Common 3D Printing Failures and How to Fight Against Them

World Maker Faire: New York City, 2014

Maker Shed, Get Making Stage

Chris D. McCoy, Ph.D.

Because we all 3D print things like this perfectly the first time...

"World's first car made by a 3D printer..." Called, "the Strati"

Article by Dylan Stableford

Or maybe more like this...

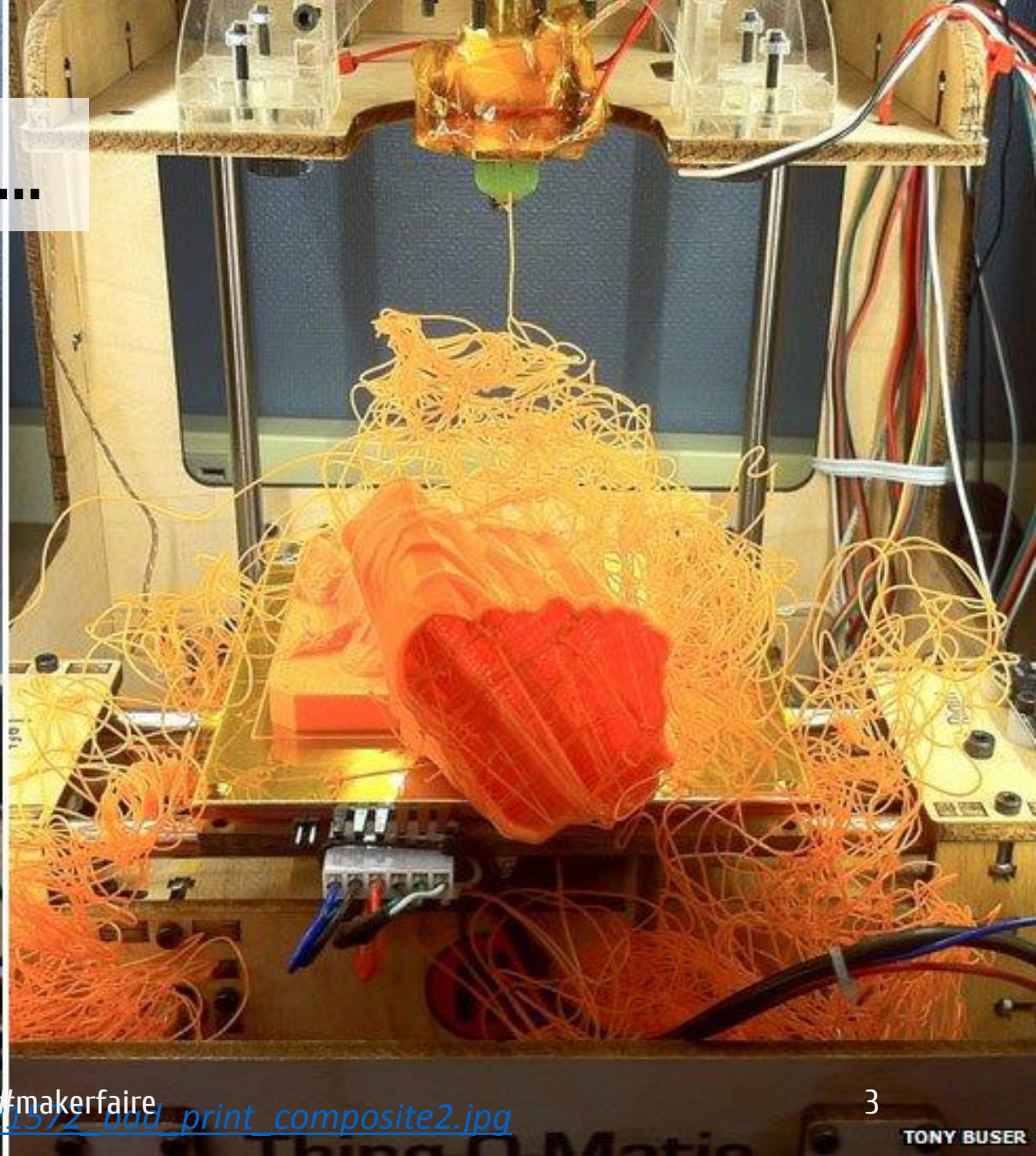
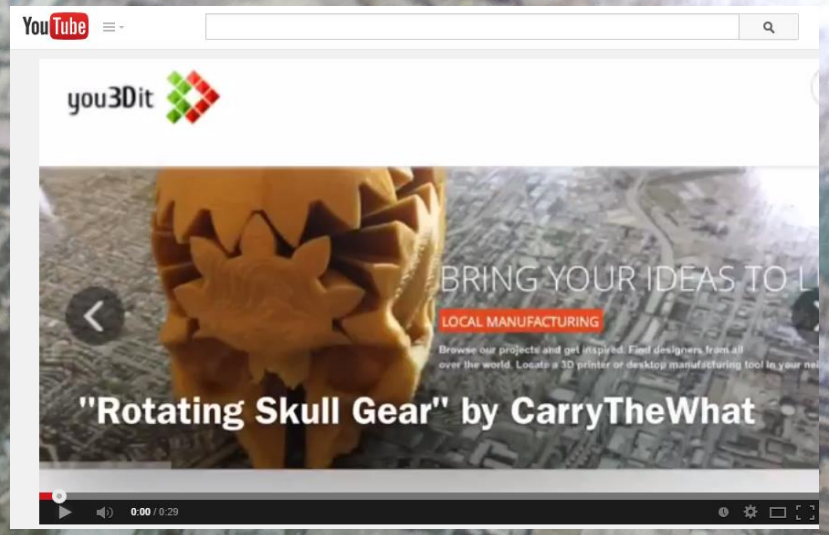


Image Credit: 3D Printing Failures, Shared Online
http://news.bbcimg.co.uk/media/images/69321000/jpg/_69321572_bdd_print_composite2.jpg

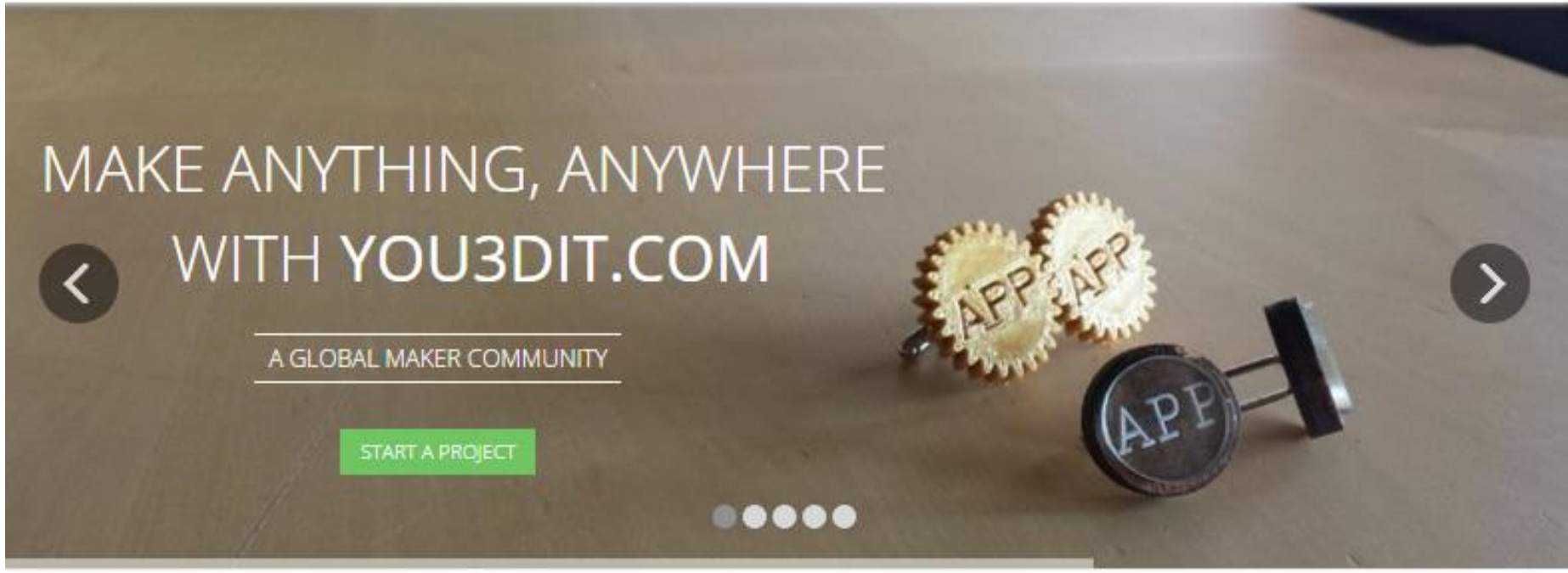
How can we get prints more like this?



"Rotating Skull Gear" by CarryTheWhat
Printed on a ~$600 Printrbot Simple Metal
http://www.thingiverse.com/make:94221

Why me?

you3Dit Co-founder of You3Dit, Inc.



Making, Teaching Digital Fabrication

BRING YOUR IDEA TO LIFE...

Recent development & growth of desktop manufacturing has started a revolution...a maker movement, where creativity is now accessible

HAVE COOL MACHINES?

Your 3D printer, desktop CNC machine or desktop manufacturing tool is ready for action. Register your machines at You3Dit and help

KNOW HOW TO DESIGN?

You have some serious design skills but no new problems to solve. Help the makers in our network make CAD models for the many desktop

Part of the 2013
"*Ultimate Guide to 3D Printing*"
by Make Magazine

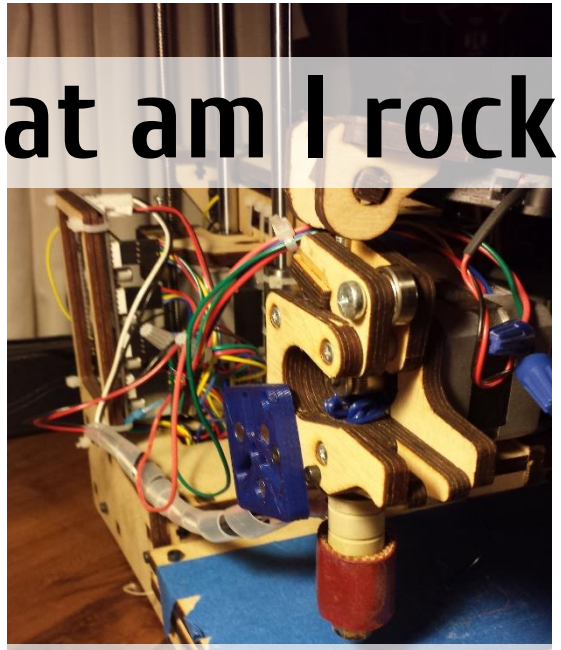
Teach 3D Printing @ TechShop, SF & HandsOnRI @ IE Business School

