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Digital_Fabrication_Studio.08
3D Printing – from bits to atoms

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Today:

* 3D printing: technologies
* 3D printing: examples
* Design techniques

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01.
3D printing technologies: atoms from bits

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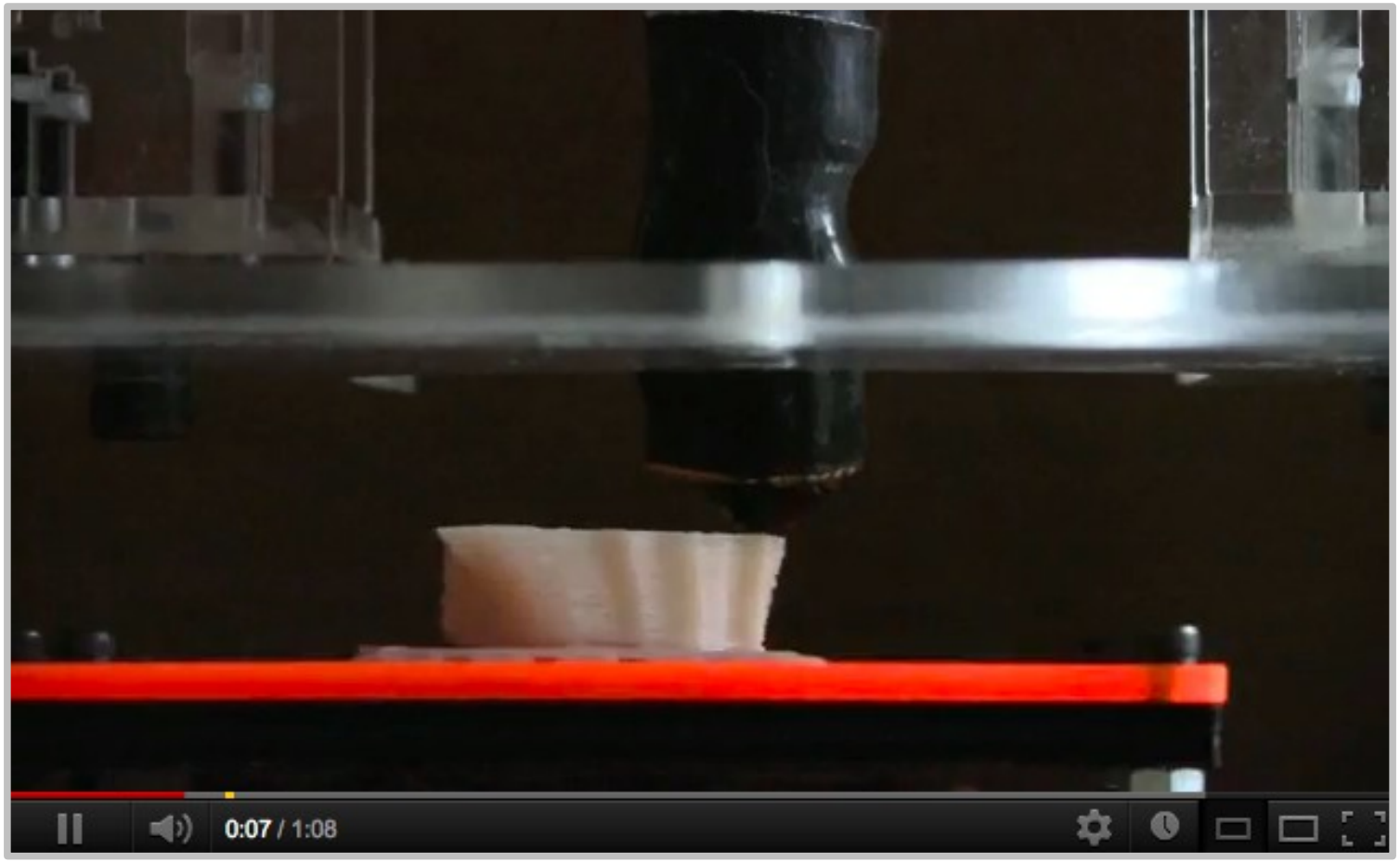
Technologies: 3D printing

Refers to object made using ink jet technology in 3 dimensions by layering powder and binding it with pigmented glue.

Source: http://replicatorinc.com/blog/2009/02/4-types-of-3d-printing/
http://youtu.be/7QP73uTJApw

Technologies: Fused Deposition Modeling



Fused Deposition Modeling (FDM) creates models by heating and extruding a filament of plastic material.

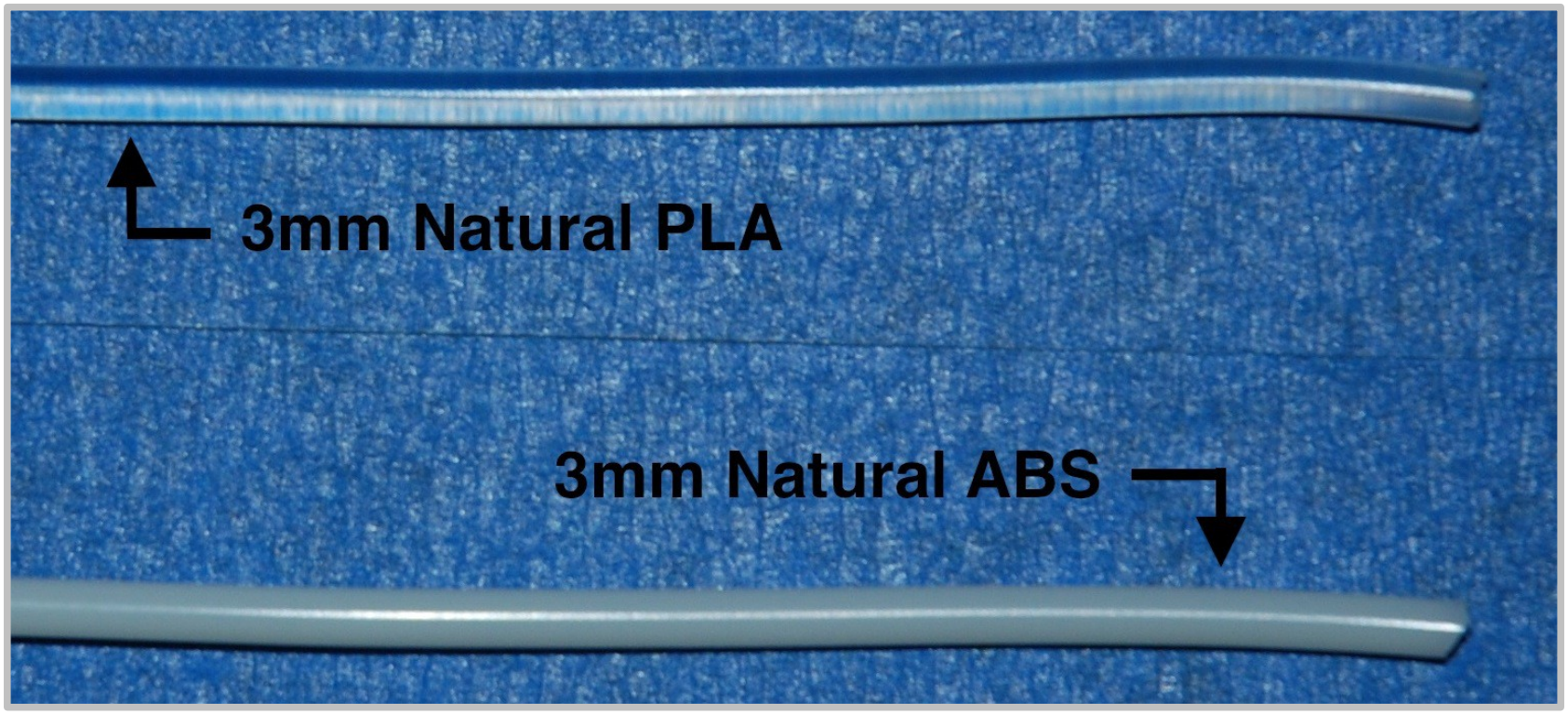
Source: http://replicatorinc.com/blog/2009/02/4-types-of-3d-printing/
http://youtu.be/h8XJUqHXgls

Technologies: Fused Deposition Modeling

Fused Deposition Modeling (FDM) but with hand control: the first 3D printing pen.

Source: http://youtu.be/DQWyhezIze4
http://www.the3doodler.com/

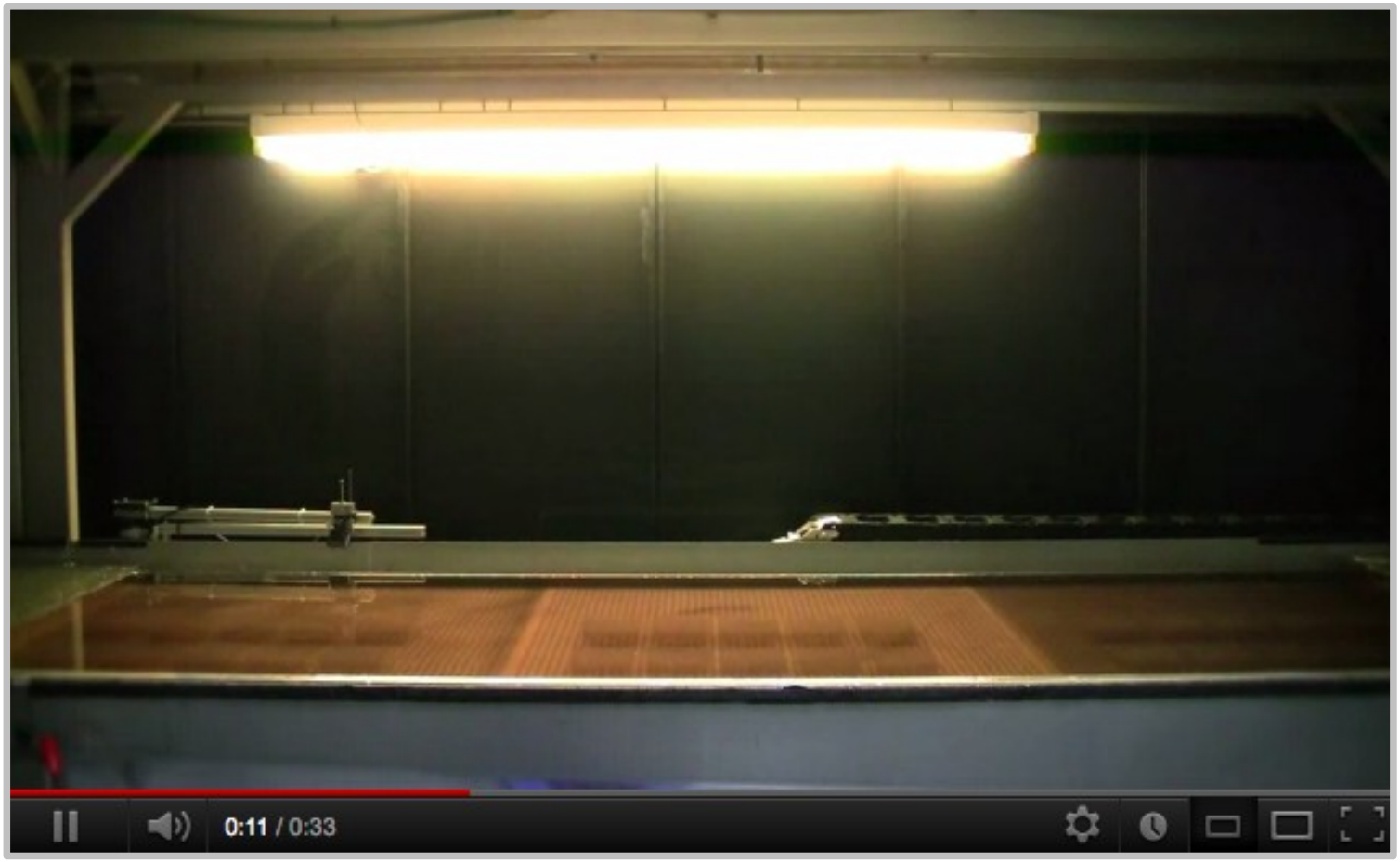
Technologies: materials for FDM



Most of the 3D Printing community uses either ABS or PLA in either 3mm or 1.75mm diameters.

Source: http://www.protoparadigm.com/2011/11/filament-tolerances-and-print-quality/

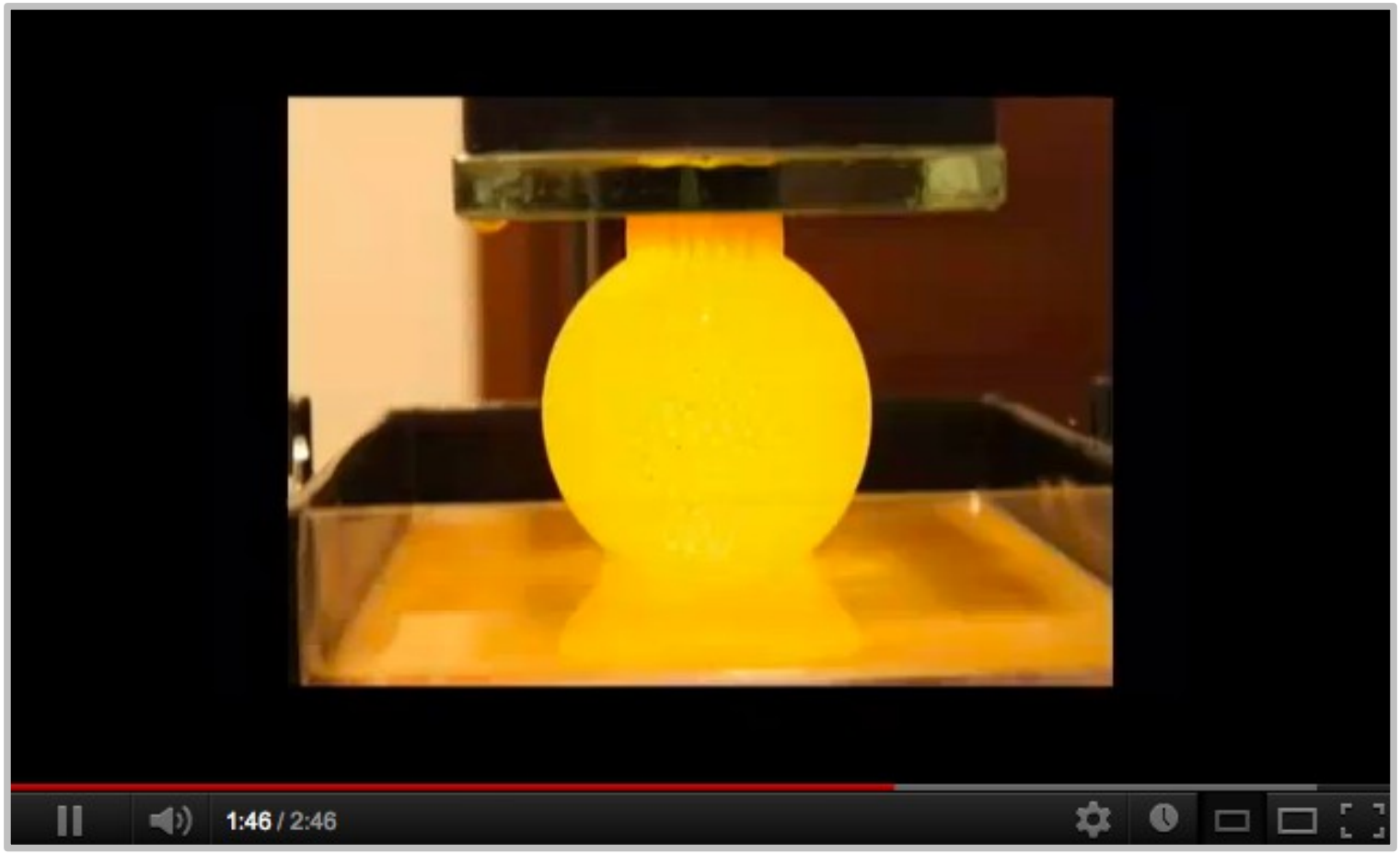
Technologies: Stereolitography



Stereolithography produces models by tracing a beam of UV light over a photosensitive pool of liquid. Over time the part is lowered into the bath.

