3D Printed Droid Parts



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Background of 3D Printing

- Additive manufacturing is a process of making a three-3 dimensional solid object of virtually any shape from a digital model – started in 1984, Chuck Hull of 3D Systems Corp.
- 3D printing is different from traditional "subtractive" machining а. techniques, which rely on the removal of material by methods such as cutting or drilling
- Objects are created through a sequential layering process. 3D Э. drawings (models) are cut into "slices" (digital cross-sections) for the machine to successively use as a guideline for printing.
- Multiple methods now widely available. Laminating layers, Э. Granular or Powder Layering, Light Sensitive Polymers, **Extrusion (Fused Deposition)**

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Fusion Deposition 3D Printing

- Developed by S. Scott Crump in the late 1980s. Think of a Hot Glue Gun, but instead of glue you melt plastics.
 - PLA polylactic acid (195 C 383 F)
 - ABS acrylonitrile butadiene styrene (230 C 446 F)
 - Nylon, Polycarbonate and others
- Commercialized in 1990 by Stratasys. Patents on this technology have expired & there is now a large open-source development community for this type of 3-D printer.
- The RepRap (short for replicating rapid prototyper) project has developed a 3D printer that can print most of its own components. RepRap uses a variant of FDM. The project calls it Fused Filament Fabrication (FFF) to avoid trademark issues.

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RepRap Mendel



Project Started in 2005. First machine, Darwin Developed In 2006 Design released in 2008 Second machine, Mendel Released in 2009

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MakerBot Cupcake CNC



Introduced in 2009 As an under \$500 kit. Company started with \$75,000. Object of providing 3D printing to large number of people.

Acquired 6/2013 by Stratasys for \$400 million

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Trinity Labs Aluminatus 1



Designed late in 2012, first delivered 3/2013.

Uses pre-assembled Linear stage as drive Component for speed and accuracy.

.4mm Extruder 3mm filament 12x12x12 build volume.

Alpha version \$1800 Pro Version \$3599

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Solidoodle 3



3rd generation machine

Belt Driven

.35mm Extruder 1.75mm filament 8x8x8 build volume

\$800 Fully assembled

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The 3D Printing Process

- Start with a 3D design.
- Convert units to mm and Export 3D design into Stereo Lithography (.slt) format. Design now represented as a set of triangles.
- "Slice" the .slt data into a set of layers
- Generate G-code to position & Control Printer. More complicated control involves:
 - X,Y,Z position of Extruder and Print Bed
 - Amount of plastic to extrude (or retract if moving).
 - Temperature of Extruder & Heated Bed.
 - Control of Fans to cool object being printed.

Printing Capabilities

- Use a layer height < 80% of nozzle diameter, and an extrusion width >nozzle diameter.
- For a 0.4mm nozzle (stock Aluminatus size) this means:
 - 0.3mm Maximum layer height (.0118 in)
 - 0.45mm Minimum extrusion width (.0177 in)
- Extruder Nozzles in sizes from .25mm, .35mm, .4mm and .5mm
- Layer heights as low as .1mm but lower layer heights means more layers and longer print times.

Printing Limitations

- Unsupported Shapes not possible. Slicing software can automatically insert support. "Bridging" - short unsupported spans – has distance limitations and is slow
- Holes will always come out too small.
- Conversion to .stl format is an approximation of the shape.
- Calibration (Tune Up) necessary for each roll of Filament. Differences in size (diameter of filament) & Melting Point (different colors and/or different vendors)
- Parts shrink when cold (170-200 C temperature change) possible to adjust printer calibration
- First Layer Adhesion critical to getting good parts

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Designing Parts for 3D Printing



Shoulder Hub – Media Conversions modified version

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First Print



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First Print Flaws



Obvious Joint

Bridging Failure

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Re-Design for Printing



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Finished Part



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Acetone Finishing



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Acetone Finishing



40 sec60 sec80 sec100 secFrank Pirz – Media Conversions
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First Layer Adhesion



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Print Surface Not Level



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Wet Filament



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Dry Filament



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Glass Print Bed



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Other Printer Mods



Thumb Screw

Wire Guide

Shock Absorber

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.stl Conversion Example



Large Data Port 1400 triangles Used

390 kb file size

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Resulting Print



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Handling .stl Format



Large Data Port

44000 triangles used

12080 kb file size

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Choices of In-Fill



Hexagonal Infill

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Choices of In-Fill



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Effects of Layer Height



.3mm Layers

.2mm Layers

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Vive la différence!



Frank'sUtility Arms – printed in 2 pieces

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Vive la différence!



Andrew's Utility Arms - .2mm layers, one piece

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Center Foot Apron



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Foot on the Half Shell



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Foot Shell



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Inside the Foot Shell



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References

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- Andrew Radovich's R2-JE facebook page https://www.facebook.com/jennasdroid
- This presentation located at: http://www.r2d2.media-conversions.net/DroidConII

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