

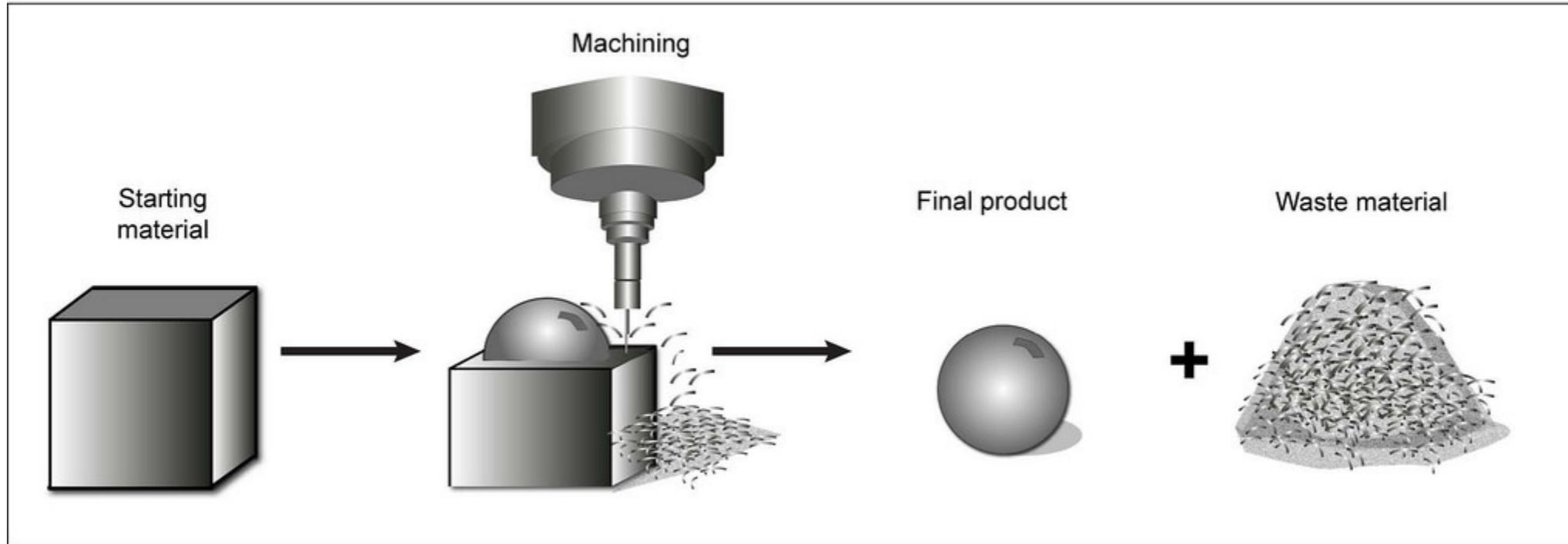
# **3D Printing**

## **Bits to Atoms**



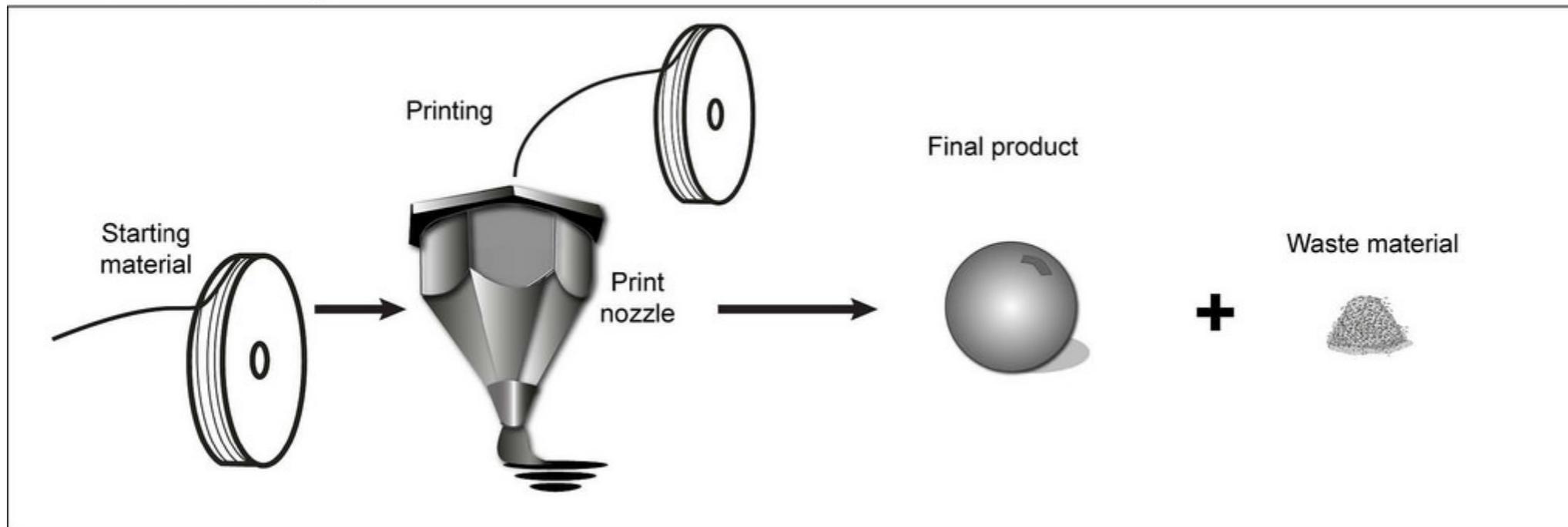
# Additive vs. Subtractive

## Subtractive manufacturing



**3rd Industrial  
Revolution**

## Additive manufacturing



**4th Industrial  
Revolution**

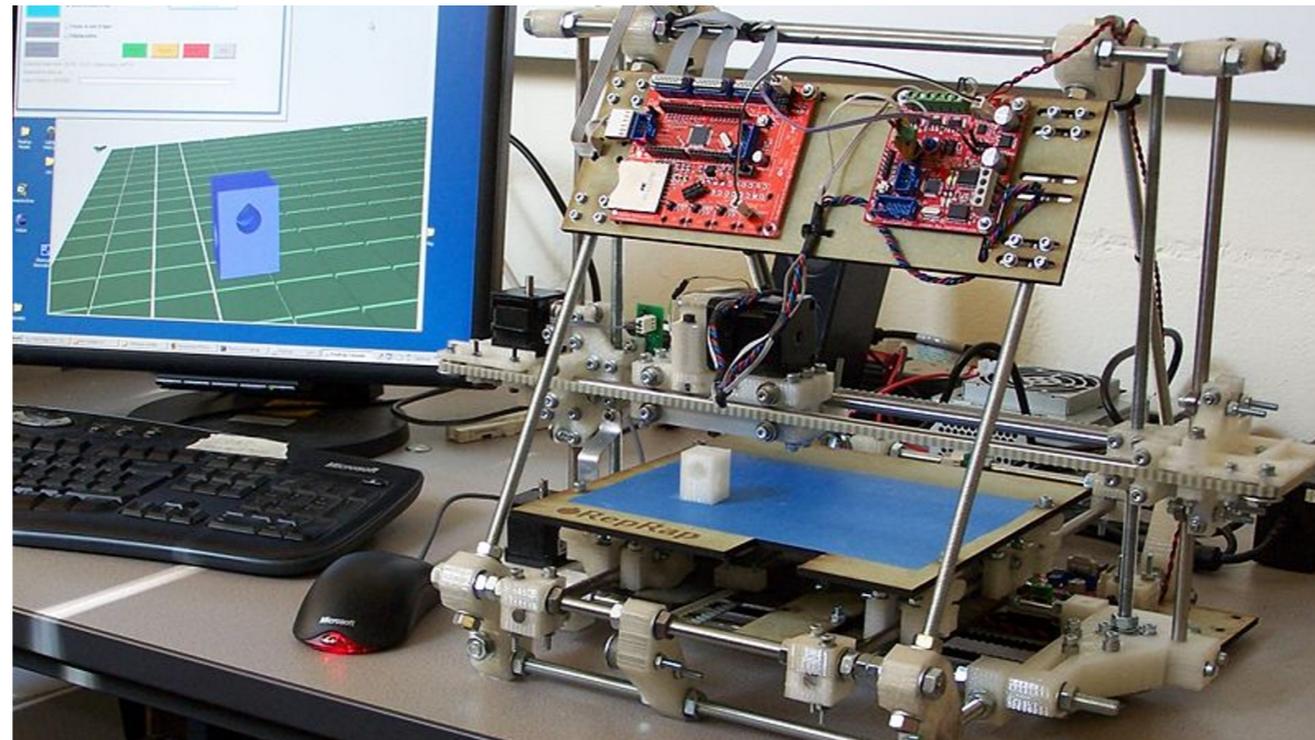
# History

1980 - SLS method developed

1992 - SLA method developed

2005 - RepRap Project

- Open Source hardware
- Goal: a printer that could build itself.



How he started the worldwide 3D printing revolution: Adrian Bowyer  
<https://www.youtube.com/watch?v=VV0Tjwq7Uc0>

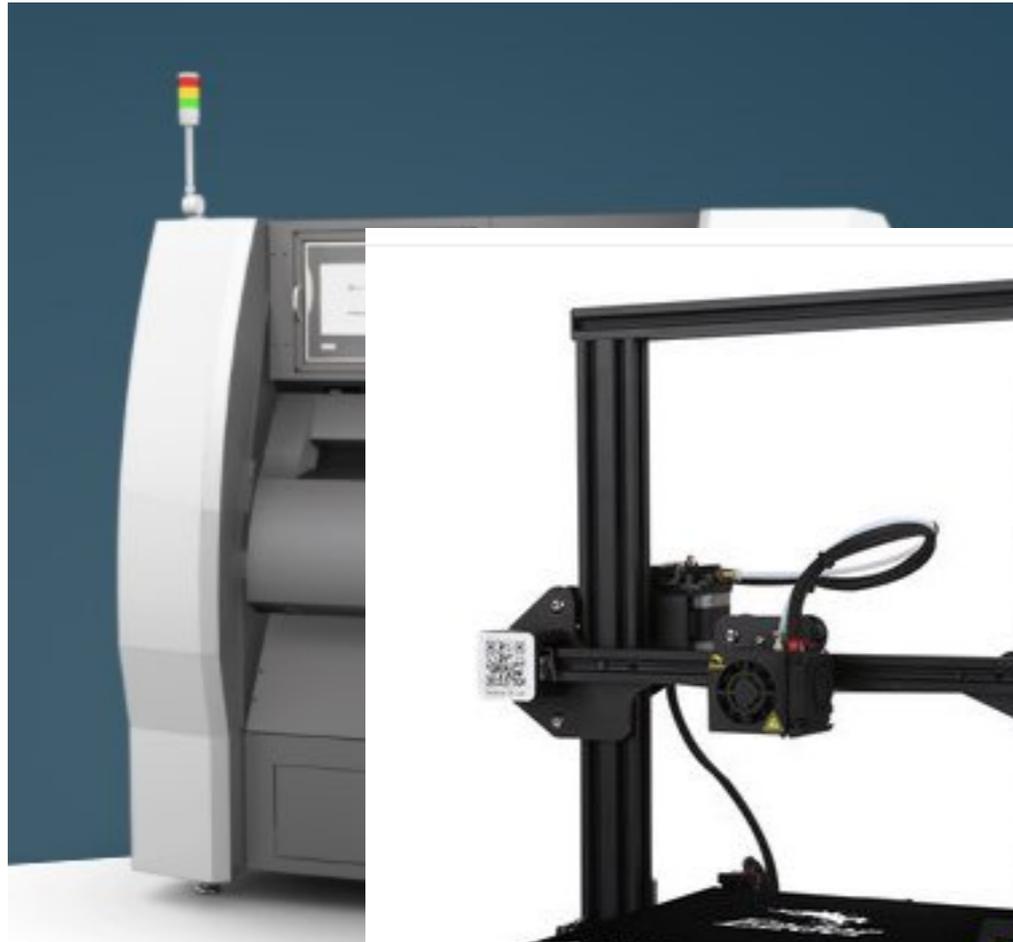
Early patent are expiring ==> an explosion of new products in all these technologies.

