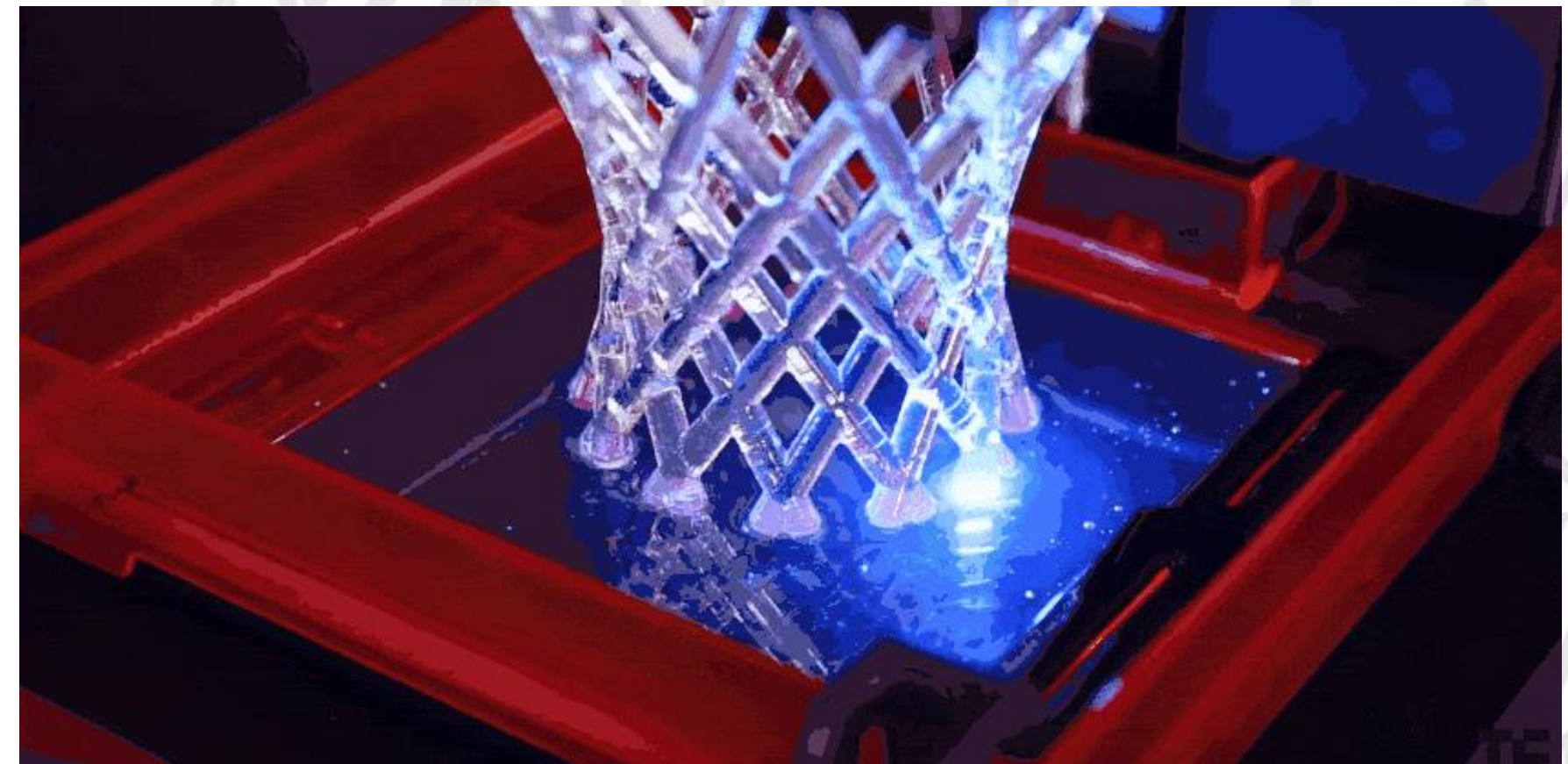


The Digital Manufacturing Laboratory (DML)

- A Shared Instrumentation Laboratory (SIL)

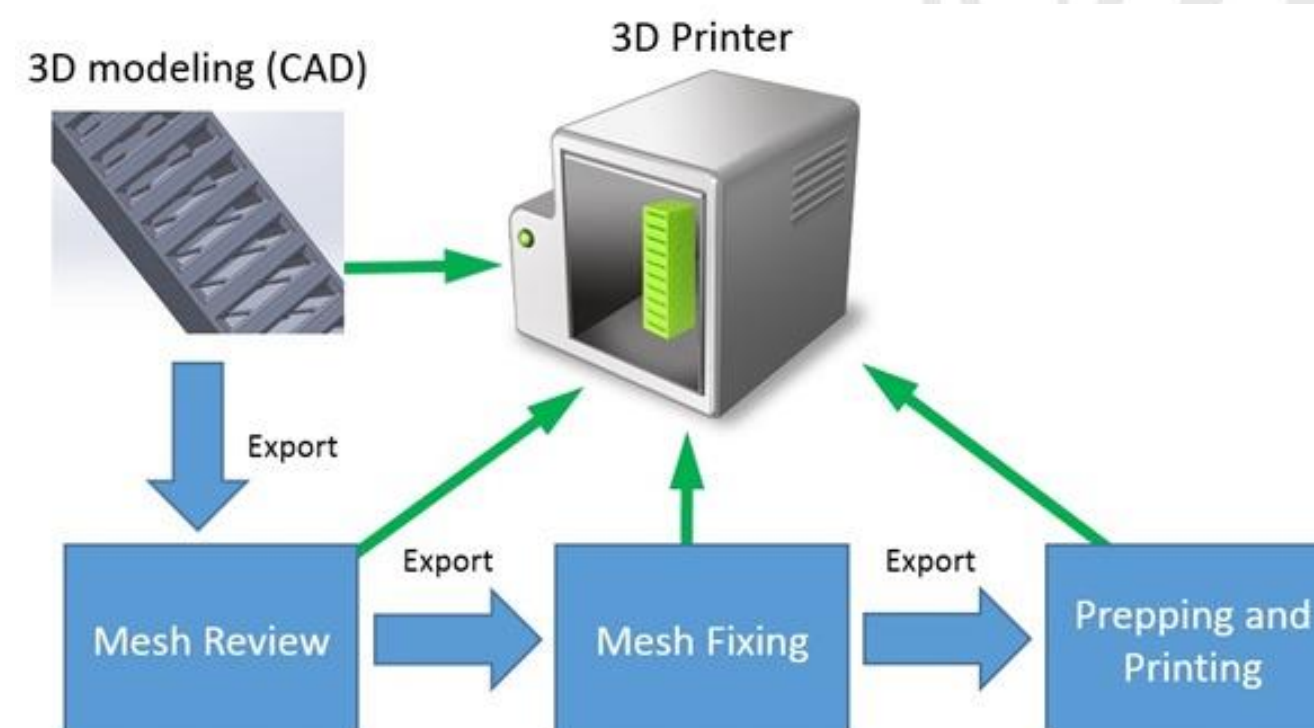
"A 3D Printing Primer"

(rev. 02-2019)





- ✓ Applications
- ✓ 3D Printing process Pipeline
- ✓ DML Printer Technologies
- ✓ Common Pitfalls
- ✓ The DML Work Order submission portal
- ✓ DML Contact Information



Manufacturing

Replacement parts - cheaper to build than to buy

Aerospace

Develop new/lightweight materials

Biomedical

Soft tissue reconstruction

Functional prosthetic limbs

Dental

Dental fillings, implants, appliances

3D Printed Food

Extruder output: chocolate, dough, sauce!

3D printed HOUSES

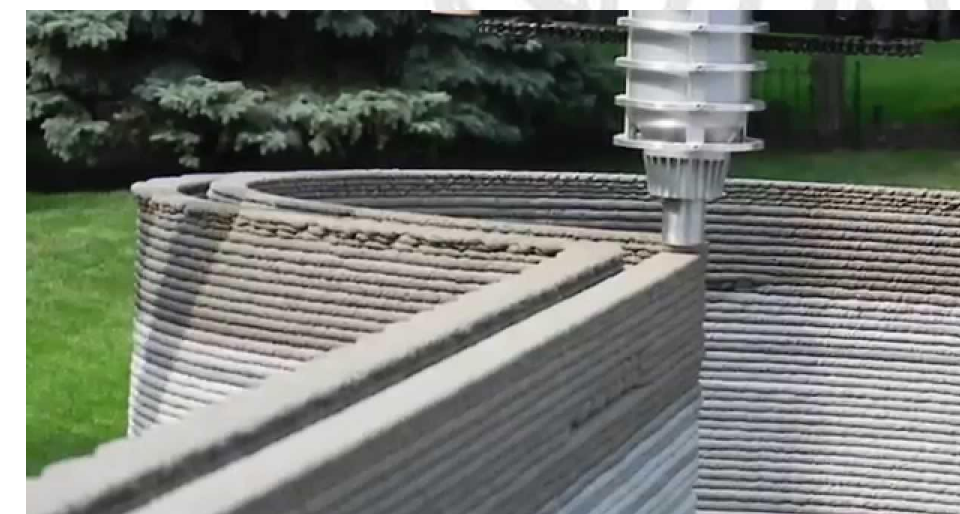
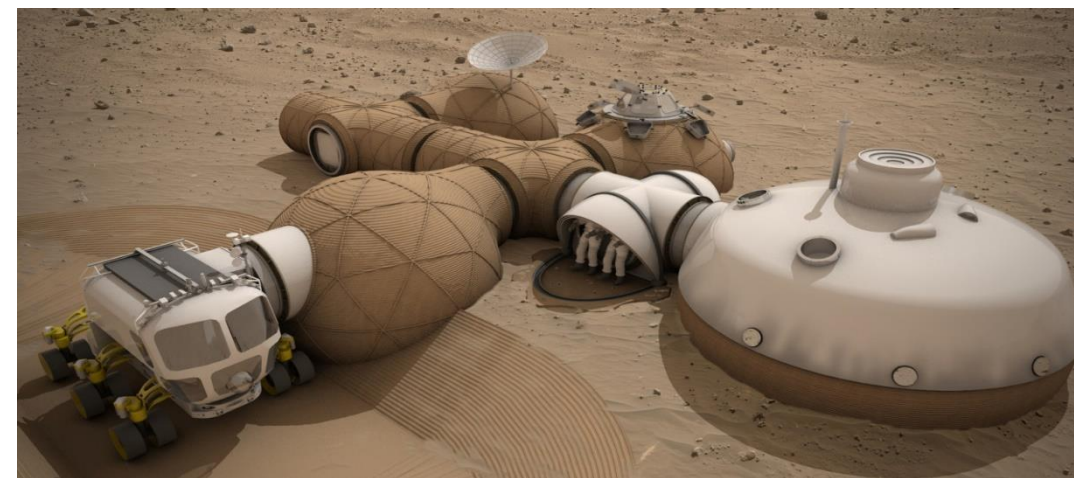
Extruder output: concrete