Image Credit: www.cubecinema.com

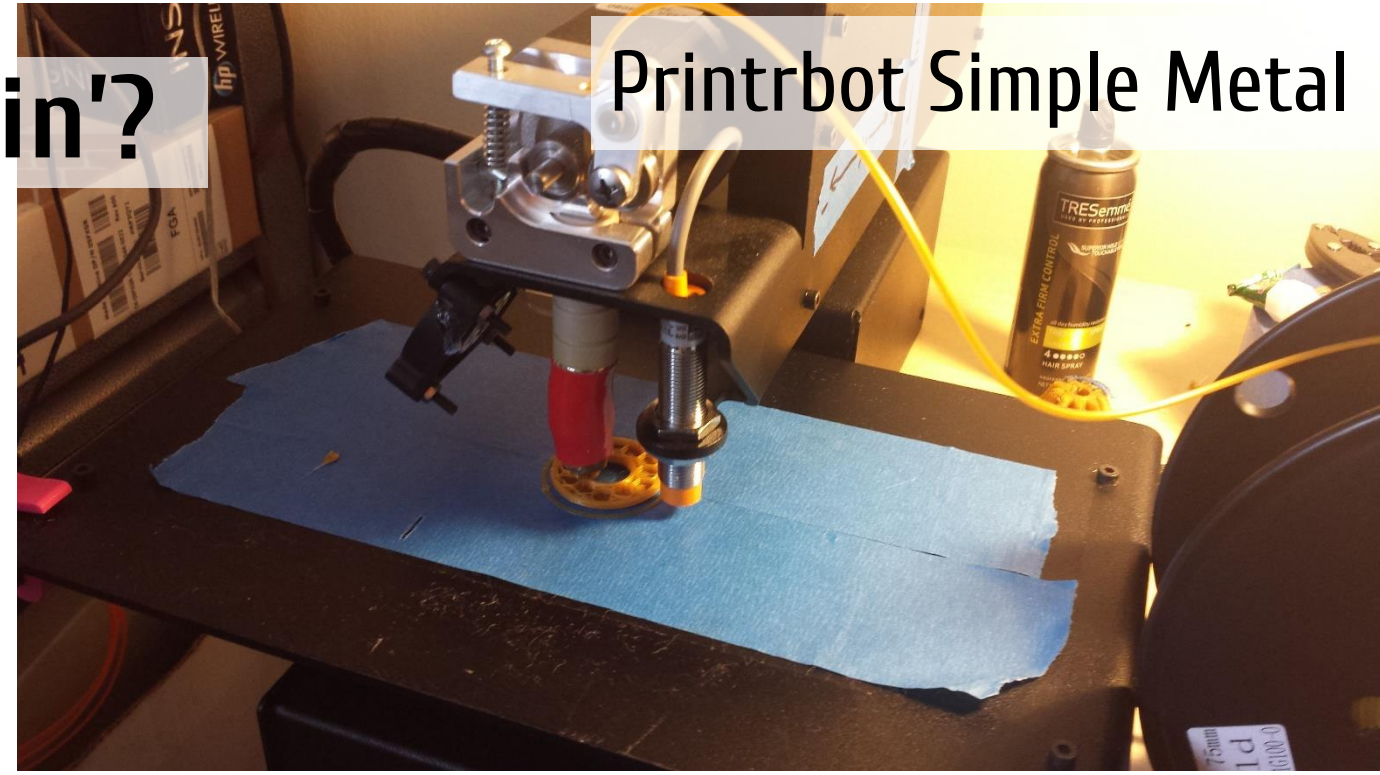

The 10 most common 3D printing failures and how to fight against them.

But first, what am I rockin'?

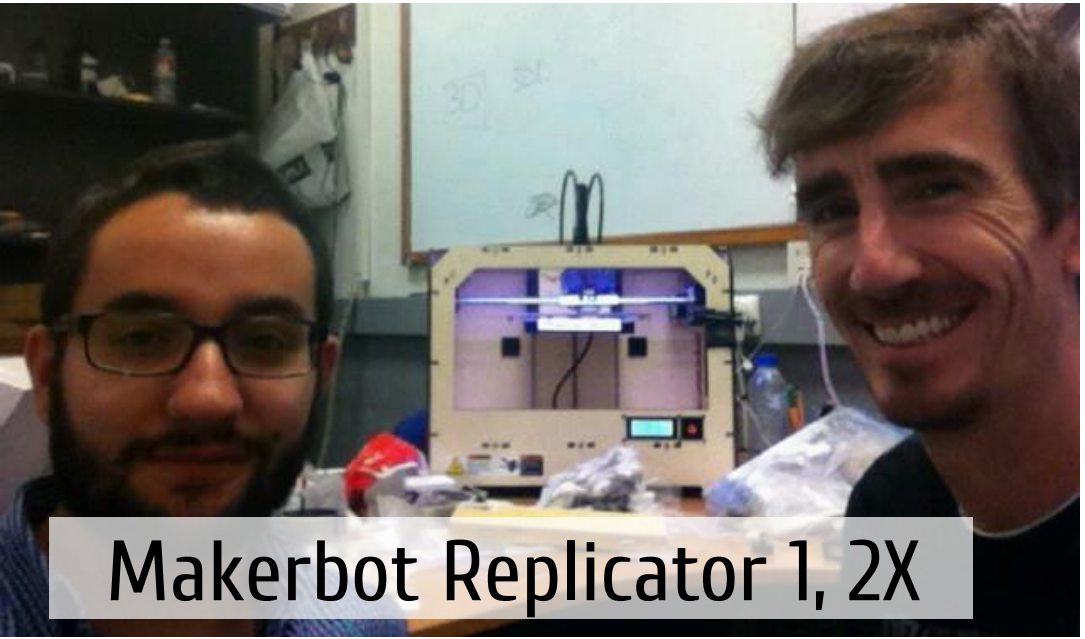
Stratasys
Dimension Elite



Printrbot Simple

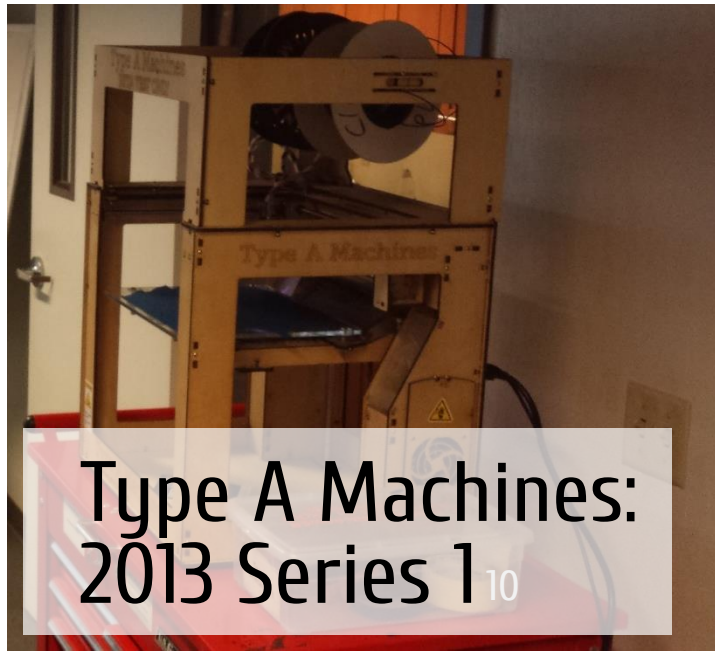


Printrbot Simple Metal



Makerbot Replicator 1, 2X

2014 Series 1



Type A Machines:
2013 Series 1

10. Problem: Tangled Filament

- Tightly wound filament unravels then tangles on itself, thereby choking off the flow of plastic to the extruder
- Causes failed parts – half printed.
- Overheats extruder nozzle
- Or worse…Pulls your 3D printer off of its desk / workbench

http://3d.balonio.com/files/2013/06/hanger0.png

10. Solution: Tangled Filament

Prevention:

- Buy quality 3D printer filament
- Periodic print monitoring “Look / Listen”
- Keep your filament wound as tight as possible.

Cure:

- Detangle: Unwind and rewind

http://3d.balonio.com/files/2013/06/hanger0.png

9. Problem: Clogged Extruder Nozzle

- This can happen and ruin your print for no reason.
- Can also damage your extruder and filament driver mechanisms

Extruded nozzle tip clogged

9. Solution: Clogged Extruder Nozzle

Prevention:

- Buy quality filament

Cure:

- Buy Malin piano wire (0.013" diameter) and apply like catheter (when nozzle is hot)
- Disassemble extruder nozzle and soak in acetone

@you3dit #makerfaire

http://i45.tinypic.com/20jmwzm.jpg

8. Problem: Failures during batch printing failures

- Printing multiple parts and then one part fails....(insert swear words here)

8. Solution: Don't do Batch Jobs prior to a full and robust calibration of your specific machine

Prevention:

- Print one part at a time

Cure:

- Research your Slicing program to see if there is an option for "sequential printing"
- Ensure great machine calibration prior to attempting batch jobs

8. Solution: Don't do Batch Jobs prior to a full and robust calibration of your specific machine

Sequential printing

Complete individual objects: ☑

Extruder clearance (mm):

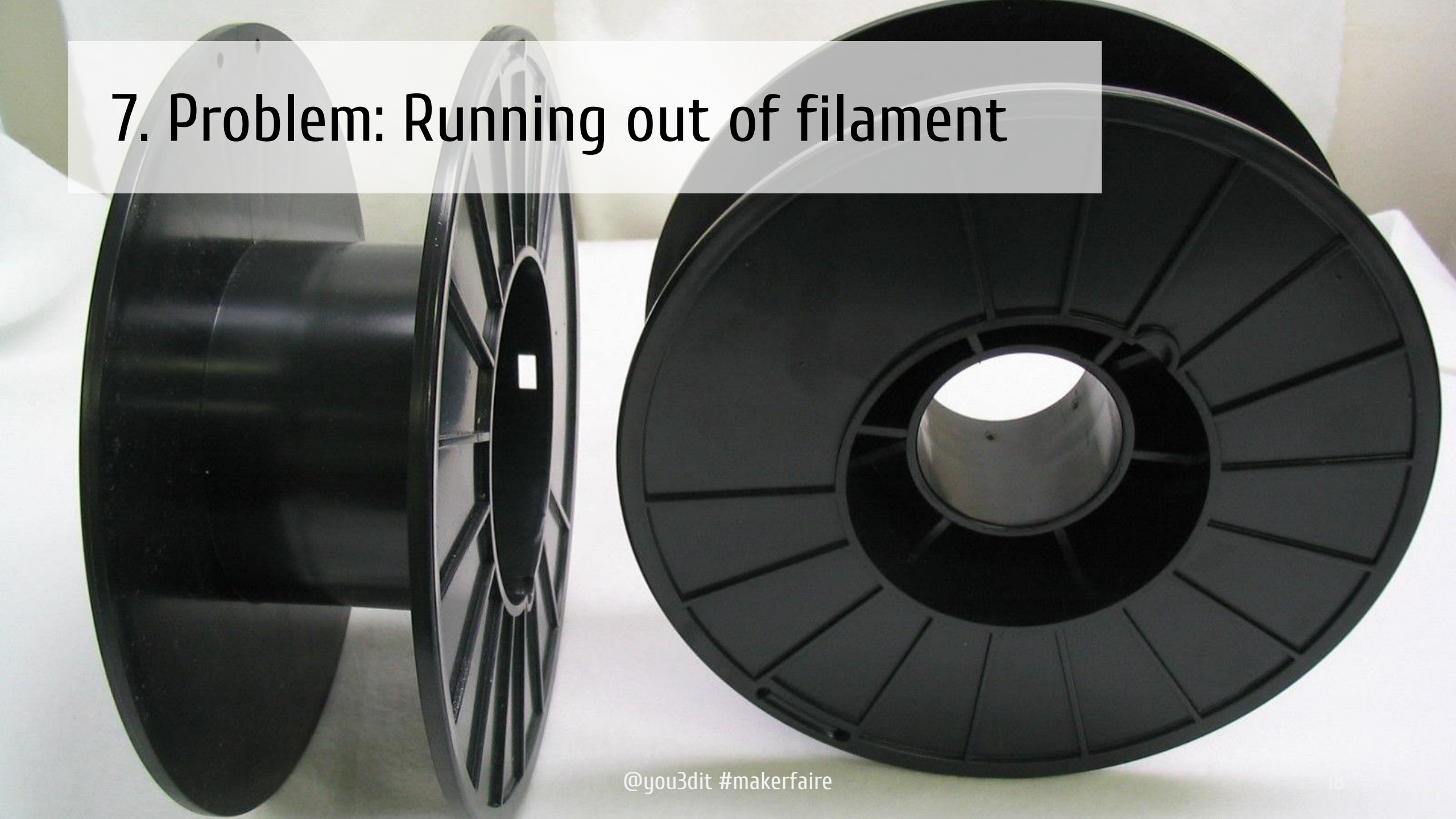
When printing multiple objects or copies, this feature will complete each object before moving onto next one (and starting it from its bottom layer). This feature is useful to avoid the risk of ruined prints. Slic3r should warn and prevent you from extruder collisions, but beware. (default: no)