# Price Spectrum



**SLS: metals, ceramics**  
**> \$250,000**  
**200x200x330mm build envelope**

# Price Spectrum



SLS: m  
> \$250,0  
200x200



Creality 3D® Ender-3 V-slot Prusa  
Resume Function/MK10 Extruder 1

★★★★★ (526 Reviews) Product ID: 1278

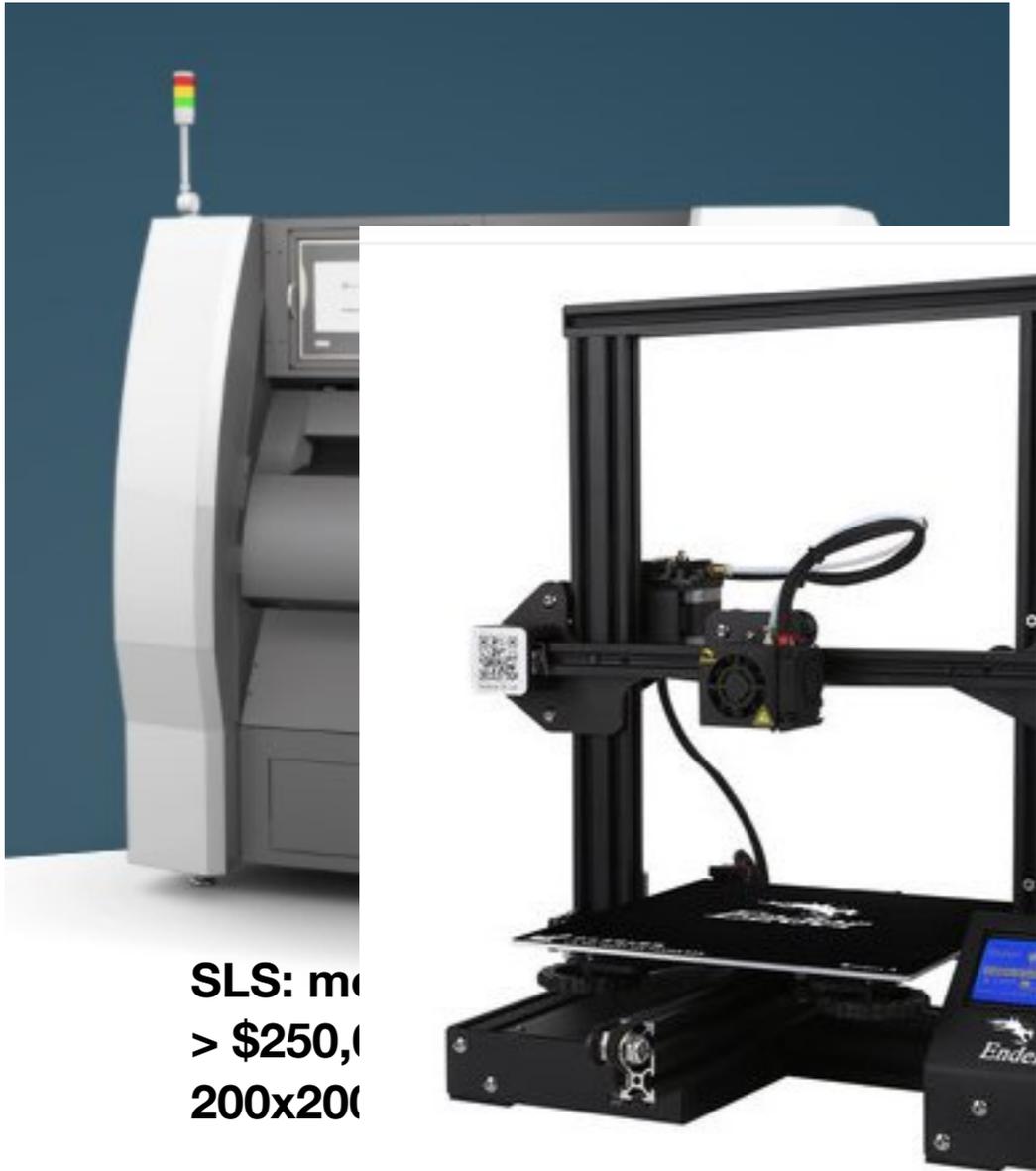
In stock, usually dispatched in 1 business day

Price: US\$ ∨ **179.99**

Shipping: **US\$6.14** to United States via U  
2-8 business days

QTY:

# Price Spectrum



SLS: m  
> \$250,0  
200x200



**Prusa i3**

**\$1000 (\$750 kit)**

**210x210x250 build envelope**

<https://www.youtube.com/watch?v=M73uIMDIvvk>

# 3D Printing Workflow

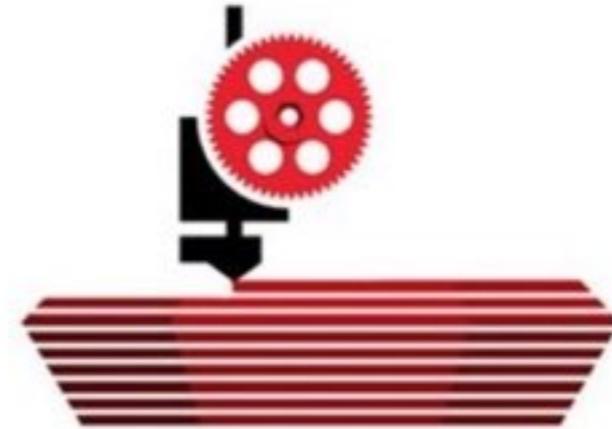
**CAD**



**Slice**

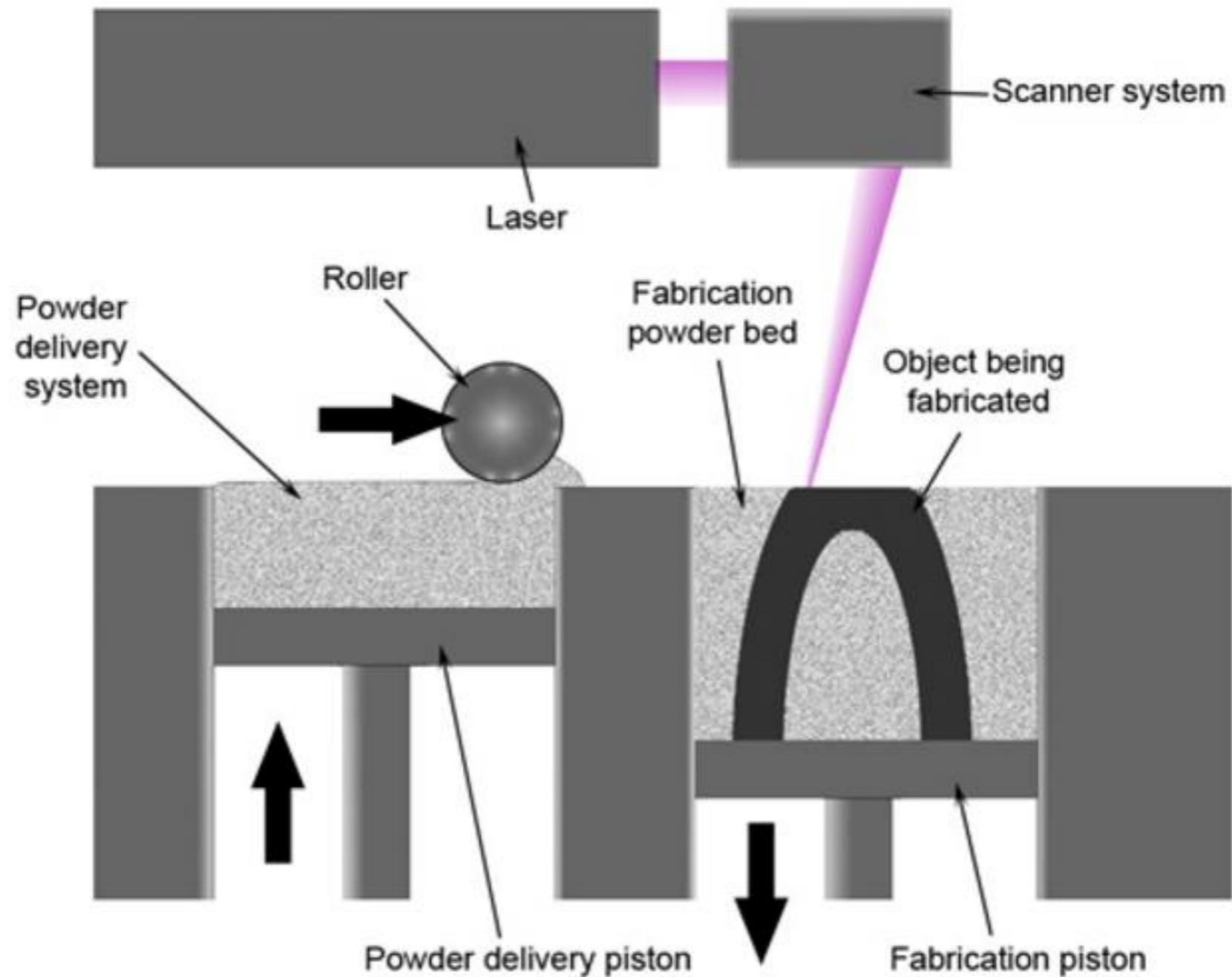


**Print**



# Selective Laser Sintering (SLS)

# Selective Laser Sintering (SLS)



# SLS Demo

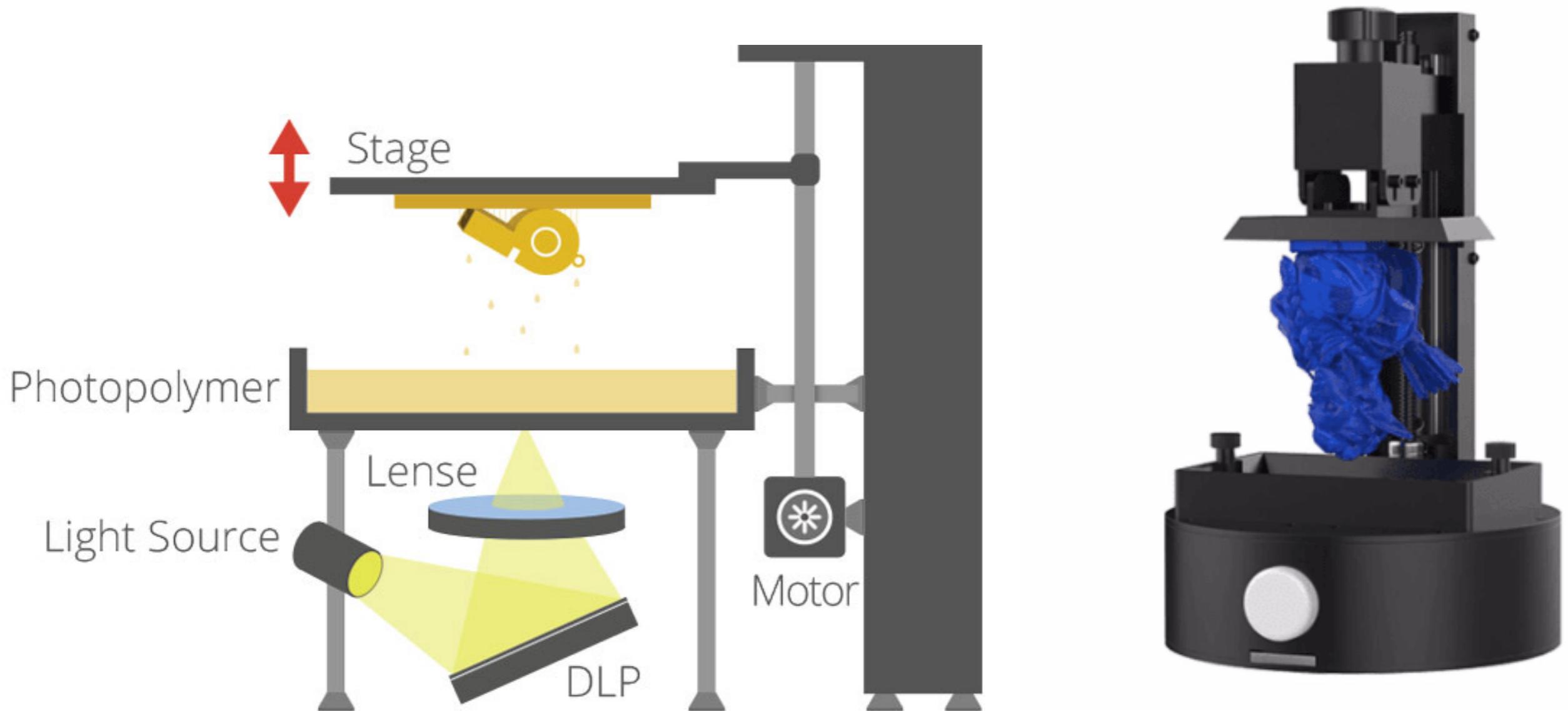


What is SLS 3D Printing? (Selective Laser Sintering)