Source: http://replicatorinc.com/blog/2009/02/4-types-of-3d-printing/
http://youtu.be/ygHVVKkJWlI

Technologies: Stereolitography



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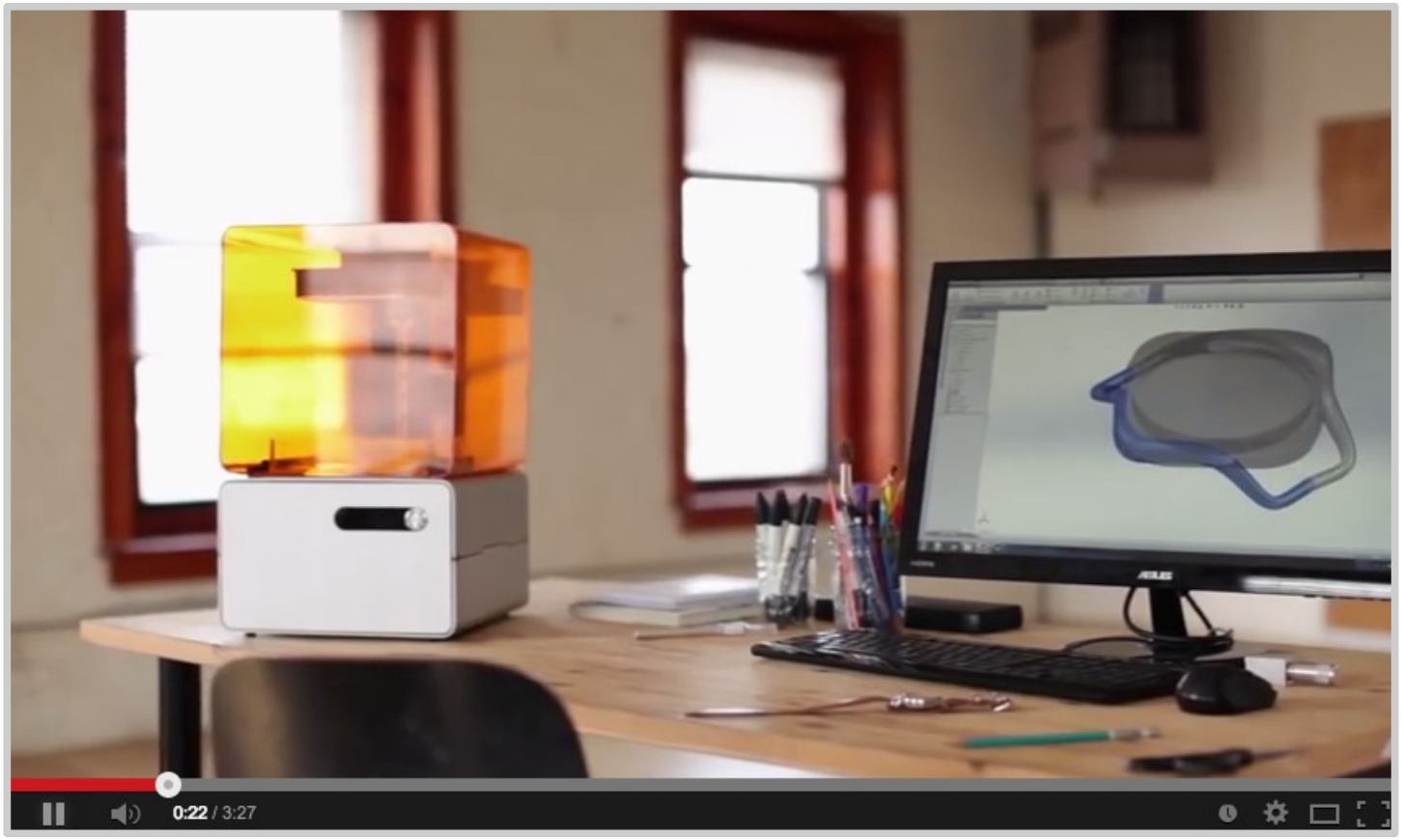
Source: http://replicatorinc.com/blog/2009/02/4-types-of-3d-printing/
http://youtu.be/snOErpOP5Xk

Technologies: Stereolitography



Stereolithography produces models by tracing a beam of UV light over a photosensitive pool of liquid. Over time the part is lowered into the bath.

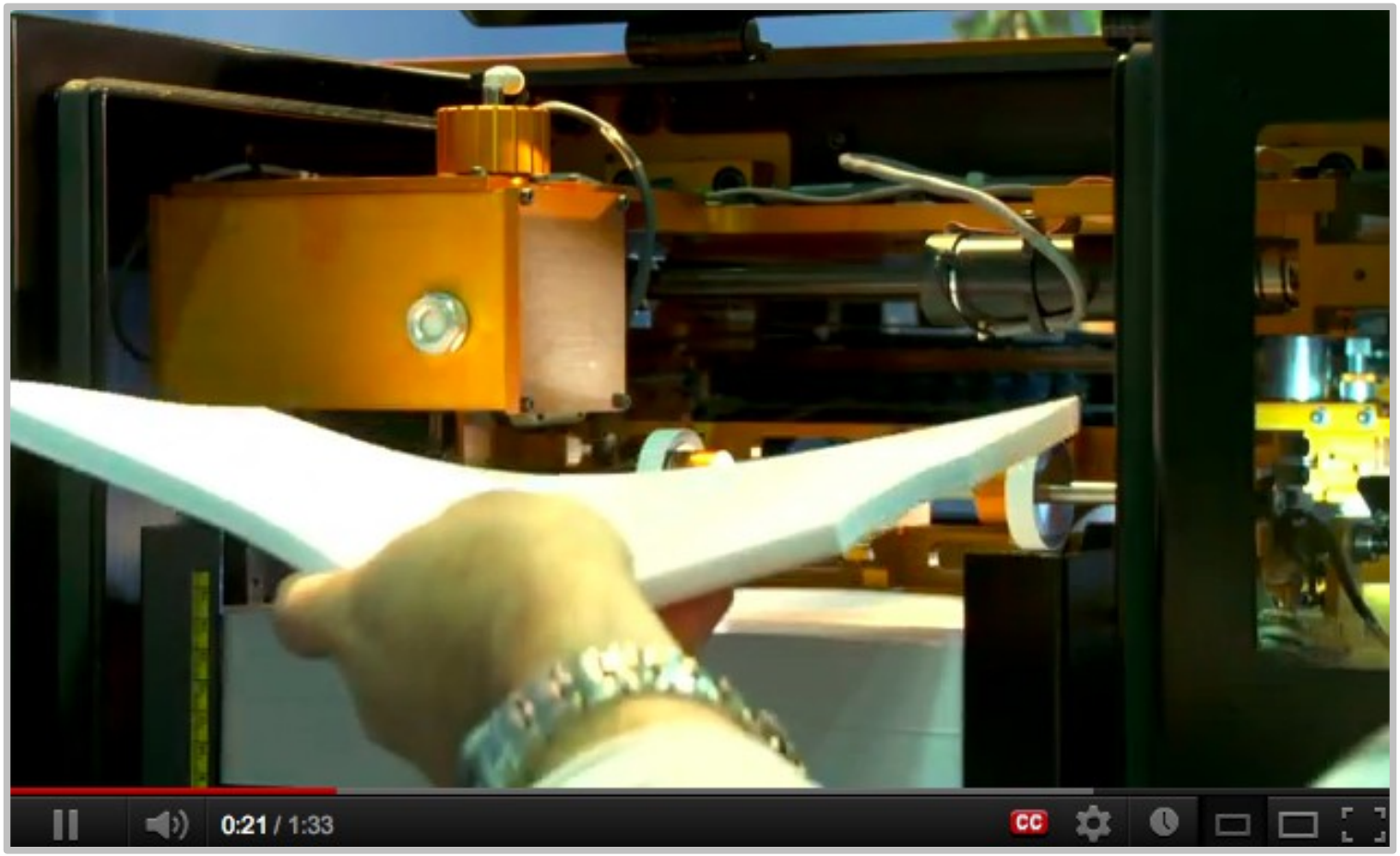
Source: https://www.youtube.com/watch?v=CHAU-9VIwzk

Technologies: Selective Laser Sintering

Selective Laser Sintering (SLS) is similar to stereolithography replacing the UV light with a laser and a vat of liquid with a powdered base.

Source: http://replicatorinc.com/blog/2009/02/4-types-of-3d-printing/
http://youtu.be/lC0uVO_uT0s

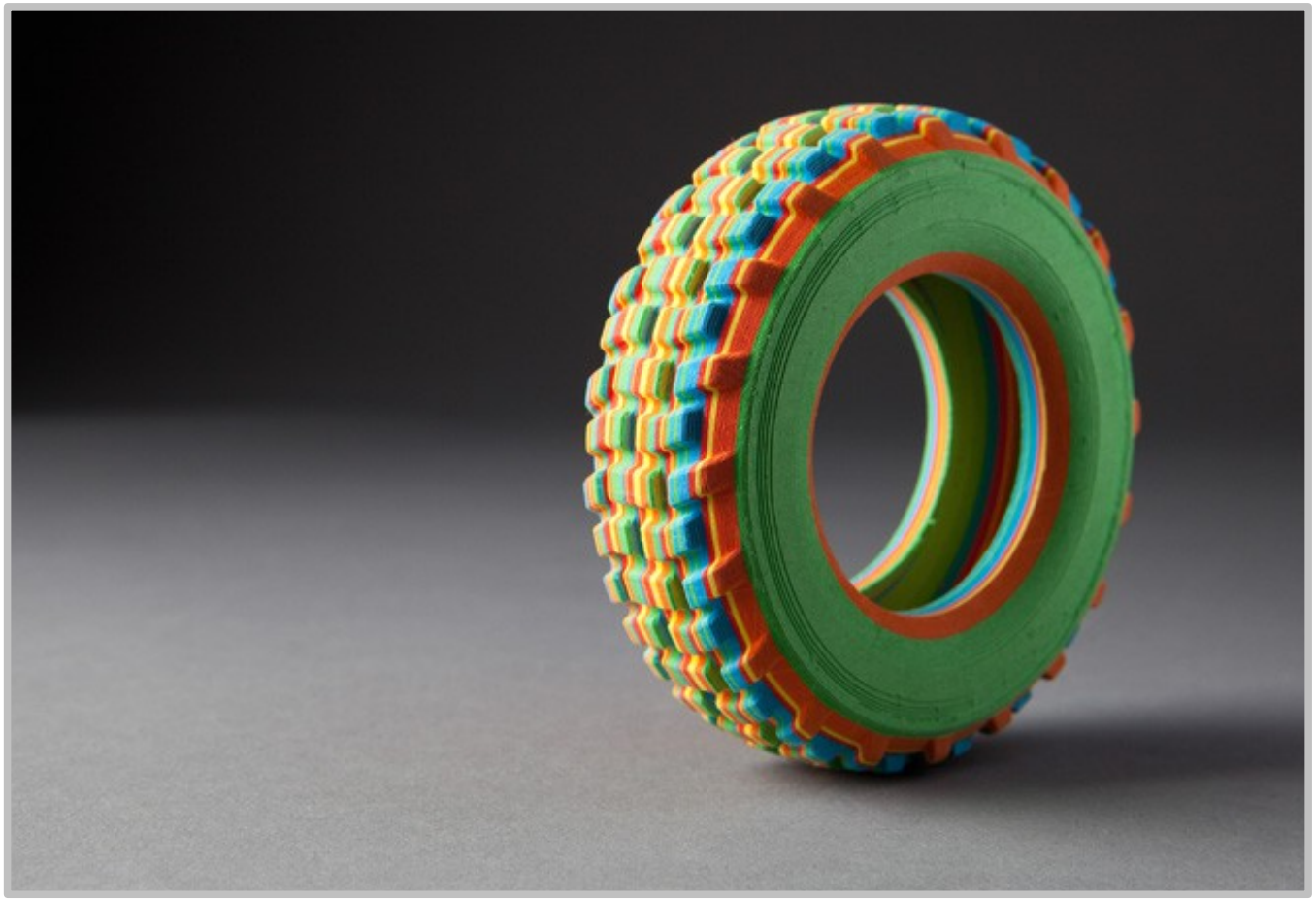
Technologies: Laminated Object Manufacturing



Laminated Object Manufacturing (LOM) machines cut and glue thousands of sheets of material together to form solids, sometimes with standard A4 paper.