3D printing for Mars astronauts

Allow mission participants to colonize

Metal Printing

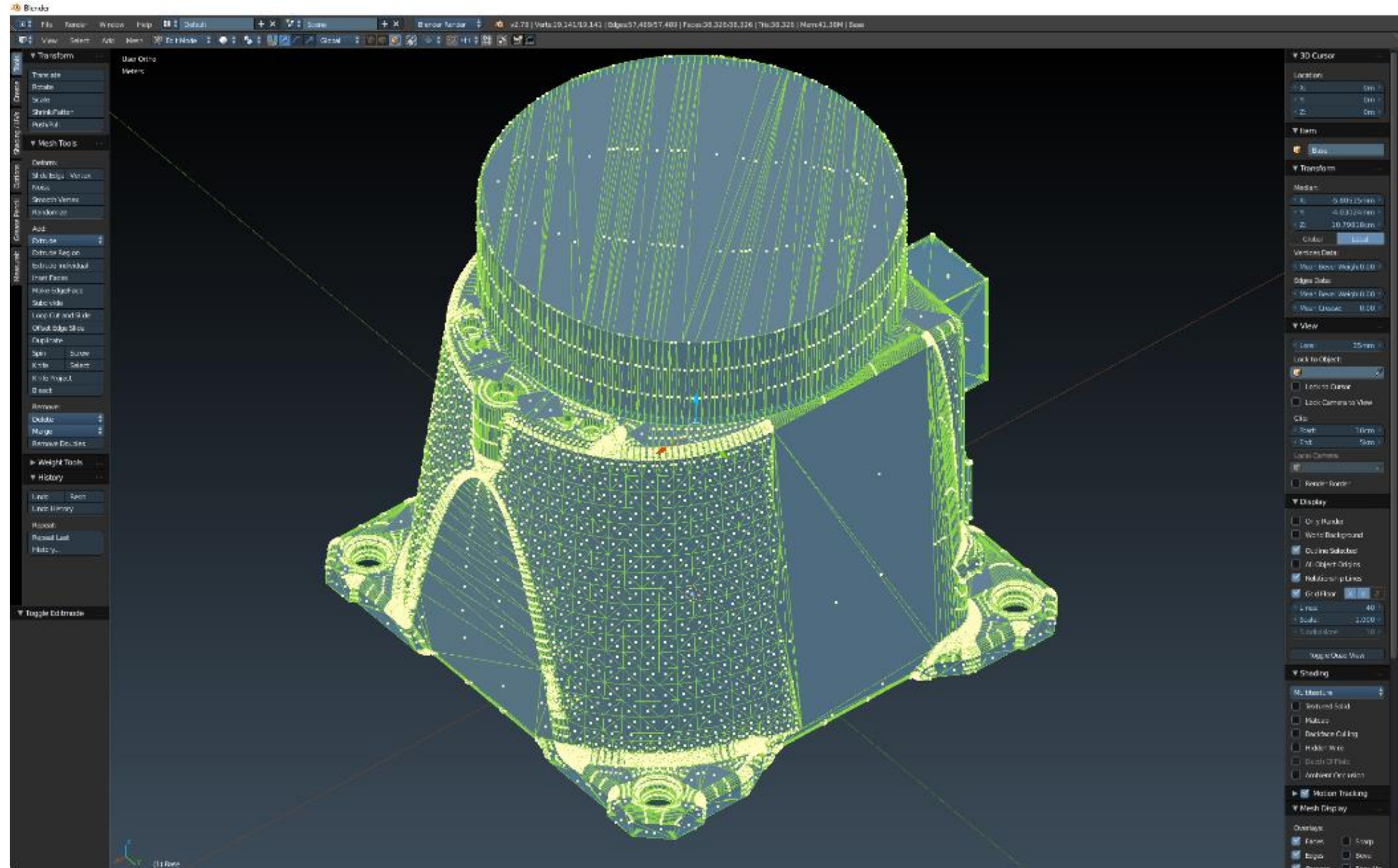
Laser sintering to produce strong/dense/complex parts



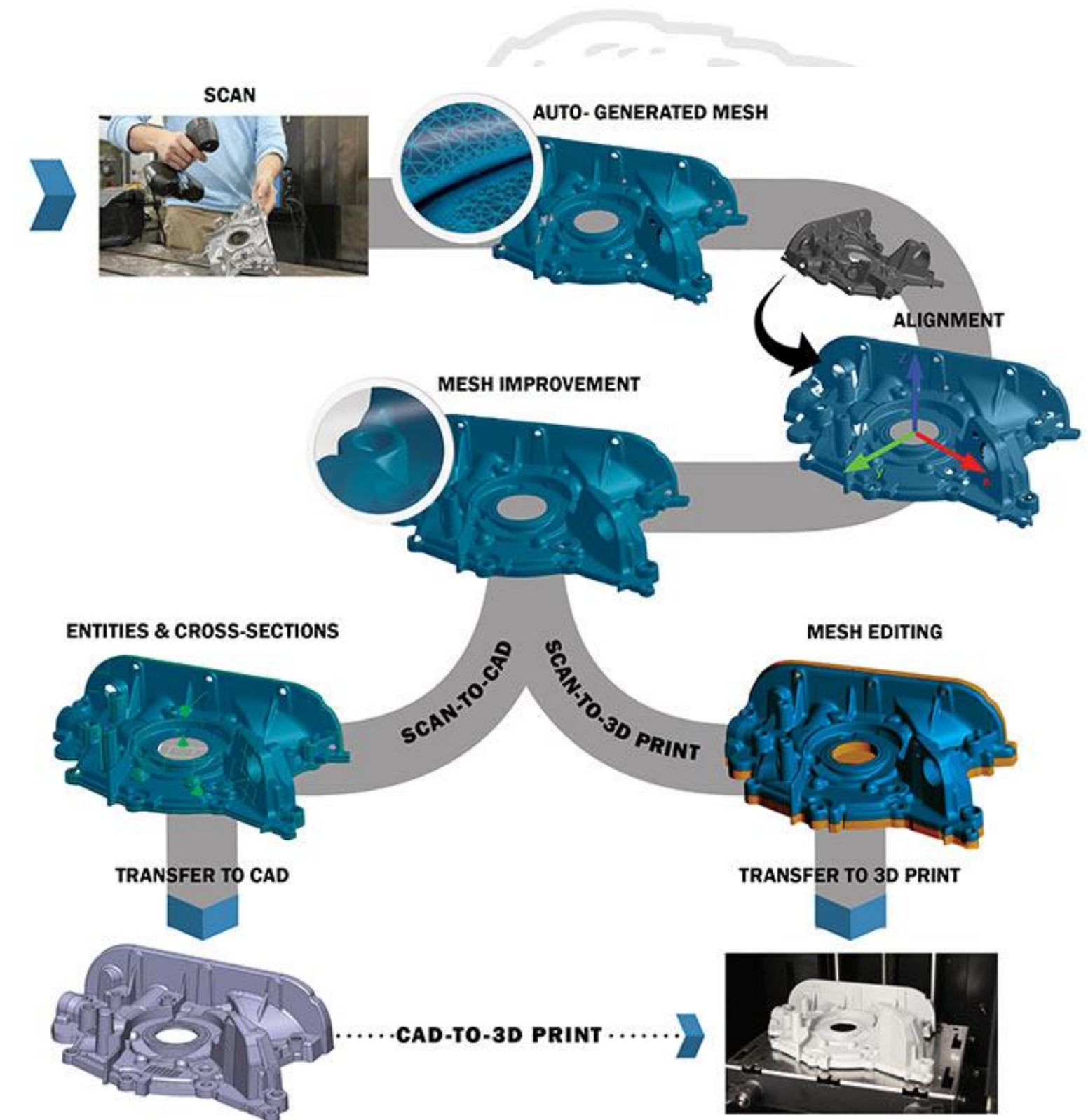
“How do I print a 3-D component?”

Digitally Construct a 3-D CAD Model

1. The DML is modeling software “agnostic”
2. Use Creo, Solidworks, or ANY modeling package!
3. For simple parts, 3-D scanning *may* be an option



CAD (e.g., SolidWorks, Creo, AutoDesk)

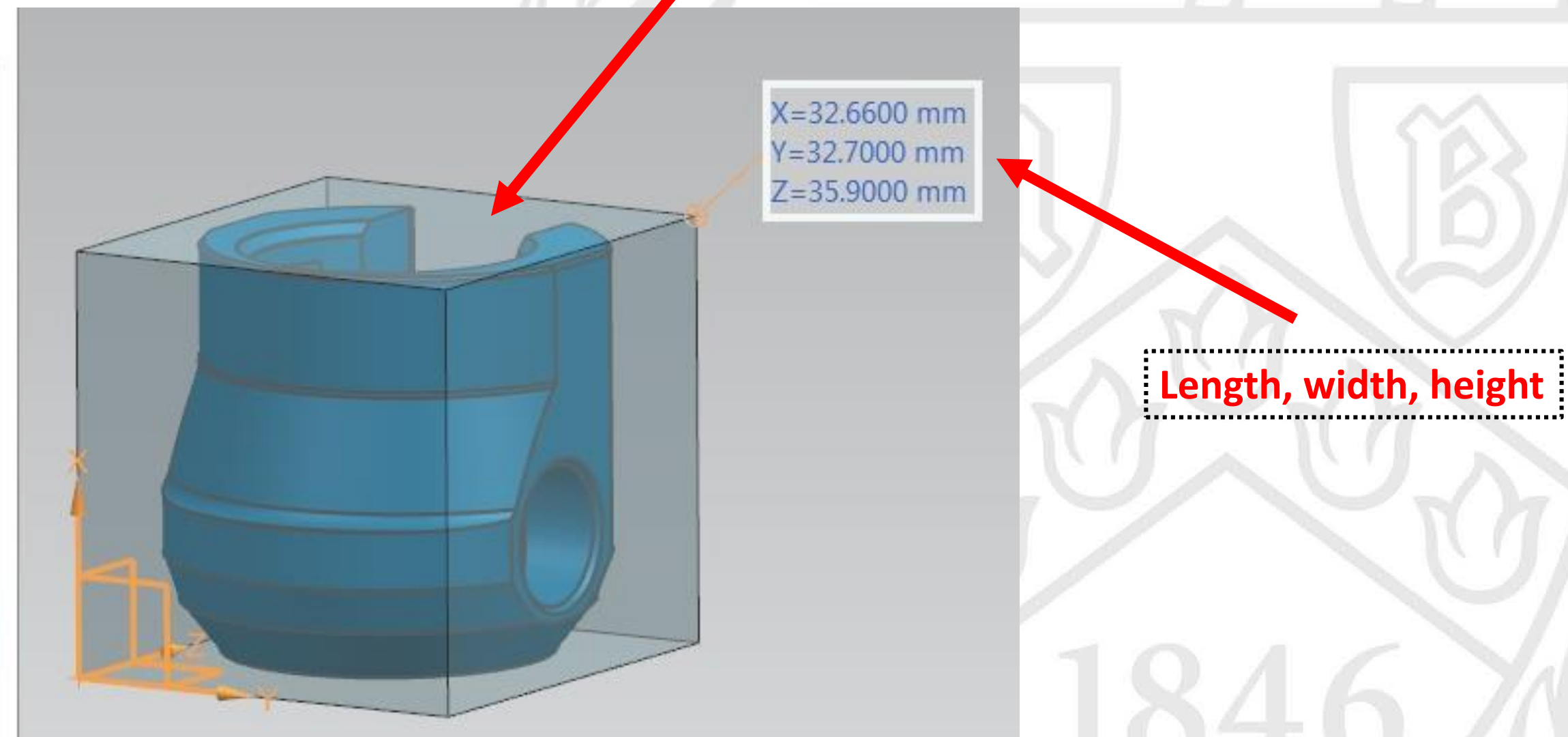
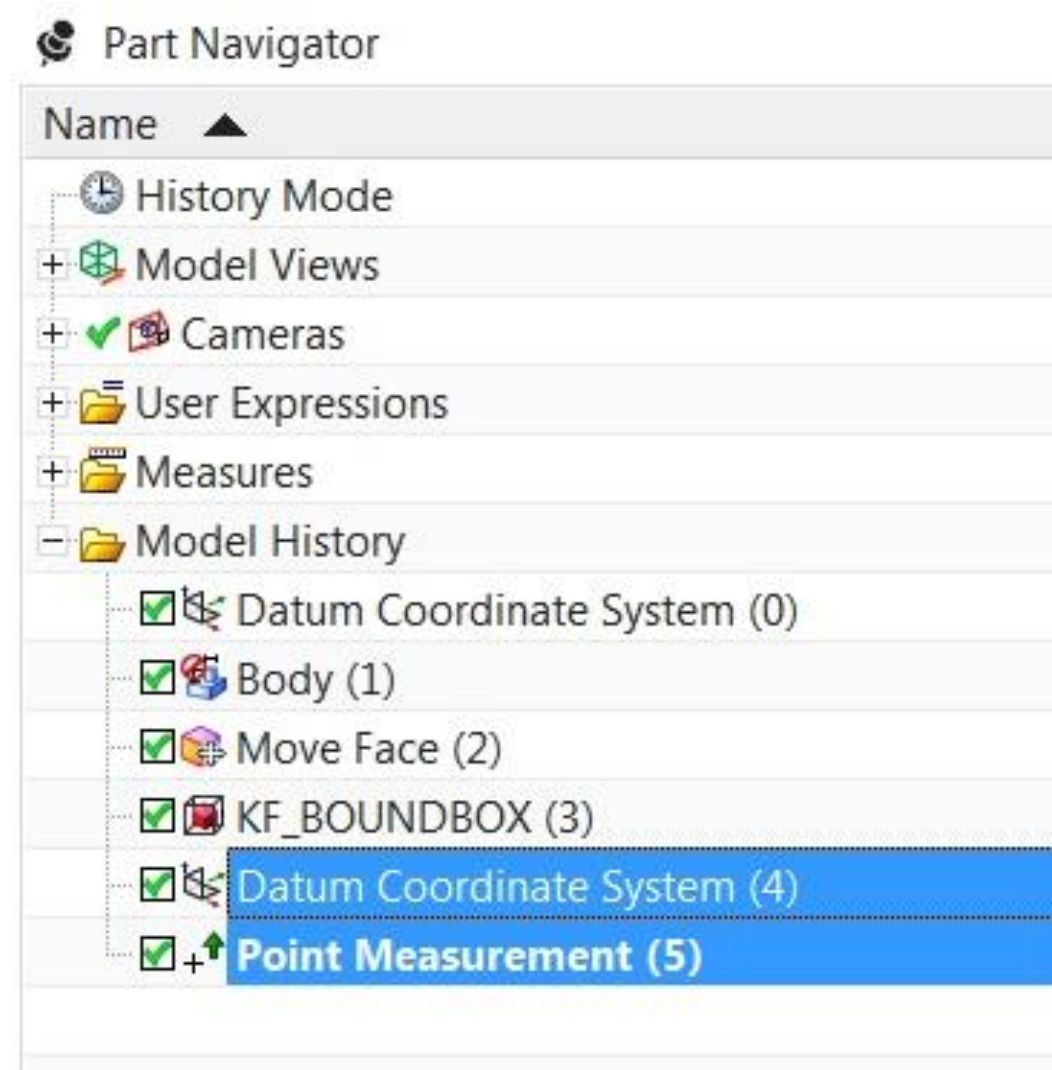