<https://www.youtube.com/watch?v=xorCFh-9EWA>

# **Stereolithography (SLA)**

# Stereolithography (SLA)



# SLA Demo – Carbon 3D

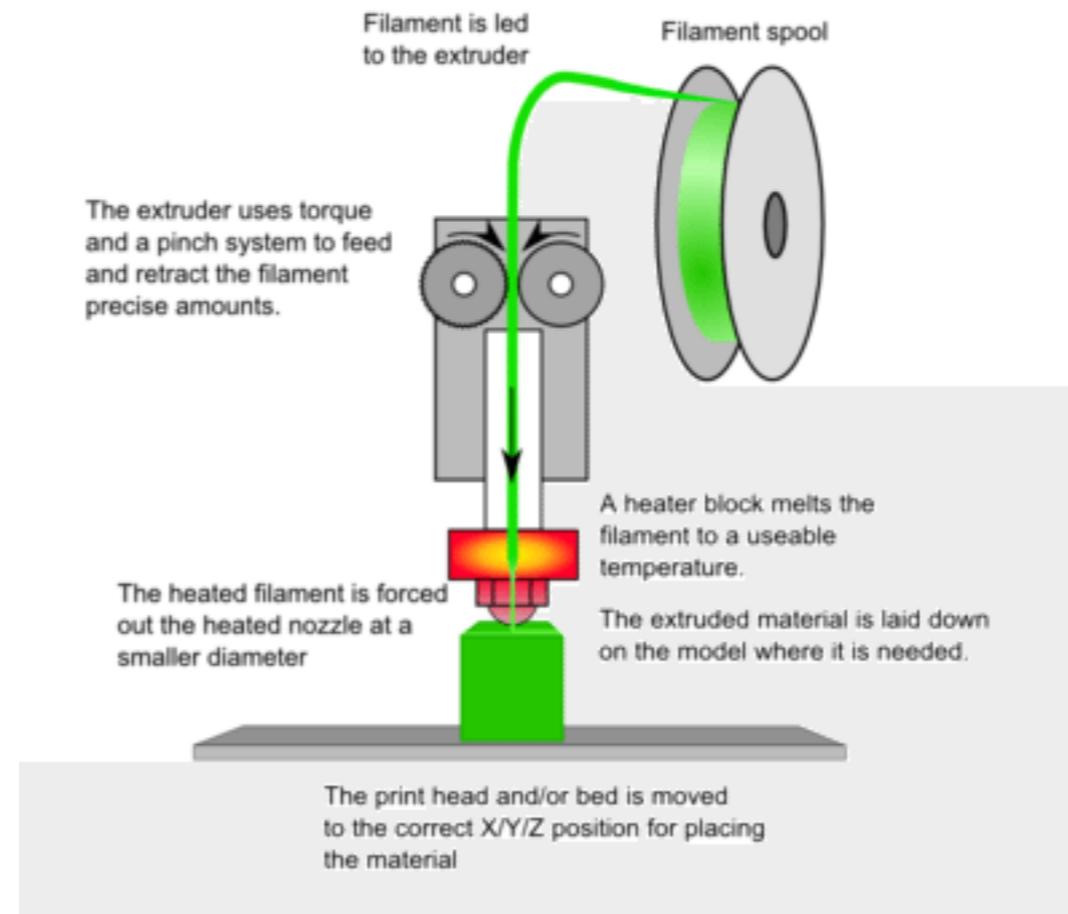


Carbon Demo

<https://www.youtube.com/watch?v=UpH1zhUQY0c>

# Fused Deposition Modeling (FDM)

# Fused Deposition Modeling (FDM)



# FDM Demo



#satisfying #3dprinting #timelapse

Satisfying 3D Print TimeLapse Compilation 7 (Prusa I3 Mk3 octopi)

<https://www.youtube.com/watch?v=Dss1yUHH-QY>

# Ecosystem

[thingiverse.com](http://thingiverse.com)

- free models
- print them yourself

[shapeways.com](http://shapeways.com)

- sell your designs
- high-end printers, exotic materials
- have them print it

[3Dhubs.com](http://3dhubs.com)

- Online manufacturing (CNC, print)
- Find a local shop
- Prototypes & small production runs

# Applications

**Medical**

# Medical

## Prosthetic Limbs



# Medical

## Prosthetic Limbs



## Custom Casts



# Medical

## Prosthetic Limbs



## Custom Casts



**\$50 vs. \$42,000**

# Medical

## Prosthetic Limbs



## Custom Casts



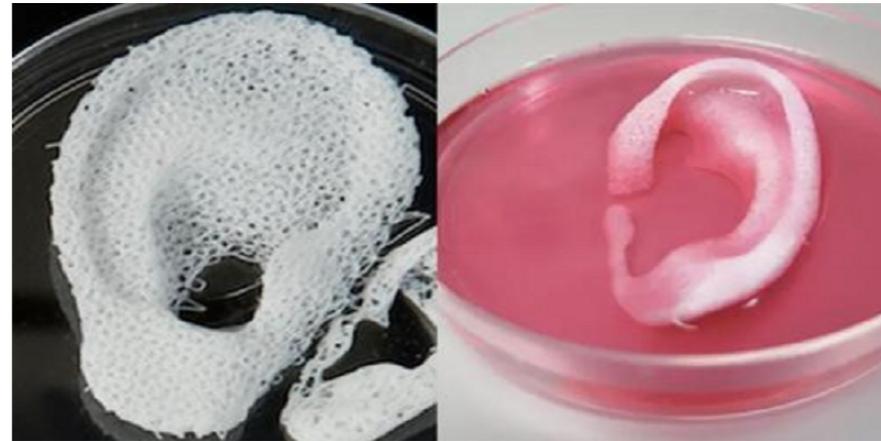
**\$50 vs. \$42,000**



# Organs - “Bio-Printing”

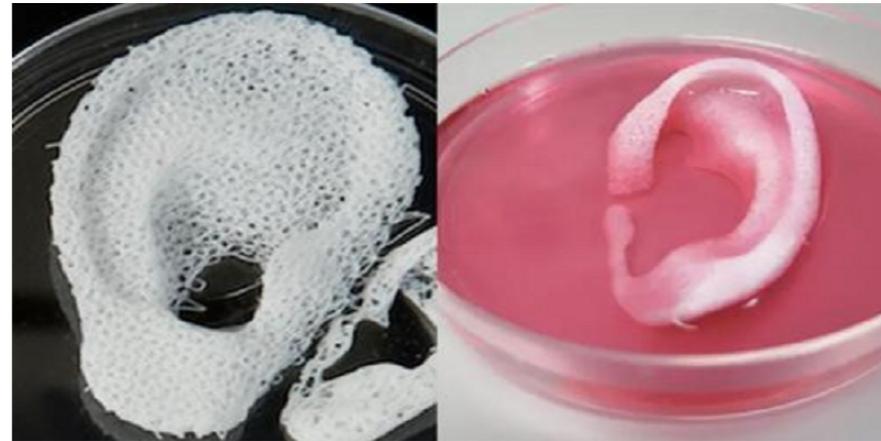
# Organs - “Bio-Printing”

“Bio-Ink” – each drop contains as few as 5 stem cells



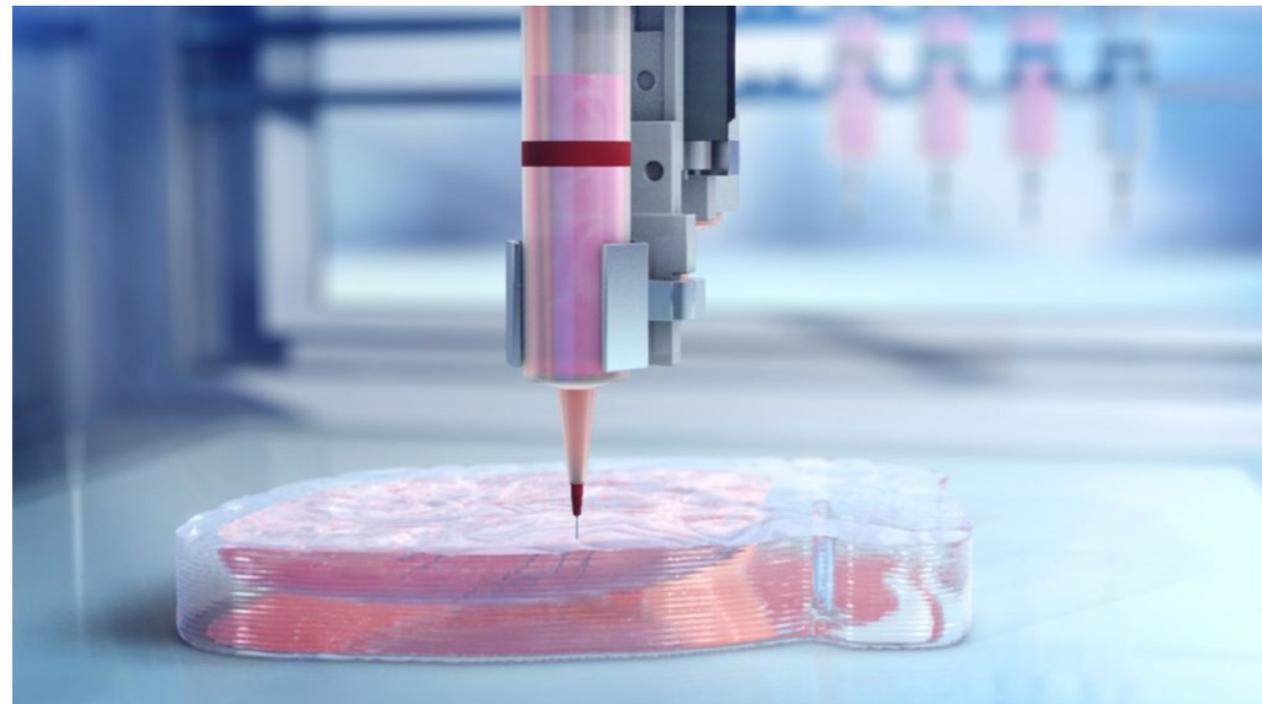
# Organs - “Bio-Printing”

“Bio-Ink” – each drop contains as few as 5 stem cells



## 5 Most Promising 3D-printed Transplantable Organs

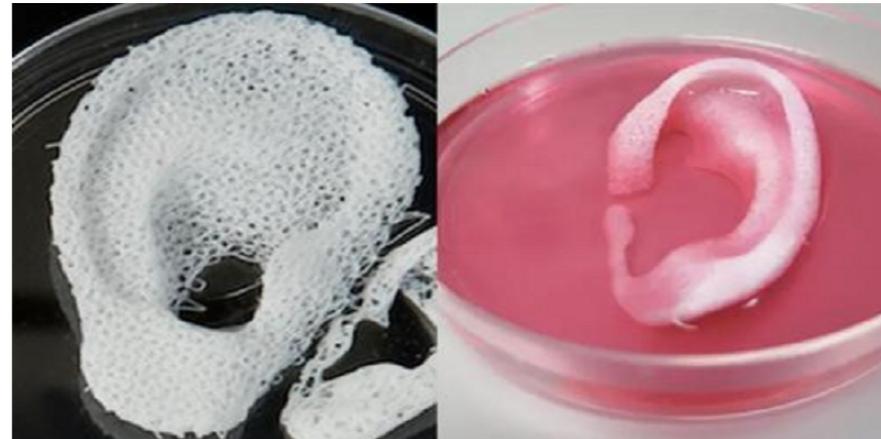
- Kidneys
- Liver
- Bones
- Heart
- Cornea



