



Printing

General Primer and Interesting facts

Printing is part of the 3D ecosystem

- 3D Inputs (Cell phones, Nintendo Wii, Leap Motion, 3D scanners)
- 3D Displays (3D Televisions, VR helmets (Oculus Rift))
- 3D Printers – translates virtual reality into something physical.

What is 3D printing?

- From Wikipedia:

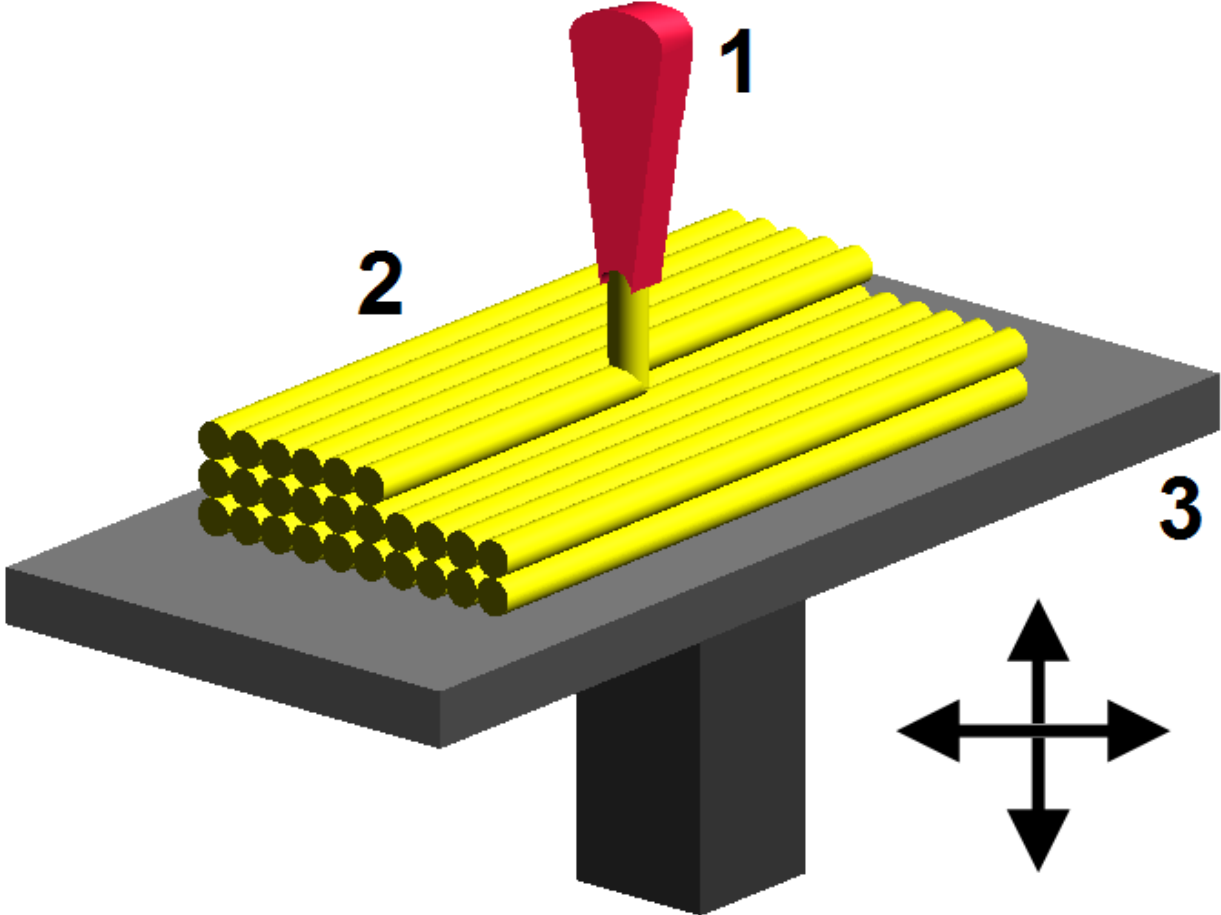
*3D printing, also known as **additive manufacturing (AM)**, refers to various processes used to synthesize a three-dimensional object.*

- Differs from CNC machines, which are subtractive
- While processes vary, all share the trait that the object is created one layer at a time.
- FDM was developed in the 1980s, commercialized in the 1990s by Stratasys

Processes

Type	Technologies	Materials
Extrusion	<p>Fused deposition modeling (FDM) or Fused Filament Fabrication (FFF)</p> <p>Robocasting or Direct Ink Writing (DIW)</p>	<p>Thermoplastics, eutectic metals, edible materials, Rubbers, Modeling clay, Plasticine, Metal clay (including Precious Metal Clay)</p> <p>Ceramic materials, Metal alloy, cermet, metal matrix composite, ceramic matrix composite</p>
Light polymerized	<p>Stereolithography (SLA)</p> <p>Digital Light Processing (DLP)</p>	<p>Photopolymer</p> <p>Photopolymer</p>
Powder Bed	<p>Powder bed and inkjet head 3D printing (3DP)</p> <p>Electron-beam melting (EBM)</p> <p>Selective laser melting (SLM)</p> <p>Selective heat sintering (SHS)</p> <p>Selective laser sintering (SLS)</p> <p>Direct metal laser sintering (DMLS)</p>	<p>Almost any metal alloy, powdered polymers, Plaster</p> <p>Almost any metal alloy including Titanium alloys, Titanium alloys, Cobalt Chrome alloys, Stainless Steel, Aluminium</p> <p>Thermoplastic powder</p> <p>Thermoplastics, metal powders, ceramic powders</p> <p>Almost any metal alloy</p>
Laminated	<p>Laminated object manufacturing (LOM)</p>	<p>Paper, metal foil, plastic film</p>
Wire	<p>Electron beam freeform fabrication (EBF)</p>	<p>Almost any metal alloy</p>