Source: http://replicatorinc.com/blog/2009/02/4-types-of-3d-printing/
http://youtu.be/FjxI2HszHzo

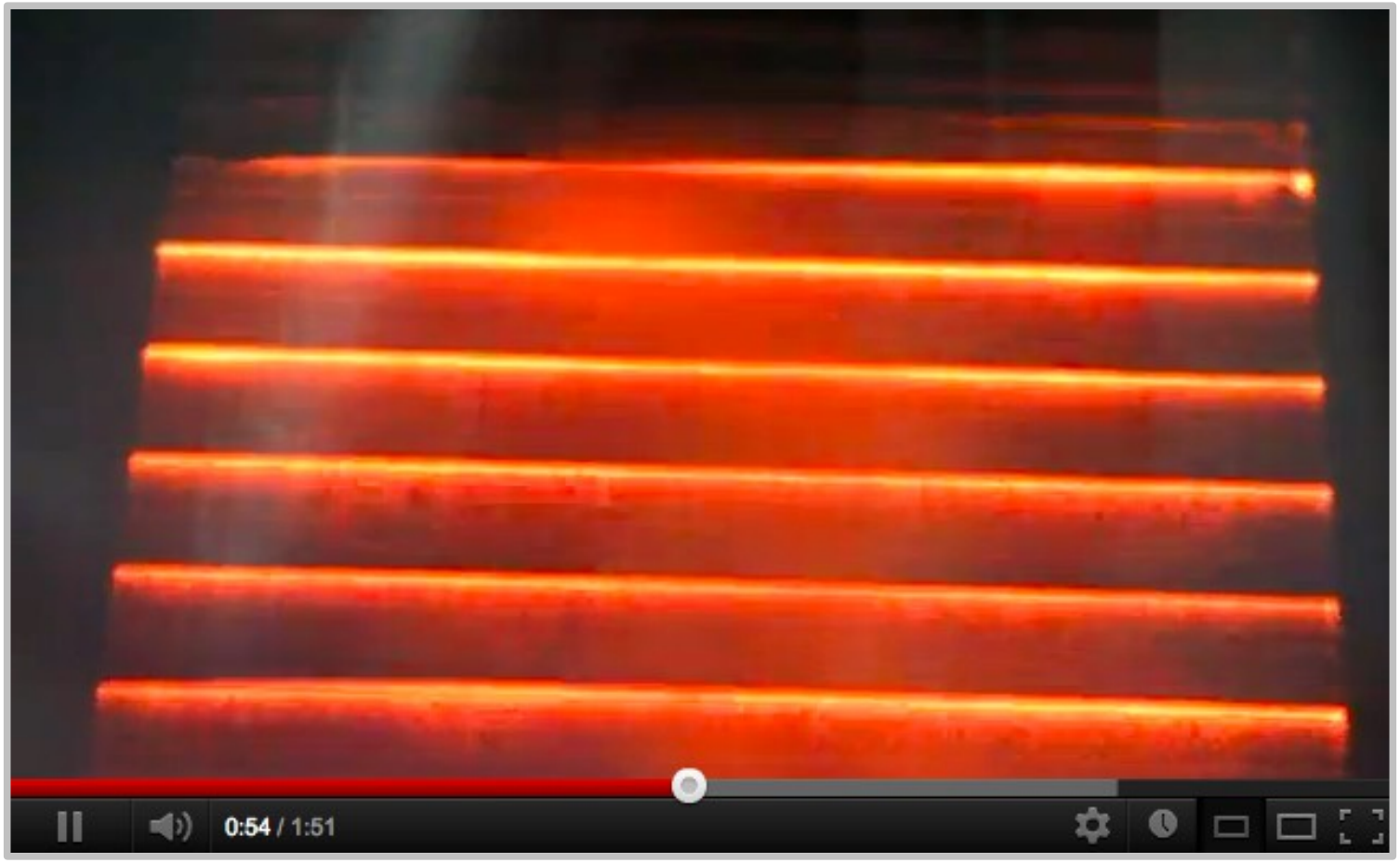
Technologies: Laminated Object Manufacturing



Laminated Object Manufacturing (LOM) machines cut and glue thousands of sheets of material together to form solids, sometimes with standard A4 paper.

Source: http://replicatorinc.com/blog/2009/02/4-types-of-3d-printing/
http://www.mcortechnologies.com/gallery

Technologies: Electron Beam Melting



Electron Beam Melting (EBM) is similar to SLS except the process is far more exact and capable of producing implant grade parts to be used in orthopedic surgery.

Source: http://replicatorinc.com/blog/2009/02/4-types-of-3d-printing/
http://youtu.be/E7--ZWPVVdQ

3D Metal printing

Now it is possible to print your model in stainless steel on Shapeways! The material will be finished in a shining stainless steel look and costs $10 / cm3.

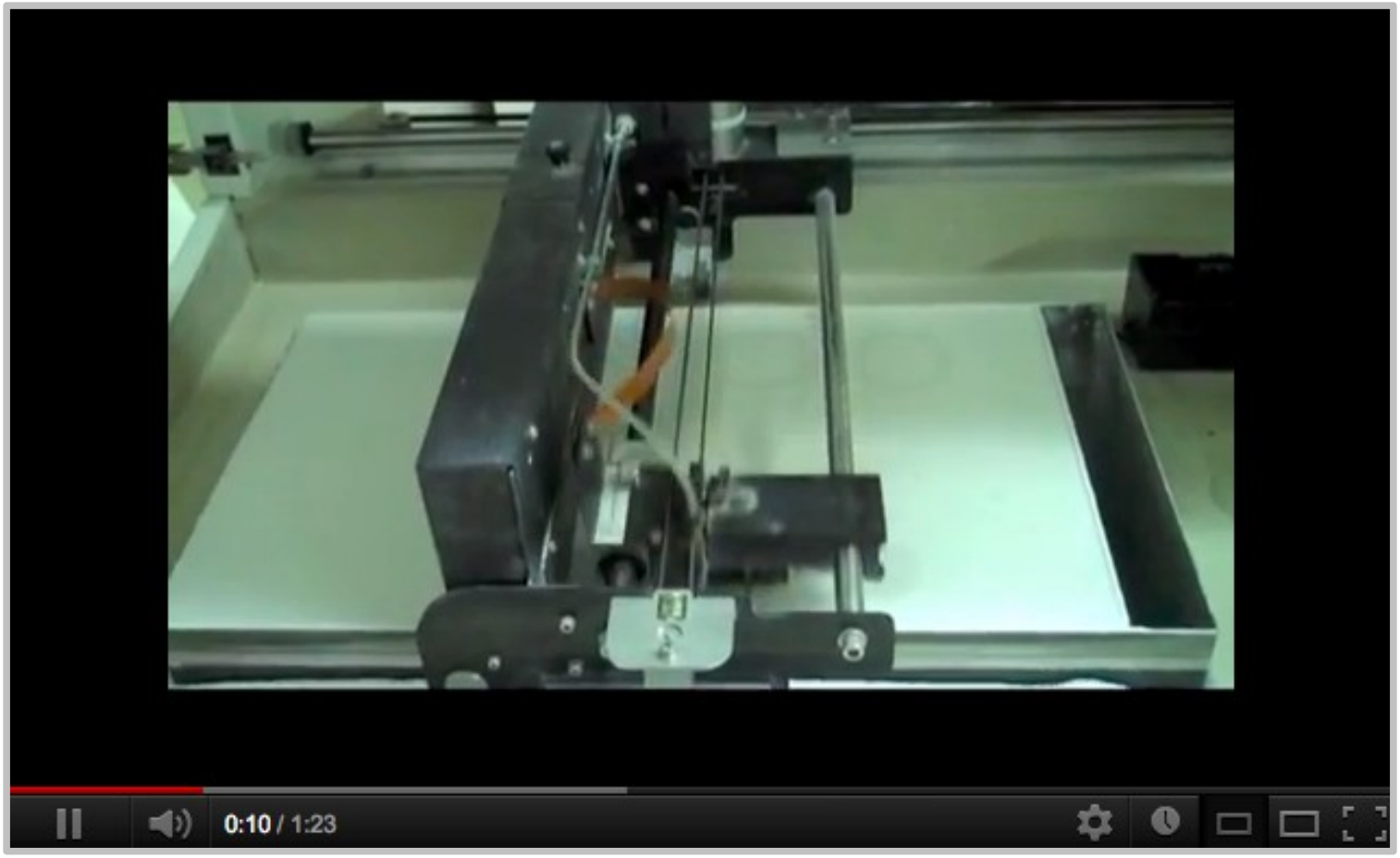
Source: http://youtu.be/B9VOwqtOglg
http://www.shapeways.com/themes/stainless_steel_3dprinting_gallery

3D Glass printing

The material is porous, opaque and fragile and made from recycled soda-lime glass, the fine glass powder is glued together with a binder and then sintered.

Source: http://youtu.be/BtK-Hqd6Q2I
http://www.shapeways.com/materials/milky_white_matte_glass

3D Ceramics printing



Material properties are the same as standard ceramics. Fine ceramic powder bound together with binder, fired, glazed with lead-free, non-toxic gloss finish.

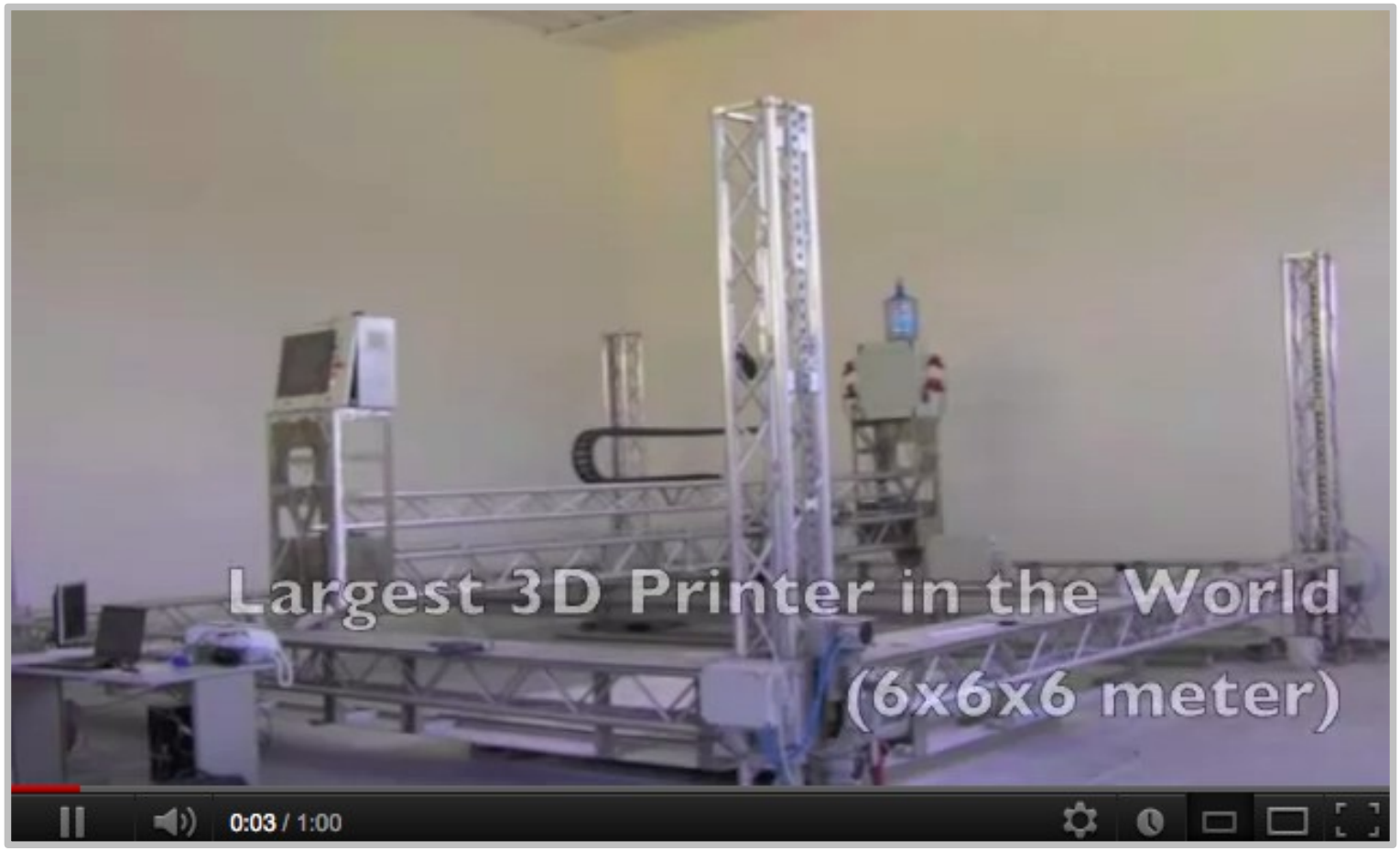
Source: http://youtu.be/zZU7O1BHfyo
http://www.shapeways.com/materials/ceramics

Big size 3D printing: Endless chair

Printing an Endless Chair from recycled refrigerators.
Design by Dirk vander Kooij.

Source: http://youtu.be/FvRTHynk9KA
http://www.dirkvanderkooij.nl/en

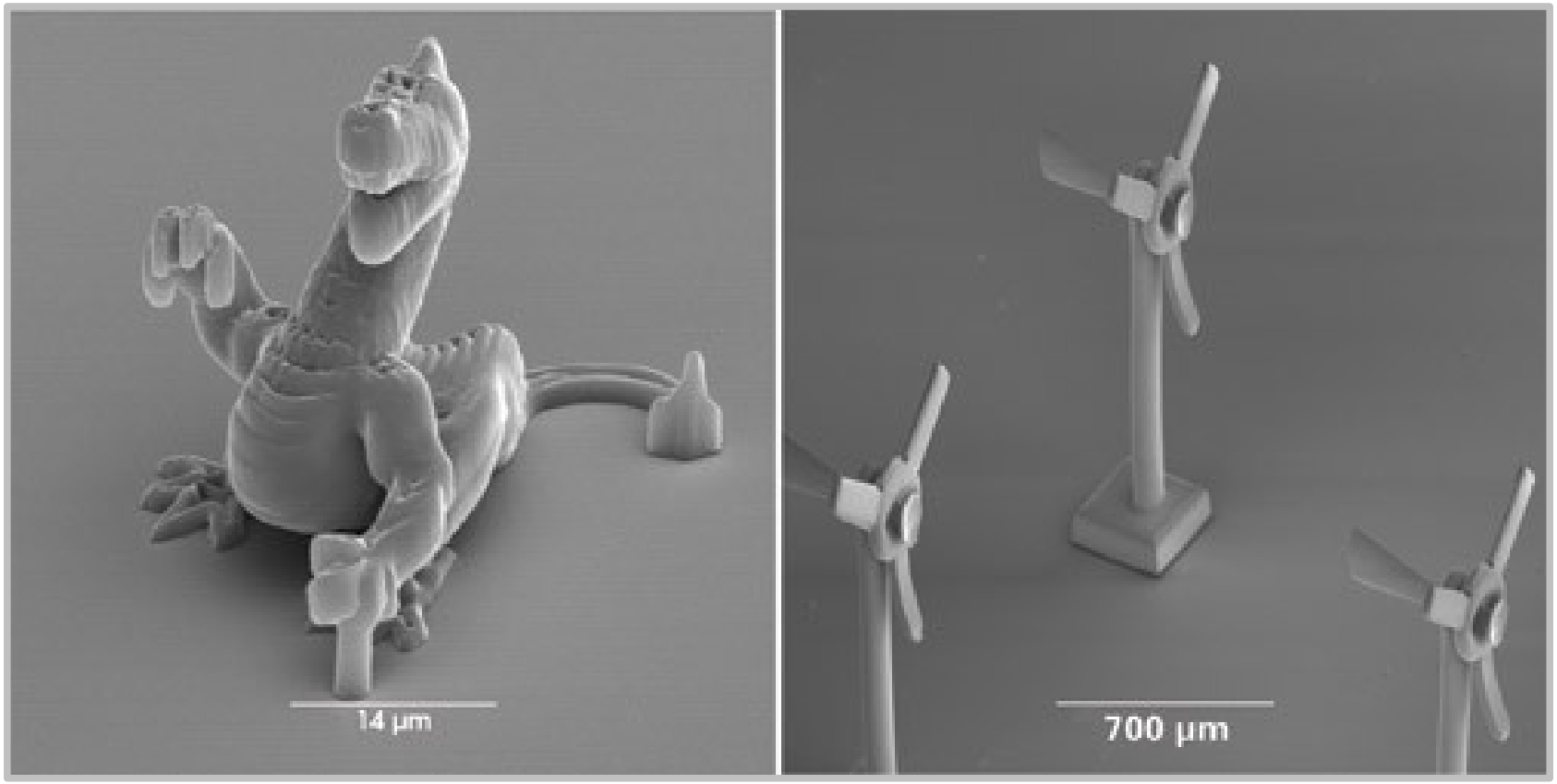
Big size 3D printing: D-Shape



D-Shape is a new robotic building system using new materials to create superior stone-like structures.