<https://all3dp.com/2/5-most-promising-3d-printed-organs-for-transplant/>

# Organs - “Bio-Printing”

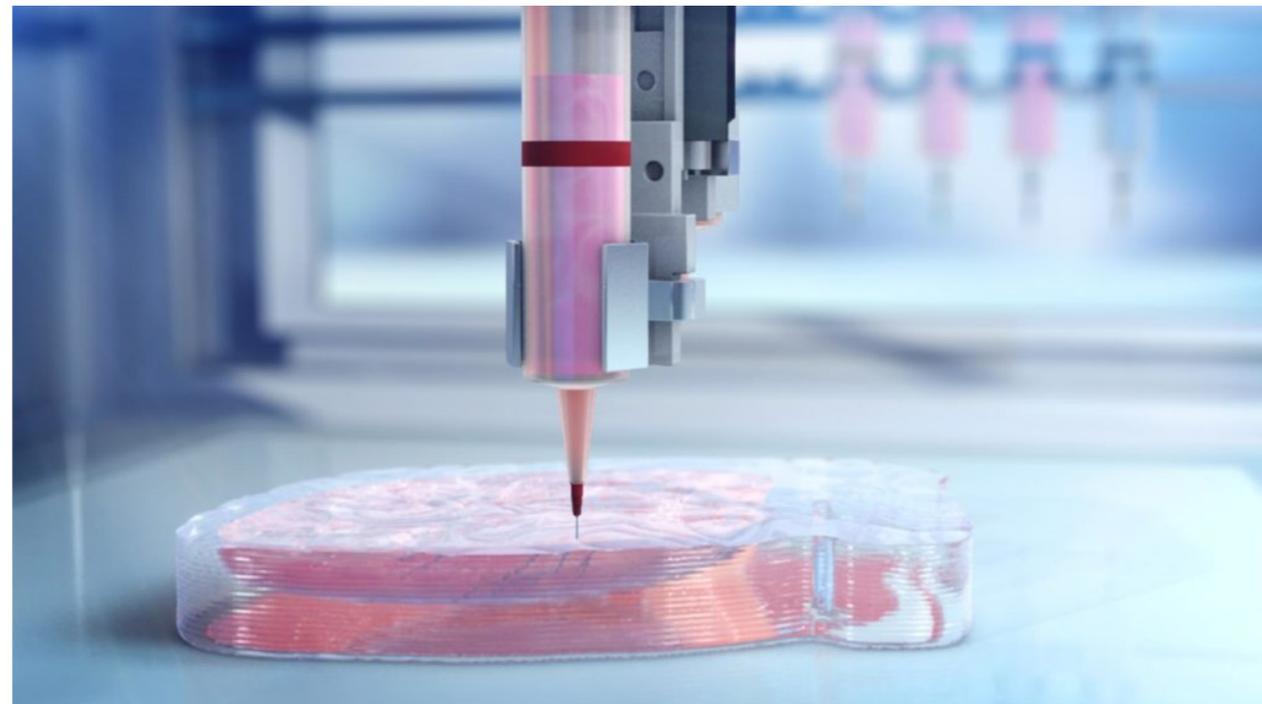
“Bio-Ink” – each drop contains as few as 5 stem cells



## 5 Most Promising 3D-printed Transplantable Organs

- Kidneys
- Liver
- Bones
- Heart
- Cornea

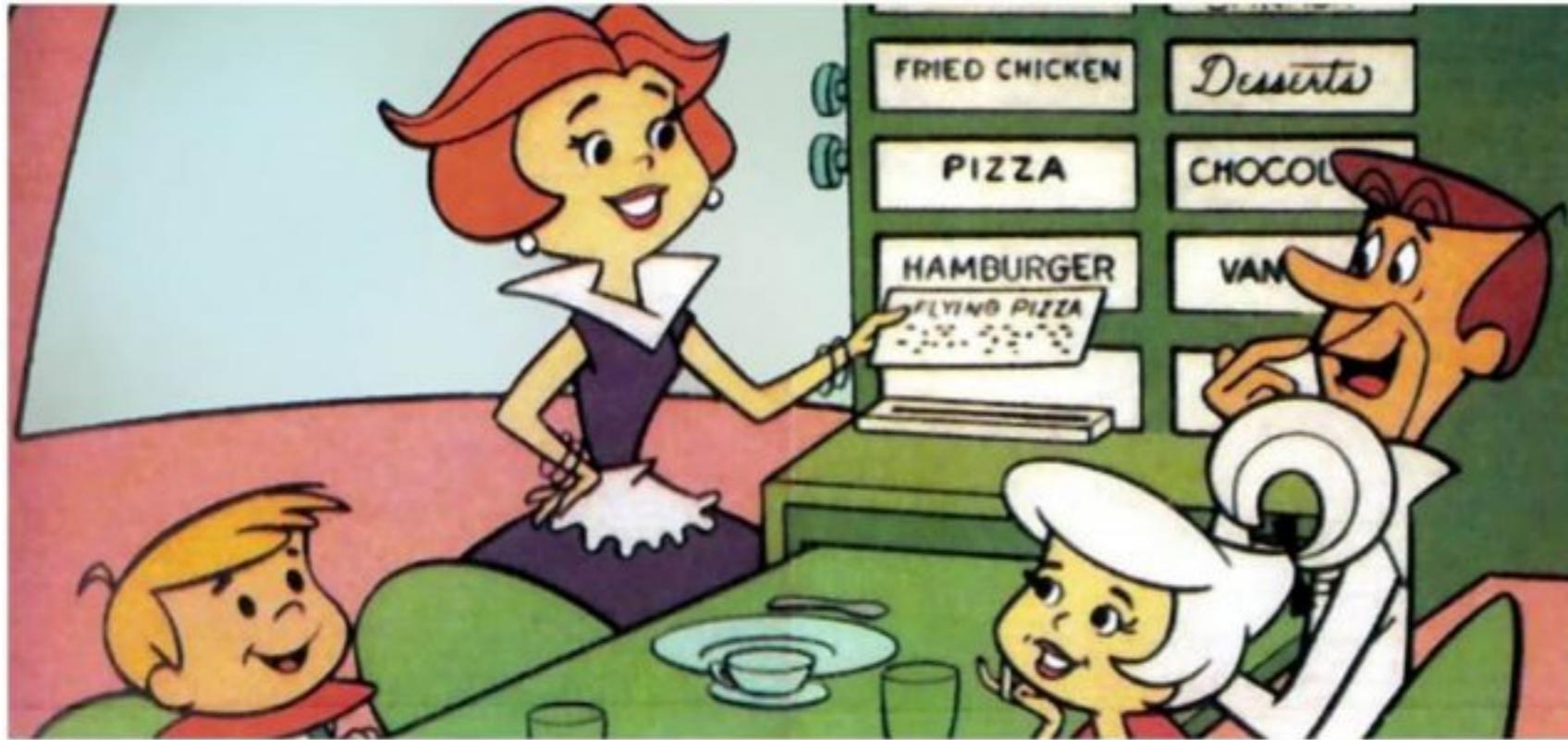
Will it solve the organ shortage?



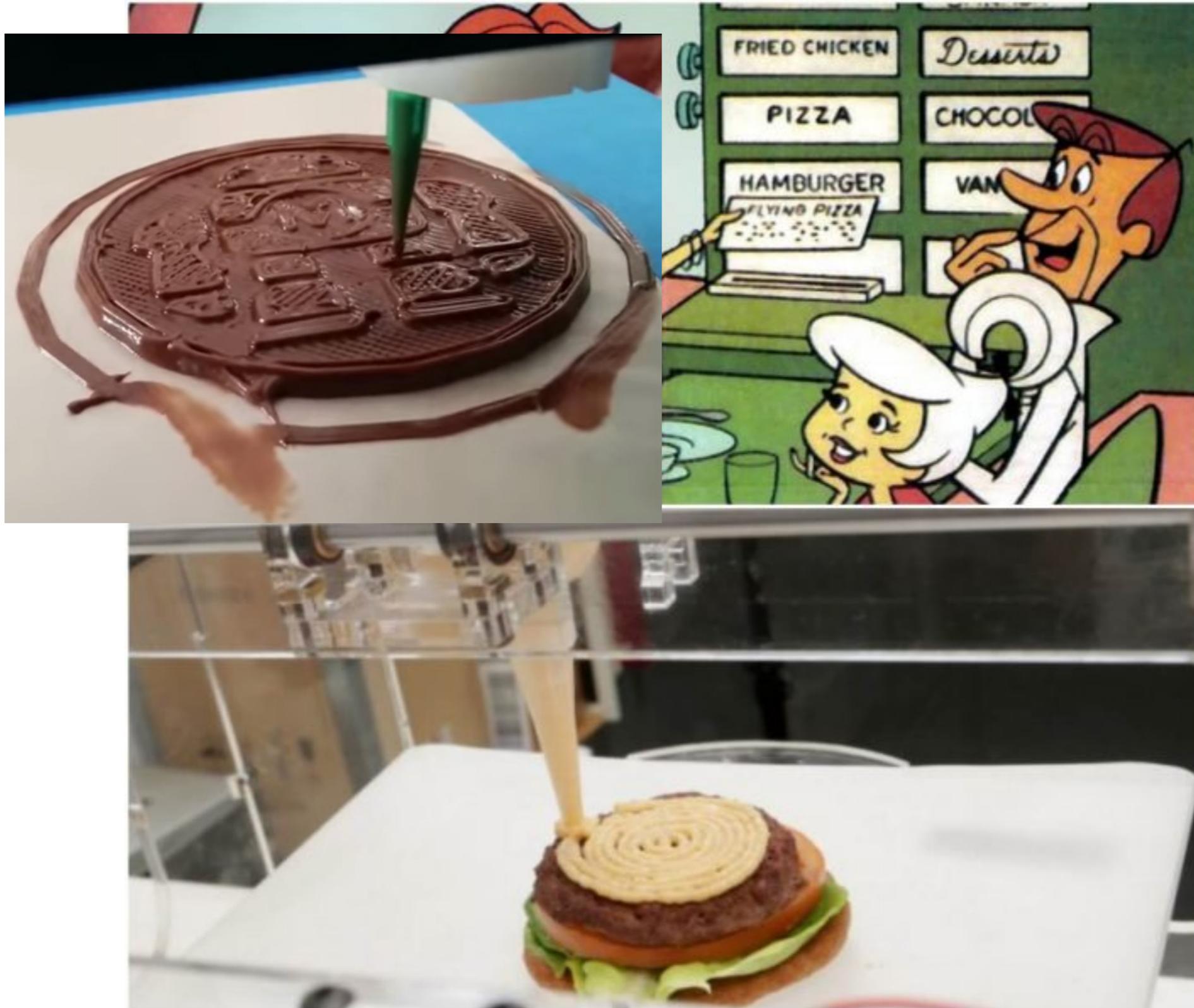
<https://all3dp.com/2/5-most-promising-3d-printed-organs-for-transplant/>

# Food

# Food



# Food



# Food



# Food



# “Made in Space”



Applications: extravehicular activity (EVA) tools and repairs, stronger and more capable intravehicular (IVA) tools, spares, and repairs, and even satellite structure can be created on site, on-demand.

