

Intro to 3D Printing

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Overview

- What is 3D Printing?
- The Flow
 - Capture a Design
 - Generate STL
 - Pick a Process
 - Prepare for Printing
- Novel Applications
- Shapeways Service
- Useful Resources
- 3D Printing Demo
- Q&A

What is 3D Printing

- What is 3D?
 - 2D: Drawings, paintings
 - 3D: Sculpture, things we use.
- What is Printing?
 - Depositing material. Paint, graphite ink.
- What is 3D Printing?
 - Depositing material to make a 3D object!
 - Layer by layer by layer...

How Does 3D Printing Work?

- Phase Change; Melting/Solidifying
 - Powder sintered (fused) by laser/sun
 - Filament melted by heater (hot-glue gun)
- Chemical Reaction
 - Binder fluid ink-jet printed on powder.
 - Pattern projected on UV-cured liquid.

The Flow

- **Capture a Design**
- Generate STL
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Capture a Design From Scratch - Easy

- 3DTin
 - WebGL in-browser app
 - <http://3dtin.com/>
- Autodesk 123D Design
 - iPad, Mac, PC
 - <http://www.123dapp.com/design>

Capture a Design From Scratch - Medium

- FreeCAD
 - FOSS (Mac, Windows, Linux)
 - Python API
 - Support for STEP, IGES & others via OpenCASCADE
 - <http://www.freecadweb.org/>
- Trimble (was Google) SketchUp
 - Mac/MS, Basic version (free=beer)
 - <http://www.sketchup.com/>

Capture a Design From Scratch - Expert

- Blender
 - Graphical user interface
 - Python scriptable
 - FOSS (Linux, Mac, MS)
 - <http://blender.org/>
- OpenSCAD
 - Text-based solid modelling
 - Simple UI or command-line executable
 - FOSS (Linux, Mac, MS)
 - <http://openscad.org/>

Capture a Design Model Scanning

- Expensive – Polhemus
 - <http://polhemus.com/>
- Mid-priced Kinect-based – ReconstructMe
 - <http://reconstructme.net/>
- MS Kinect Hacks – From Kinect to MakerBot
 - <http://blog.makezine.com/projects/from-kinect-to-makerbot/>
- From Photographs – Autodesk 123D Catch
 - Online, iPhone/iPad, PC-only
 - <http://www.123dapp.com/catch>
- DIY Laser-Based – Spinscan:
 - <http://www.thingiverse.com/thing:9972>

Capture a Design

Design Sharing

- Thingiverse
 - <http://www.thingiverse.com/>
 - All designs have explicit share and/or re-mix friendly licenses specified by the creator.
 - Parametric designs via OpenSCAD
 - <http://www.thingiverse.com/apps/customizer>
- Other sites exist for pay-for designs.
- Other sites exist for controversial subject material. They exist; be aware of them. Don't break whatever laws may apply in your jurisdiction; I Am Not A Lawyer.

The Flow

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Generate STL

Export From Software

- STL (**ST**ereo **L**ithography file format)
 - [http://en.wikipedia.org/wiki/STL_\(file_format\)](http://en.wikipedia.org/wiki/STL_(file_format))
 - Pile of triangles.
- Blender
 - Enable in User Preferences
 - AddOns – Import-Export: STL format
 - Export as OpenSCAD Plug-in
 - https://github.com/graphicsforge/io_mesh_openscad
- OpenSCAD
 - Export as STL

Generate STL

Software Glue - Mesh Clean-Up

- MeshLab (FOSS):
 - <http://www.meshlab.org/>
- Netfabb (Free=Beer):
 - Cloud Service:
 - <http://cloud.netfabb.com/>
 - Studio Basic:
 - <http://www.netfabb.com/basic.php>
- Pleasant 3D (FOSS, Mac):
 - <https://github.com/zaggo/Pleasant3D>