Source: http://youtu.be/HBxx8XTpDZ4
http://d-shape.com/

Small size 3D printing: 2 photons polymerization



A promising 3D microfabrication method that has recently attracted considerable attention is based on two-photon polymerization with ultrashort laser pulses.

Source: http://www.photonics.com/Article.aspx?AID=26907

Bio 3D Printing

A new tissue engineering technology now has the ability to arrange culture cells in three dimensions. It is now possible to manufacture tissue in demand.

Source: http://youtu.be/YOnIxcc0DW8

Bio 3D Printing: Organovo

Organovo is focused on delivering breakthrough three-dimensional biology capabilities to create tissue on demand for research and surgical applications.

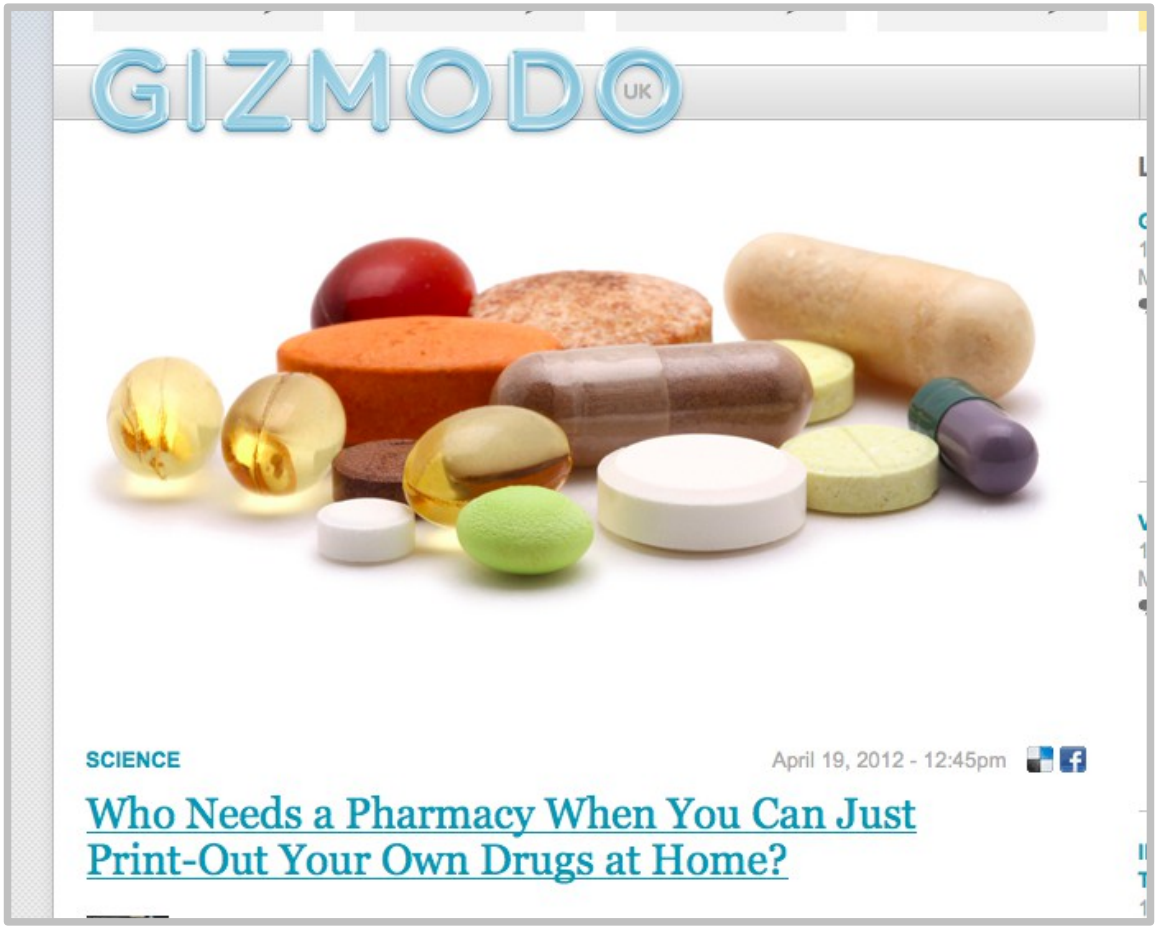
Source: http://www.organovo.com/

Bio 3D Printing: Organovo

The NovoGen MMX Bioprinter™ is a novel hardware and software platform at the forefront of bioprinting research and development.

Source: http://www.organovo.com/products/novogen-mmx-bioprinter

Drug 3D Printing



Researchers from Scotland have made their own DIY 3D-printing drugstore and you'll be able to use them to print your own drugs right at your own home.

Source: http://www.gizmodo.co.uk/2012/04/who-needs-a-pharmacy-when-you-can-just-print-out-your-own-drugs-at-home/

Food 3D Printing

Choc Creator, the world's first 3D chocolate printer was developed by a team of researchers at the University of Exeter and is now available to purchase.

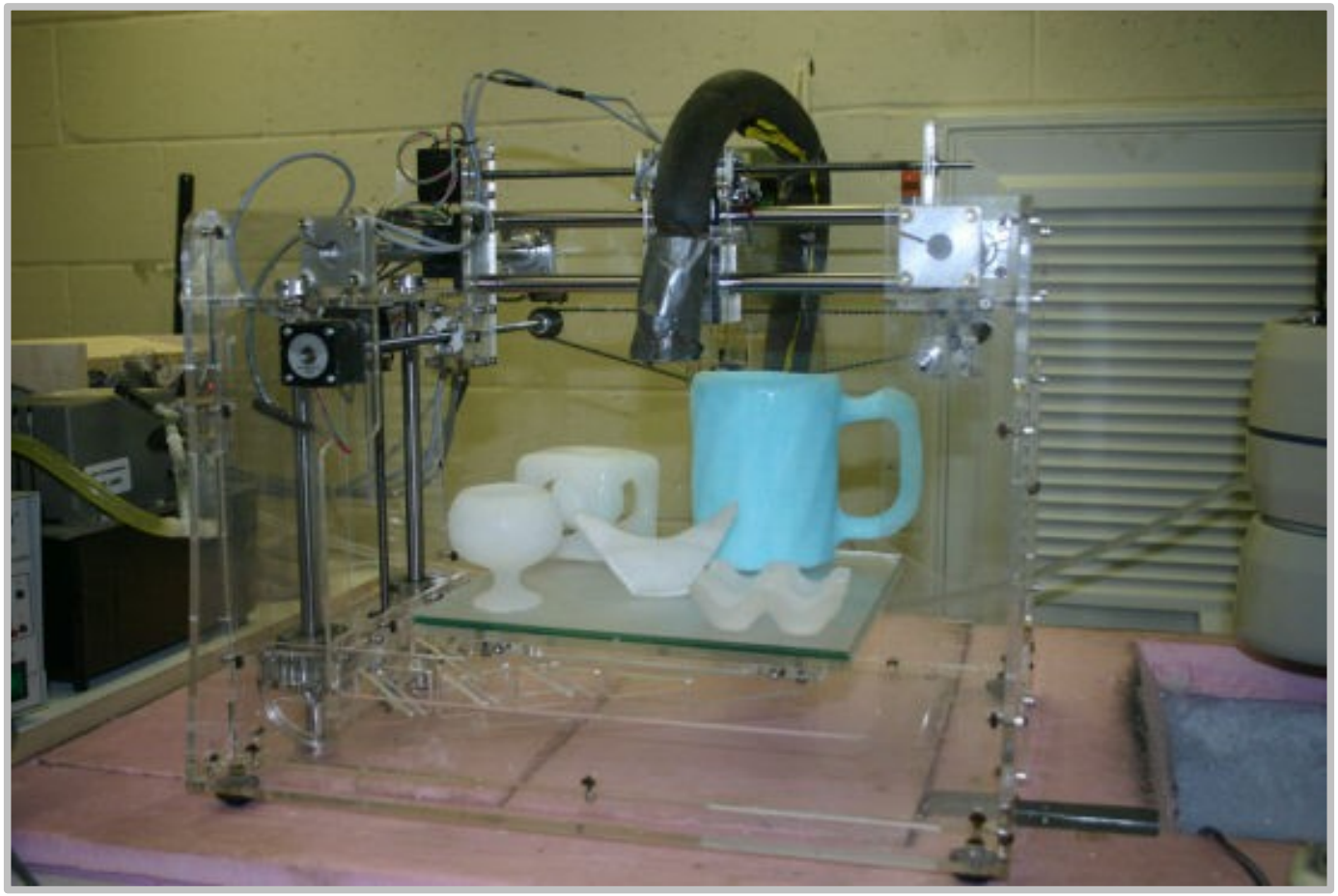
Source: http://laughingsquid.com/choc-creator-the-chocolate-3d-printer-is-now-available-to-purchase/
http://youtu.be/r7xs-cHAt3I

Food 3D Printing

CandyFab is a machine that can make arbitrary 3D solid objects at low cost from a variety of low-melting point materials including pure sugar.

Source: http://laughingsquid.com/choc-creator-the-chocolate-3d-printer-is-now-available-to-purchase/
http://youtu.be/r7xs-cHAt3I

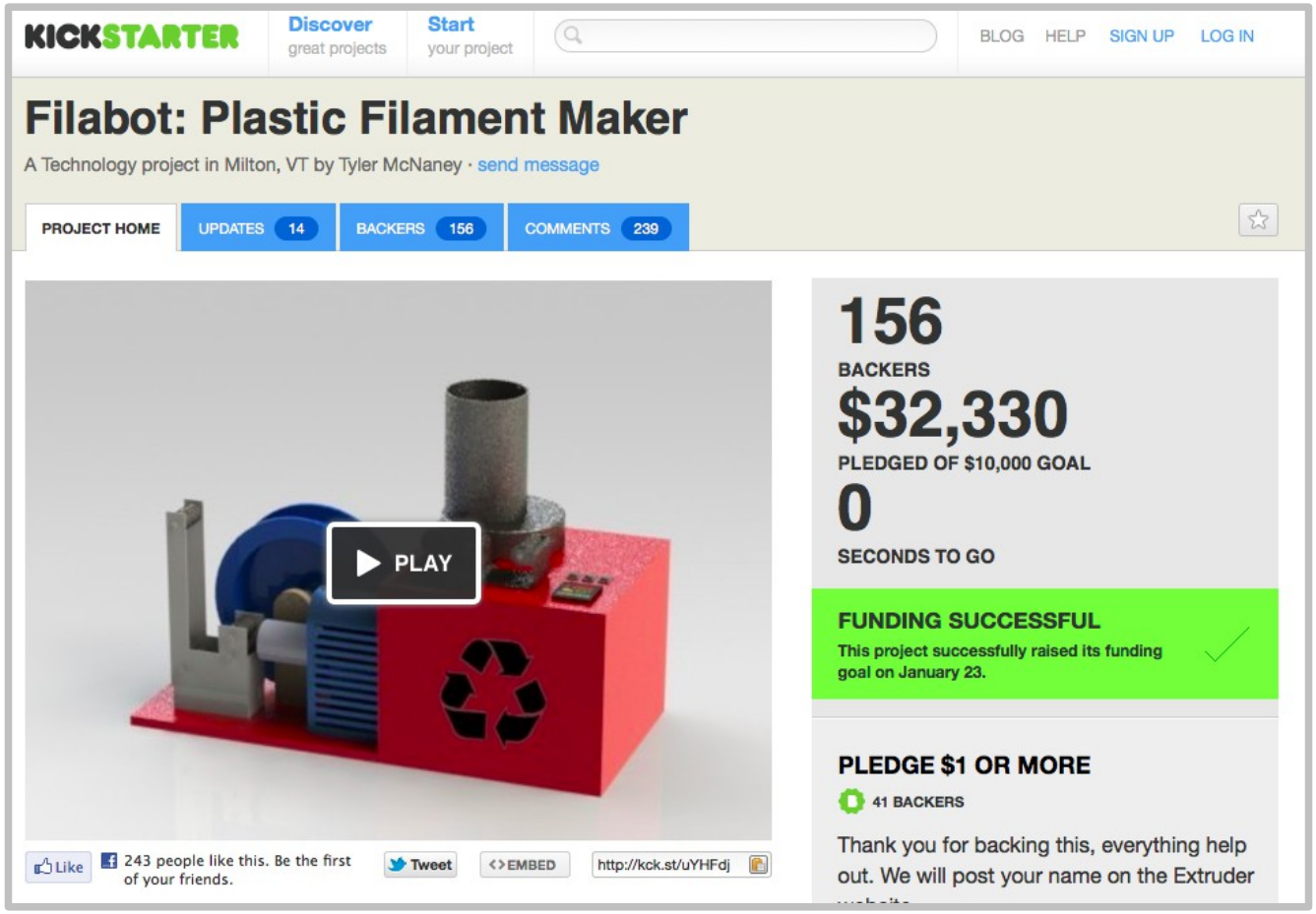
Ice 3D Printing



Pieter Sijpkes, a professor at McGill University, has discovered since cobbling together a machine that prints objects by building up ultrathin layers of ice.

Source: http://www.wired.com/magazine/2011/12/st_3diceprinting/
http://www.3ders.org/articles/20120103-3d-ice-printer.html

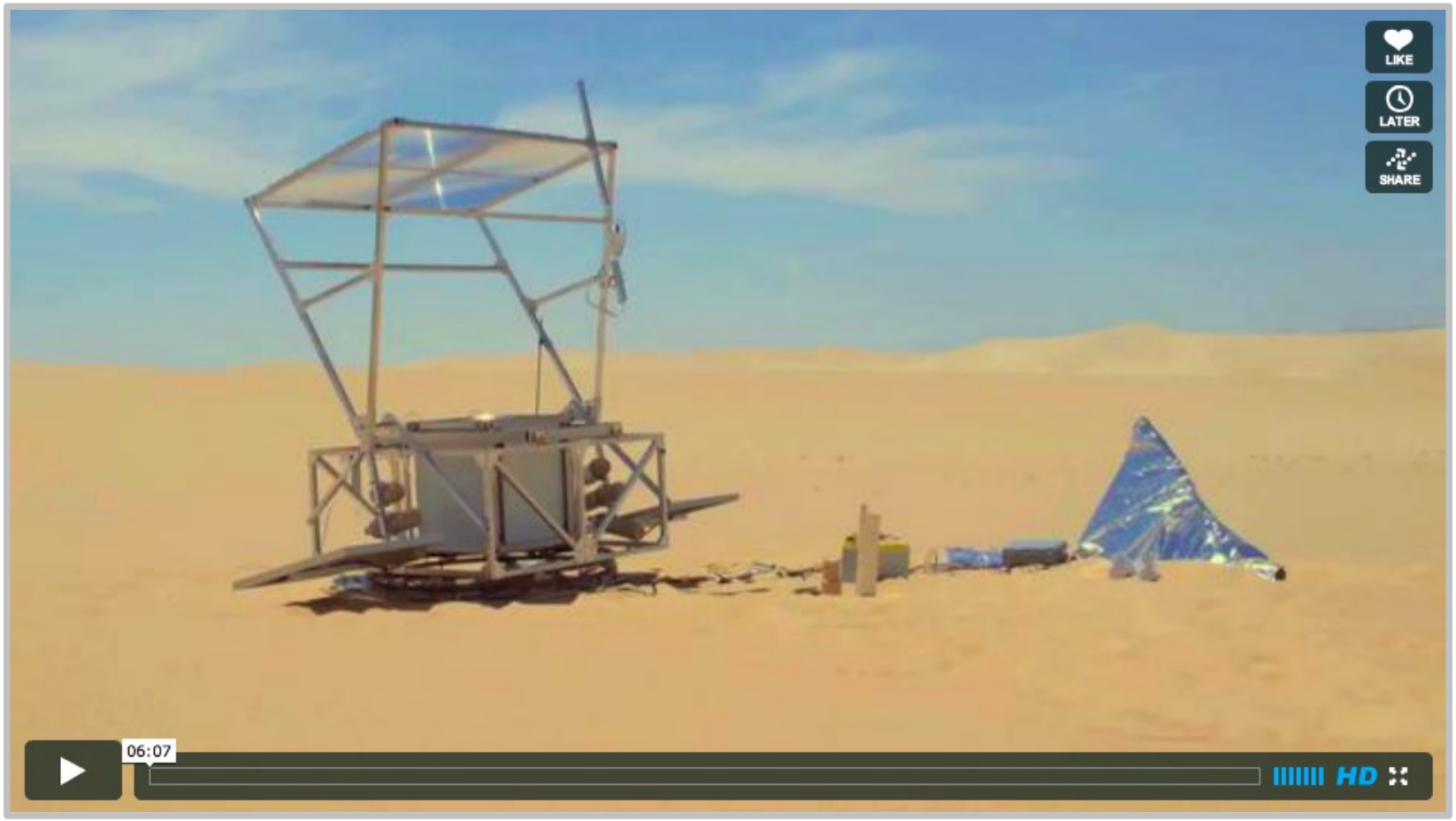
Recycle plastic for your FDM machine



A 3D plastic extrusion system for mostly any type of recyclable plastic, to make usable 3D printing filament by grinding, melting, extruding the plastic filament.