3-D scanning (steps, scan-to-print)

“What are the UNITS of my CAD Model (bounding box)?”

As the modeler of your part, YOU must understand the size of your “**bounding box**”

- Units should be in either inches or millimeters for part export
- These **key dimensions** will be requested on your Work Order



“What file format do I export my models to for 3-D Printing?”

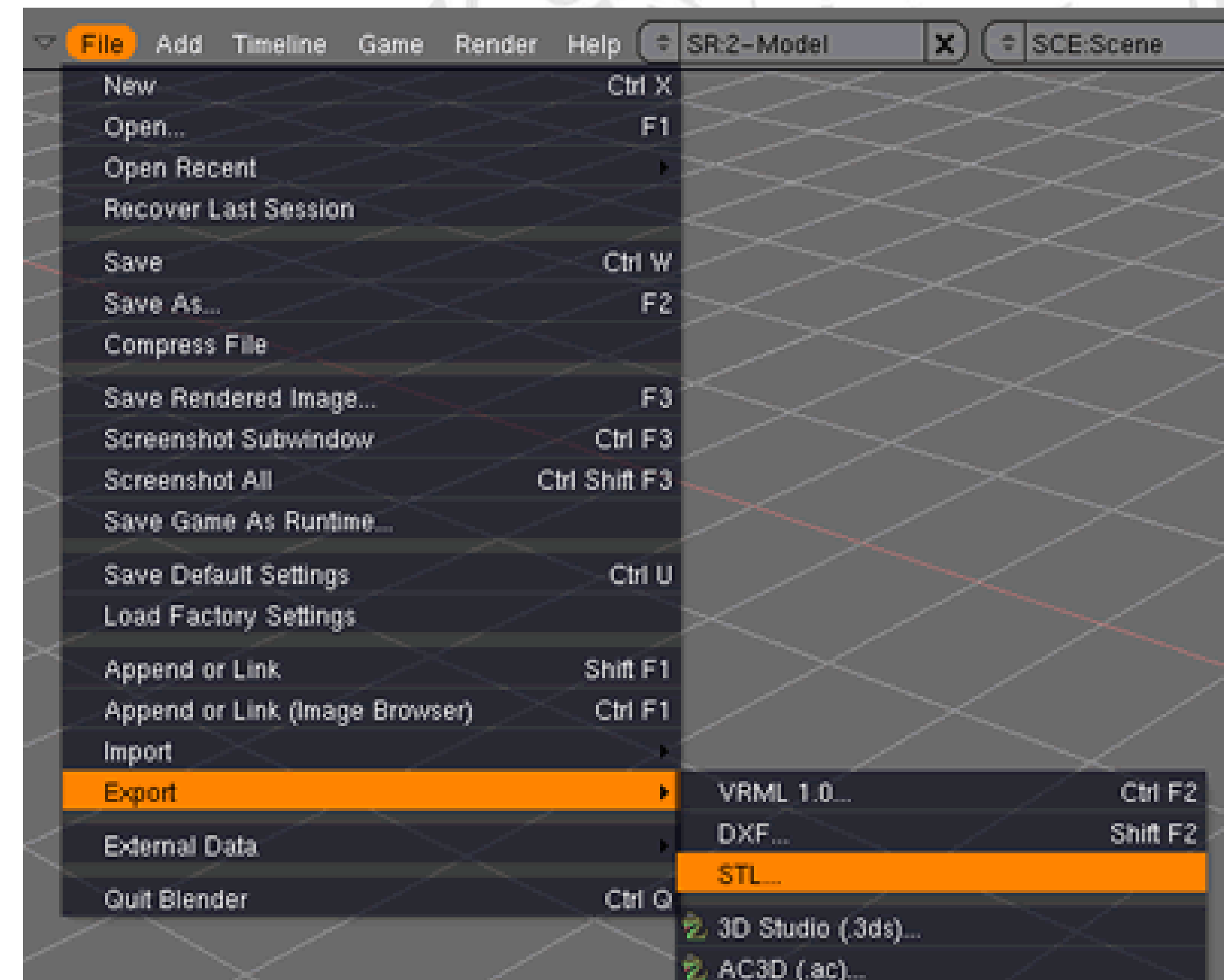
Once you have FINALIZED your 3-D CAD Model:

Export finalized model(s) to .stl file format (Most Common export format for 3-D printing)

** Note: each part needs to be exported as a separate .stl file*

** Note: 3-D printing may require other file formats, e.g., .OBJ files, for 3-D prints with colors/materials. Unless otherwise instructed, **please export your files into .stl format***

STL file format: [https://en.wikipedia.org/wiki/STL_\(file_format\)](https://en.wikipedia.org/wiki/STL_(file_format))

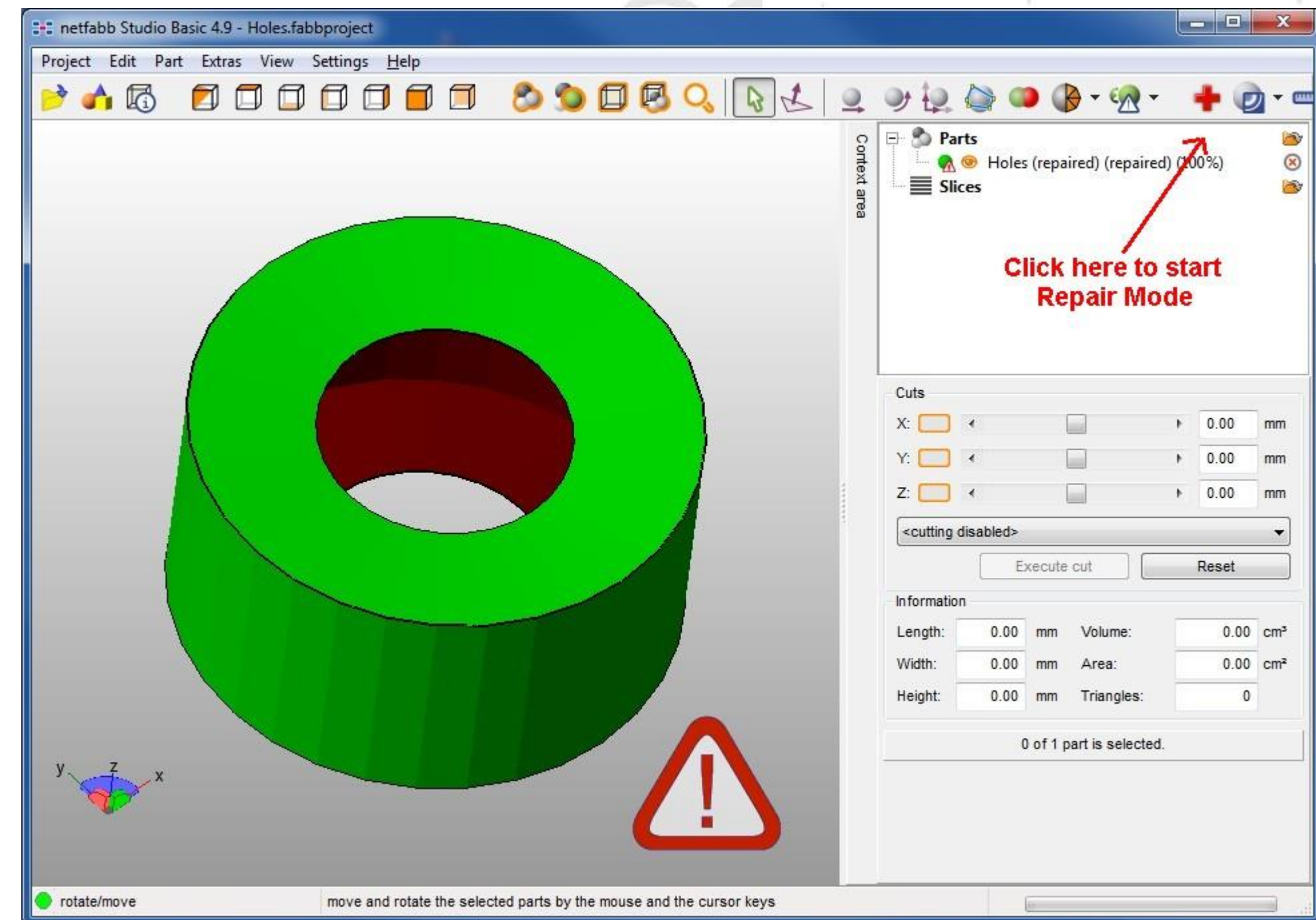


“Is my CAD model ready to be 3-D printed?”