Output file

Verbose G-code: ☐

Output filename format: [input_filename_base].gcode

7. Problem: Running out of filament



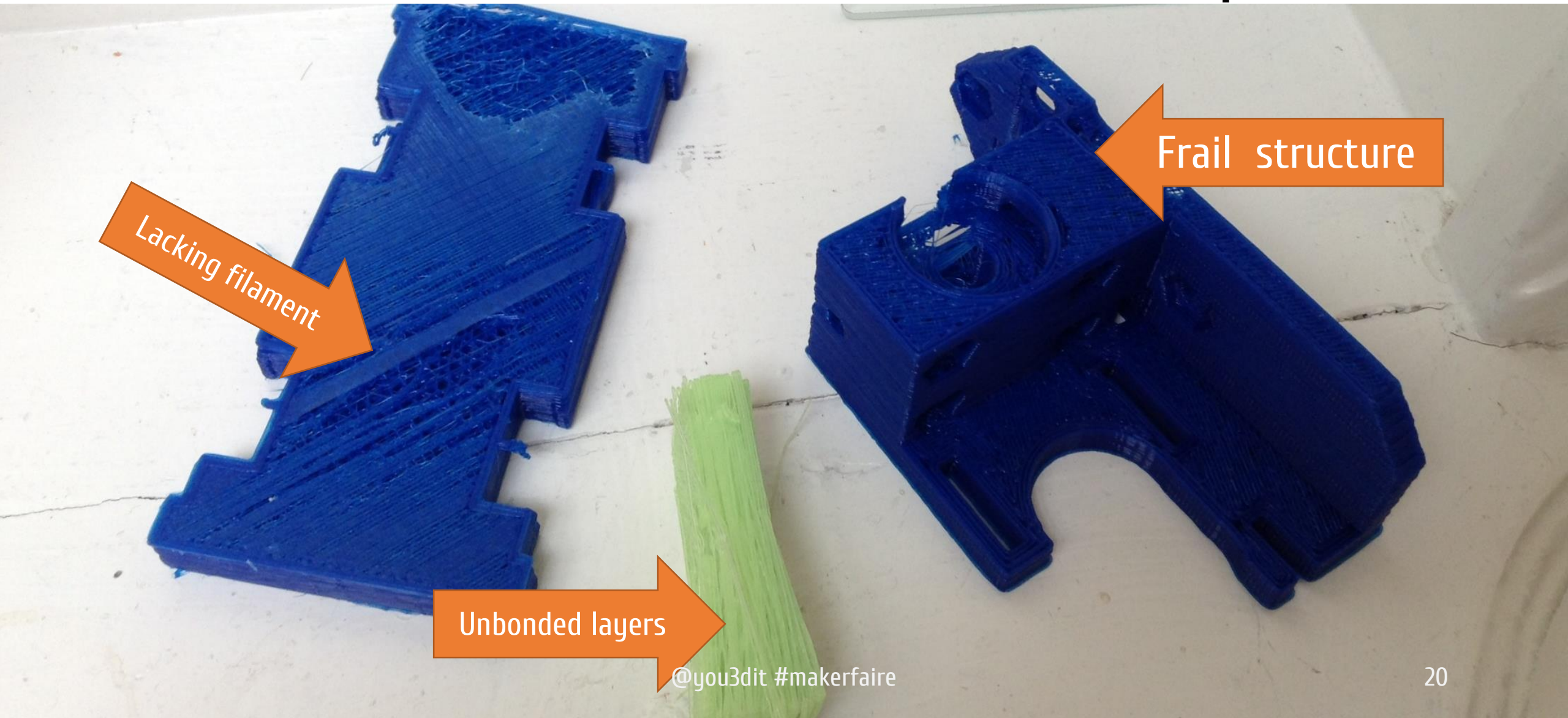
7. Solution: Running out of filament

- Use a full spool – duh
- Longer prints? Run some calcs
  - (Material Density) x (Part Volume) = (Mass of final part)
  - (Total mass) – (Mass of empty spool) = (Mass of filament)
  - (Mass of filament) > (Mass of final part) + 10%
- Order extra rolls of the same filament, same manufacturer

Universal 3D Printer Filament Spool

3DPrintingEra.com Article

6. Problem: Brittle or “filament starved" parts



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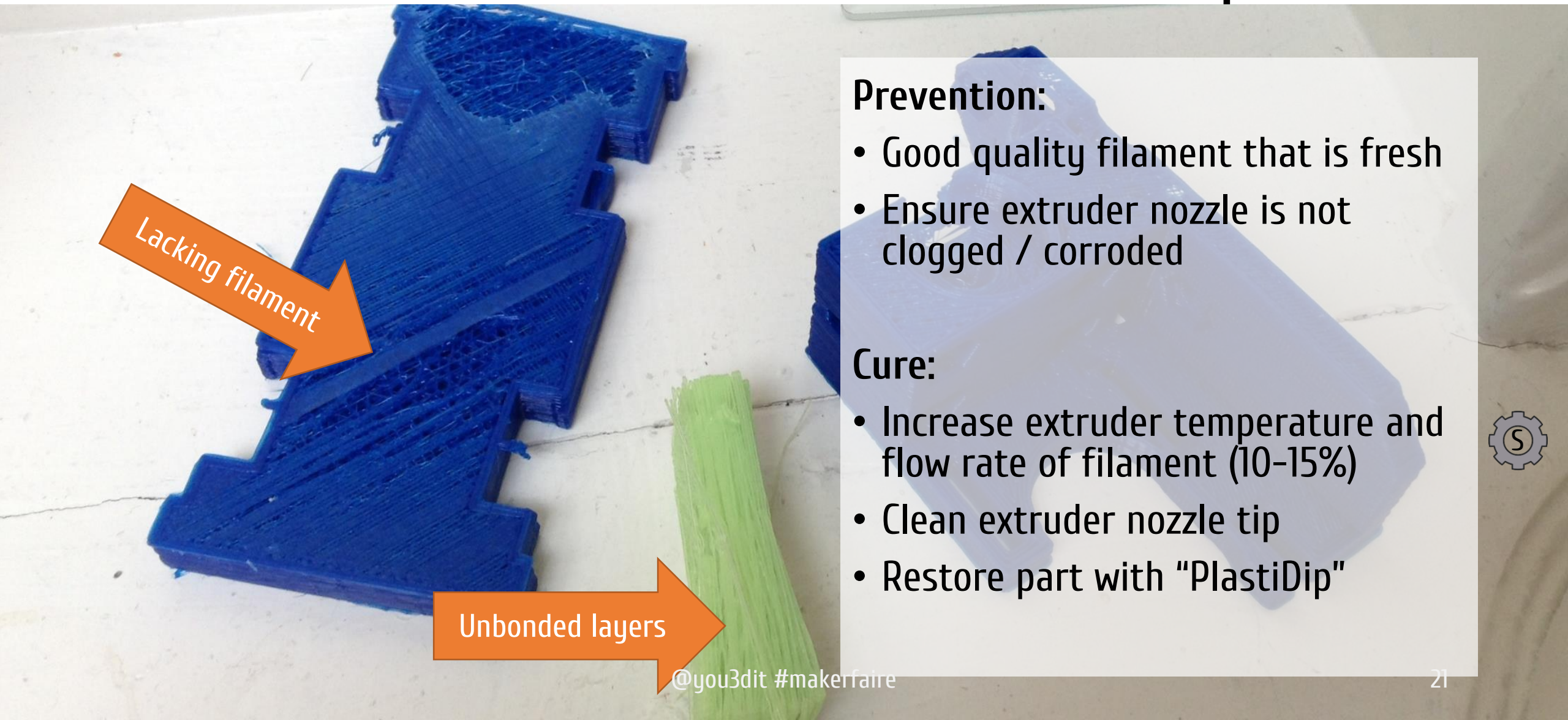

Prevention:

- Good quality filament that is fresh
- Ensure extruder nozzle is not clogged / corroded

Cure:

- Increase extruder temperature and flow rate of filament (10-15%)
- Clean extruder nozzle tip
- Restore part with “PlastiDip”

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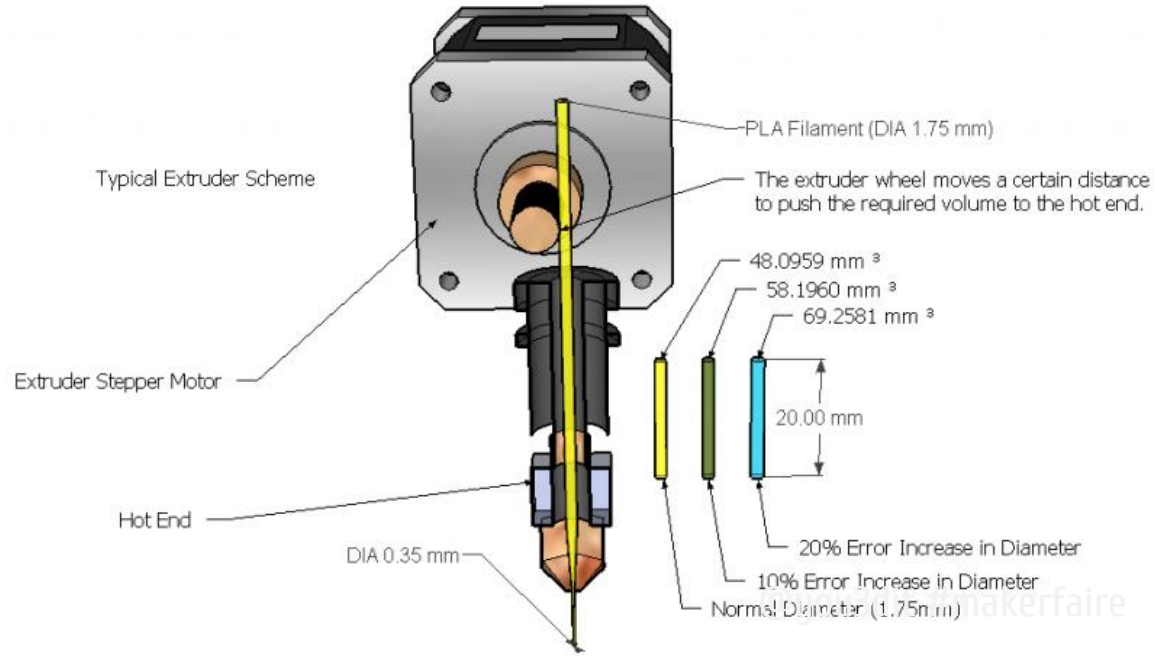
5. Problem: Using bad filament

- Poly Lactic Acid – aka PLA – absorbs moisture
- Cheap filament varies in diameter by 5-20%
- Cheap filament often has air bubbles / impurities