Source: http://www.kickstarter.com/projects/rocknail/filabot-plastic-filament-maker

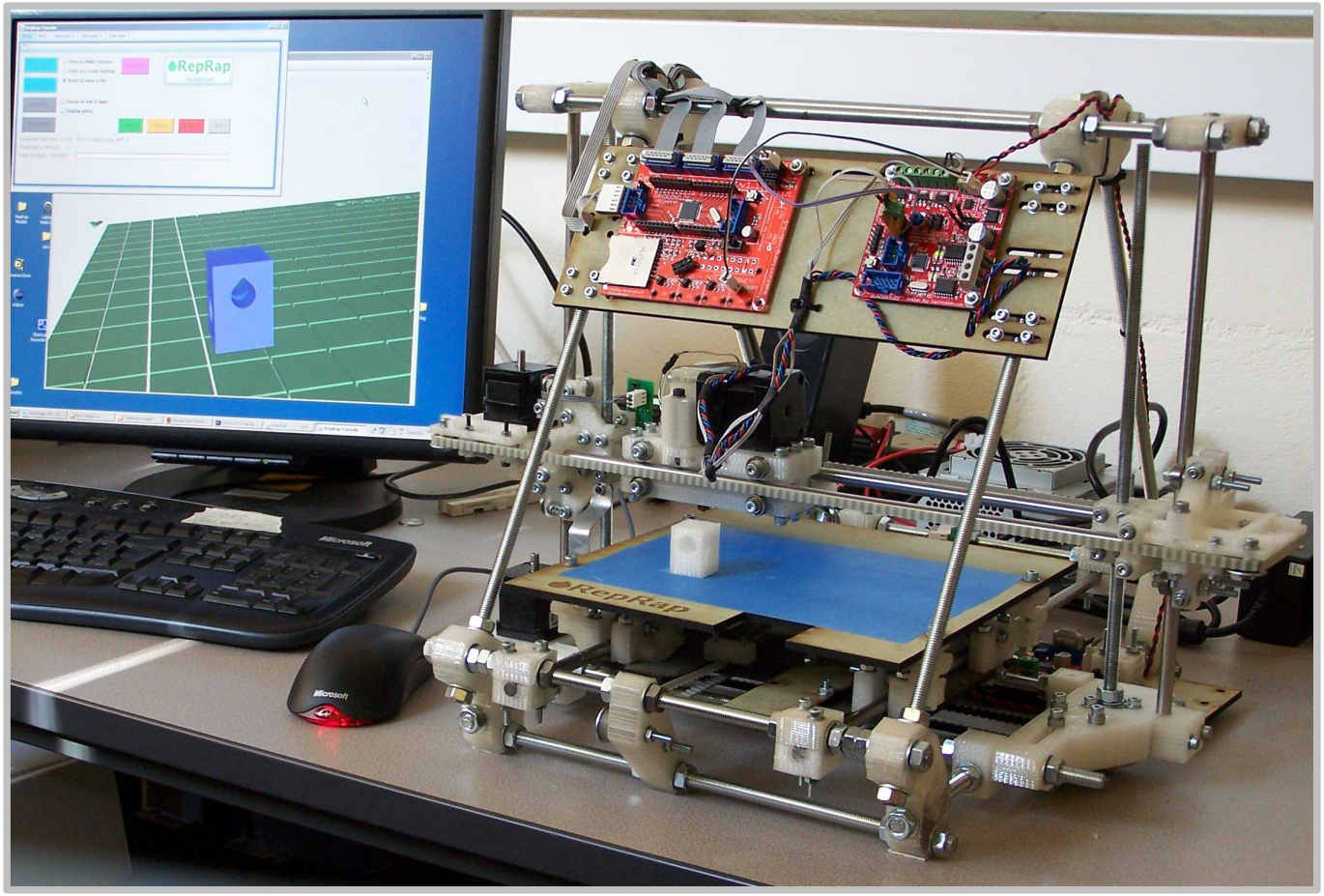
Markus Kayser - Solar Sinter Project



In this experiment sunlight and sand are used as raw energy and material to produce glass objects using a 3D printing process.

Source: http://vimeo.com/25401444

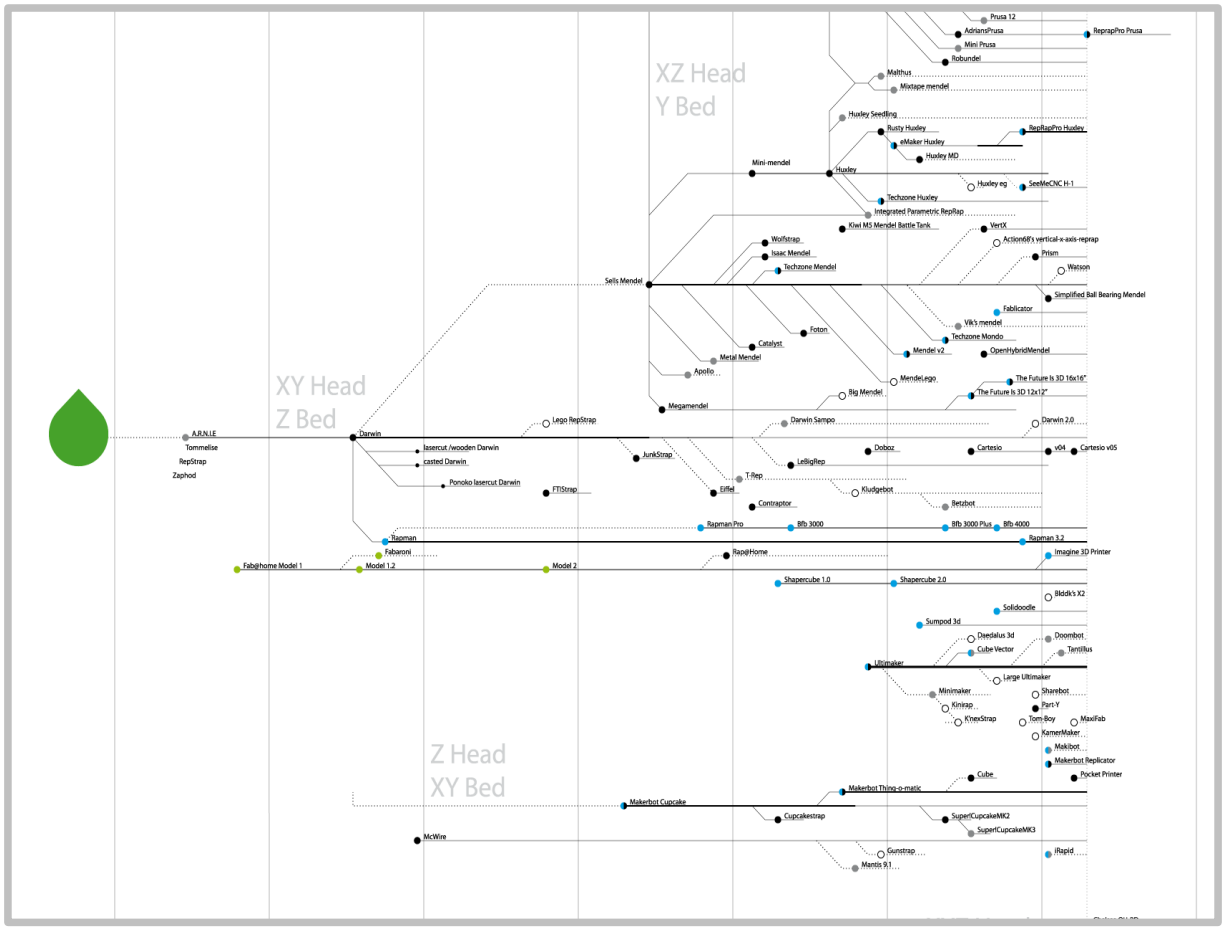
Open Source 3D printers: RepRap



It's the second, improved version of RepRap: small enough to fit on your desk, but with a print volume large enough for you to make big things.

Source: http://reprap.org/wiki/Mendel

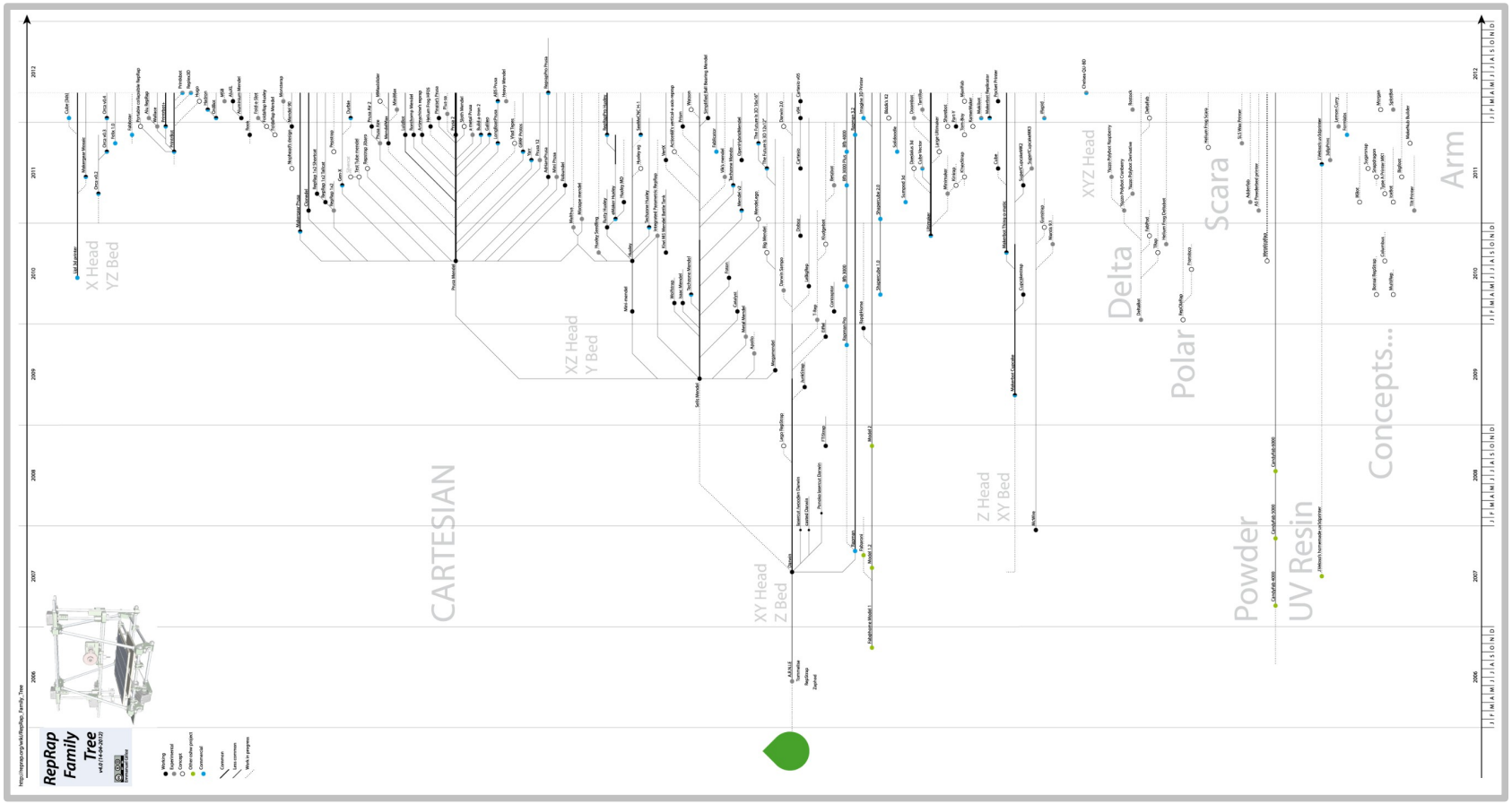
Open Source 3D printers: RepRap



Again, the evolution of an open source project that's too big to fit into one slide...