As modeler, it is your responsibility to ensure that your CAD model, and your exported .stl parts, are free of any defects

CAD model repair tools:

- **netFabb (free trial):**
<https://www.autodesk.com/products/netfabb>
- **Meshmixer:**
<http://www.meshmixer.com/download.html>

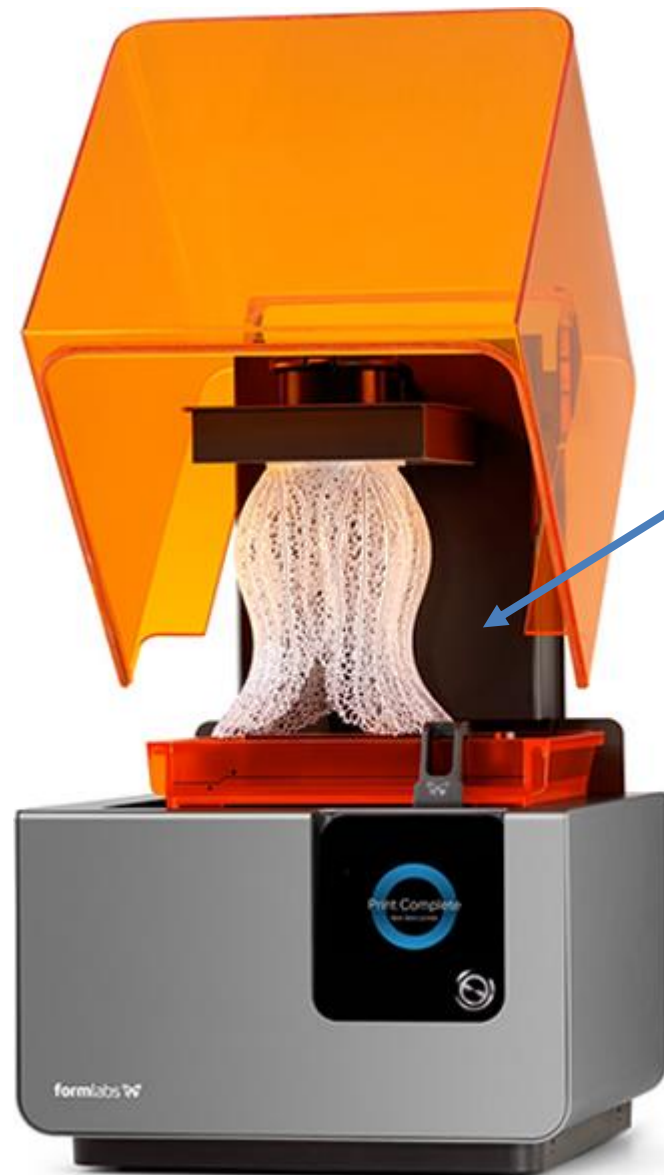


Compress (VERIFIED) .stl file(s) into a single .zip archive

“How large can my model be for a 3-D Print?”

A: It depends on the size of the Build Plate, per printer

- And each printer (typically) has a designated material type
- For printers in the DML, build volumes range from: (5”x5”x5”) to (12”x5”x6”)





“What are my Printer/Material options?”

MakerBot Replicator (5th Generation) printers

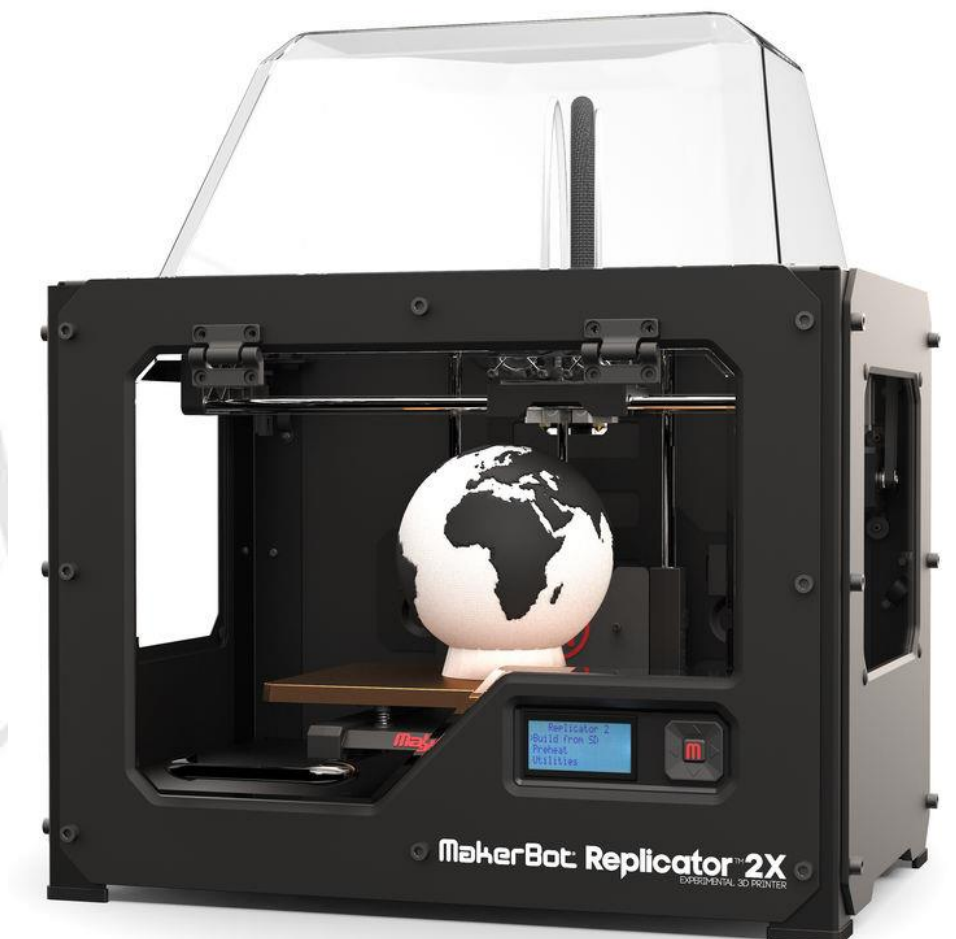
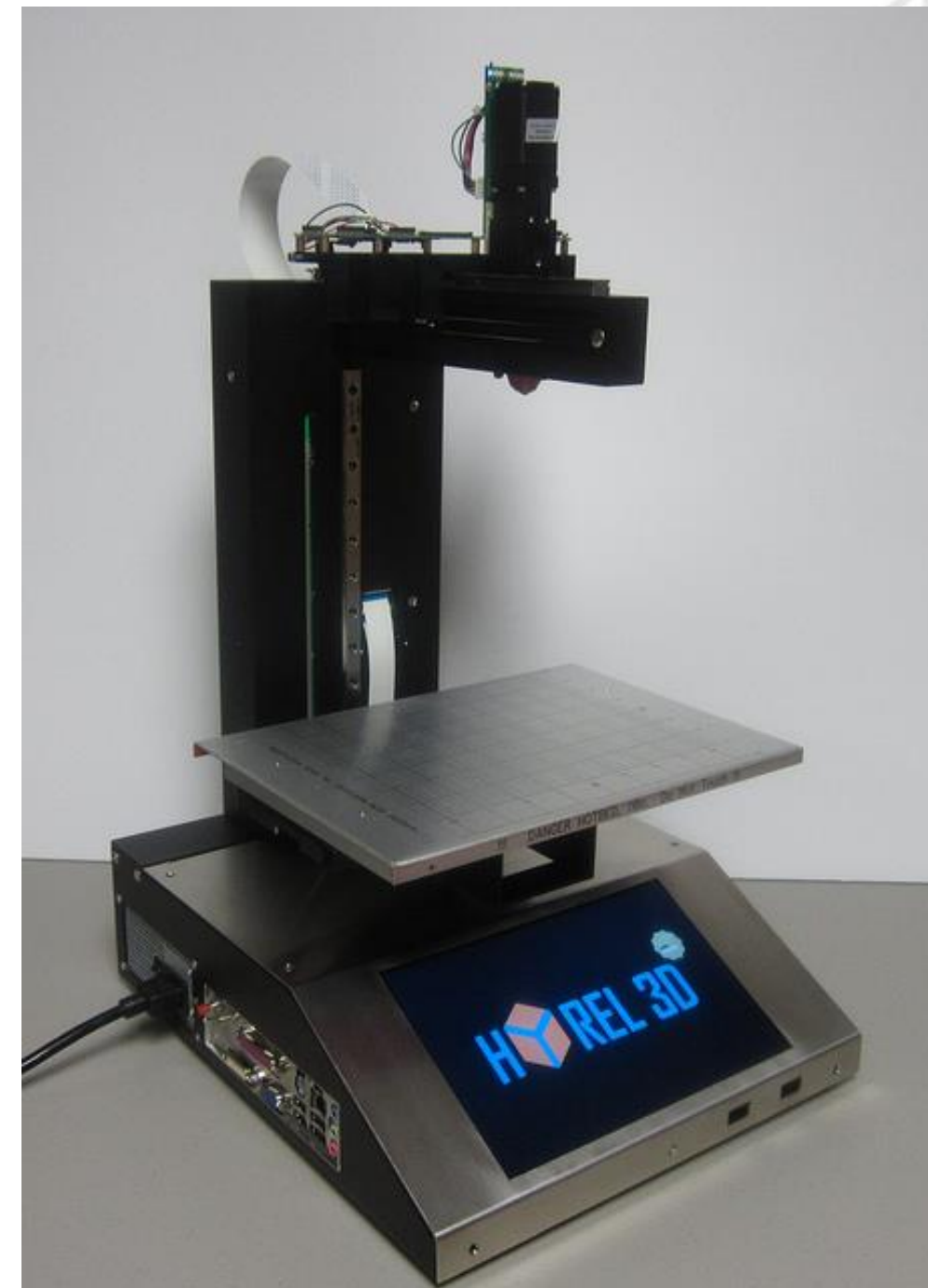
- Uses *PLA plastic* for filament

MakerBot Replicator 2X printer

- Has **2 extruders** for multi-colored prints
- Uses *ABS plastic* filament

Hyrel 3-D Engine E3 Printer

- Can print in PLA, nylon, flexible materials
- More for *experimental applications*



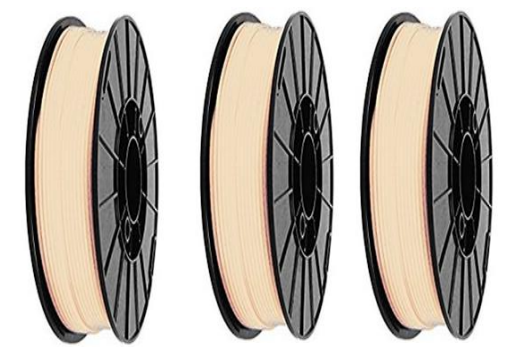


“What are my Printer/Material options?”