Fused deposition modeling: 1 – nozzle ejecting molten material, 2 – deposited material (modeled part), 3 – controlled movable table



If it was done in the 90s, why all
the excitement now?

The Patent expired!

Process isn't rocket science

- Basically a motorized glue gun
- Gave birth to lots of projects – RepRap (short for replicating rapid prototyper) is probably the most famous.
- Costs for parts are not cost prohibitive.

Types of FDM printers

- Cartesian
- Delta
- Polar

<http://makezine.com/2015/03/10/cartesian-delta-polar-common-3d-printers/>

Workflow to 3D print

Create Model (hard part!)

Feed Data to a Slicer (outputs gcode)

Specify resolution, fill, additional info (supports)

Print gcode with printer



Potential for innovation is vast

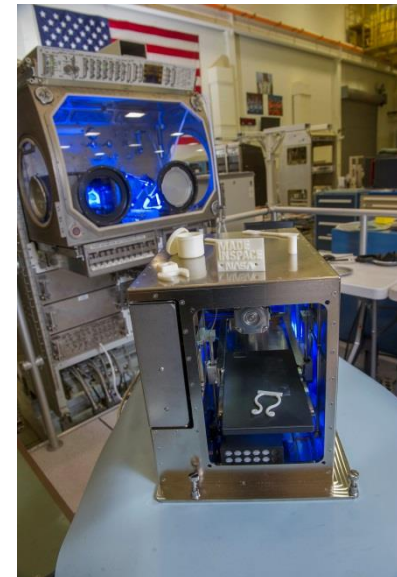
- In space:

NASA Team Moves Closer to Building a 3-D Printed Rocket Engine

<http://www.nasa.gov/centers/marshall/news/news/releases/2015/piece-by-piece-nasa-team-moves-closer-to-building-a-3-d-printed-rocket-engine.html>

International Space Station's 3-D Printer

<https://www.nasa.gov/content/international-space-station-s-3-d-printer>



- In medicine

[Scientists Can Now 3D Print Transplantable, Living Kidneys](http://gizmodo.com/scientists-can-now-3d-print-transplantable-living-kidn-1120783047)

<http://gizmodo.com/scientists-can-now-3d-print-transplantable-living-kidn-1120783047>

– Other organs (liver), blood vessels, skin have been printed

Creating [Heart] Valve Tissue Using 3-D Bioprinting

<https://www.asme.org/engineering-topics/articles/bioengineering/creating-valve-tissue-using-3d-bioprinting>

[3d printed prosthetics – Enabling The Future](http://enablingthefuture.org/tag/3d-printed-prosthetics/)

<http://enablingthefuture.org/tag/3d-printed-prosthetics/>

Noses, ears, teeth and other parts have been printed and used already

- In electronics

3D Printed Graphene Battery

<http://www.graphene3dlab.com/s/battery.asp>

3D Printing: 3D Print A Solderless Circuit Board

<http://www.instructables.com/id/3D-Printing-3D-Print-A-Solderless-Circuit-Board/>

AUO Develops 3D Printed OLED Technology Suitable for Mass Production

http://www.ledinside.com/news/2014/4/auo_develops_3d_printed_oled_technology_suitable_for_mass_production

- **In Pharmaceuticals**

Why it matters that the FDA just approved the first 3D-printed drug

<https://www.washingtonpost.com/news/innovations/wp/2015/08/11/why-it-matters-that-the-fda-just-approved-the-first-3d-printed-drug/>

- **In Historical Preservation**

3D PRINTING FOR HISTORIC PRESERVATION/RESTORATION

<http://www.ajsny.com/3dprintingforhistoricpres/>

How 3D printers can help undo the destruction of ISIS

<https://www.washingtonpost.com/news/innovations/wp/2016/01/07/how-3d-printers-can-help-undo-the-destruction-of-isis/>

- **In Food**

[A Fully 3D Printed Meal to Satisfy Every Elder's Appetite](#)

<http://3dprintingindustry.com/2015/10/20/the-performace-concept-a-full-3d-printed-meal-to-satisfy-every-elderly-persons-appetite/>

Even though you don't have one,
realize that:

- **Automakers globally using 3-D printing to speed production, prototyping**

<http://www.plasticsnews.com/article/20141027/NEWS/141029919/automakers-globally-using-3-d-printing-to-speed-production-prototyping>

- **3D printing: A potential game changer for aerospace and defense**

<https://www.pwc.com/us/en/industrial-products/publications/assets/pwc-gaining-altitude-issue-7-3d-printing.pdf>

- **And we all heard of the Internet of Things (IOT)**

And if BestBuy has a section, you
know it's mainstream.