**A 3D printer flies on the International Space Station.**



# Mobility

# Mobility



# Mobility



# Mobility



# Housing

# Housing



# Housing



# Housing



# Weapons

## "The Liberator"



<https://taskandpurpose.com/3d-printed-guns-defense-distributed/>

# Materials

**Plastics**

**Nylon**

**Carbon fiber**

**Ceramics**

**Metals**

**Concrete**

**Wood**

**Human Cells**

<http://3dprintingfromscratch.com/common/3d-printer-filament-types-overview/>

# 4D Printing

**A 3D print is made using soft, slightly elastic materials  
==> the “ink”**

**That 3D-printed object can then harden into a variety of intricate ceramic shapes after being heated, stretched, magnetically stimulated, folded, or otherwise altered via the passage of time.**



**Still a research area**

**Why do \*I\* have a 3D printer?**

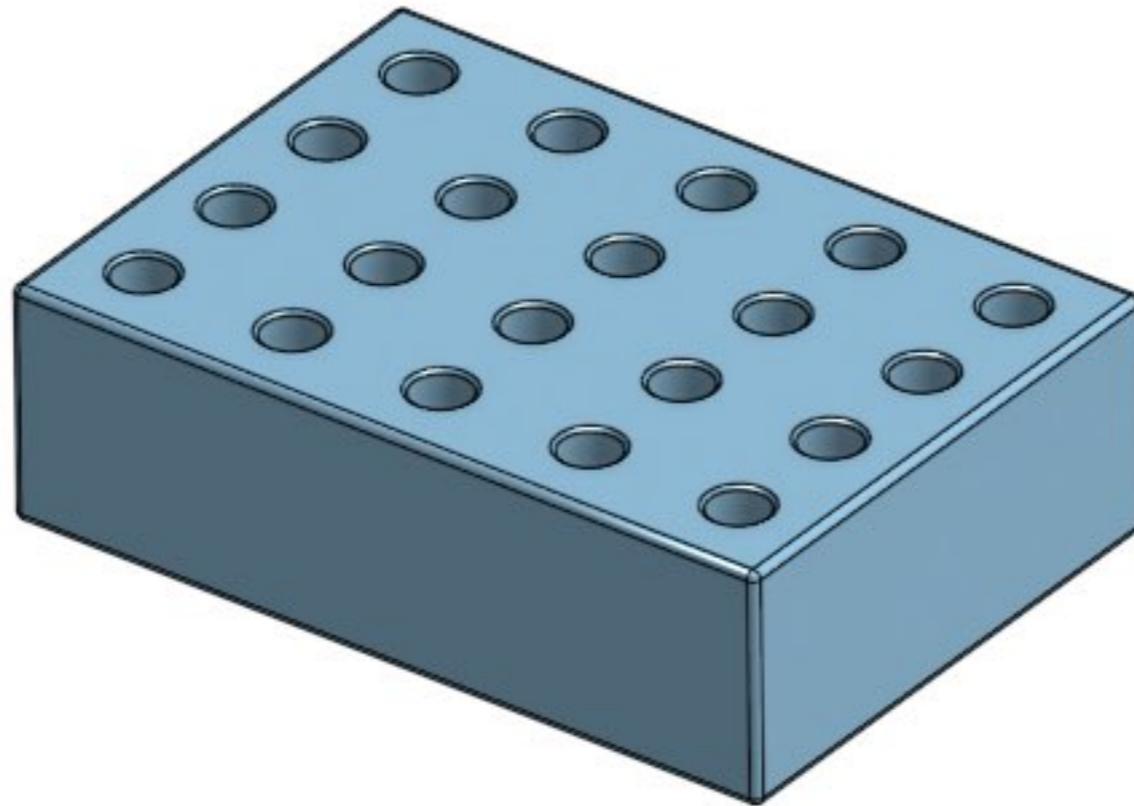
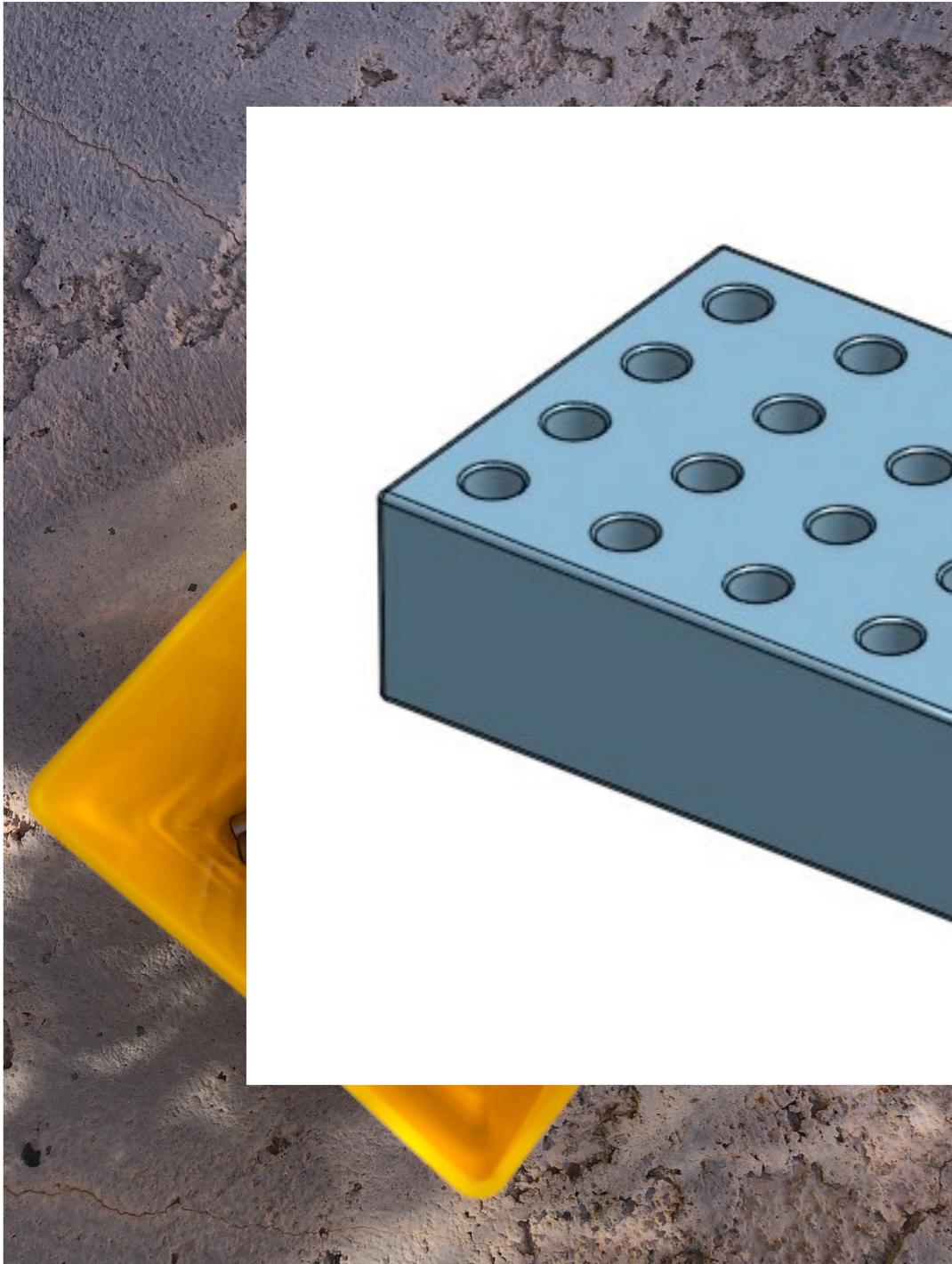
**Why do \*I\* have a 3D printer?**