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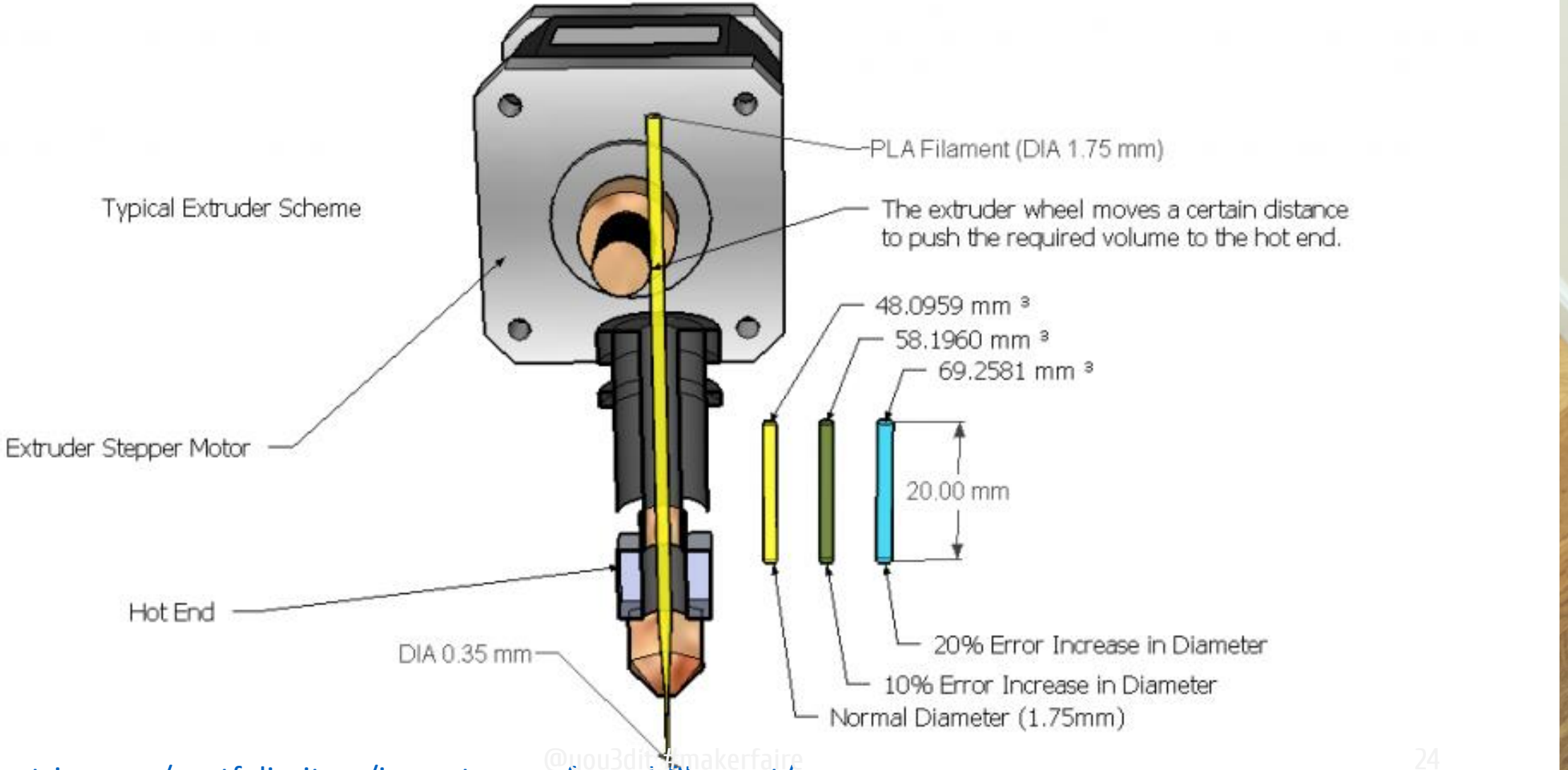
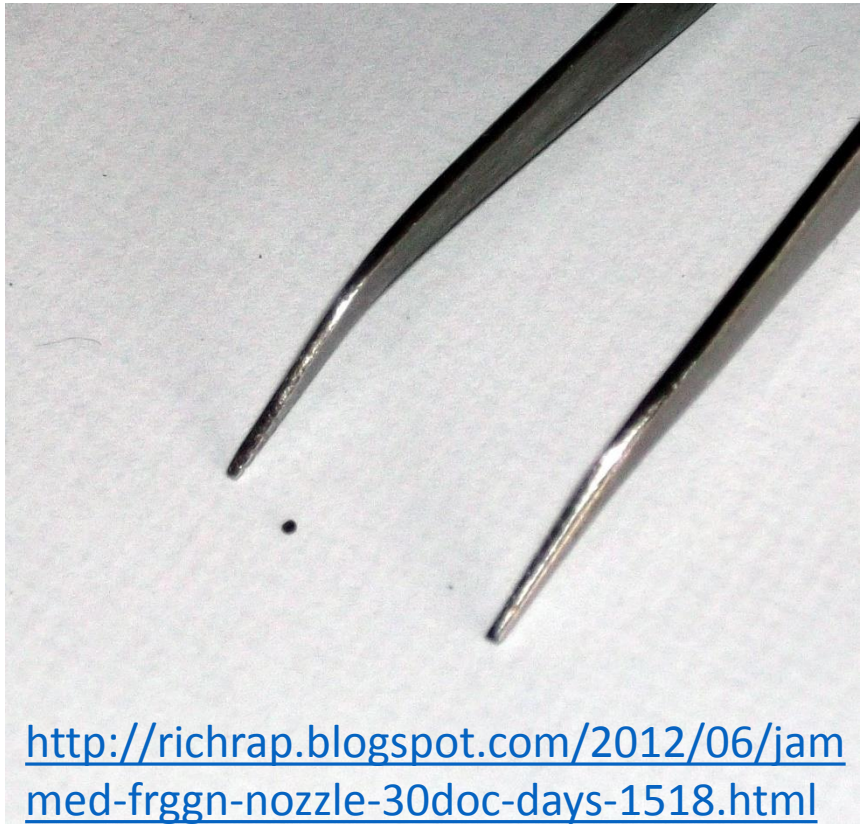


http://bootsindustries.com/portfolio-item/importance-of-good-filament/

5. Solution: Use quality filament

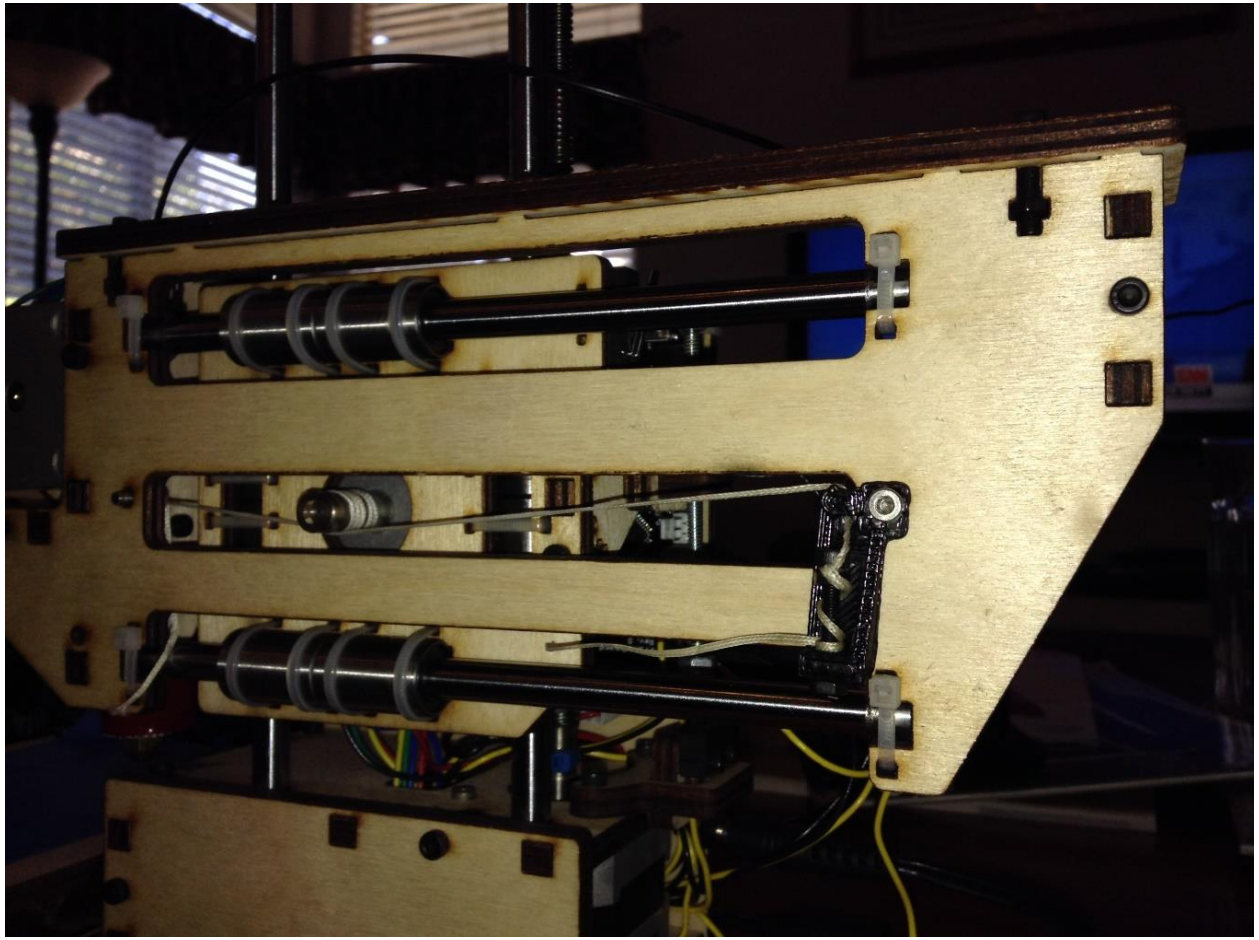
- Either recommended by the manufacturer
- Or by reputable sources, like Cubicity.com