Source: http://reprap.org/wiki/RepRap_Family_Tree

Open Source 3D printers: RepRap



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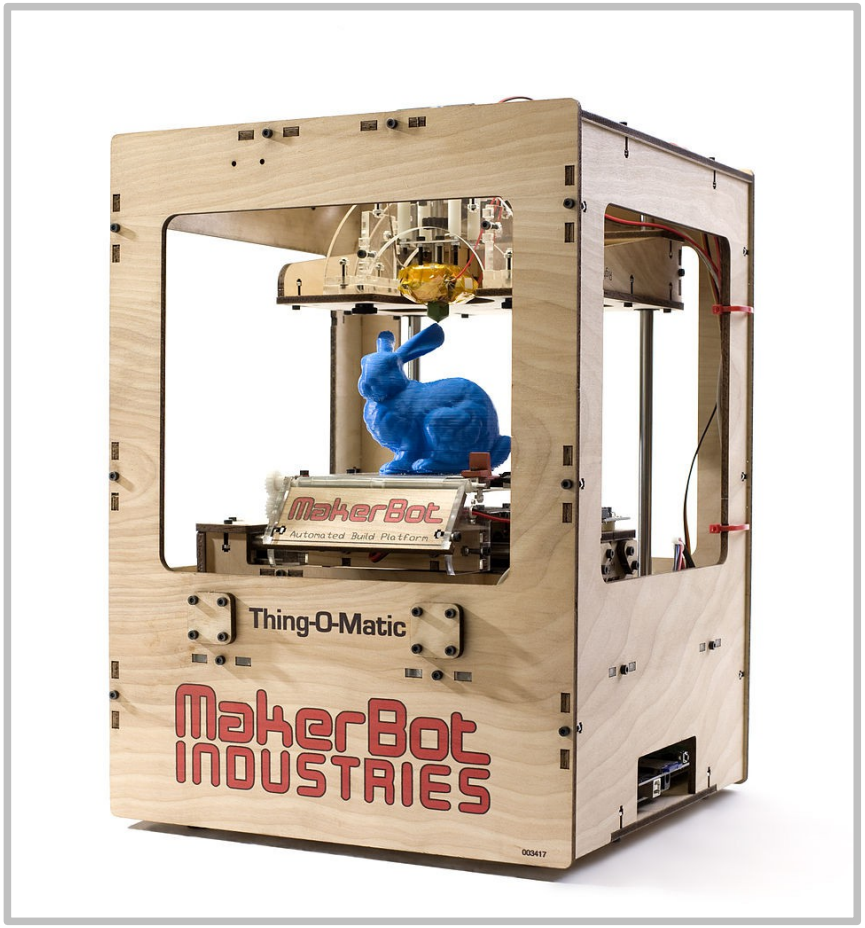
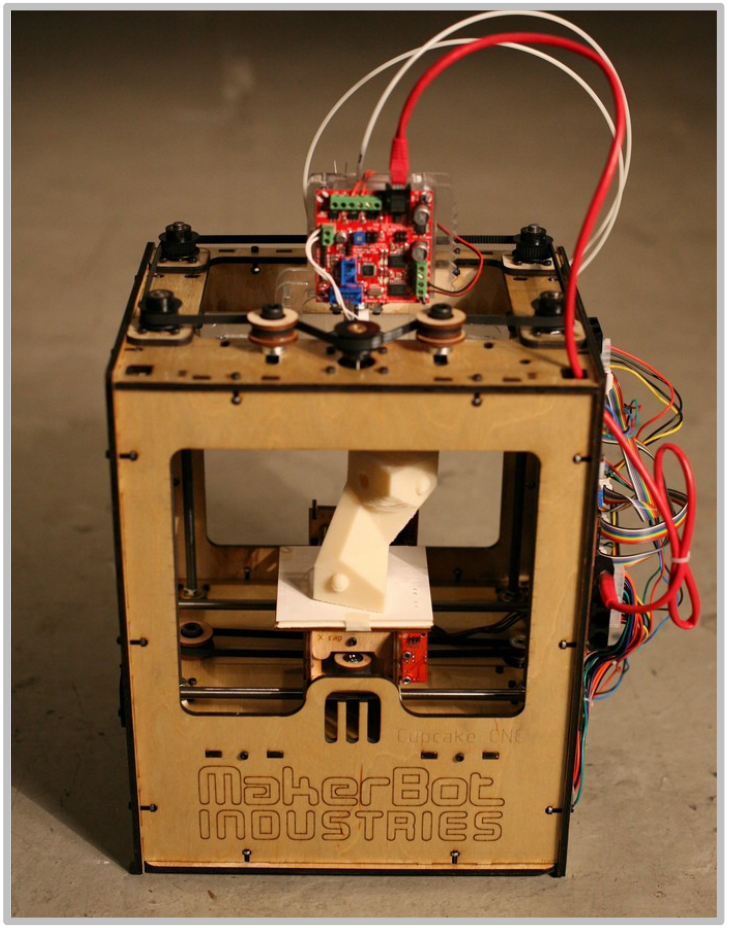
Source: http://reprap.org/wiki/RepRap_Family_Tree

RepRap and its children... Makerbot





The first user-friendly open source 3D printer, from RepRap

Source: http://en.wikipedia.org/wiki/Makerbot

RepRap and its children... Makerbot

The second edition of the Makerbot

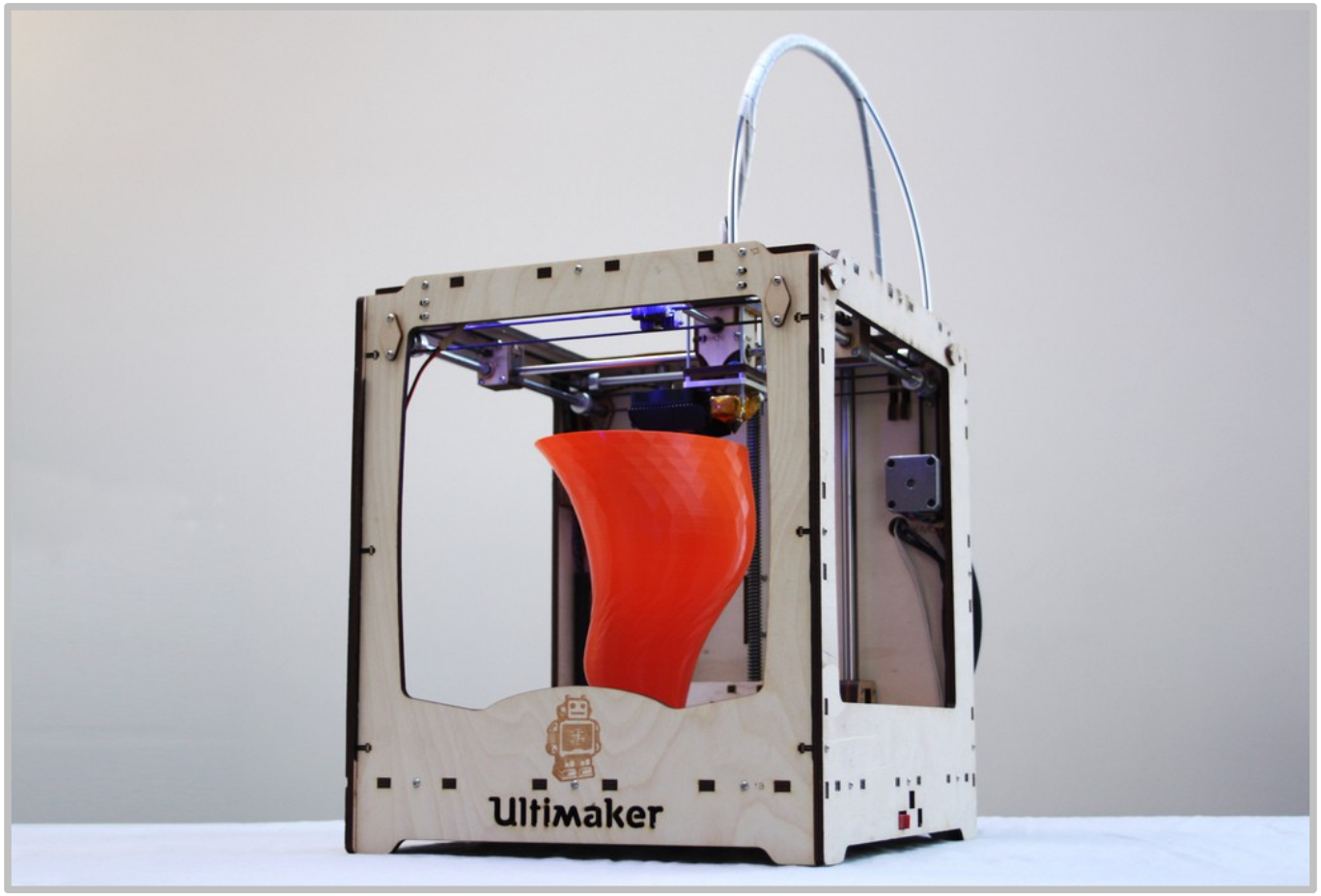
Source: http://store.makerbot.com/replicator-404.html

RepRap and its children... Makerbot

The current range of the Makerbot family

Source: http://makerbot.com/

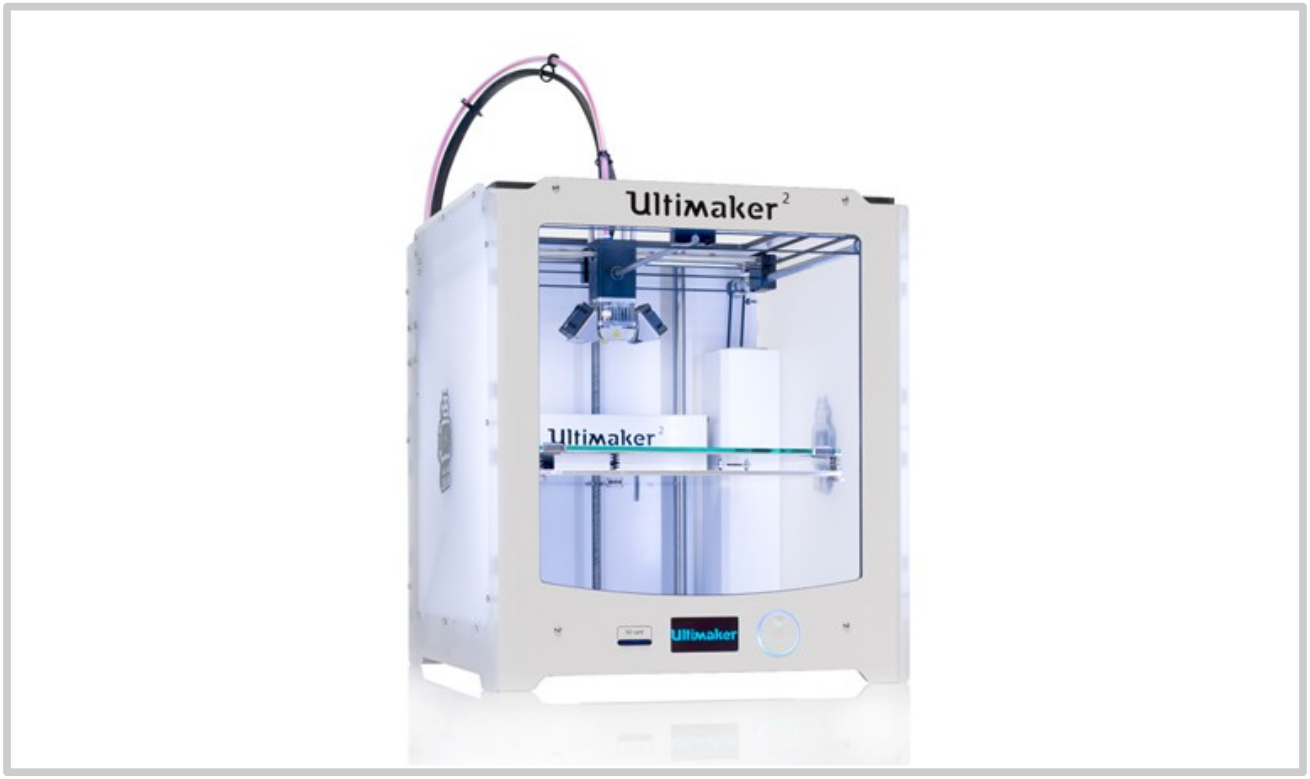
RepRap and its children... Ultimaker



From the RepRap, the Ultimaker, the best resolution and speed from an open source machine

Source: http://reprap.org/wiki/Ultimaker
http://blog.ultimaker.com/

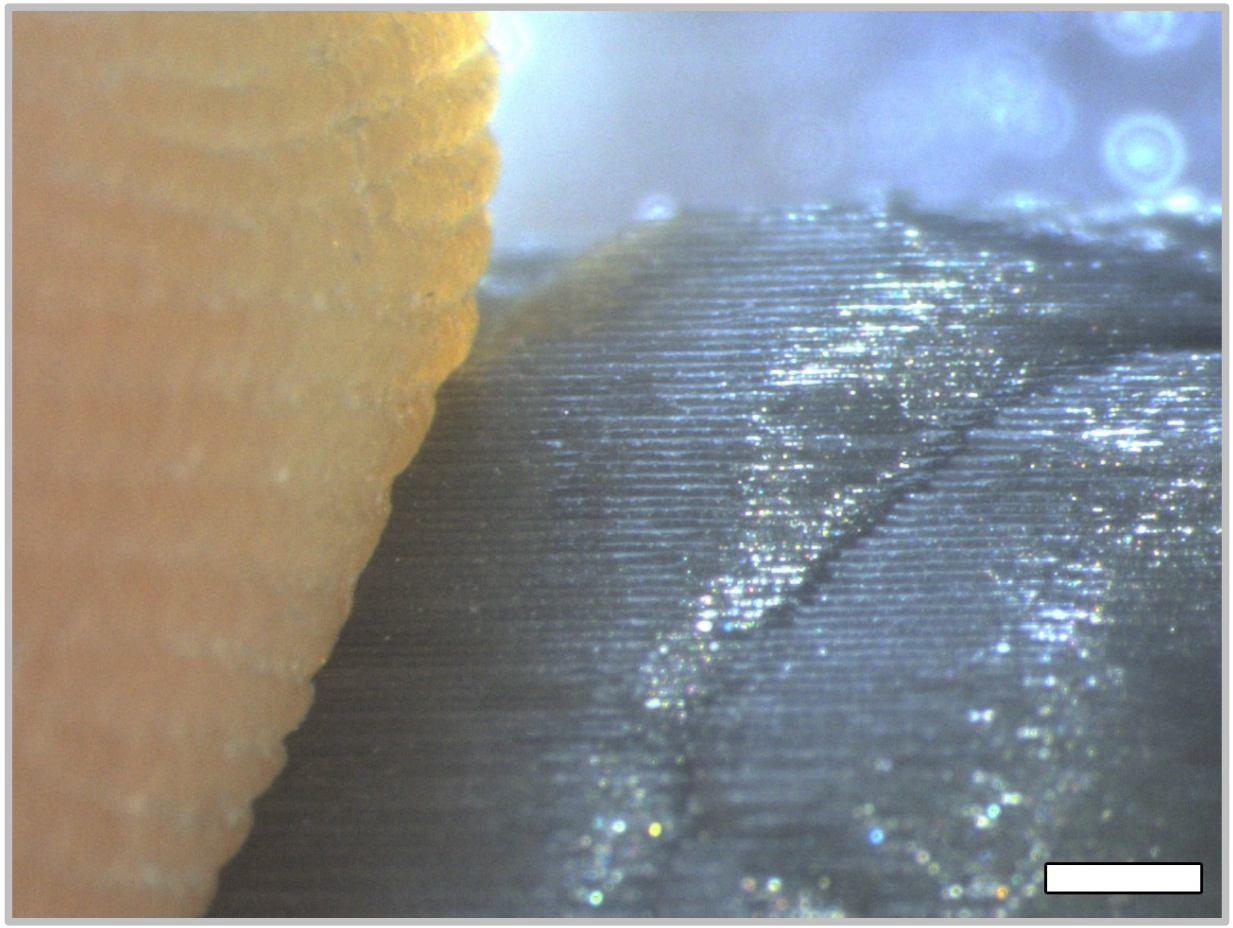
RepRap and its children... Ultimaker



Ultimaker, the second edition

Source: https://www.ultimaker.com/pages/our-printers/ultimaker-2

RepRap and its children... Ultimaker



The average layer height in that pic is
around 0.074 mm (that is 74 microns).

Source: http://www.hive76.org/insane-3d-printing-resolution-ultimaker-under-the-micro

A portable 3D printer…

PopFab: at its heart is a computer-controlled motion platform and a means of attaching various toolheads.