**I Build Stuff!**

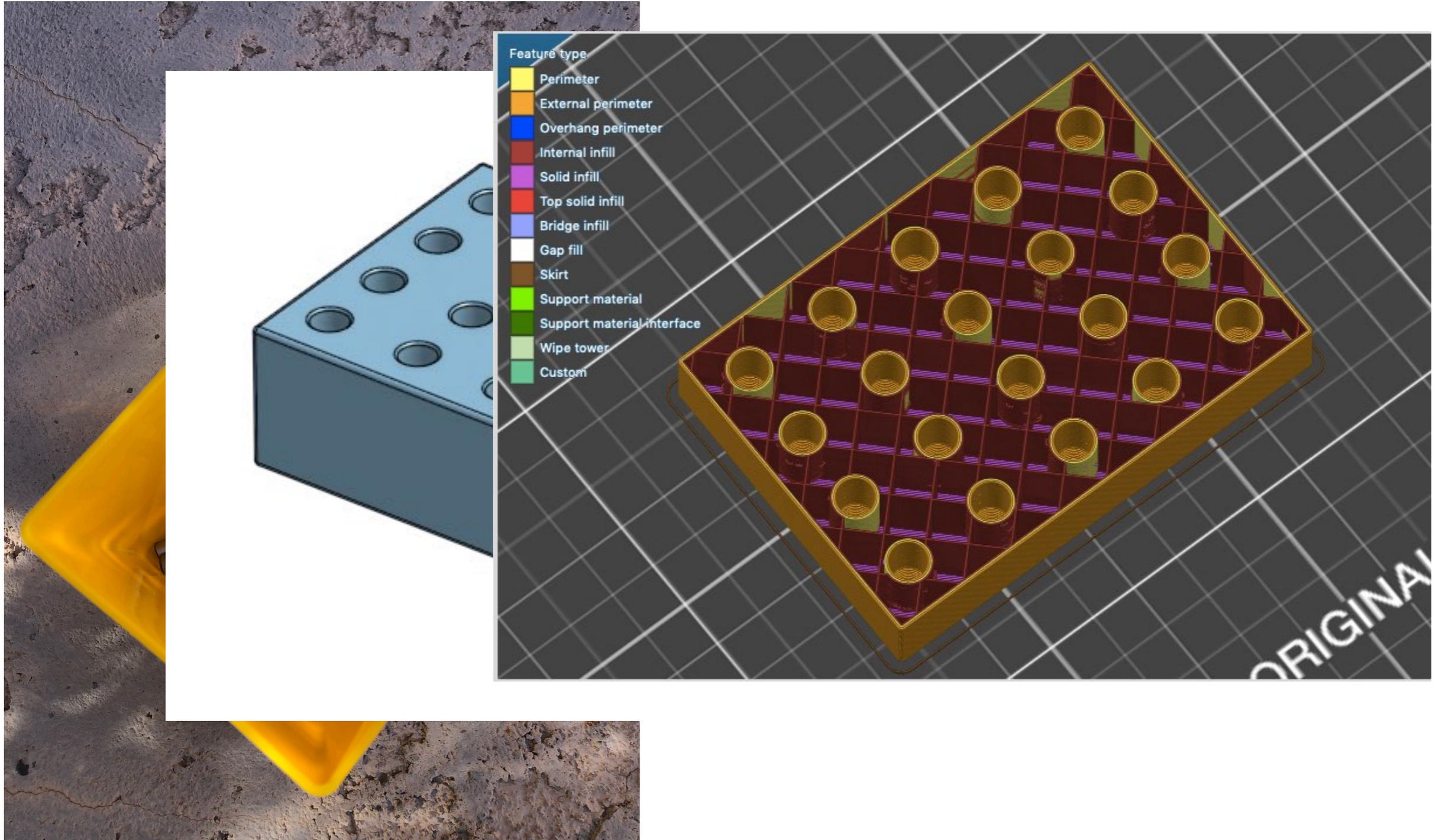
**“I can do better than this mess...”**



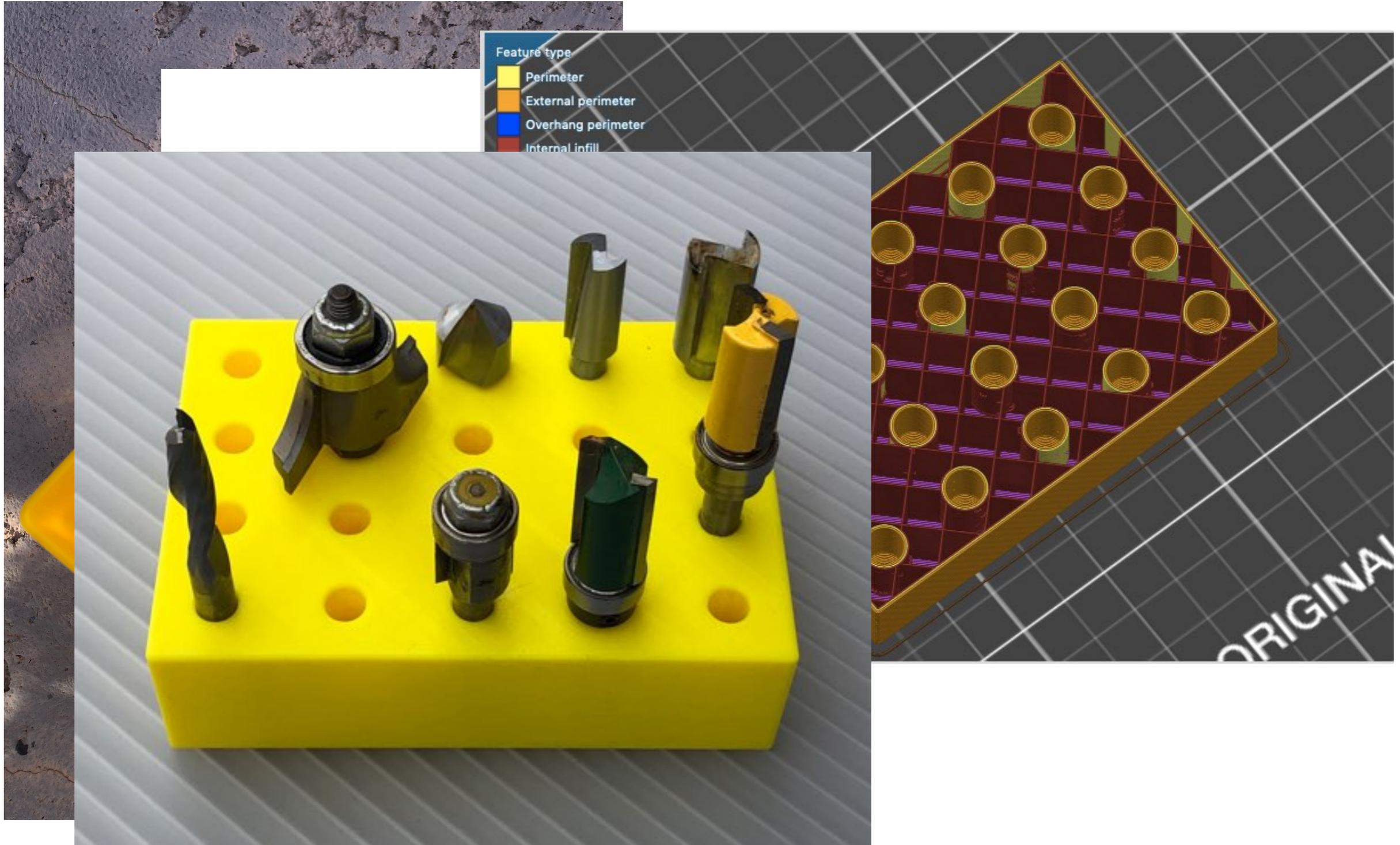
**“I can do better than this mess...”**



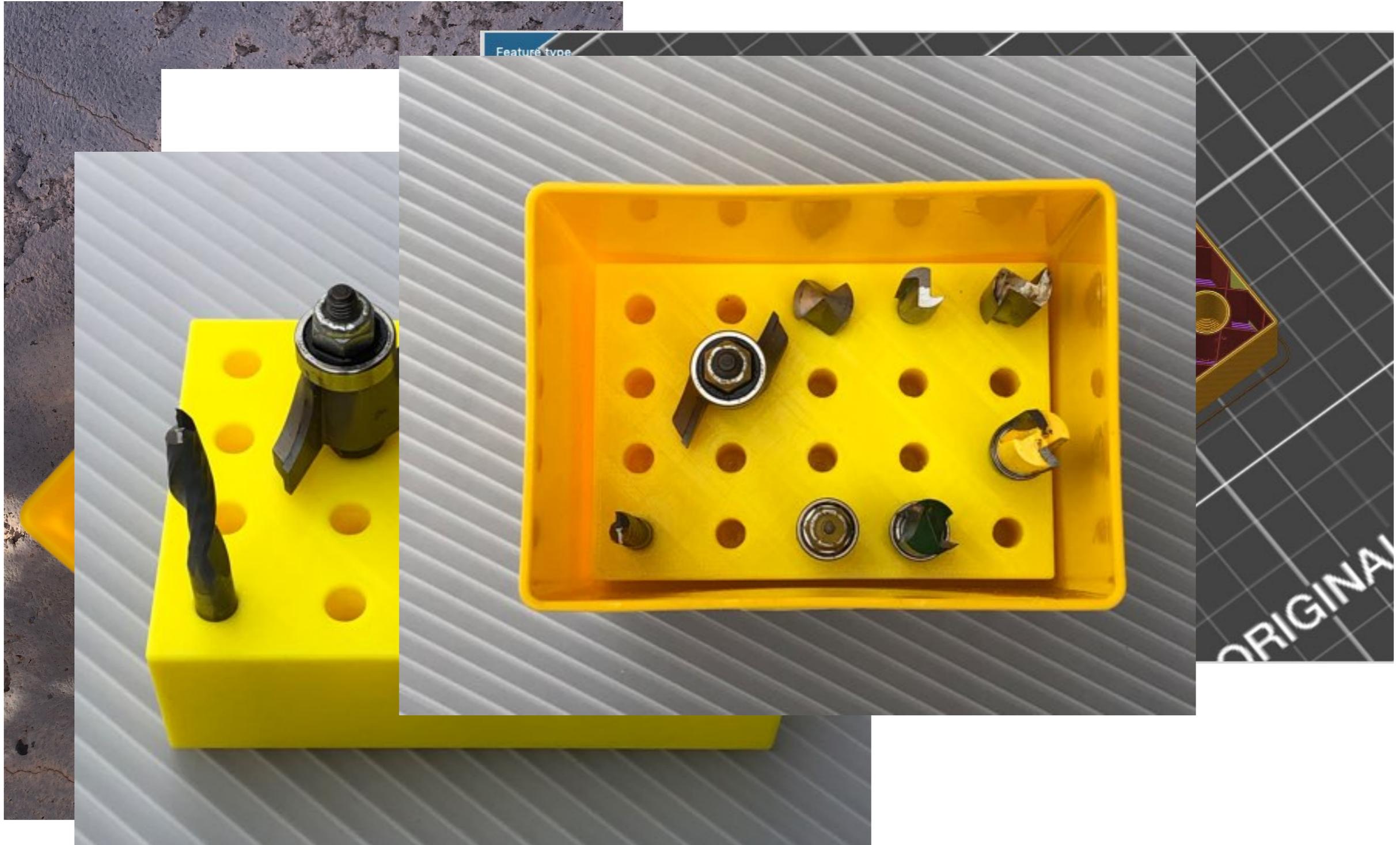
“I can do better than this mess...”



“I can do better than this mess...”



“I can do better than this mess...”

