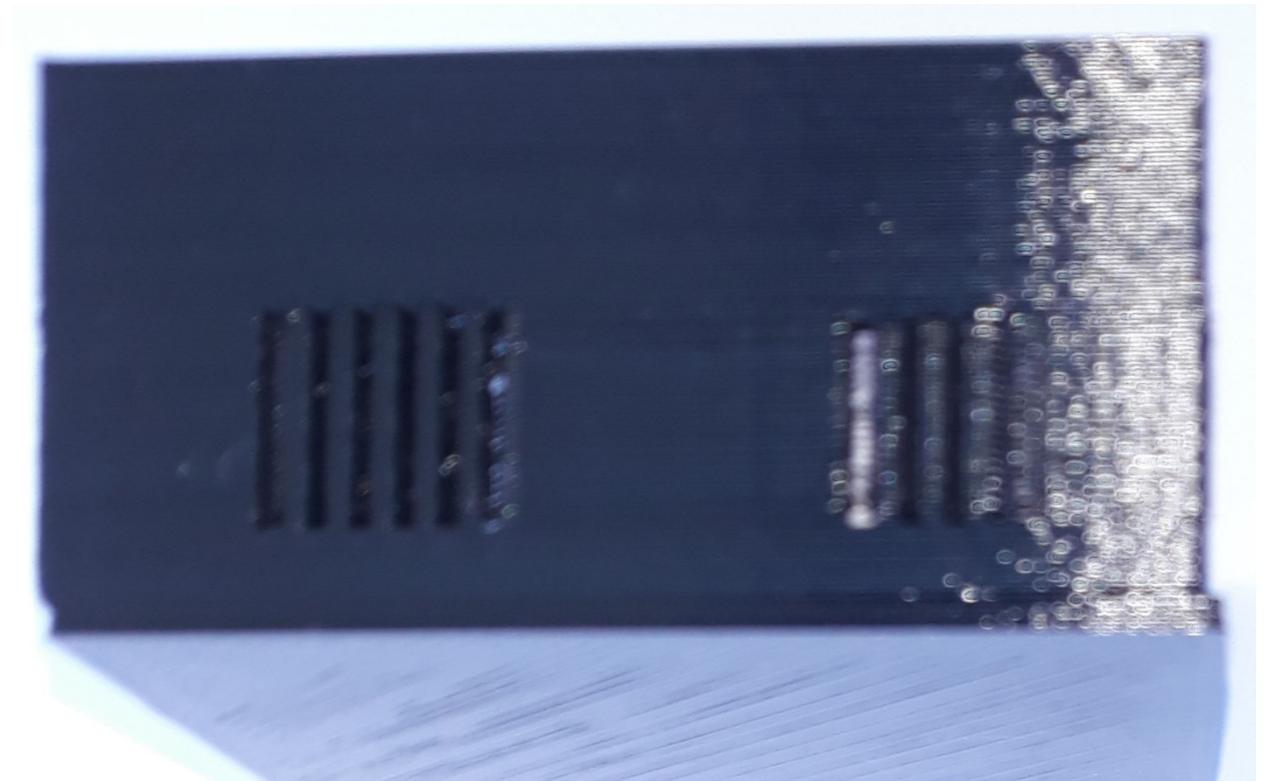


Figure 5.2.1. Layer shifting. Source: Ludor Engineering

STRINGING

- **The problem:** small strings of plastic are left behind on a 3D printed part
- **Possible causes:** wrong settings for retraction, temperature or speed
- **How to solve:**
 - make sure you have correct retraction settings selected
 - try lower printing temperature
 - use a heat gun to melt the strings

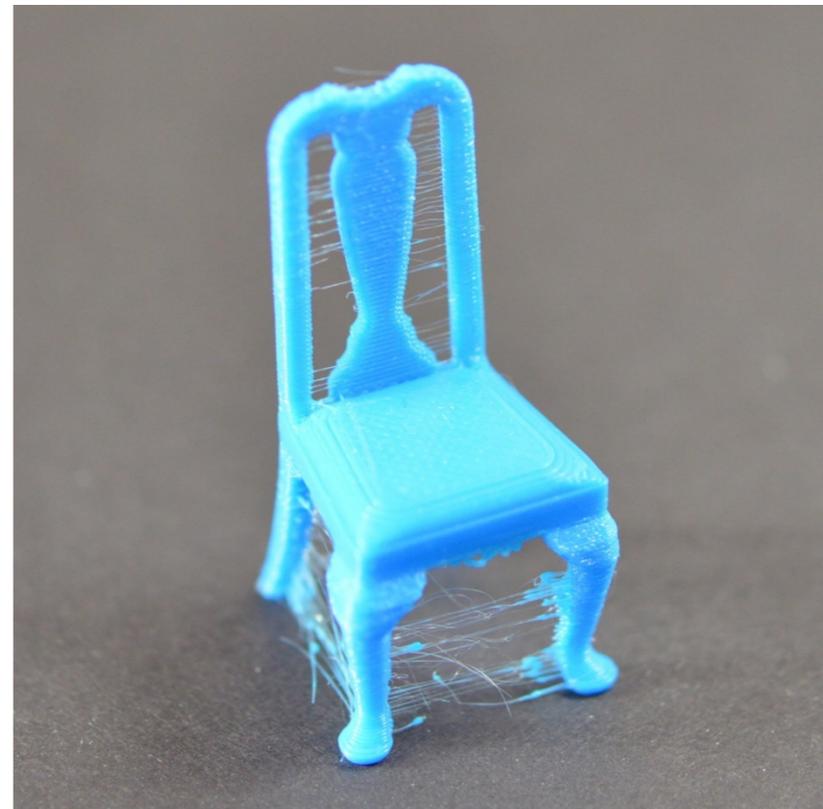


Figure 5.2.2. Stringing. Source: Simplify3D

BLOBS AND ZITS

- **The problem:** poor print quality
- **Possible causes:** incorrect retraction settings; vibrations; printing too fast
- **How to solve:**
 - check that the correct Extrusion multiplier is selected in the slicing software; if yes, decrease filament flow settings
 - check / modify retraction settings in the slicing software
 - decrease print speed
 - reduce vibrations
 - make sure everything is tight
 - check bearings
 - adjust the firmware acceleration
 - clean/lubricate all the rods