Source: http://www.core77.com/blog/digital_fabrication/a_suitcase-sized_3-in-1_cnc_multi-tool_23007.asp
http://vimeo.com/45911972

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02.
3D printing: examples
what people are doing with it

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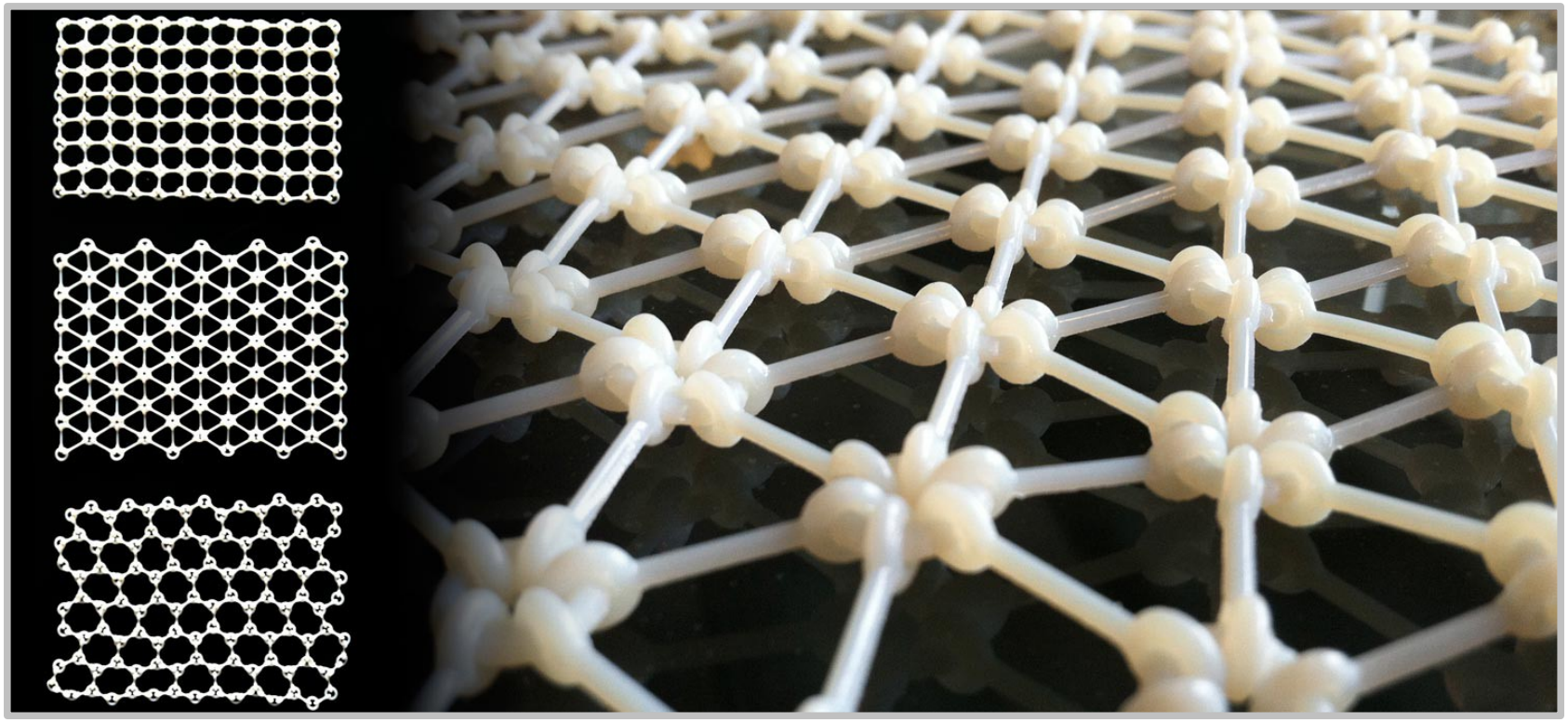
Printable VELCRO

The velcro is printed with 0.3mm ABS with a MK6 extruder on a Makerbot.

Source: http://www.thingiverse.com/thing:12798

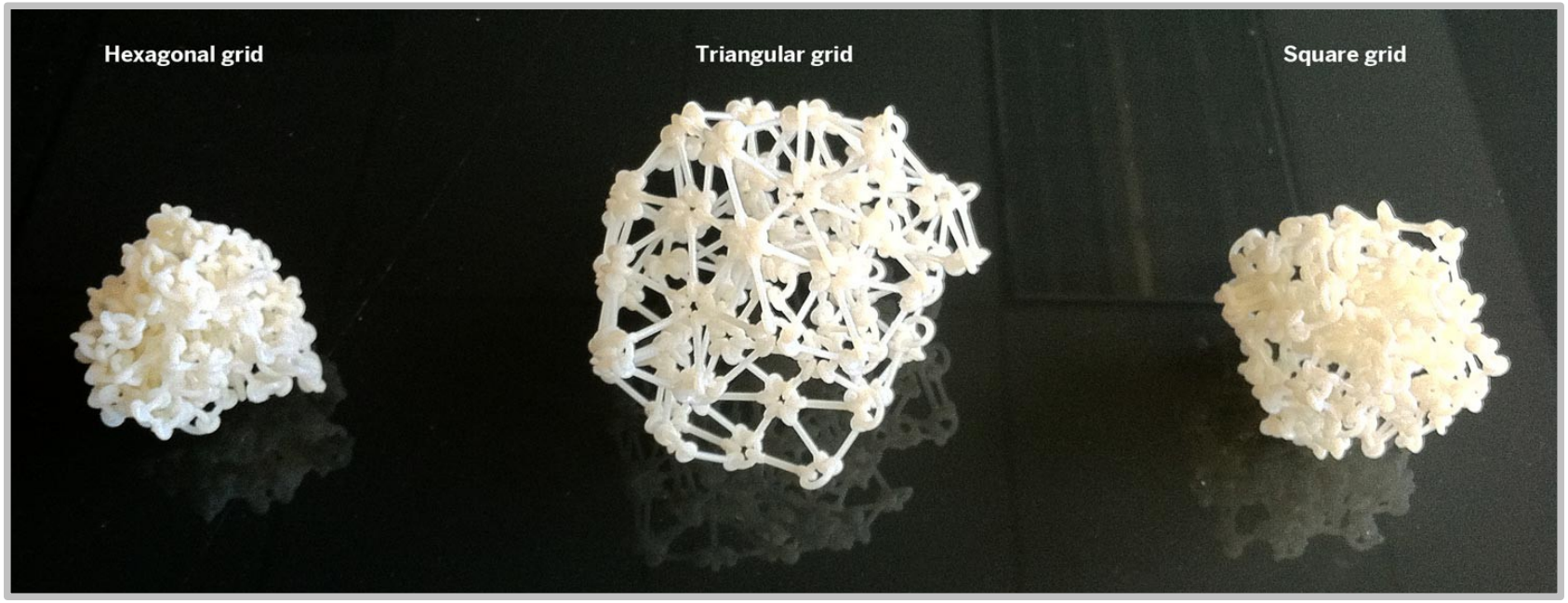
3D Printing Flexible Grids



Done with a Grasshopper definition that used the grid components to create a set of flexible triangular, square, and hexagonal grids.

Source: http://lmnts.lmnarchitects.com/fabrication/printed-flexgrids/

3D Printing Flexible Grids



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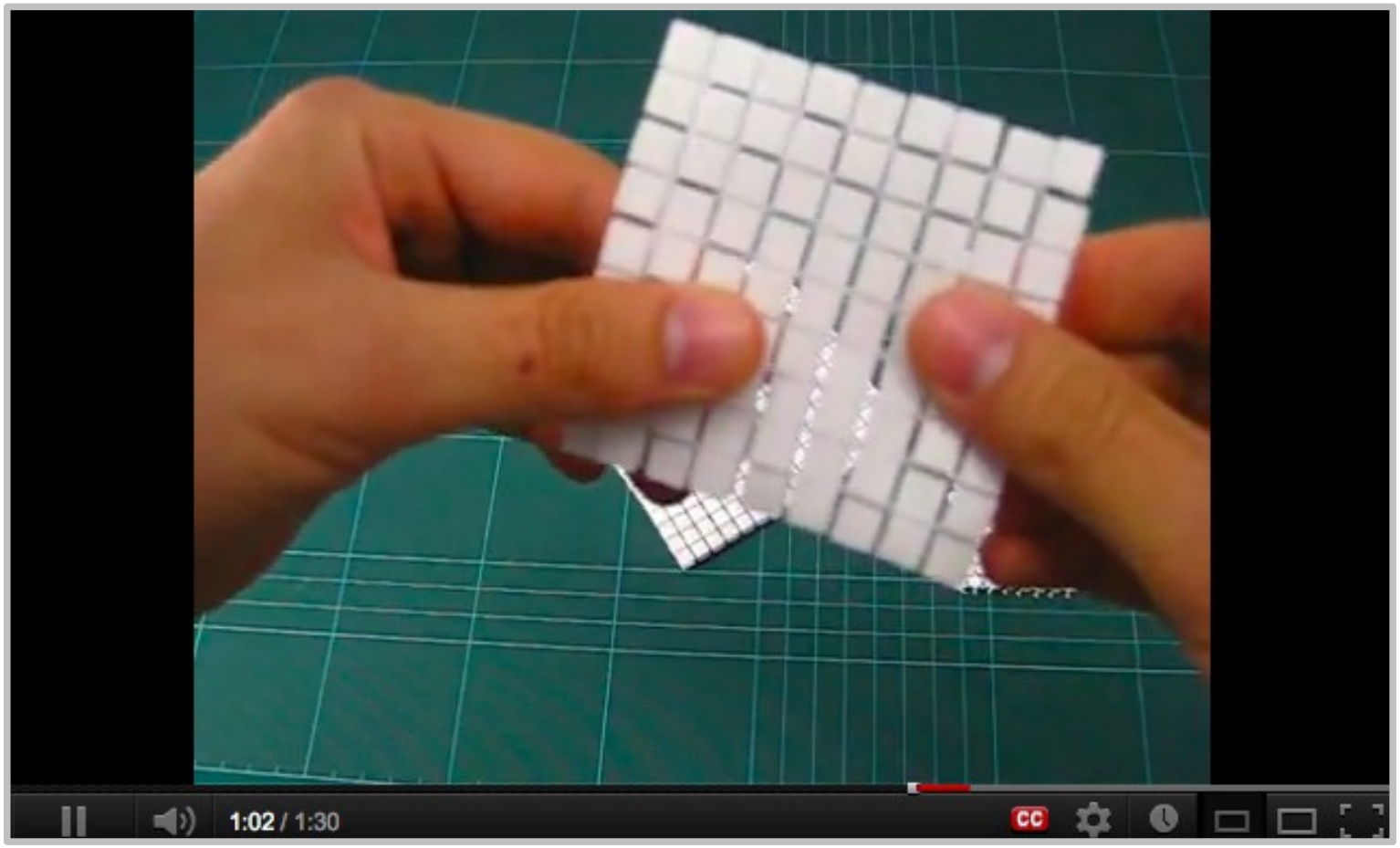
Digi-Fabrics



A test done by Shapeways with their White Strong & Flexible material.

Source: http://youtu.be/JSCDw6mThk4
http://www.shapeways.com/blog/archives/525-White-Strong-and-Suuuuper-Flexible..html

3D printed bikini

The N12 bikini is the world's first ready-to-wear, completely 3D-printed cloth. All of the pieces are snap together without any sewing.

Source: http://www.continuumfashion.com/N12.html

3D printed fashion design

Dutch designer Iris Van Herpen uses 3-D printers to create designer fashion for Björk and Lady Gaga.

Source: http://www.wired.com/design/2012/04/10-things-3d-printers-can-do-now?pid=167

3D printed fashion design

A collection of 3D printed hats and acessories were shown on the runway as part of the Materialise World Conference in Leuven, Belgium.

Source: http://blog.ponoko.com/2012/04/24/a-fashion-show-of-3d-printed-hats/
http://i.materialise.com/challenge/the-hats-off-to-3d-printing-challenge/

3D printed shoes

Melissas' shoes are among the most amazing examples of what 3D printing can do for style and design. Designer Andreia Chaves created the Invisible Shoes

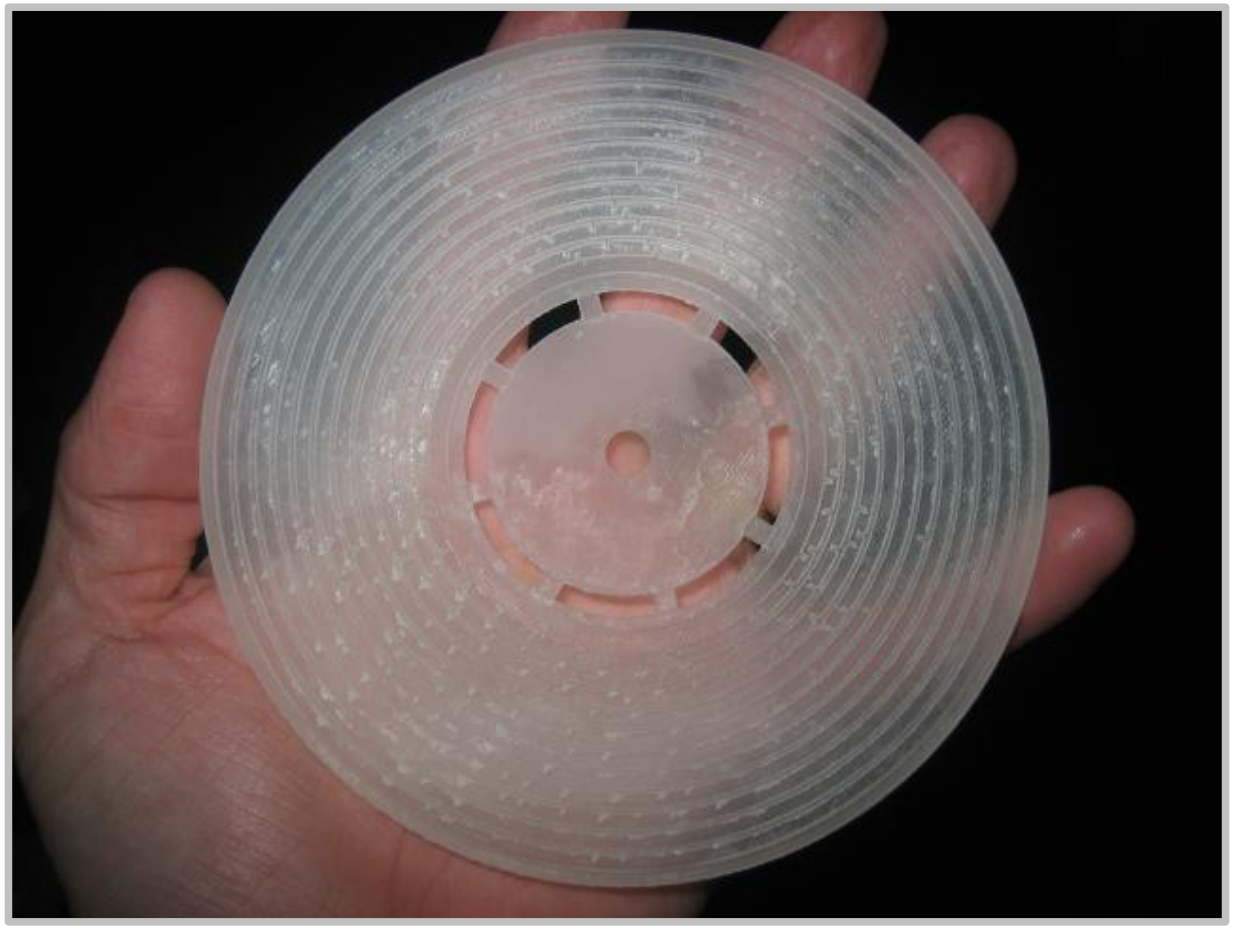
Source: http://blog.sculpteo.com/2012/03/29/3d-printing-for-green-fashion-melissas-footwear-experiments/

3D printed characters

Yoni Binstock is using front and side portrait photos together with 123D Catch to reconstruct a facial model and texture this on to a cake topper design.