FormLabs 1+ Printers

- Use a liquid resin (SLA) as the product build material
- Options for different colors, material types and constituencies





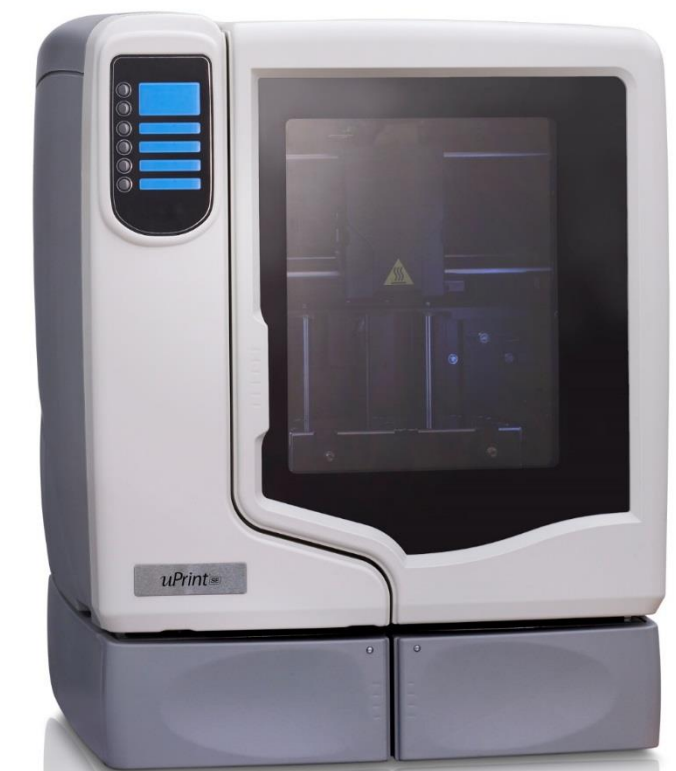
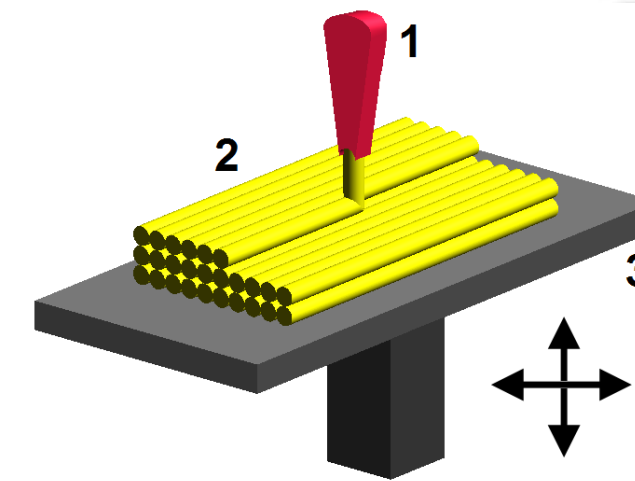
“What are my Printer/Material options?”

mojo

- Uses ABS-plus plastic (Ivory)
- Fused Deposition Modeling (FDM) Technology
- **Efficient post-processing bath (no trimming/cutting required)**

uPrint SE printer

- Higher quality builds than standard ABS/PLA
- **Uses a water soluble support material**
- **Efficient post-processing bath (no trimming/cutting required)**

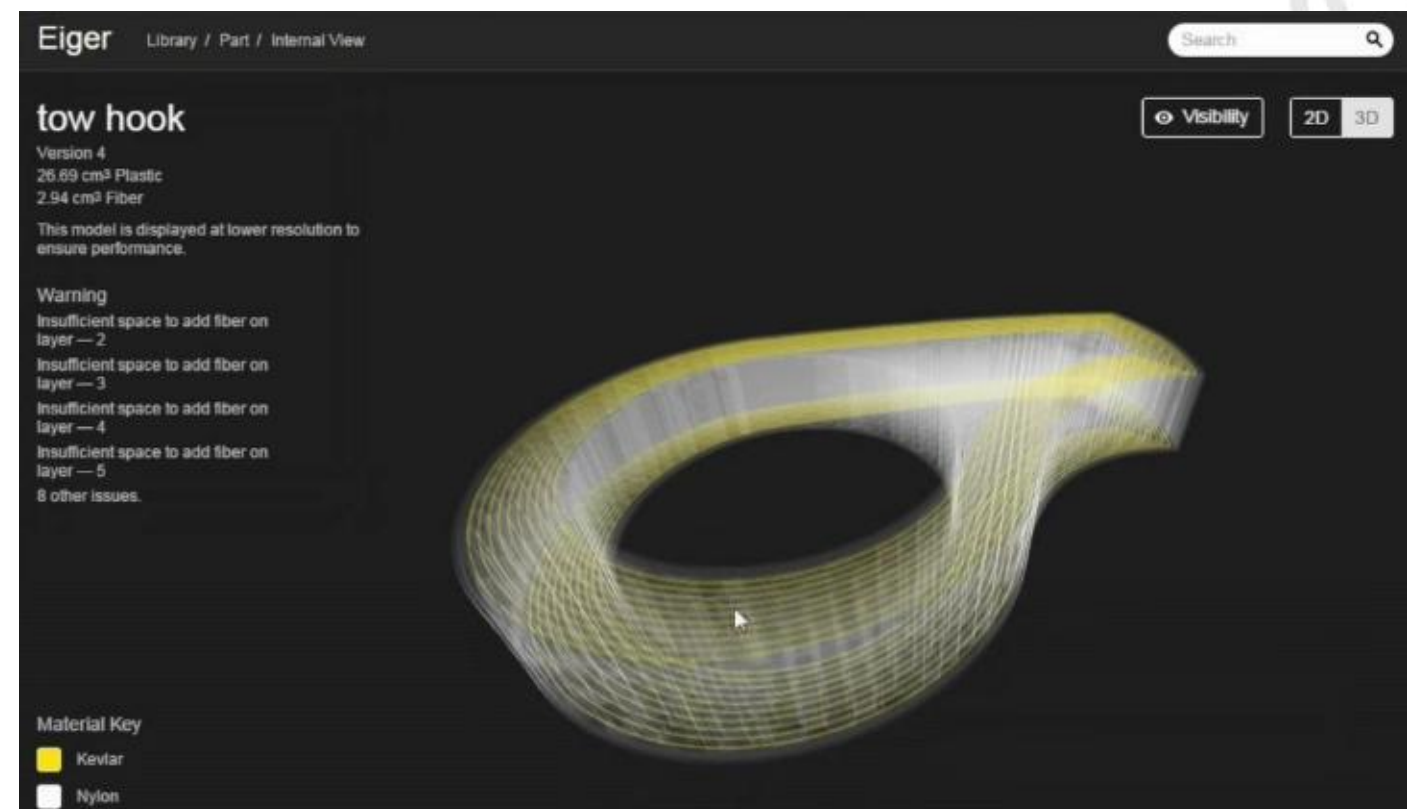




“What are my Printer/Material options?”

MarkForged MarkTwo printer

- A composite material printer (stronger, durable parts)
- Uses nylon base, with carbon/kevlar/fiberglass embedded
- “Onyx” material embeds carbon fibers within the nylon matrix material

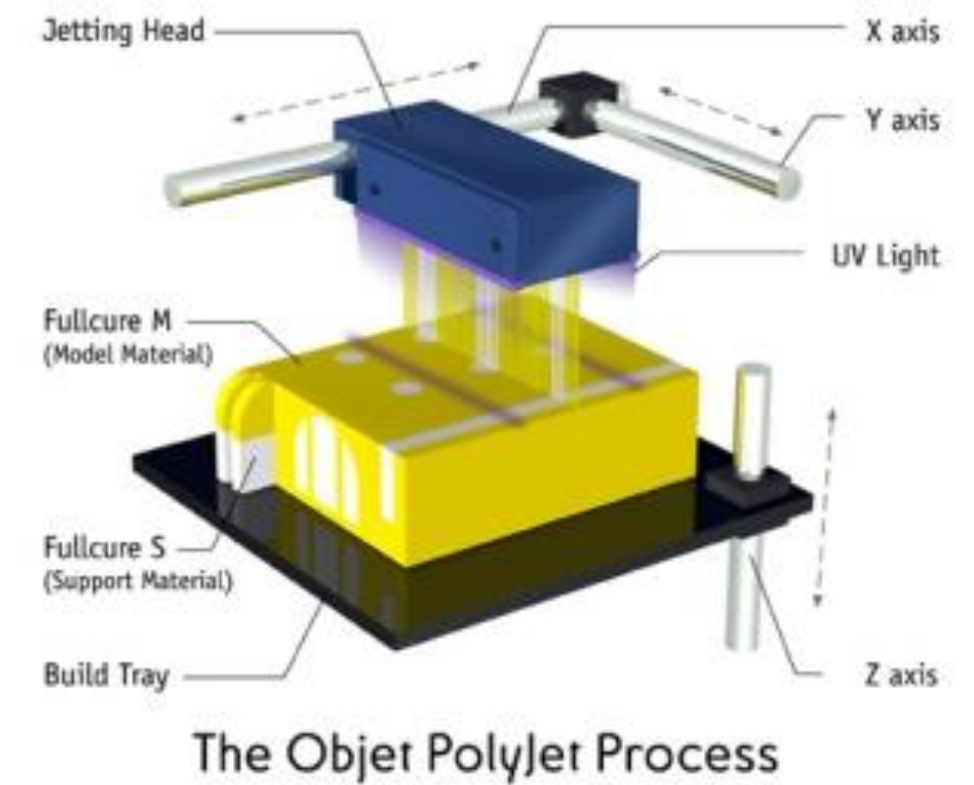




“What are my Printer/Material options?”

objJet 30 printer

- “PolyJet” 3D printer is analogous to inkjet 2-D printing
- Can produce complex parts using a wide range of (pre-loaded) materials
- **Power-wash station enables support material to be easily removed**

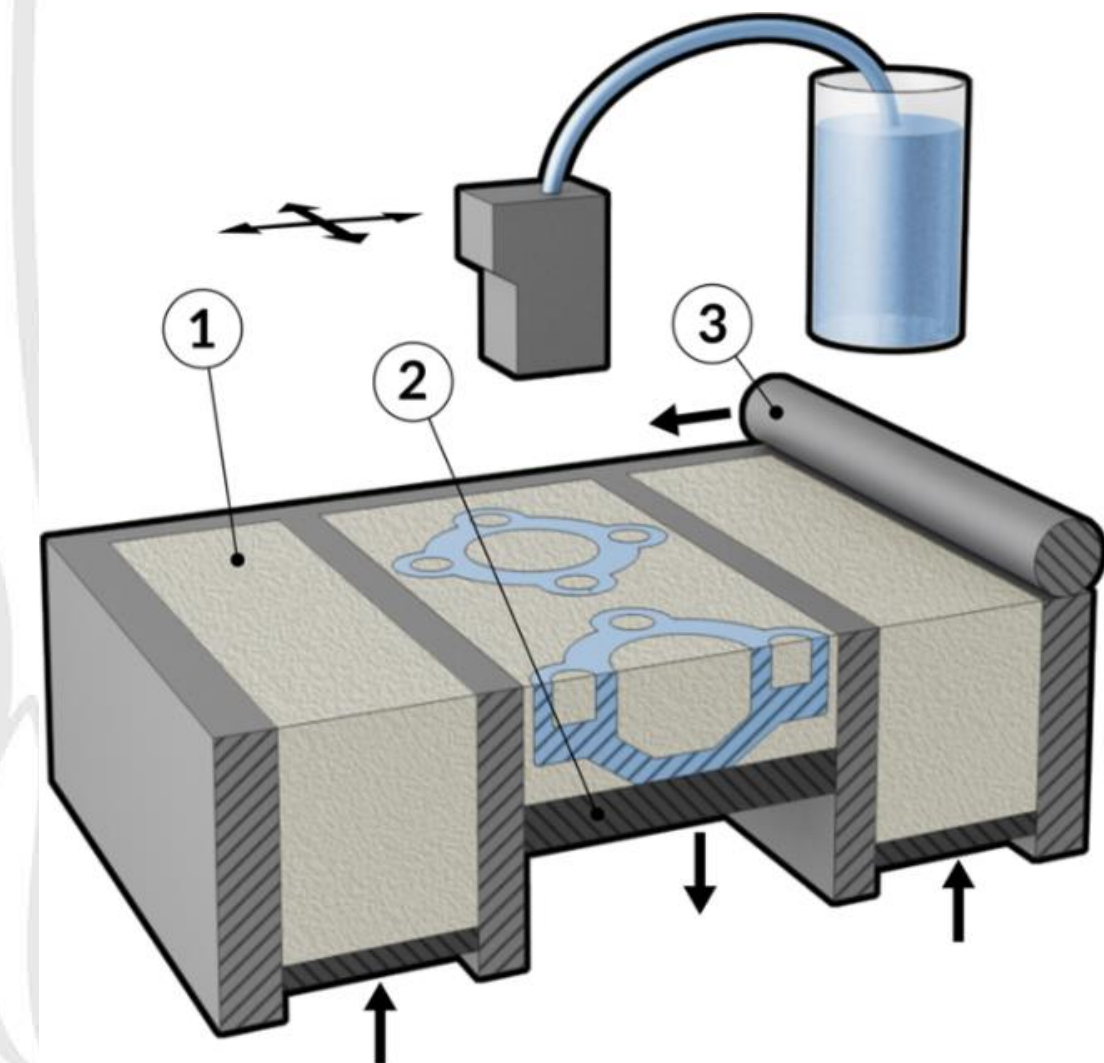
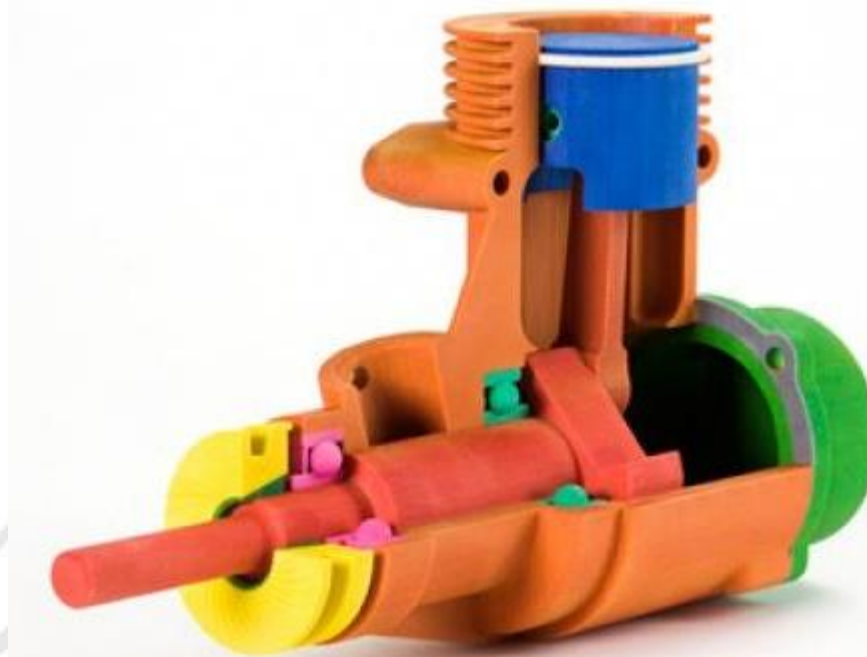