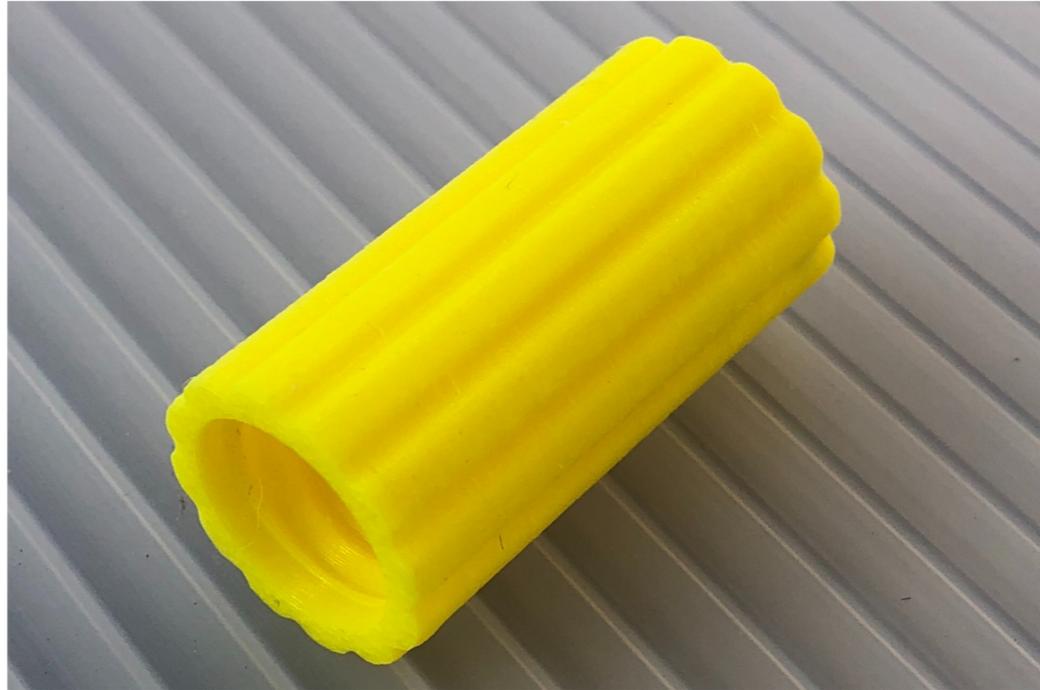


# Personal Design Examples

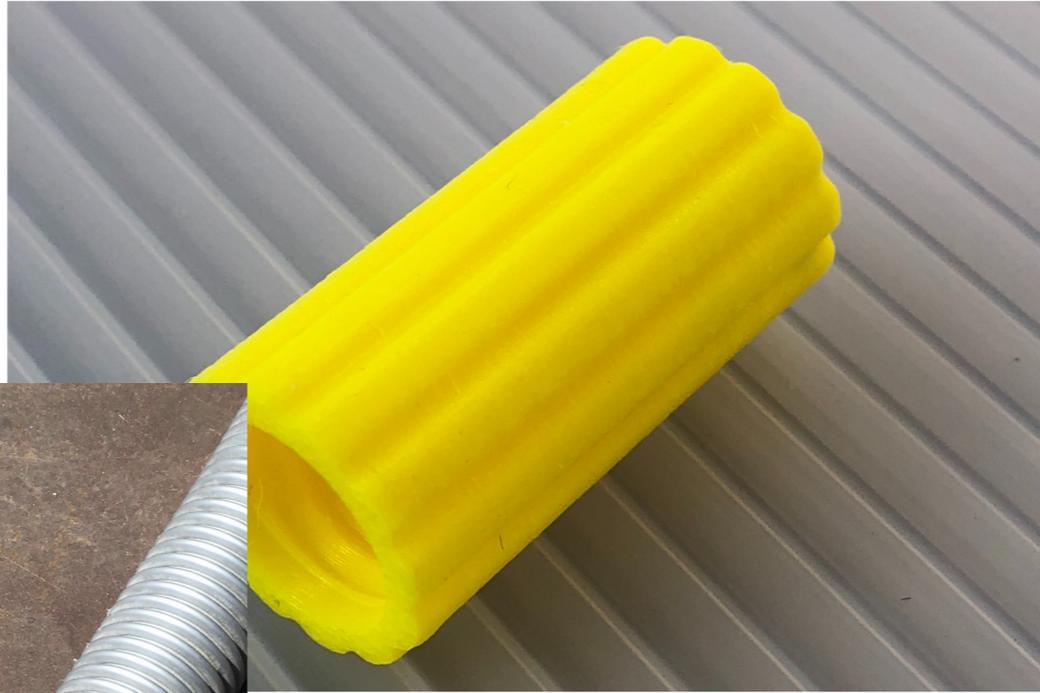
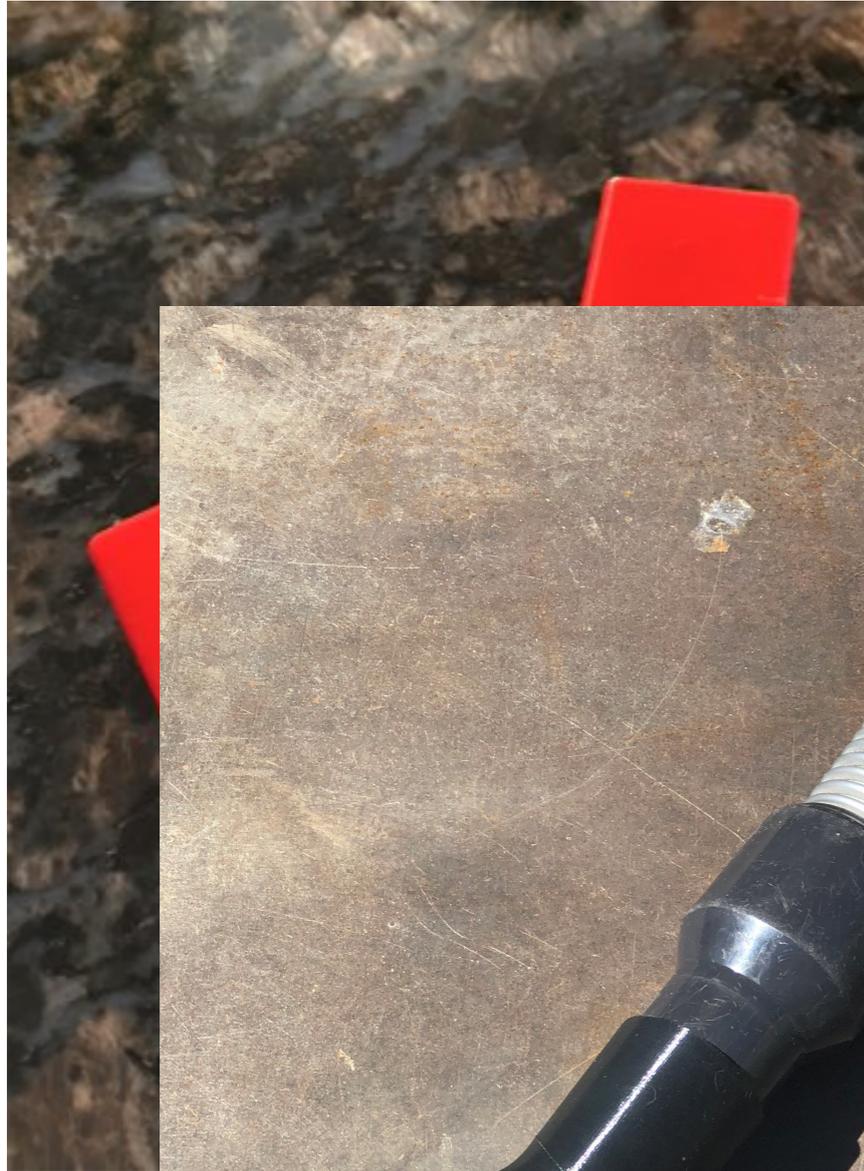
## Personal Design Examples



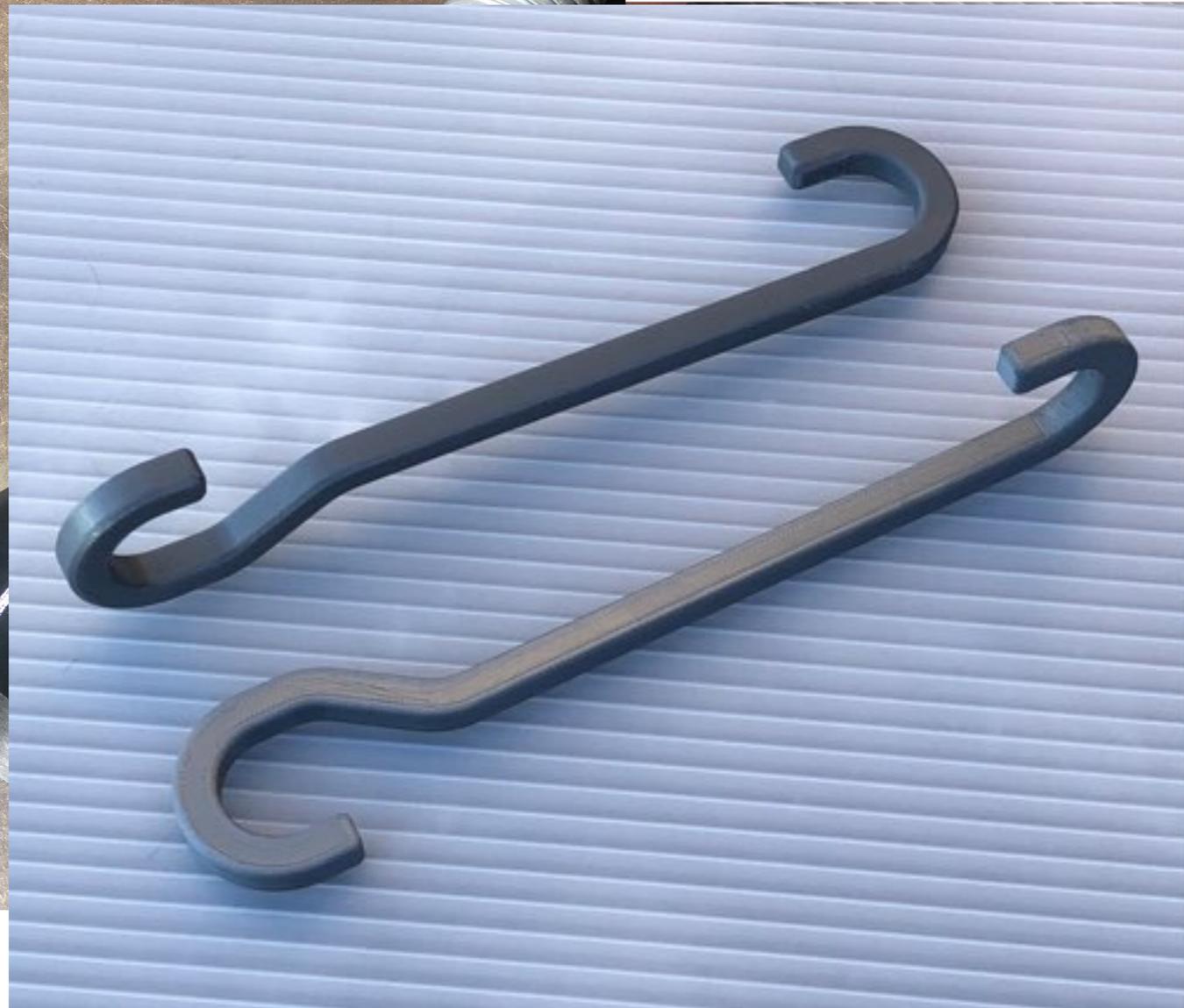
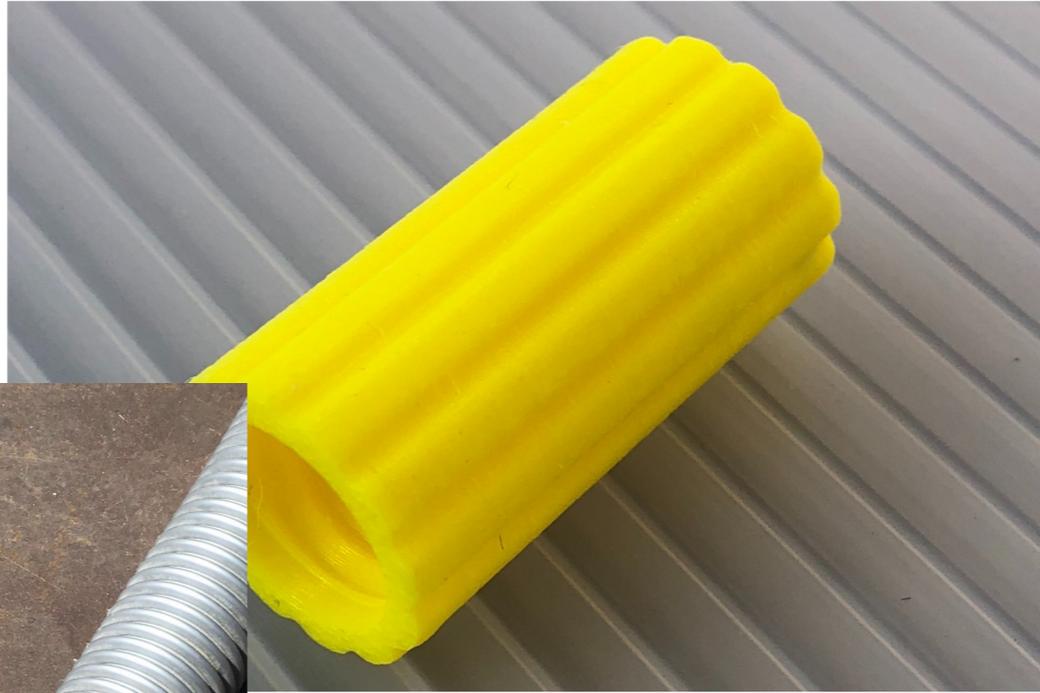
# Personal Design Examples