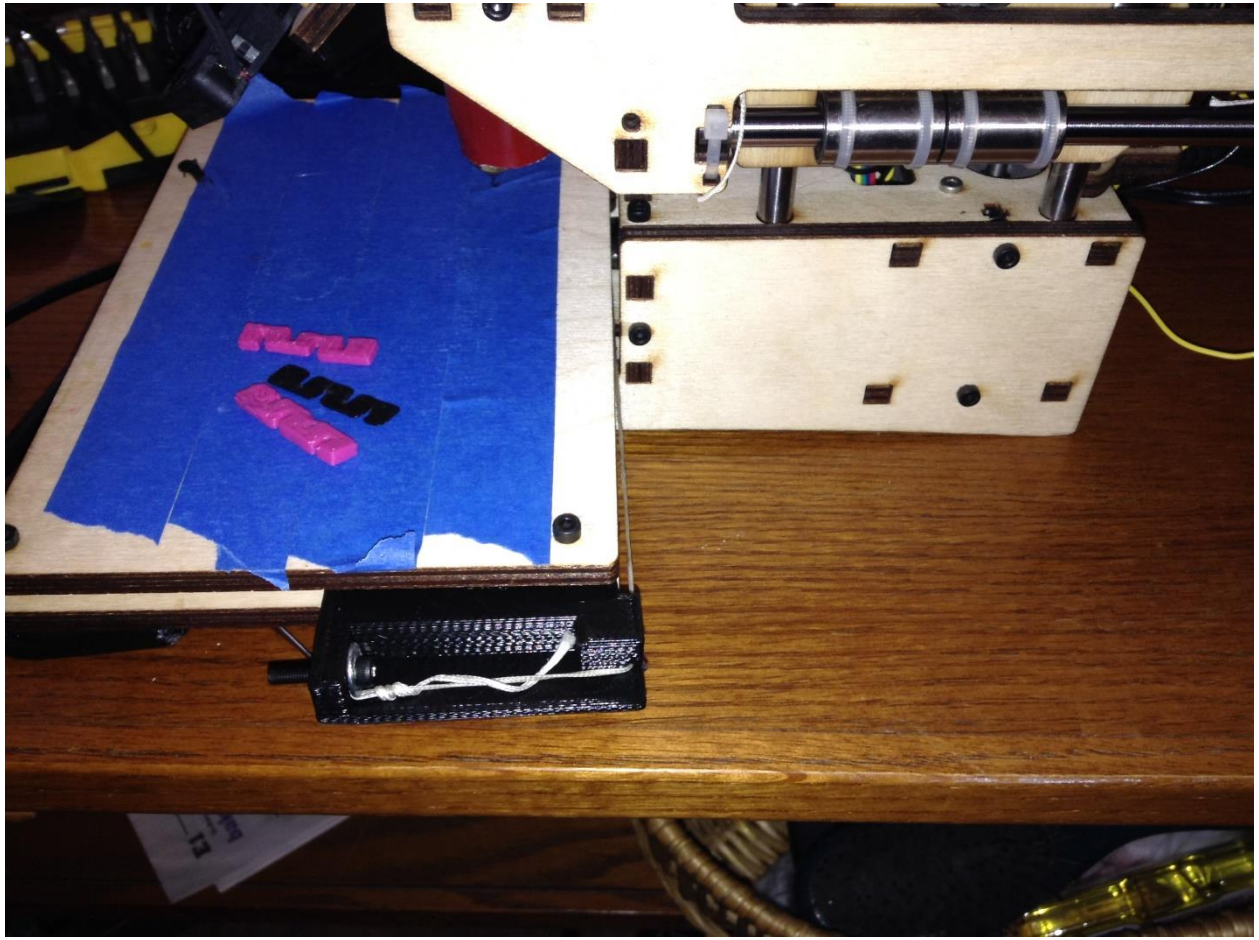


http://richrap.blogspot.com/2012/06/jammed-frggn-nozzle-30doc-days-1518.html

4. Problem: Poor z-layer alignment

4. Solution: Poor z-layer alignment – belt tensioners





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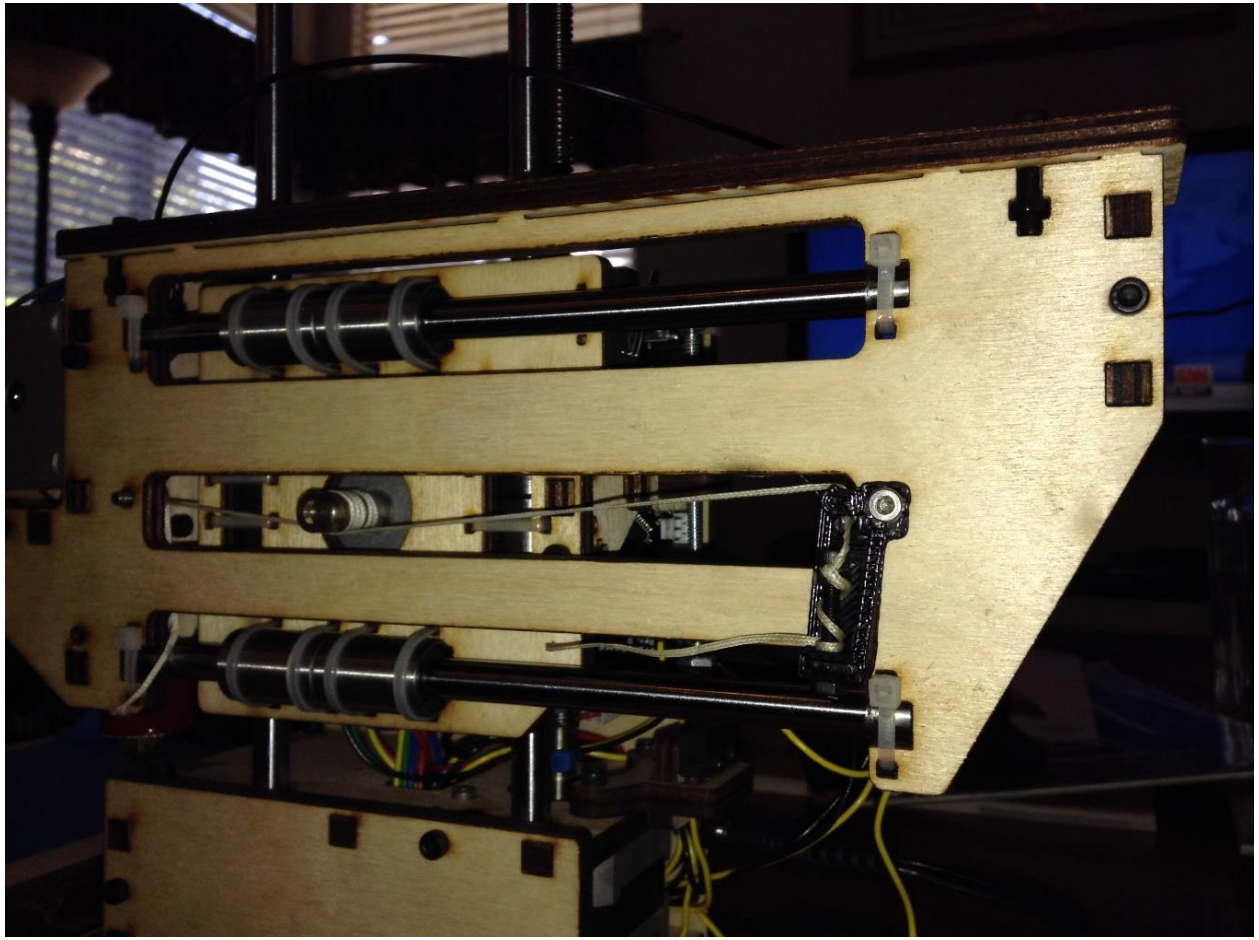
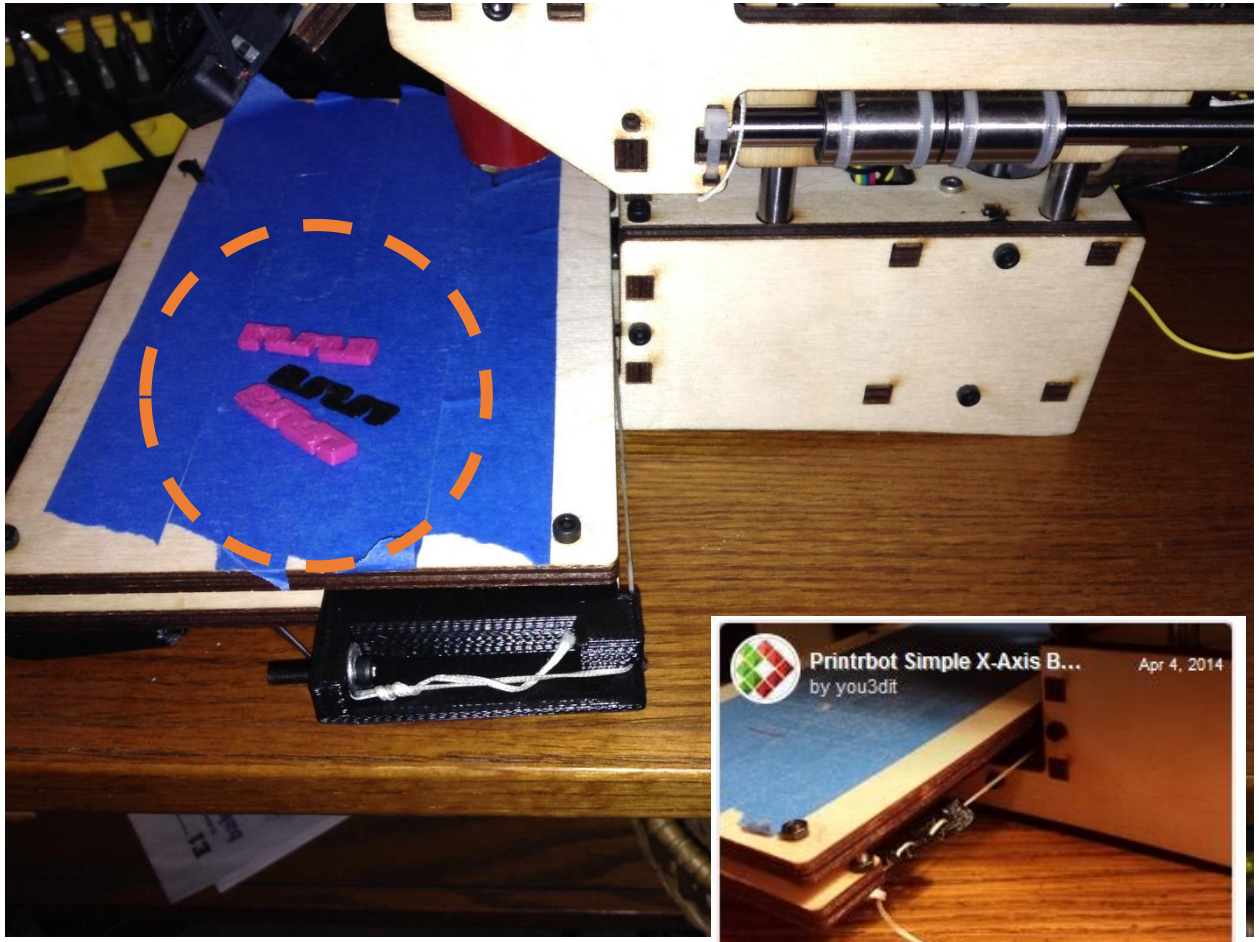
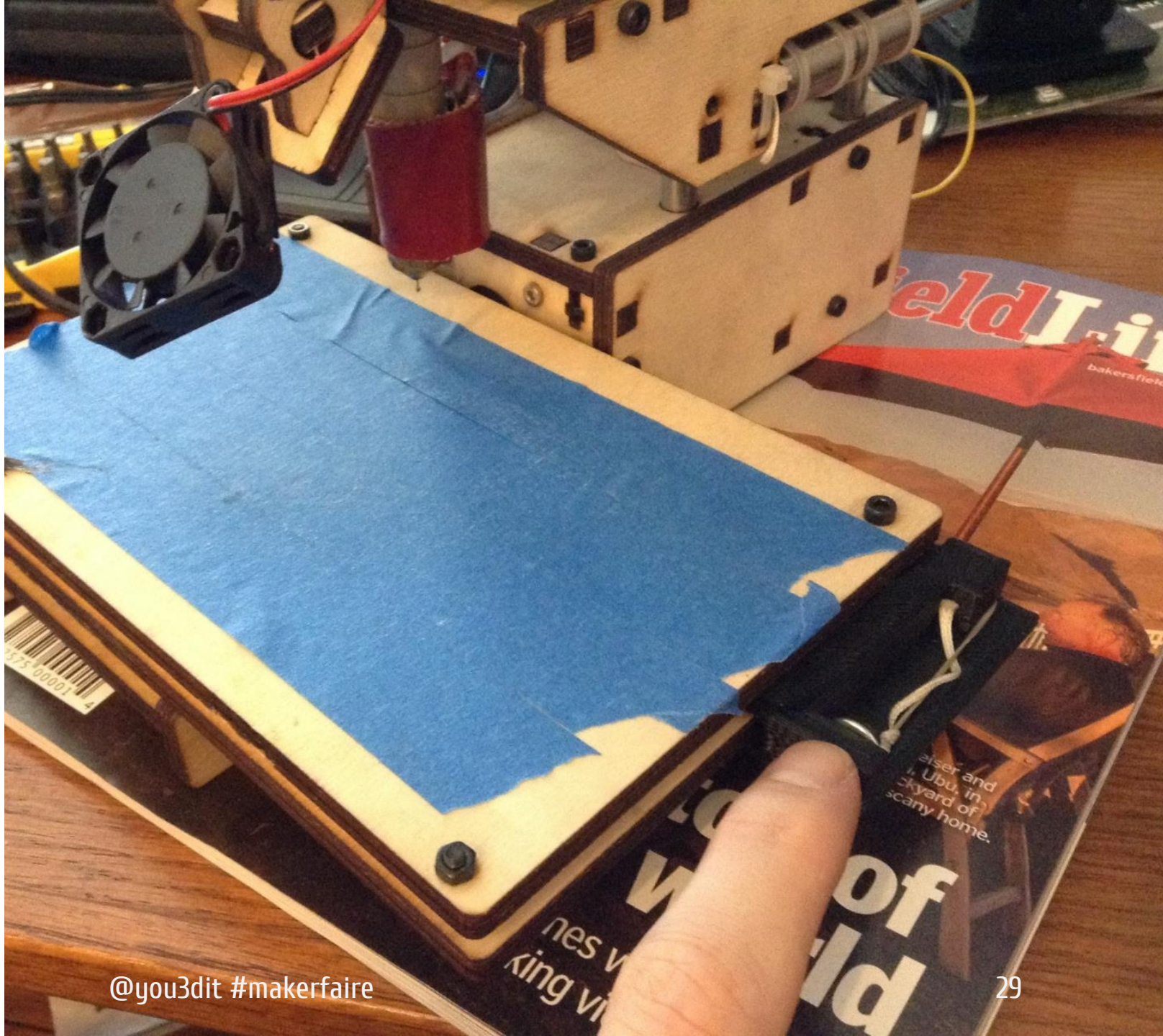


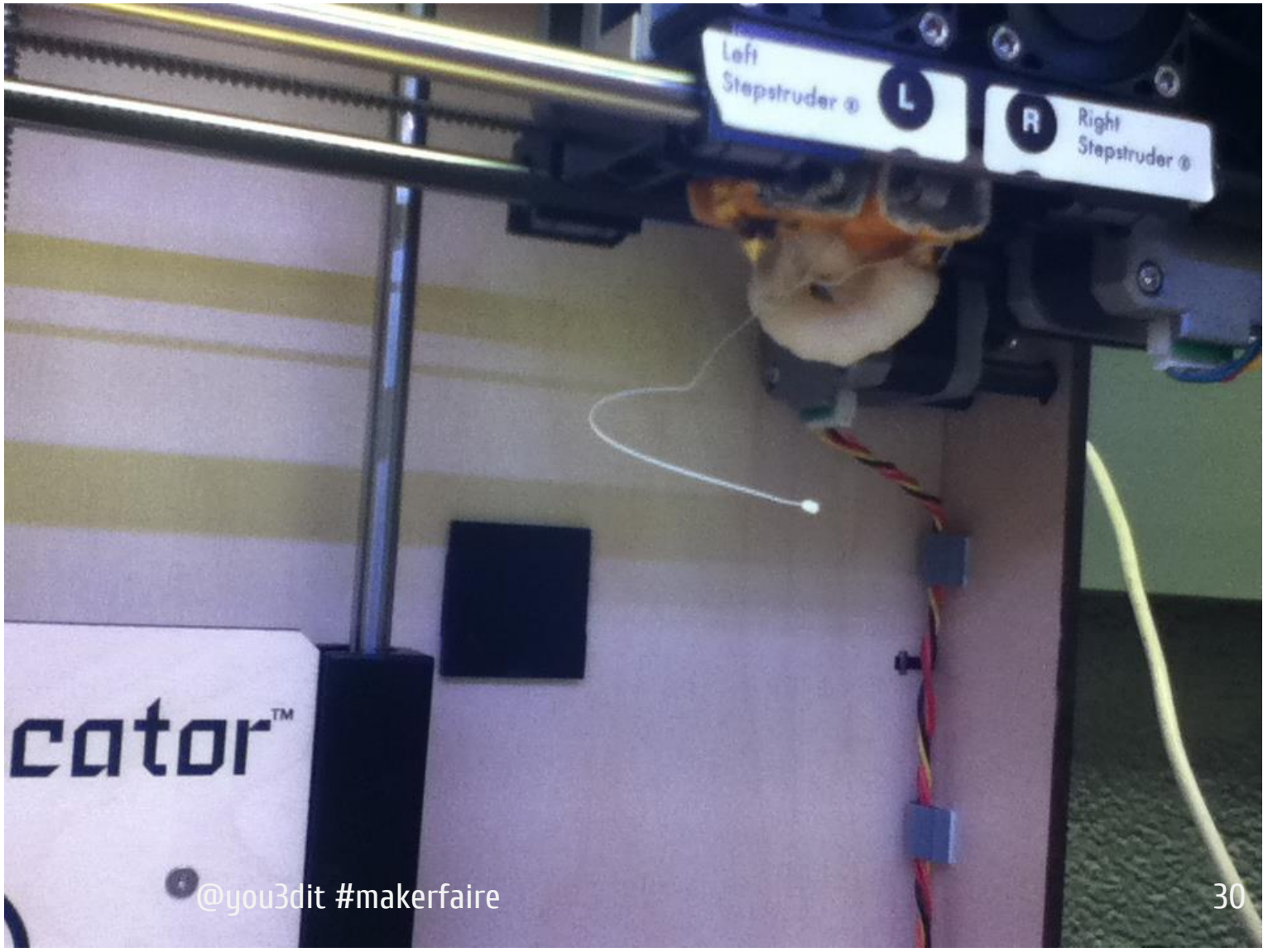


4. Solution: Poor z-layer alignment

1. More solutions:
    1. Reducing layer print speeds
    2. Adding acceleration ~30-60 mm/s^2
2. Upgrade axis motion mechanisms (belts vs. tensioned cables)