“What are my Printer/Material options?”

ColorProJet 260 Plus printer

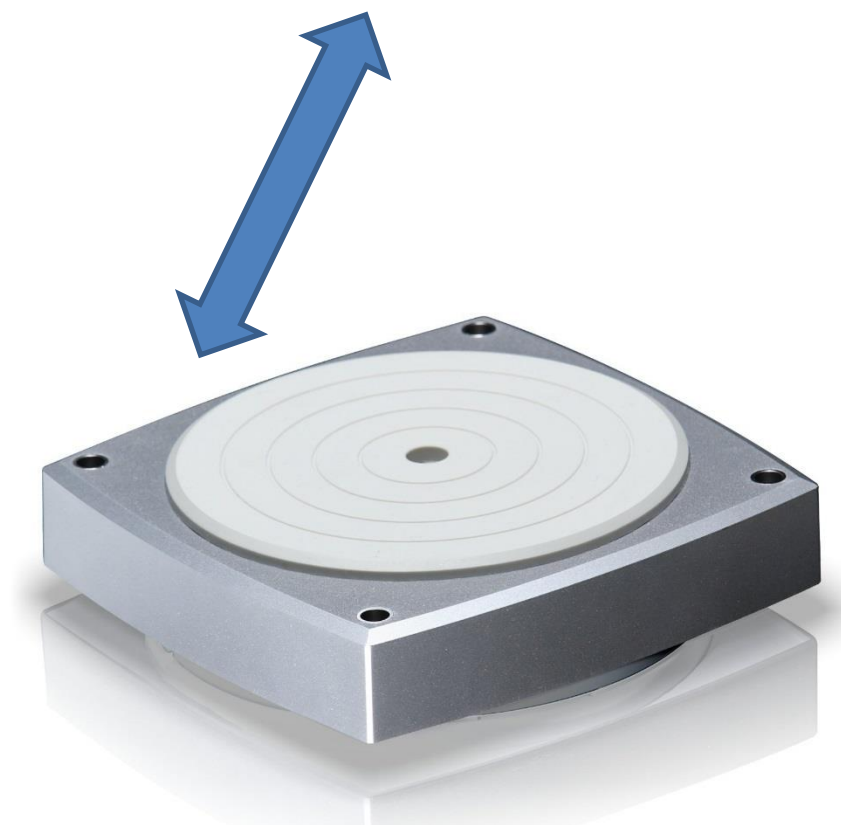
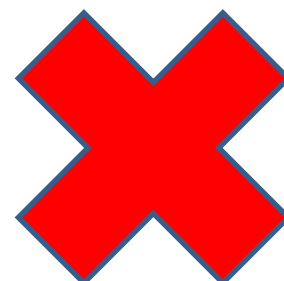
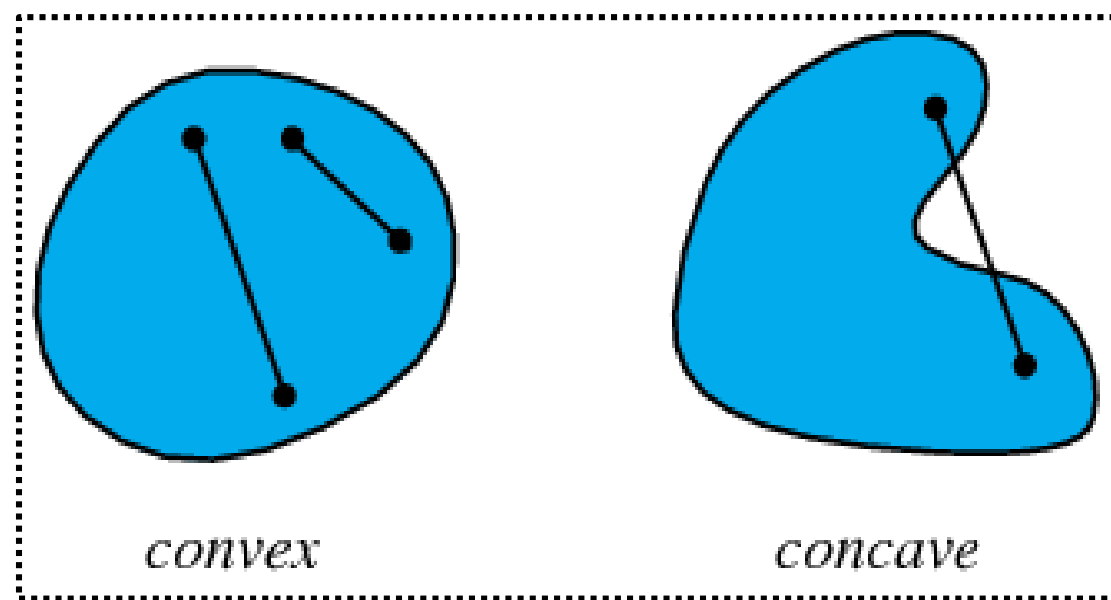
- Core material is a gypsum powder (fragile/brittle)
- Liquid binder causes core to solidify
- Creates photo-realistic parts in full CMY color
- Useful for assembly modeling, simulation models (e.g., contours, FEA)





“What is 3D Scanning?”

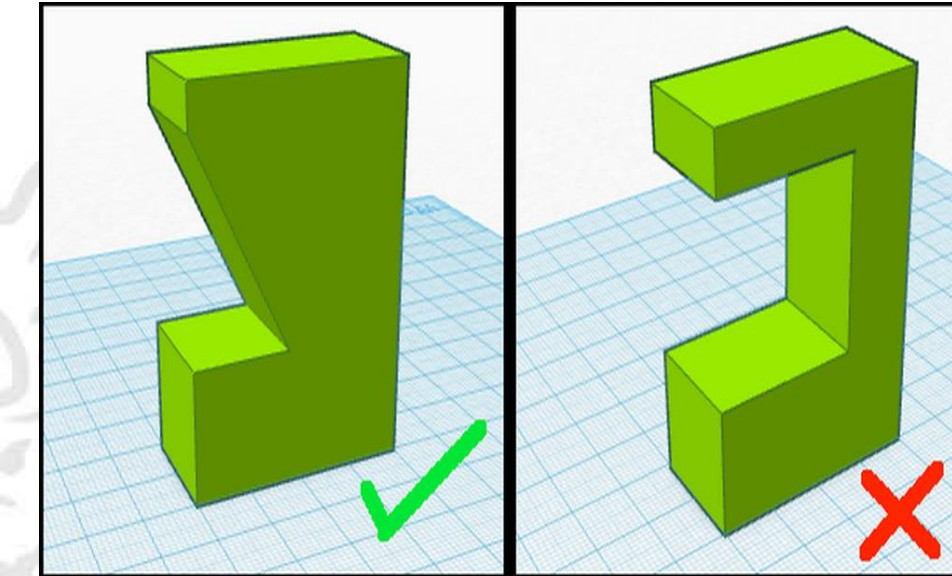
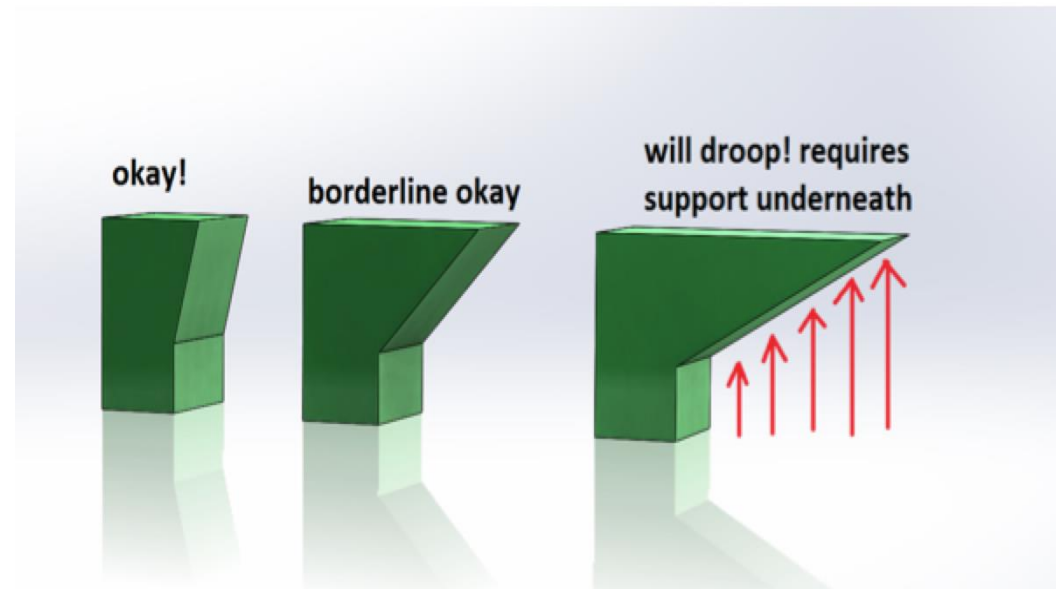
- Ultra High Definition 3D Scanner
- Infrared technology used to scan 3D parts
- Useful to Reverse Engineer products
- Useful to recover broken parts
- Best for matte (not shiny) parts, with minimal concavities (internal holes/voids)



“What are structural considerations in 3-D Printing?”