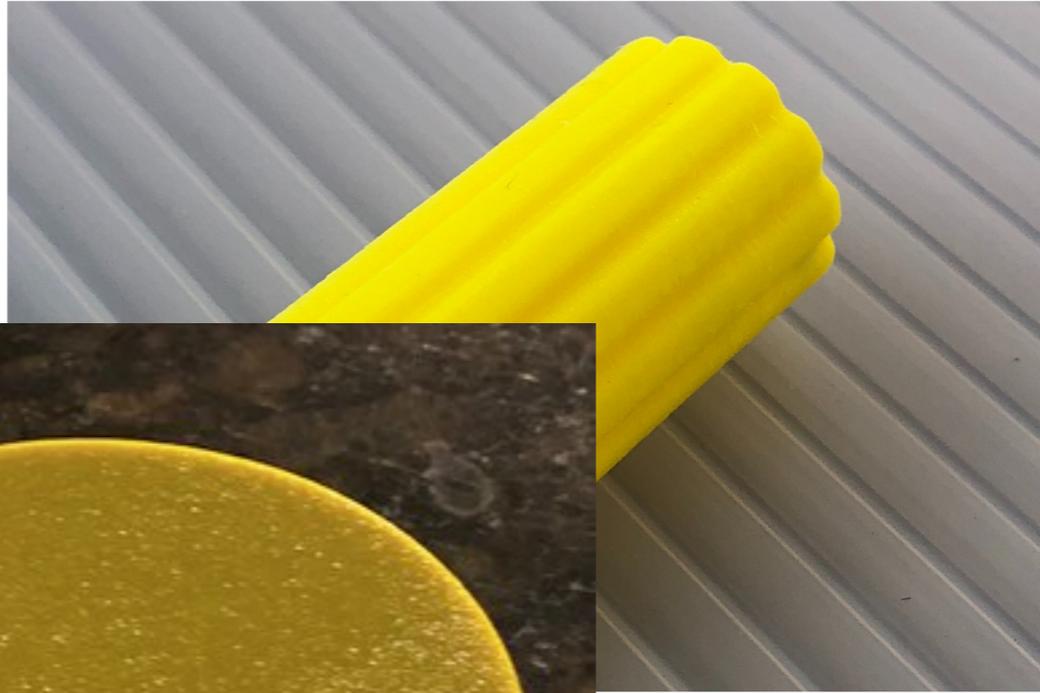
# Personal Design Examples



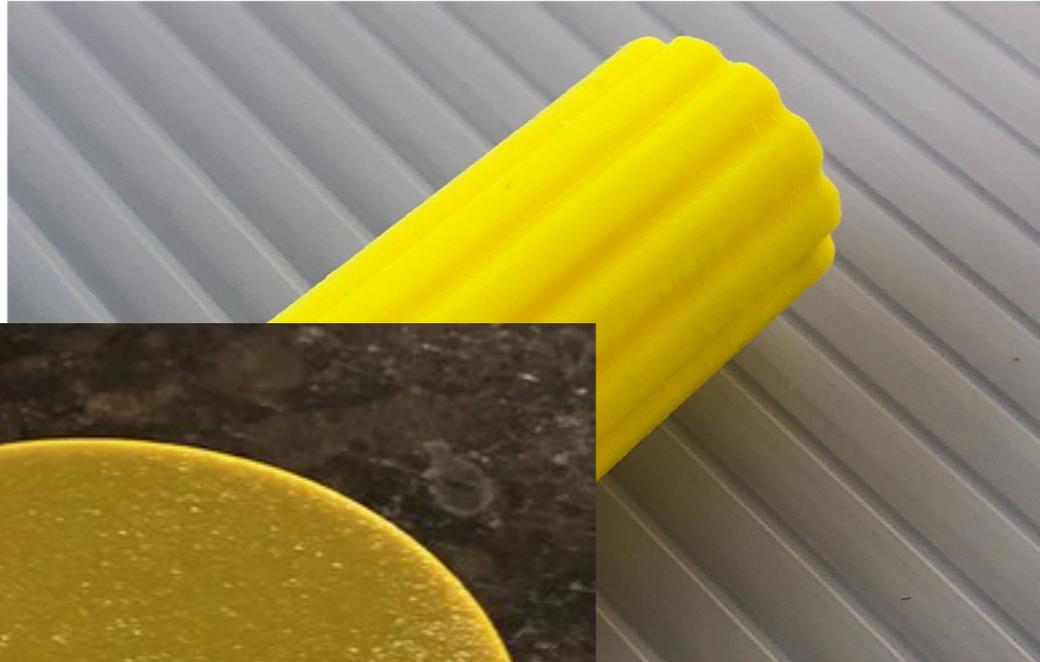
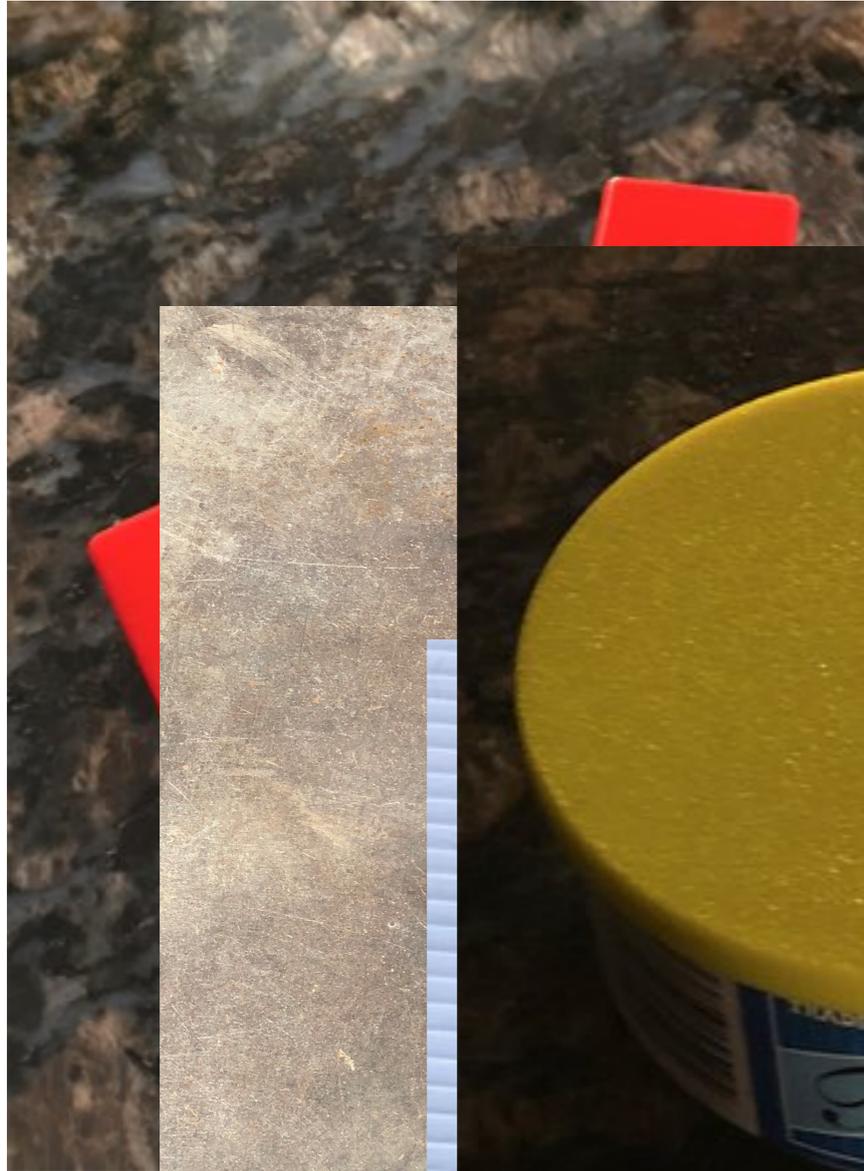
# Personal Design Examples



# Personal Design Examples



# Personal Design Examples





# Personal Design Examples



# Personal Design Examples



# Personal Design Examples



# Personal Design Examples



# Personal Design Examples

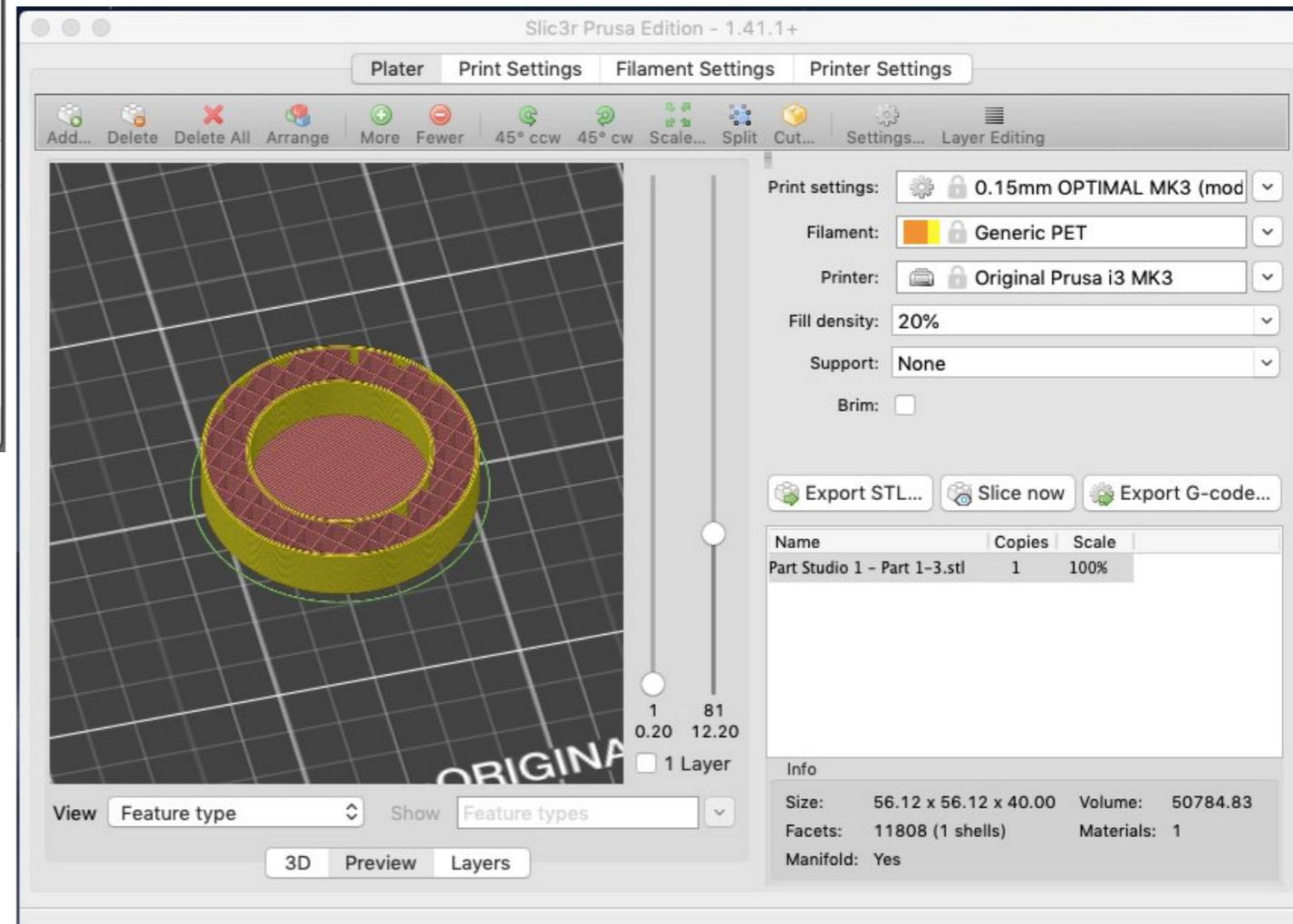
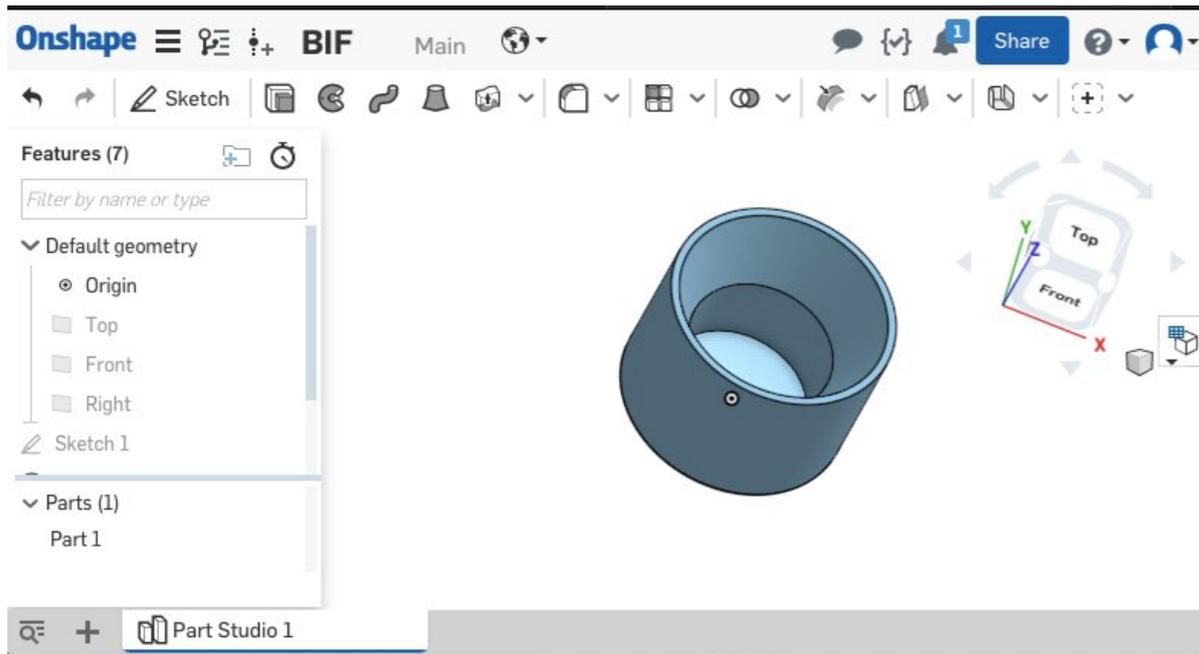


# Personal Design Examples



# Example Design

In this live 5 minute demo, we fired up a CAD application ([onshape.com](https://onshape.com)), created a very simple 3D model, exported the model as an STL file, then imported that STL file into a “slicer” application ([slic3r.org](https://slic3r.org)) to prepare it for printing.



# Live Print

During the presentation, the Prusa i3 MK3 printer was busy printing a simple kitchen “device”; a chip bag clip.

It should be noted that an FDM 3D printer takes a LONG time to print anything useful. Our simple, tiny bag clip took 45 minutes to print. Many of the objects I’ve printed take 6 to 10 hours (or more) to print. One can hardly become a “manufacturer” at those rates, but it’s a great tool for solving problems around the home.