3. Problem: Part separation from build platform



3. Problem: Part separation from build platform

- This has dire consequences:
  - Failed parts
  - Or worse…damages machine
  - Or even worse…SETS FIRE TO YOUR OFFICE

3. Solution: Part separation from build platform

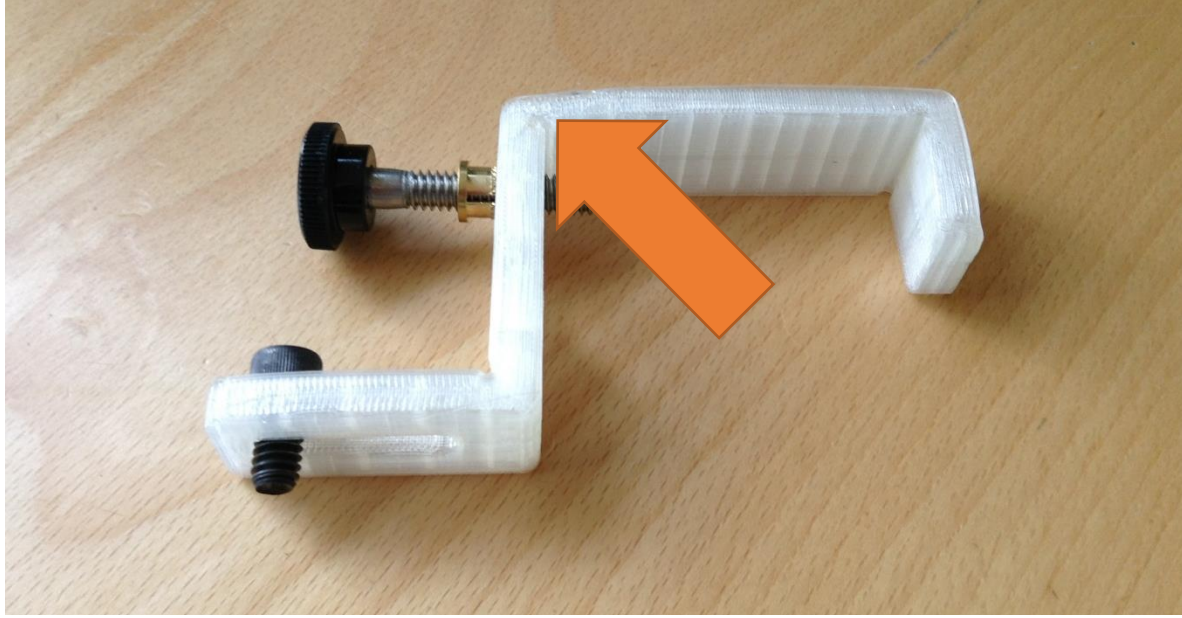
Prevention:

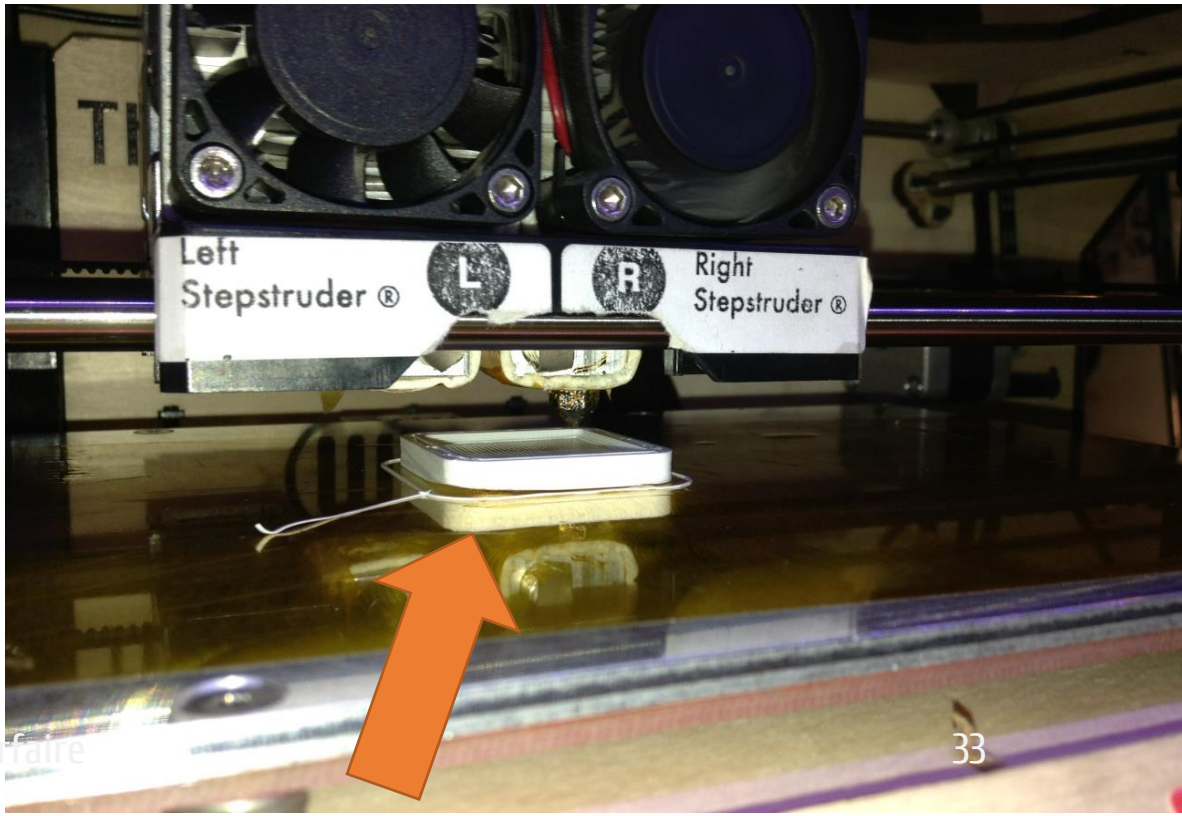
- Good z-axis calibration
- Clean print surfaces
- Replace bed tape
- Apply adhesives: hairspray / gluestick

Cure:

- End print, start over

2. Problem: Part warping





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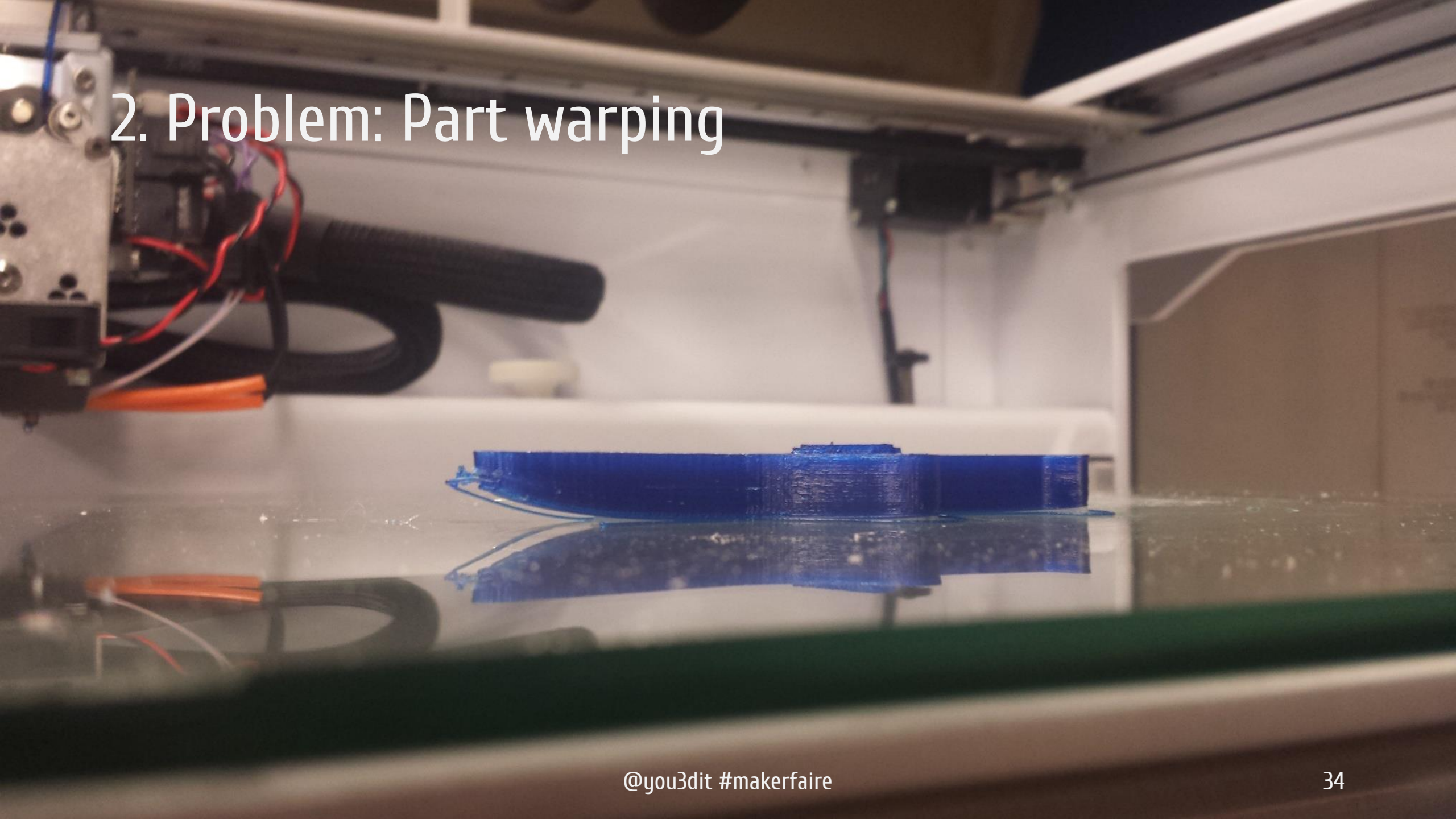
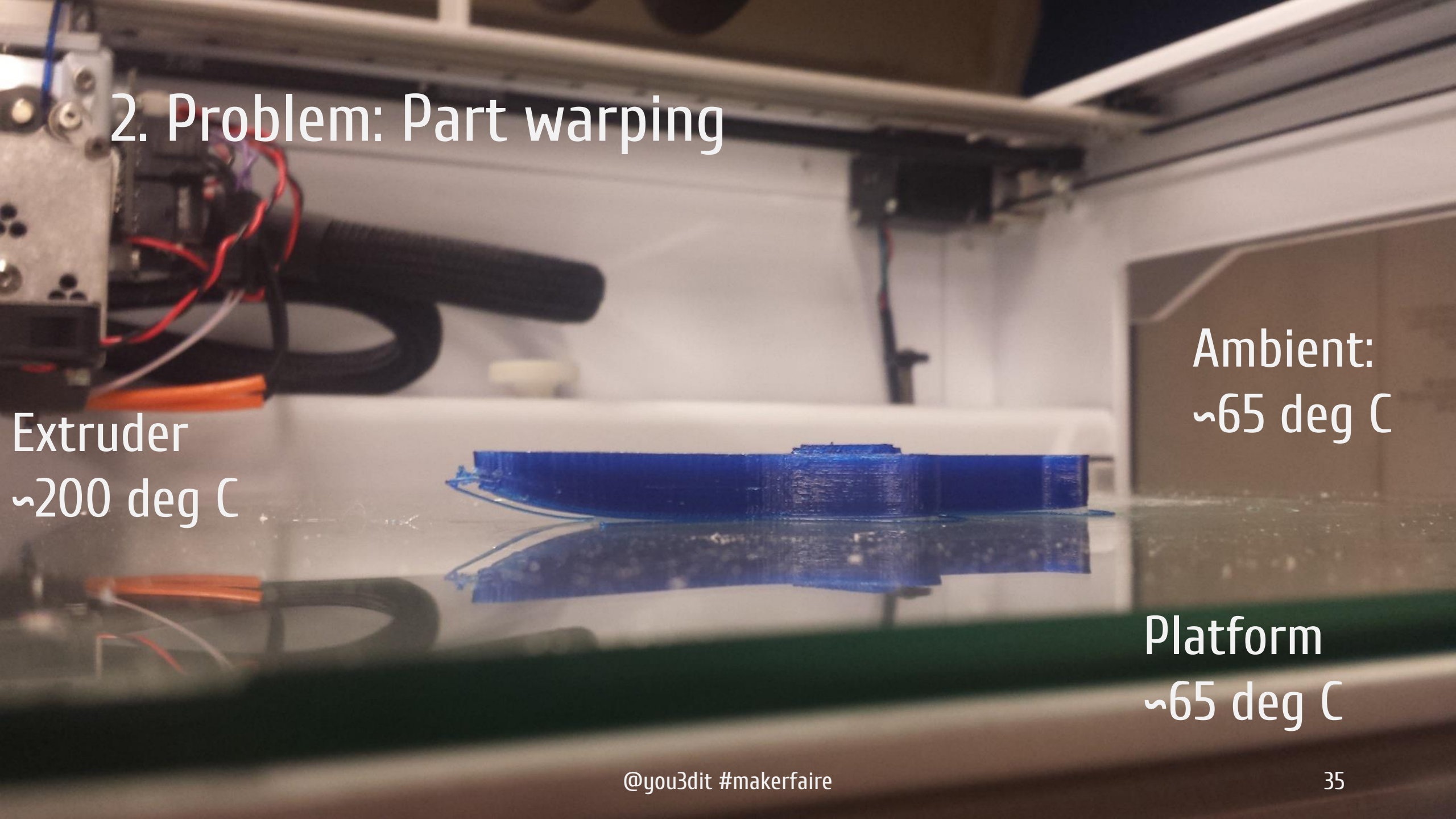
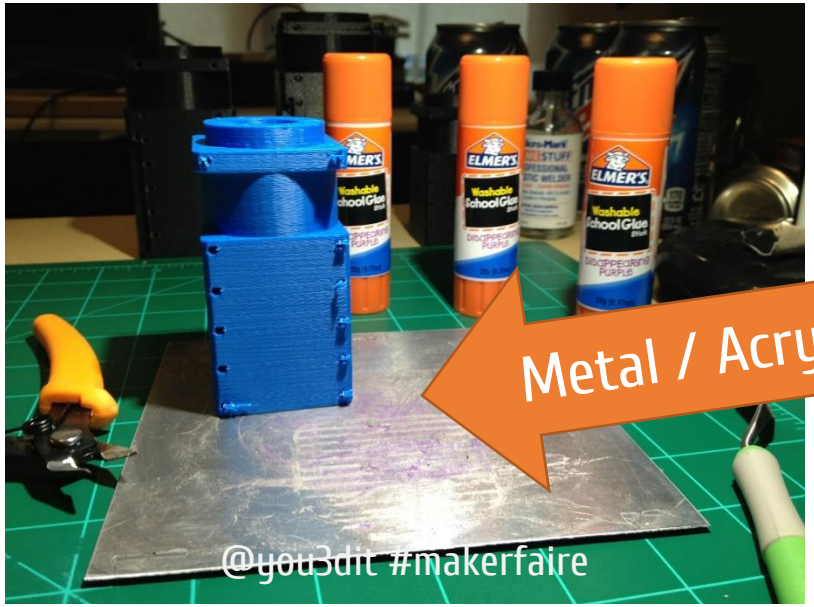
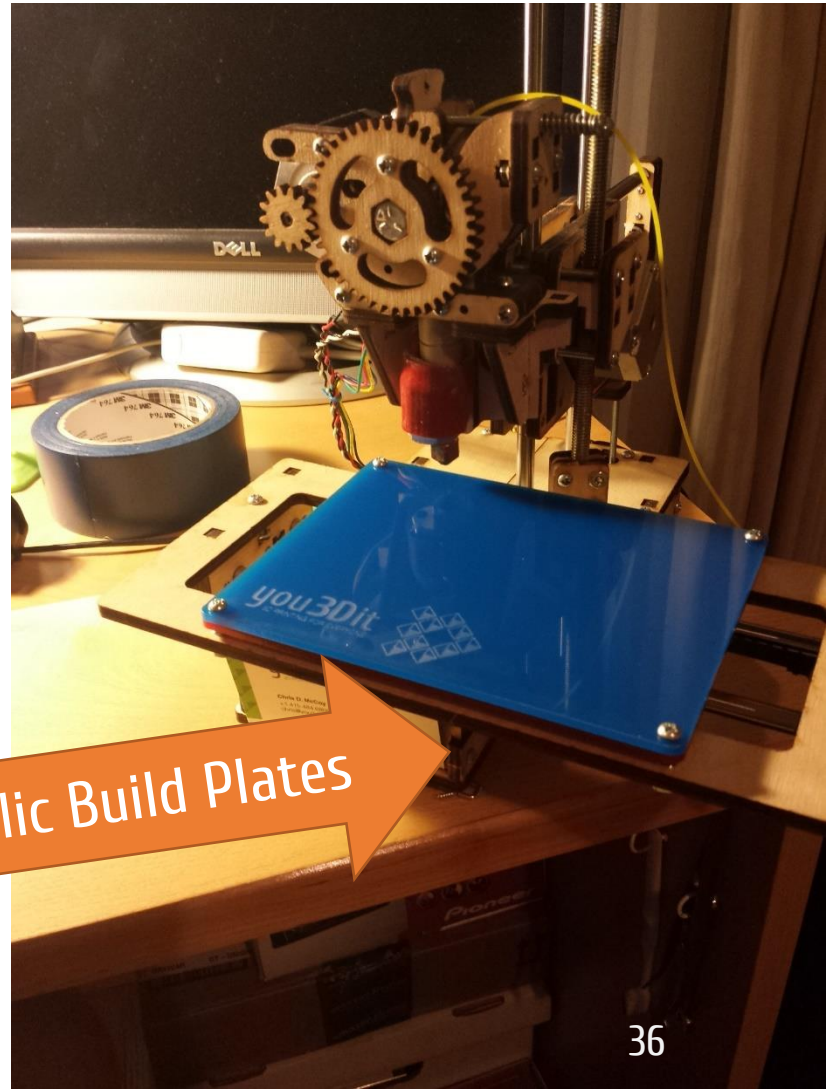



2. Problem: Part warping
Extruder
~200 deg C
Ambient:
~65 deg C
Platform
~65 deg C

2. Solution: Part warping – temperature management & surface adhesives

- Temperature difference $T_{bed} \sim 1/2\ T_{ext}$.
- Using:
  - Heated build plates
  - Thermally-isolating build platforms: glass / acrylic / wood
  - Print a "Brim" to buffer heat loss
- Cheat w/Adhesives:
  - Hairspray
  - Glue sticks