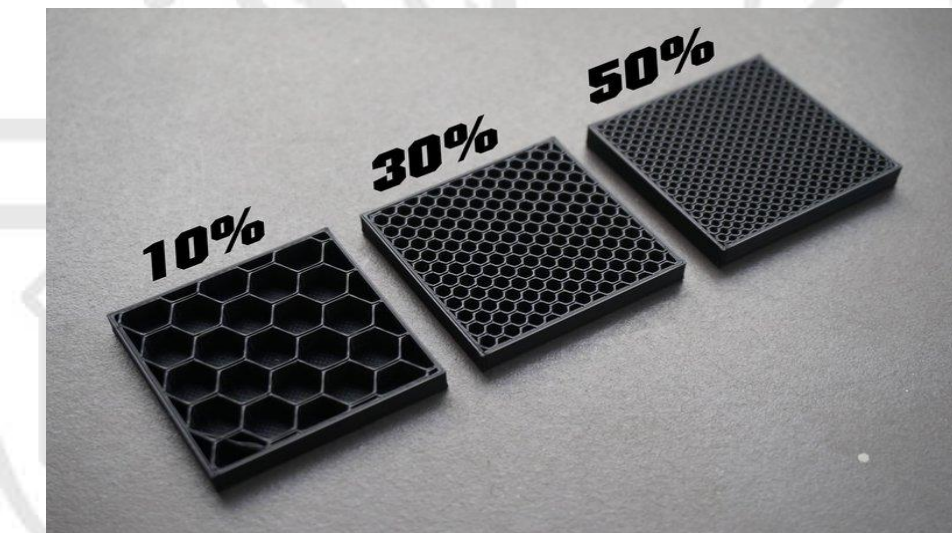
What are “overhangs”?

- **3-D Prints take place in a vertical manner**, and each layer needs to be supported from below
 - If so, you will require a **support structure** during the 3-D build
 - Temporary **material must be removed** during post-processing



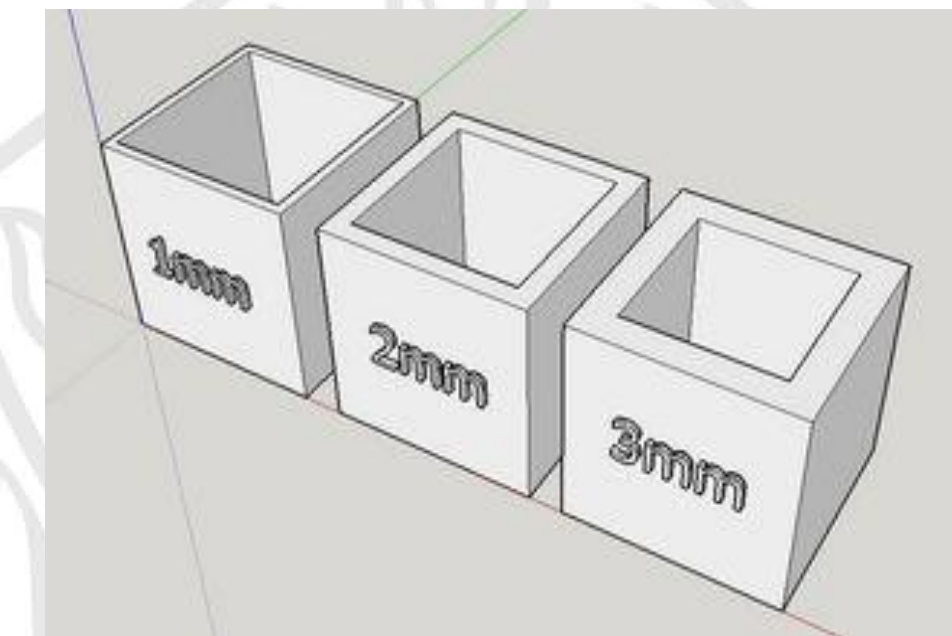
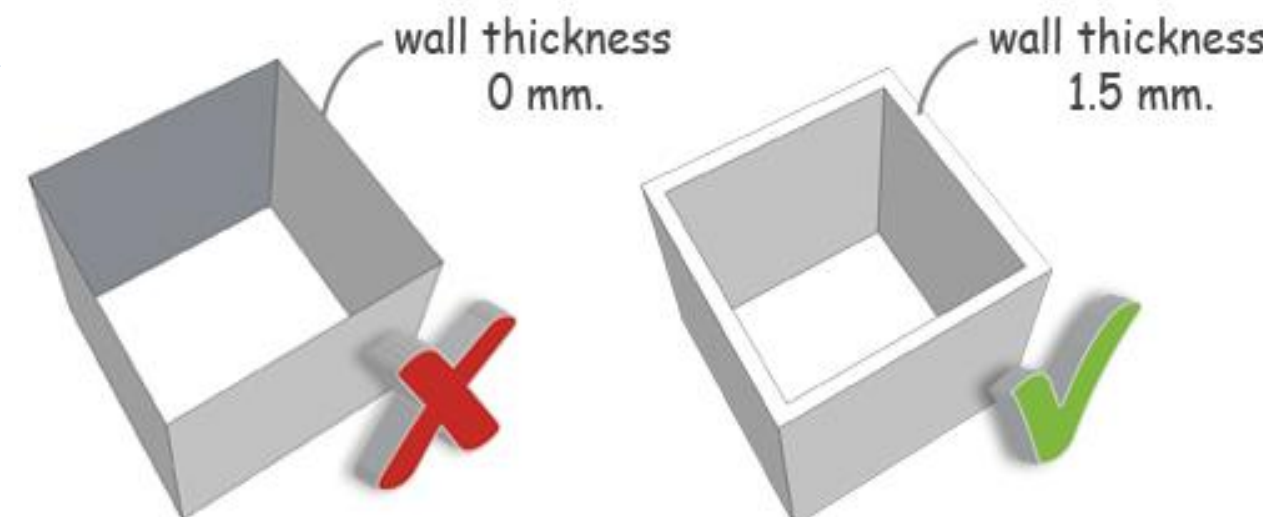
Model Infill Percentage

- How “solid” does your model need to be?
 - Assigned during (printer) software setup
 - Should be dictated by the CAD modeler
 - 10% is default



Wall Thickness Limitations

- Make sure the printed wall has integrity
 - **Can't print** a thin “foil” (i.e., NO thickness)
 - Most printers can handle 1 mm
 - To be safe, go as large as is feasible



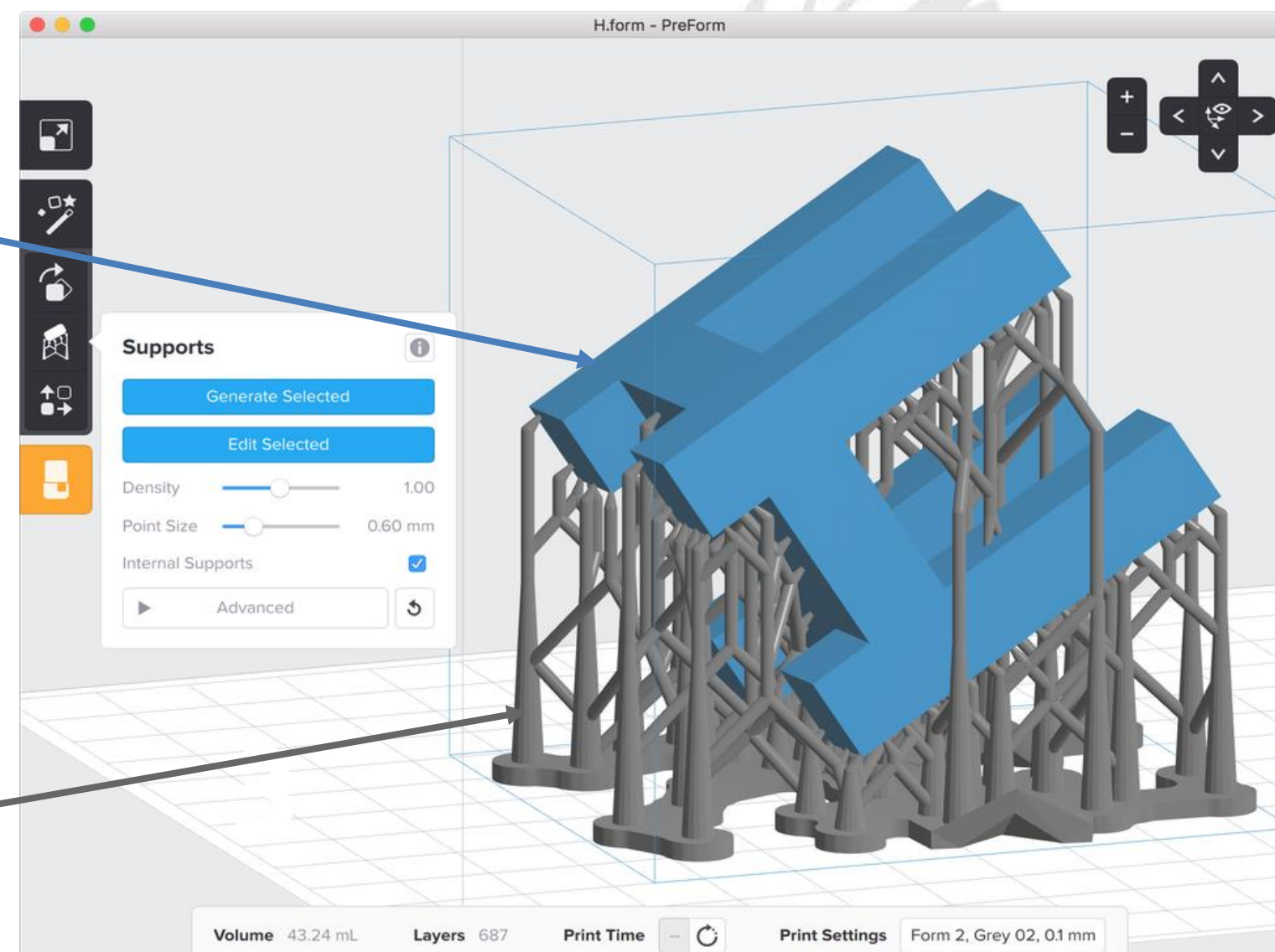
“What are SUPPORTS in 3-D Printing?”

In order to print your part, a temporary “support structure” will be required

- Supports are **generated by the 3-D printer software – NOT by the CAD modeler**
- Supports will be removed after the print is complete
- Supports will add to your overall print volume (e.g., in³ of total material consumed) **and costs**

3-D Printed Model
(permanent)

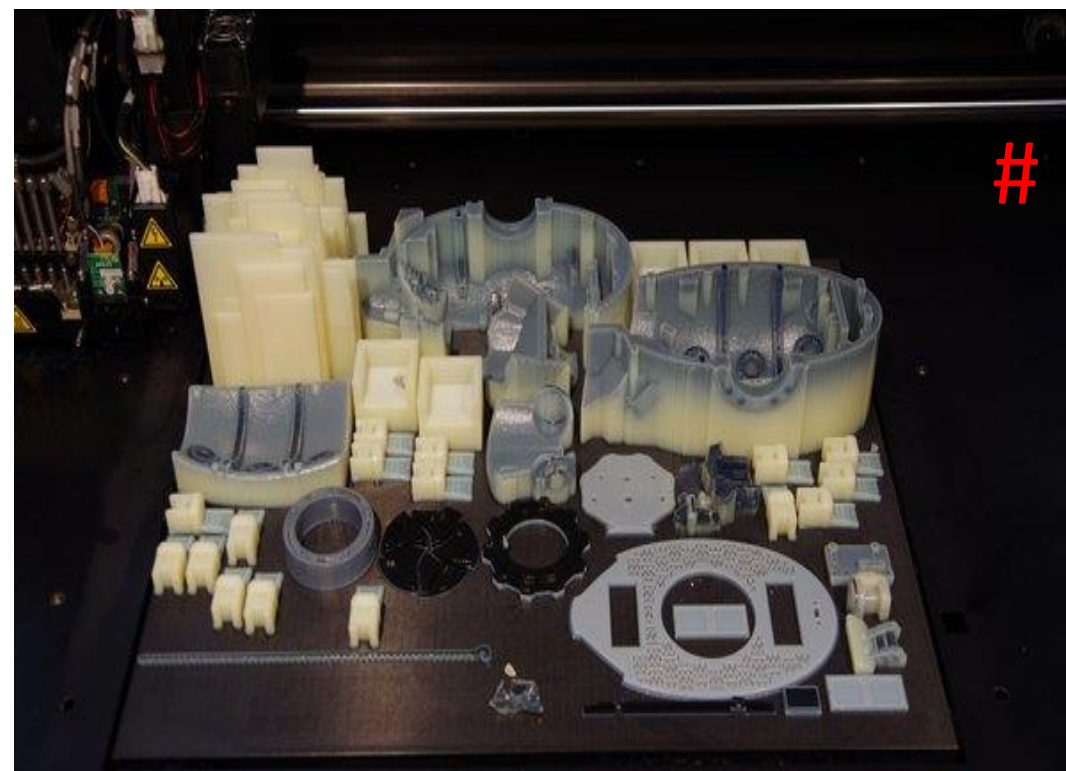
Supports
(temporary)



“What is post-processing in 3-D Printing?”