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Pick a Process

Build Your Own - RepRap Project

- Site: <http://reprap.org/>
- Printers printing printers!
- Parent to many Open Source Hardware 3D printers.
- Active global community.
- Platform for standard and unconventional materials.
- Open Source Hardware Association
 - I'm a Founding Member! - <http://www.oshwa.org/>
 - What is it? - <http://youtu.be/9xGRaPrcvVg>

Pick a Process

Buy Kit vs Pre-Assembled

- Many, many, many to choose from!
- Read: **Make: Ultimate Guide to 3D Printing**
 - <http://blog.makezine.com/volume/make-ultimate-guide-to-3d-printing/>
- Pick your battles
 - Build a kit; learn how it (doesn't) work.
 - Buy it pre-assembled; base-line “it works”.
 - Open Source Hardware = Future-Proof.
 - Support matters; community vs corporate.
 - Operating costs.

Pick a Process

Printing Services

- Shapeways: <http://www.shapeways.com/>
 - Sell your models
 - Experienced, material selection
- i.Materialise: <http://i.materialise.com/>
 - Exotic materials (e.g. SLS Titanium)
- Ponoko: <http://www.ponoko.com/>
 - Sell your models
 - Other services (laser cutting) and components (via SparkFun).

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Prepare for Printing Machine Interface

- ReplicatorG (MakerBot machines; FOSS):
 - Official Version
 - <http://replicat.org/>
 - Sailfish Version (including firmware)
 - Community-supported version
 - Better legacy, custom & clone support
 - <http://www.thingiverse.com/thing:32084>
- Cura (Ultimaker; FOSS):
 - <http://software.ultimaker.com/>

Novel Applications

- Experiments & Prototypes -

- Printing plastic on paper and cloth (mine!)
 - <http://www.instructables.com/id/3D-Printing-PLA-on-Tissue-Paper/>
- 3D Printed Vascular System with Sugar
 - <http://www.upenn.edu/pennnews/news/penn-researchers-improve-living-tissues-3d-printed-vascular-networks-made-sugar>
- Open recipes for powder-based printing
 - <http://open3dp.me.washington.edu/category/formulas/>
- DIY BioPrinter
 - <http://www.instructables.com/id/DIY-BioPrinter/>
- Solar Sintering
 - <http://www.markuskayser.com/work/solarsinter/>
- Neri Oxman @ MIT
 - <http://www.materialecology.com/>

Novel Applications

- Other Machines -

- Pwdr Open Source Powder-Based System
 - <http://pwdr.github.com/>
- 3Doodler pen
 - <http://www.the3doodler.com/>
- Affordable high-res photopolymer printers
 - <http://b9creator.com/>
 - <http://formlabs.com/>
- Giant scale
 - <http://www.d-shape.com/>

Shapeways Service

- Go to Shapeways slides here.

Useful Resources

- Ottawa Region -

- ArtEngine @ Arts Court
 - ModLab gatherings every 1st and 3rd Wednesday
 - Ultimaker 3D Printers - http://wiki.ultimaker.com/Main_Page
 - <http://artengine.ca/>
- PrototypeD
 - Urban workshop/hackerspace
 - <http://prototyped.org/>
- Envirolaser
 - Local commercial service bureau
 - <http://www.envirolaser.com/>
- Carleton University School of Industrial Design
 - <http://www.id.carleton.ca/>

Useful Resources

- Online -

- Community-Shared Models
 - <http://www.thingiverse.com/>
- 3D Printing on Google Plus
 - <https://plus.google.com/u/0/communities/117814474100552114108>
- Useful Blogs
 - <http://www.3ders.org/>
 - <http://3dprintingindustry.com/>
 - <http://www.core77.com/blog/>
 - <http://solidsmack.com/>
- Intellectual Property & Related Legal Matters
 - <http://publicknowledge.org/issues>

3D Printing Demo

- MakerBot Replicator (v1, personal printer):
 - Last fully Open Source Hardware version. :-)
 - <http://www.makerbot.com/support/replicator/>

Q&A