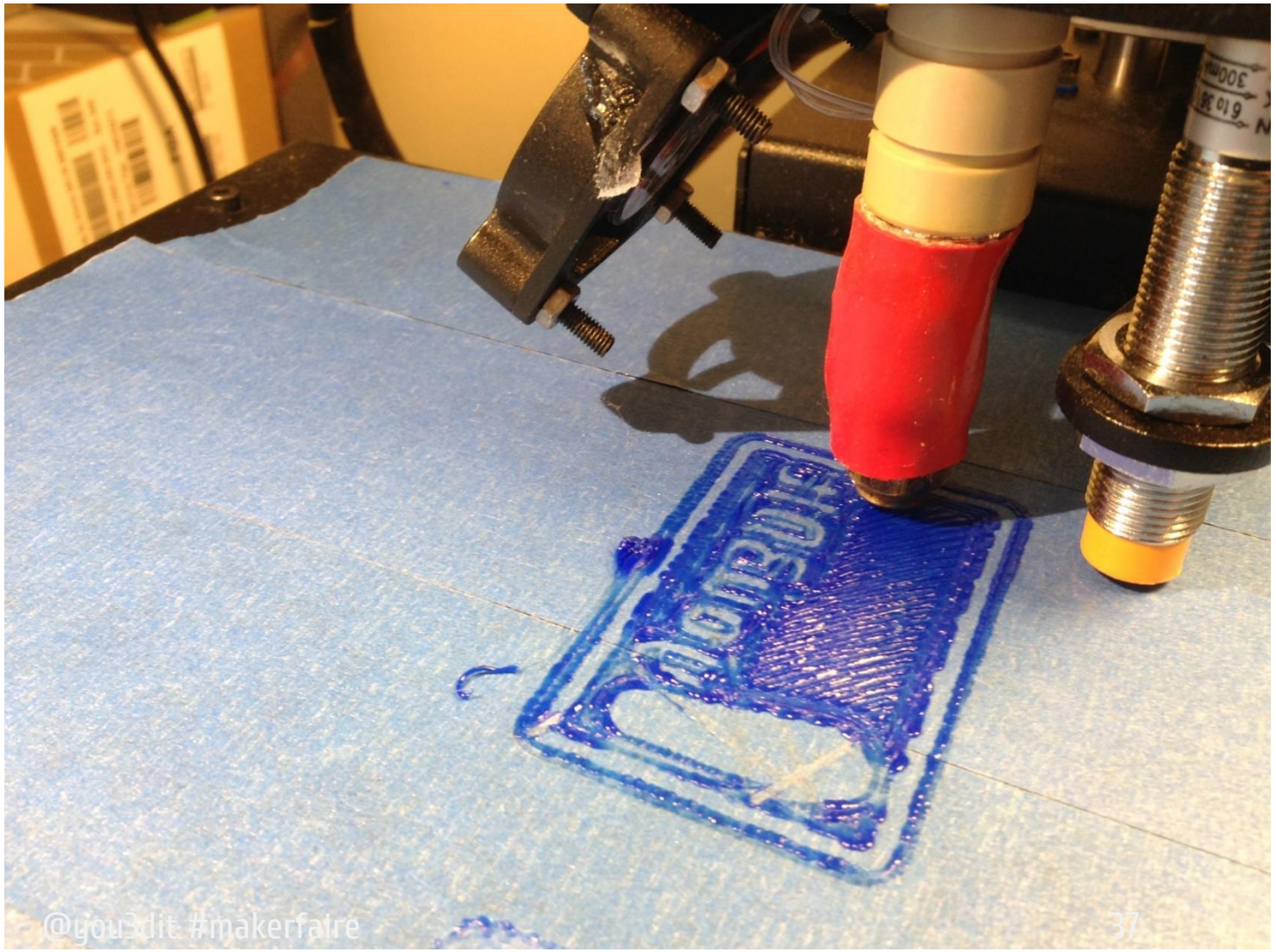




Metal / Acrylic Build Plates

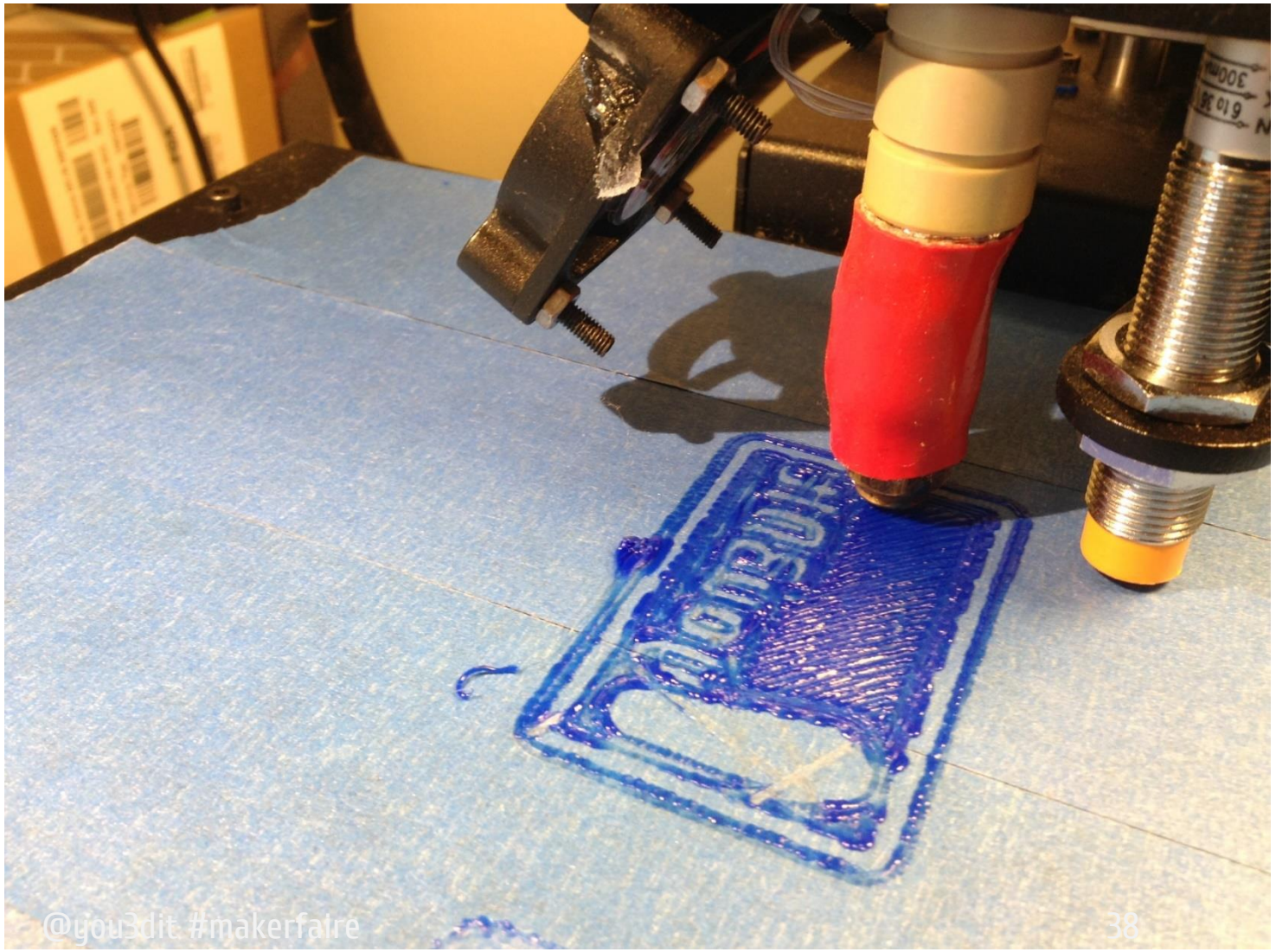
1.5. Problem: Improper Bed Leveling

1. Calibration of your bed height along the z-axis is SUPER important.
2. Additionally, the extruder nozzle x-y plane needs to be exactly parallel to your base plate x-y surface.

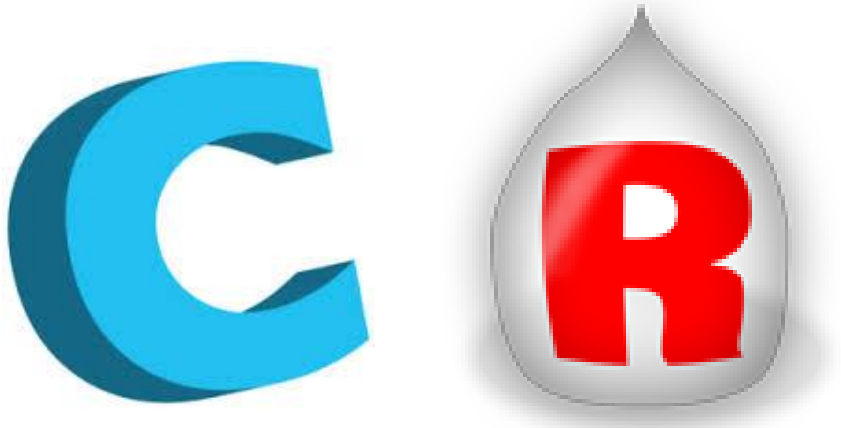


1.5. Solution: Improper Bed Leveling

1. Run through on-board leveling instructions if they exist
2. Manually adjust leveling screws until the z-height gap is equal across the plane of the platform
3. Choose the “print skirt” option in your slicing engine in order to see bed orientation before starting big prints.



1. Problem: Incorrect Software / Hardware setup



1. Solution: Incorrect Software / Hardware setup

- Fellow makers are your friend
- Google is your friend
- Manufacturer forums
- Start with simple models to print
- Start with default slicing settings
- Check / replace USB / Power cables
- Check / replace computer

Thanks

- World Maker Faire 2014 - NYC
- Claude Noriega – TechShop SF
- Max Cornell – Serial Entrepreneur, TechShop SF
- Hans Luther – Cubicity.com
- Miguel Angel de Frutos Caro – bq.com, CloneWars, Madrid, Spain
- Jose Luis Mondelo – You3Dit.com
- Joan McCoy "Mom"
- Nicolas Vighi – PlastiDip Reference

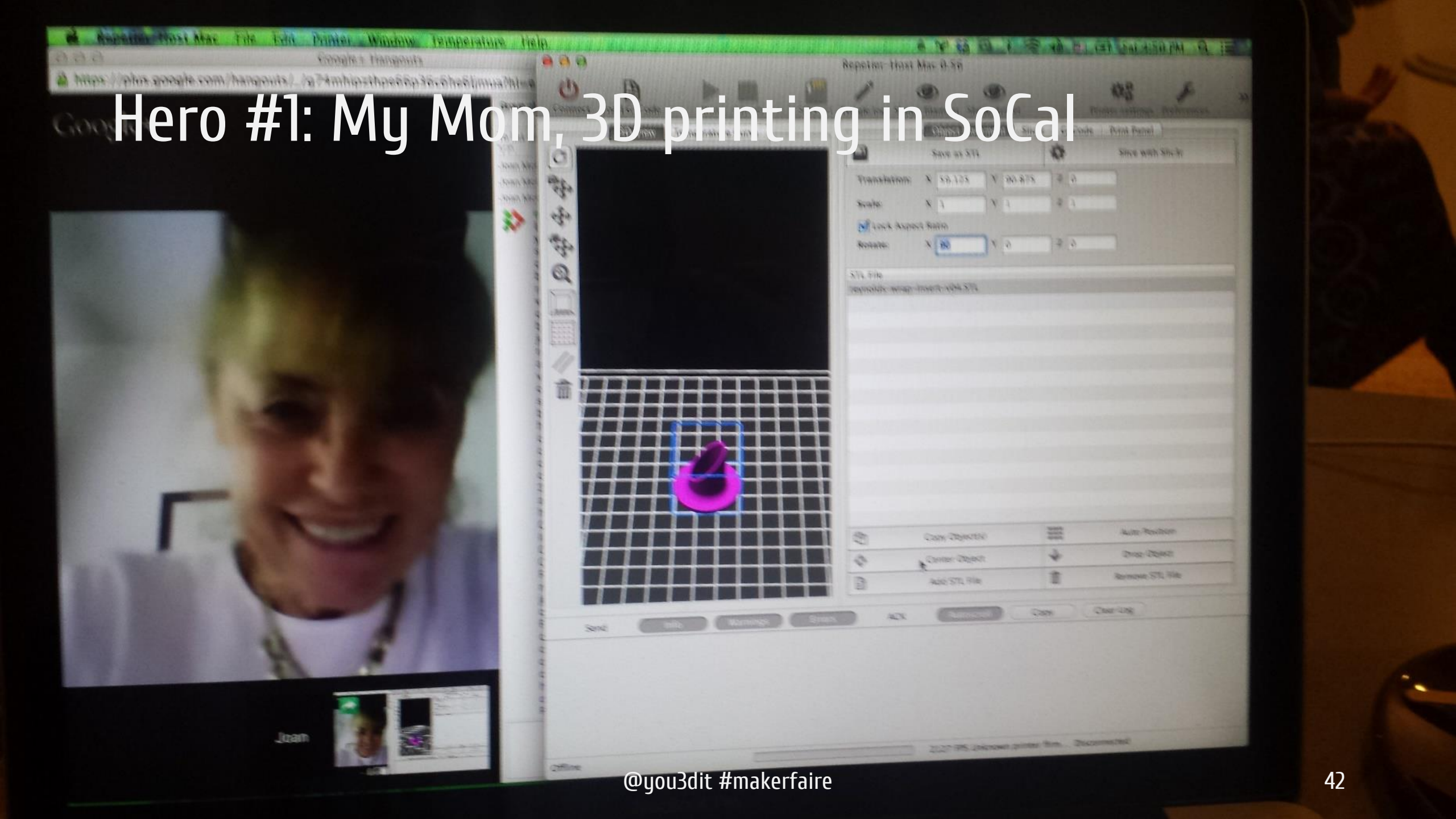
REFERENCES:

- Reprap Pictoral Guide for 3D Printer Problems (link)
- Presentation at: http://www.bit.ly/Make3DPFun

Questions?

chris@you3dit.com

Hero #1: My Mom, 3D printing in SoCal

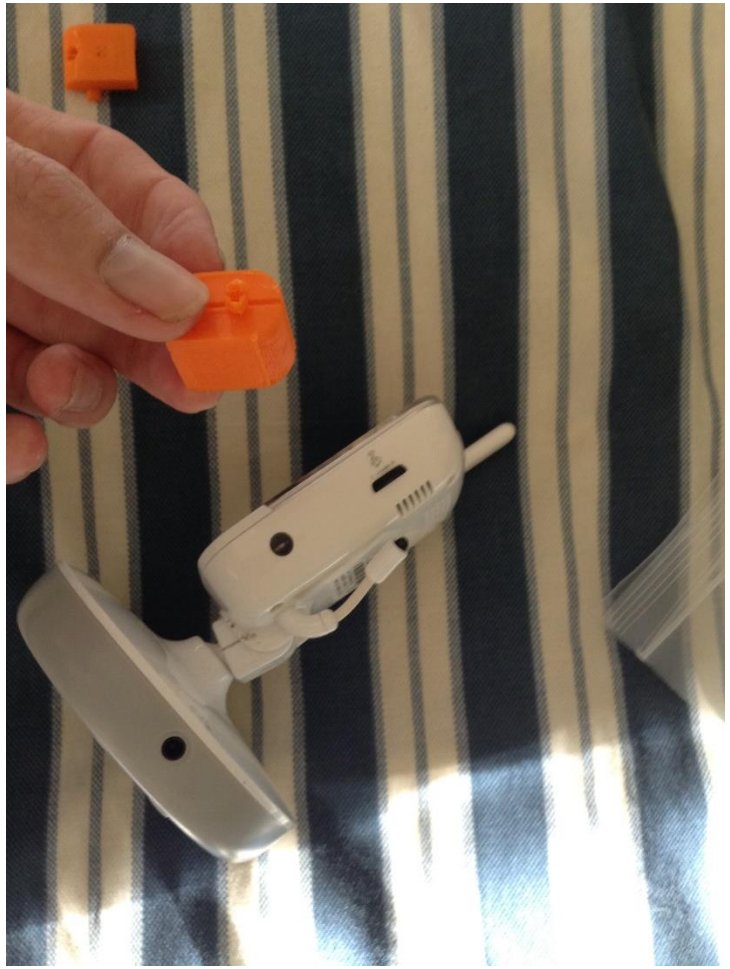


Hero #2: Brook Drumm, founder of PrintrBot

Hero #3: Bre Pettis, Founder of Makerbot

Hero #4: Dale Dougherty, Founder of Make Media

Other problems: Aspect ratio challenged parts



Other Problems: Output part sizes don't match design