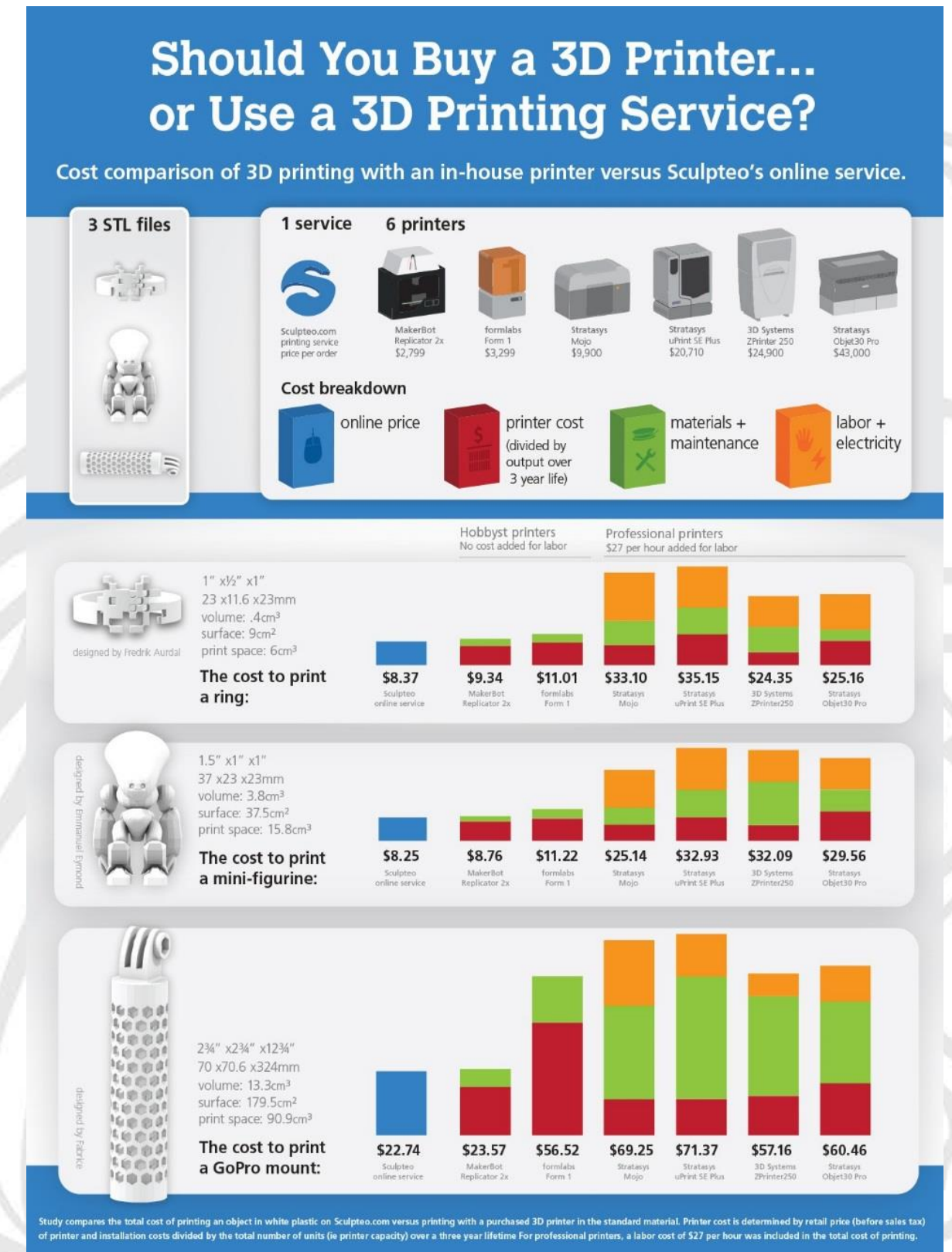
Remove support structure from completed part

- Manual removal may be required to finish part
 - ✓ Responsibility of the customer (not the DML staff)*
- Washing/rinsing may be required to finish part
 - ✓ Responsibility of the DML staff (not the customer)#



“How much will it cost to print my part?”

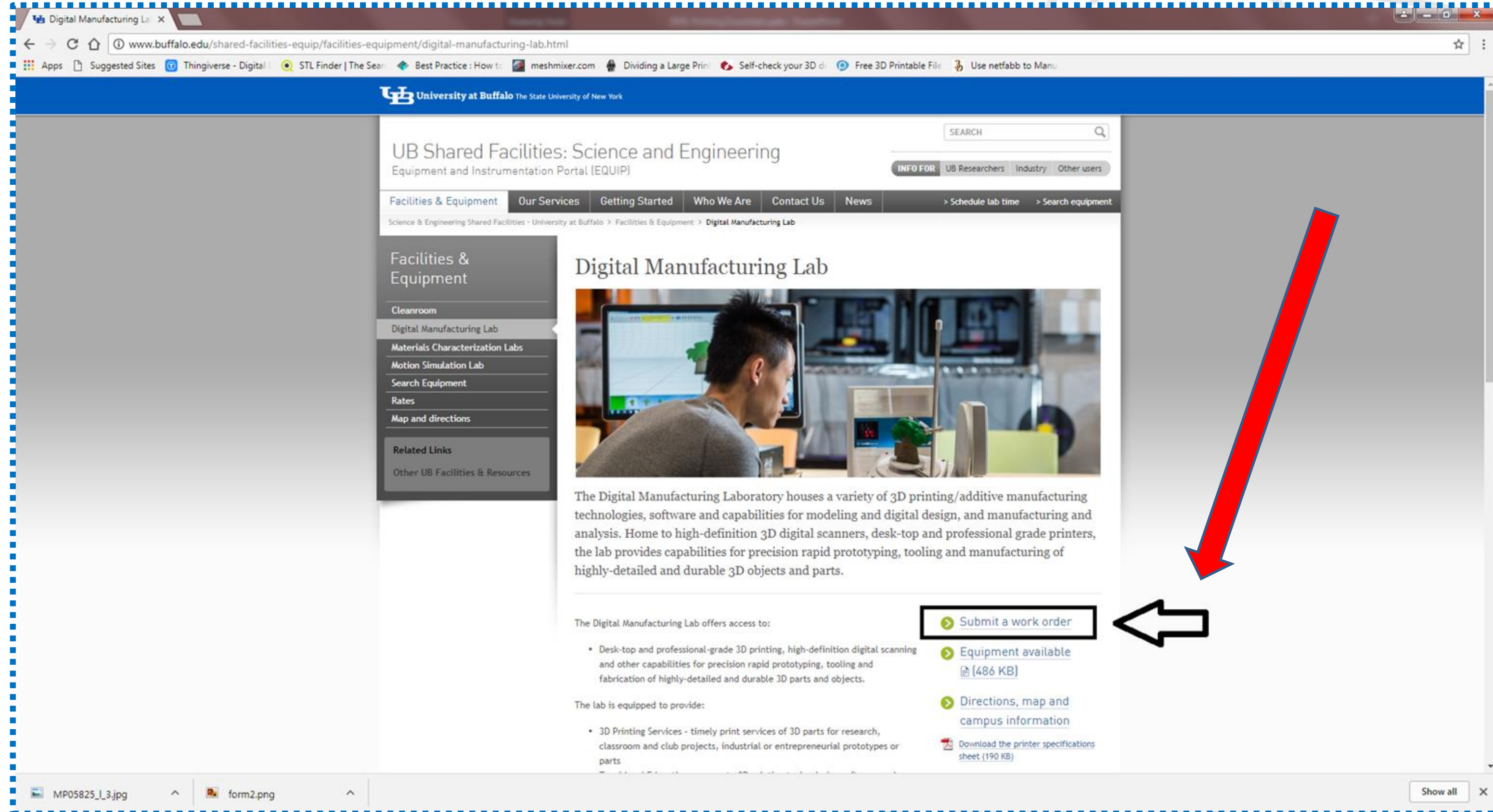
- The DML is an established UB Service Center
 - Rate structure established to recover costs
 - Rates are based per printer, per material
 - Rates are based on total print volume (in³), model & supports
- We have 3 tiers of rates, and payment:
 1. Student Educational projects (*pay by epay*)
 2. UB Sponsored Research/Internal (*pay by Monthly IDI*)
 3. Industry/External (*pay by credit card or Monthly Invoice*)



Current DML Printing Rates: https://www.buffalo.edu/content/dam/www/shared-facilities-equip/Digital%20Manufacturing%20Laboratory%20-%20Rates_11-08-17.pdf

“Where do I submit my Work Order?”

 <http://www.buffalo.edu/shared-facilities-equip/facilities-equipment/digital-manufacturing-lab.html>



UB Shared Facilities: Science and Engineering
Equipment and Instrumentation Portal (EQUIP)

Facilities & Equipment | Our Services | Getting Started | Who We Are | Contact Us | News

Science & Engineering Shared Facilities - University at Buffalo > Facilities & Equipment > Digital Manufacturing Lab

Digital Manufacturing Lab

The Digital Manufacturing Laboratory houses a variety of 3D printing/additive manufacturing technologies, software and capabilities for modeling and digital design, and manufacturing and analysis. Home to high-definition 3D digital scanners, desk-top and professional grade printers, the lab provides capabilities for precision rapid prototyping, tooling and manufacturing of highly-detailed and durable 3D objects and parts.

The Digital Manufacturing Lab offers access to:

- Desk-top and professional-grade 3D printing, high-definition digital scanning and other capabilities for precision rapid prototyping, tooling and fabrication of highly-detailed and durable 3D parts and objects.

The lab is equipped to provide:

- 3D Printing Services - timely print services of 3D parts for research, classroom and club projects, industrial or entrepreneurial prototypes or parts

[Submit a work order](#)

[Equipment available](#)
(486 KB)

[Directions, map and campus information](#)

[Download the printer specifications sheet](#)
(190 KB)

“What happens after I submit my Work Order?”

1. You will be contacted (e-mail) by a qualified DML staff member
2. We will schedule a consultation to discuss project requirements
3. You will be provided a cost estimate for your prototype
4. You will pay for your part using an approved payment mechanism
5. We will contact you with any questions/concerns
6. When the part is complete, we will contact you to arrange for pickup

Note: Normal turnaround time can be expected to be 3-5 business days

- During peak periods, this may increase to 5-7 business days
- **Our print submission queue is FIRST COME, FIRST SERVED. NO EXCEPTIONS**





“Where are you Located?”

Digital Manufacturing Laboratory (DML)
School of Engineering and Applied Sciences
118 Bonner Hall
University at Buffalo
Buffalo, NY 14260