Figure 5.2.3. Blobs and zits. Source: Ludor Engineering

EXTRUDING TOO MUCH PLASTIC

- **The problem:** the printer supplies more material than needed, resulting in poor print quality
- **Possible causes:** incorrect extrusion settings
- **How to solve:** check that the correct Extrusion multiplier is selected in the slicing software; if yes, decrease filament flow settings



Figure 5.2.4. Over-Extrusion. Source: Ludor Engineering

FURTHER LEARNING

Simplify3D, Print Quality Troubleshooting Guide,

<https://www.simplify3d.com/support/print-quality-troubleshooting/>

All3DP, 2018 3D Printing Troubleshooting Guide: 41 Common Problems,

<https://all3dp.com/1/common-3d-printing-problems-troubleshooting-3d-printer-issues/>

The Ultimate 3D Print Quality Troubleshooting Guide 2018

<https://rigid.ink/pages/ultimate-troubleshooting-guide>

Gunaydin, Kadir & S. Türkmen, Halit. (2018). Common FDM 3D Printing Defects.

Print Troubleshooting Pictorial Guide

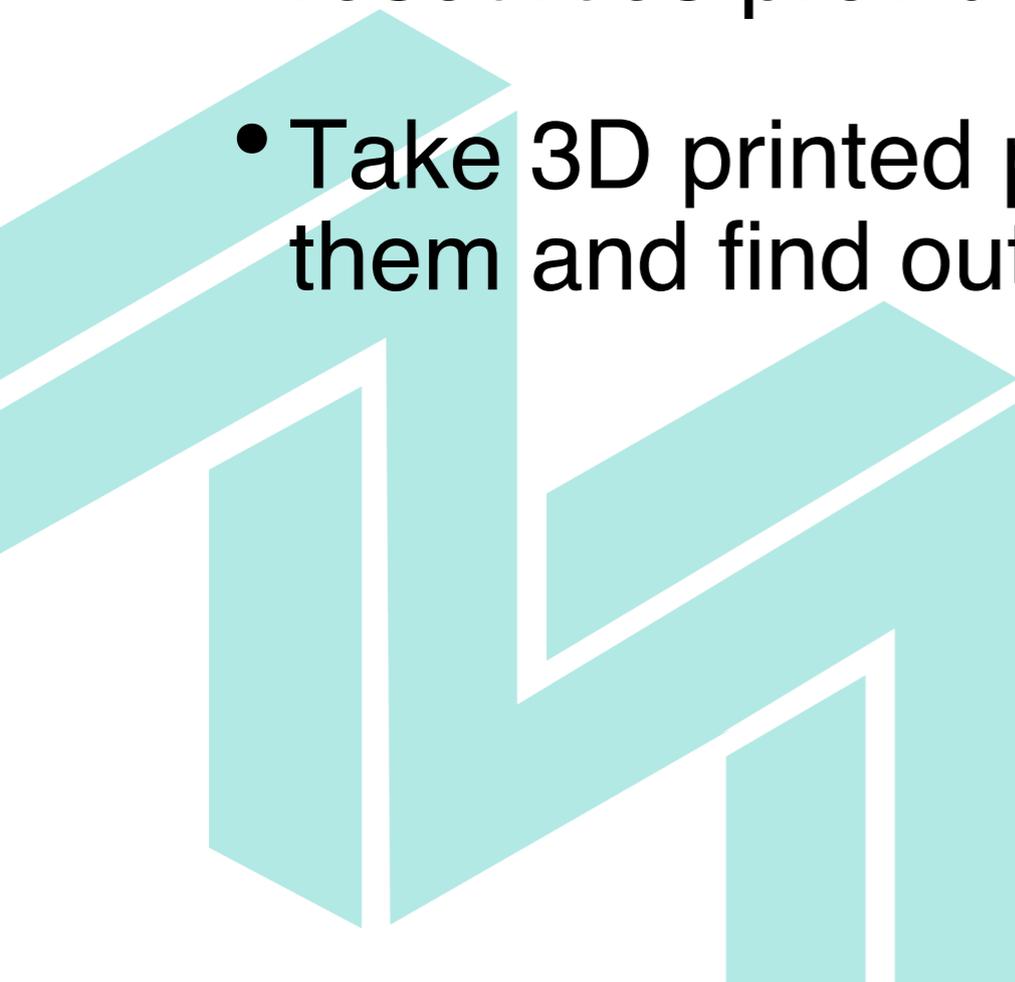
https://reprap.org/wiki/Print_Troubleshooting_Pictorial_Guide

The Anatomy of a 3D Printer: Bed Leveling

<https://www.matterhackers.com/articles/3d-printer-bed-leveling>

Unclogging Nozzles <https://forums.matterhackers.com/topic/39/unclogging-nozzles>

TASKS FOR REFLECTIONS

- Think to a set of rules that could reduce or prevent some of the defects discussed.
 - Read more about 3D printing defects using the resources provided in the previous slide
 - Take 3D printed parts, look for defects, analyze them and find out how to avoid them.
- 
- A decorative graphic in the bottom-left corner consisting of several overlapping teal-colored geometric shapes, including rectangles and trapezoids, arranged in a stylized, abstract pattern.



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