Source: http://www.shapeways.com/blog/archives/1332-Lifes-Memorable-Moments-Captured-In-3D.html

3D printing media...



A 3D printed record for the Fisher-Price record player playing 'Still Alive'. The tune and model were all generated in Processing. Sold on Shapeways.

Source: http://www.shapeways.com/blog/archives/1179-Video-of-3D-Printed-Record-Playing-Still-Alive-from-Portal.html

3D printing media...

A 3D printed record for the Fisher-Price record player playing 'Still Alive'. The tune and model were all generated in Processing. Sold on Shapeways.

Source: http://youtu.be/ElAJJnSvQtk

3D printing media...

The first 3D printed prototype of the programmable kalimba sequencer.
Pegs can be set to produce different 16-step sequences of 5 tones.

Source: http://youtu.be/ERiw664xMKE

3D printing media...

3D printing of film props has long been common in big budget movies, but now its increased affordability is aiding its introduction to smaller budget productions.

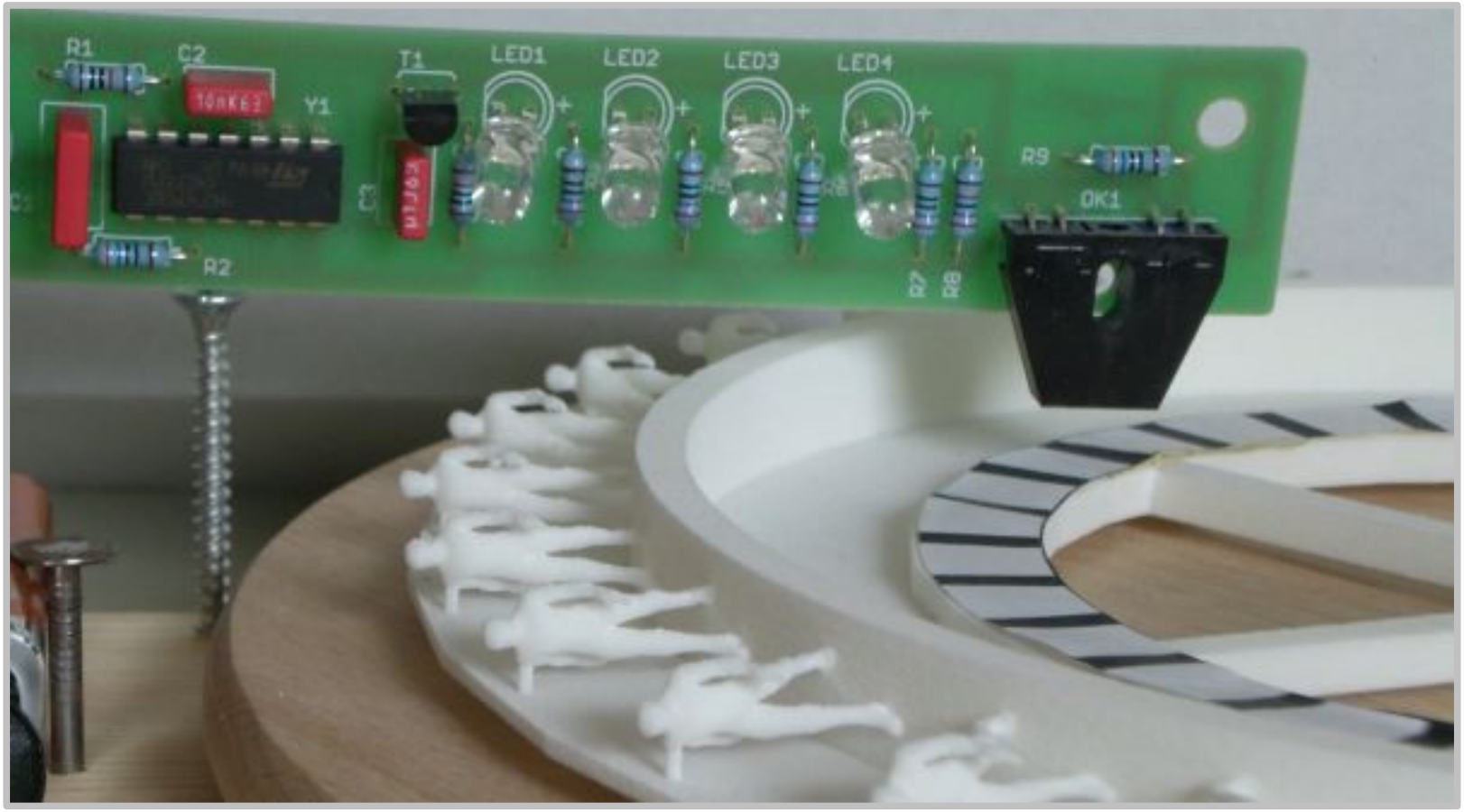
Source: http://vimeo.com/91711011

3D printing media...

With the help of technologies from Objet Geometries, the creative team behind the feature film, Coraline, broke new ground in stop-motion animation.

Source: http://youtu.be/_2F0PA7qUQE

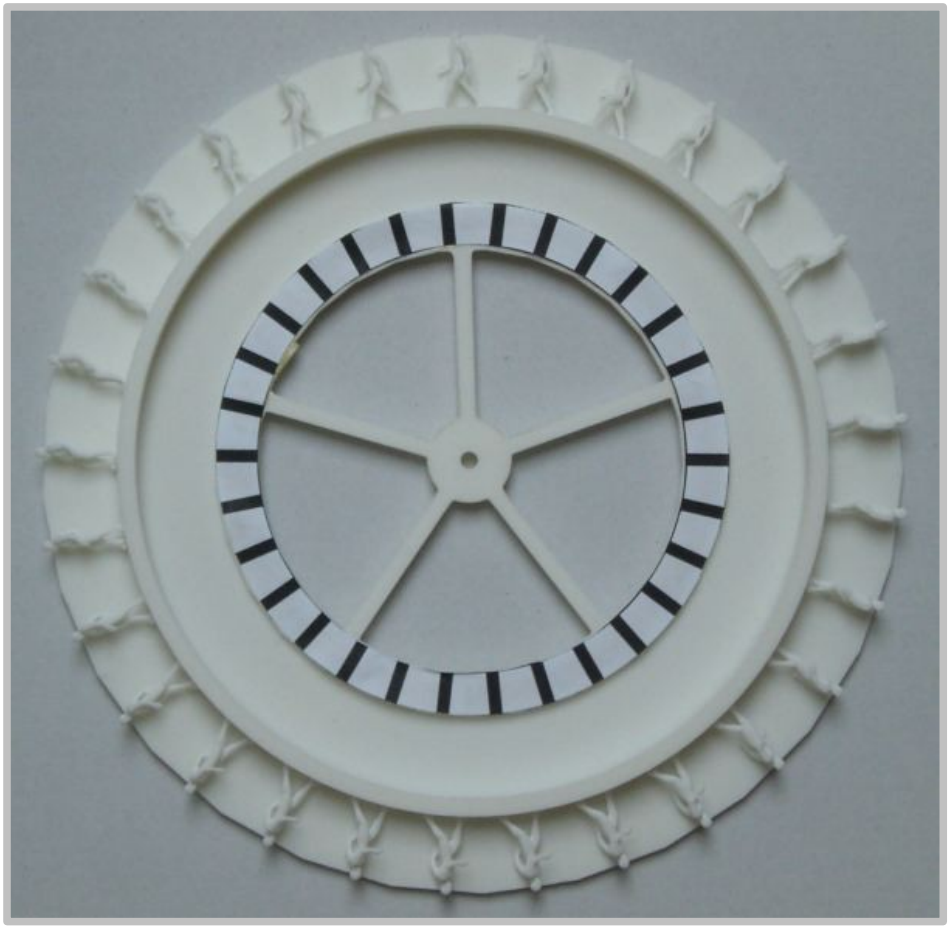
3D printing media...



3Drehkino took an animation in Blender, 3D printed it with Shapeways, hacked some electronics and created his own zeotrope under a CC license.

Source: http://drehkino.de/3Drehkino_en.php

3D printing media...



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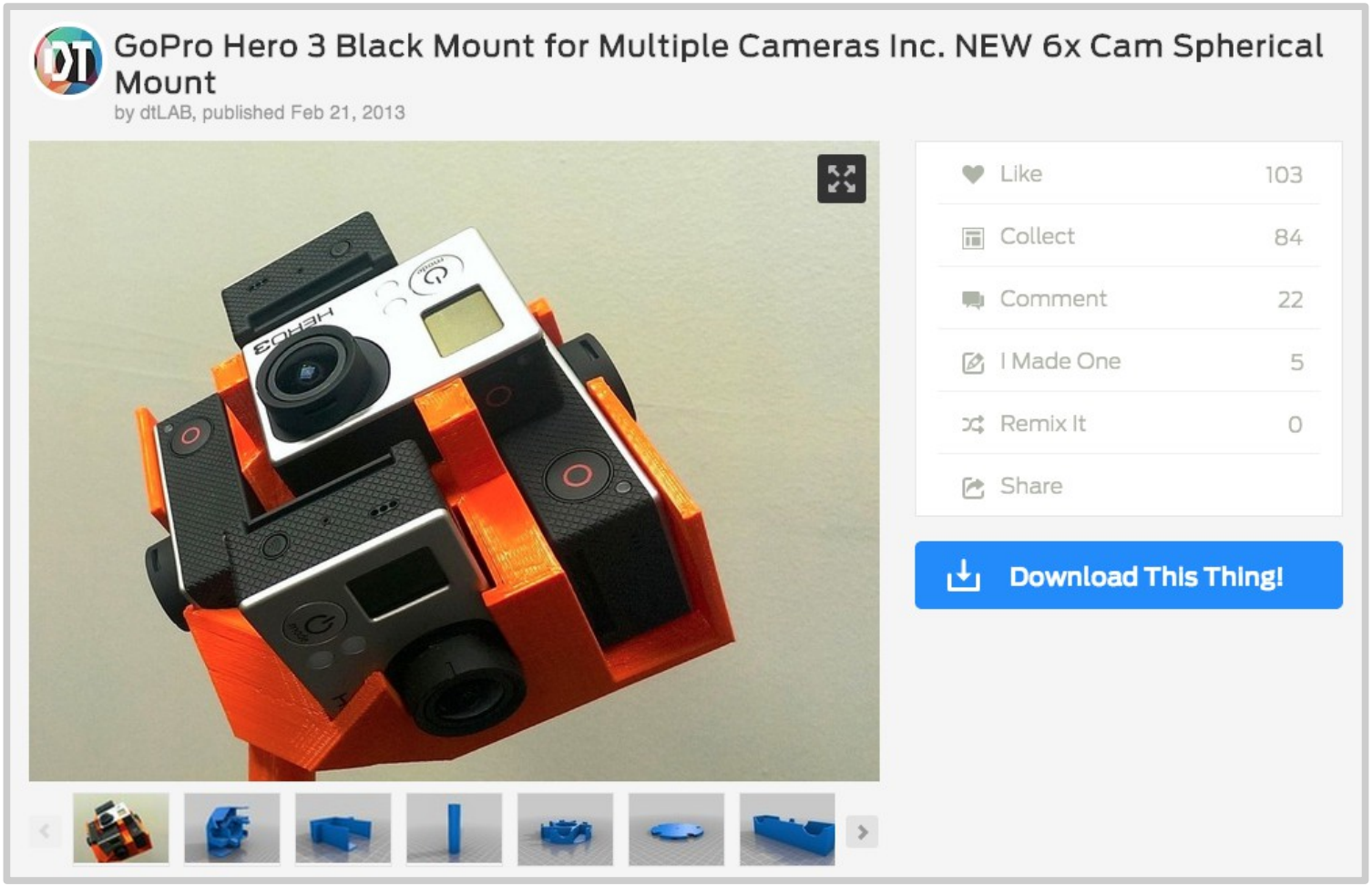
Source: http://youtu.be/LVa_WwBFtA4

3D printing for media...



GoPro Hero 3 Black Mount for Multiple Cameras Inc. NEW 6x Cam Spherical Mount

Source: http://www.thingiverse.com/thing:52584

3D printing for media...

GoPro Hero 3 Black Mount for Multiple Cameras Inc. NEW 6x Cam Spherical Mount

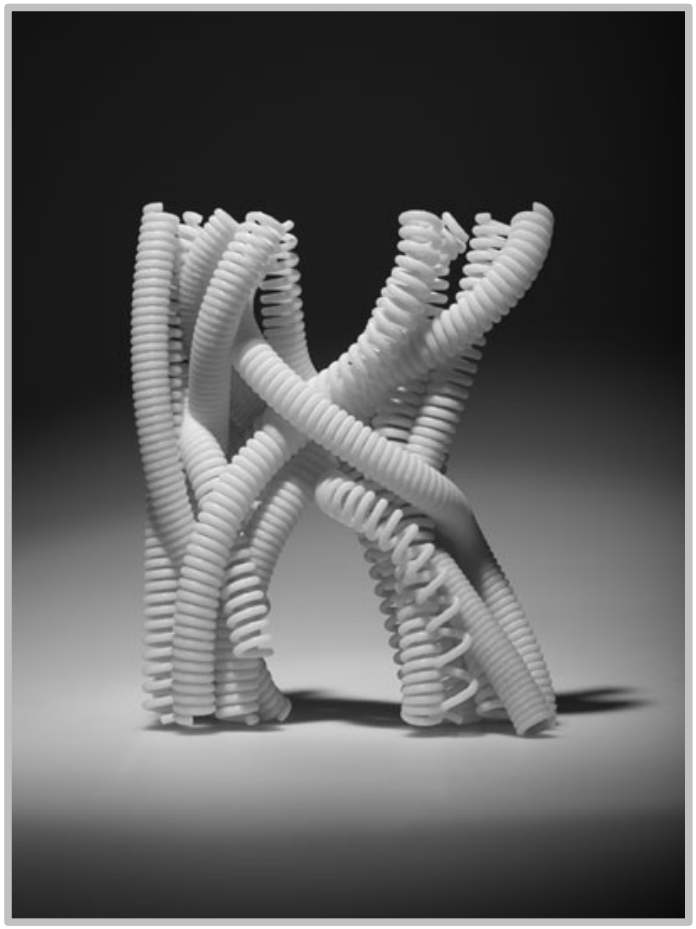
Source: http://vimeo.com/90312869

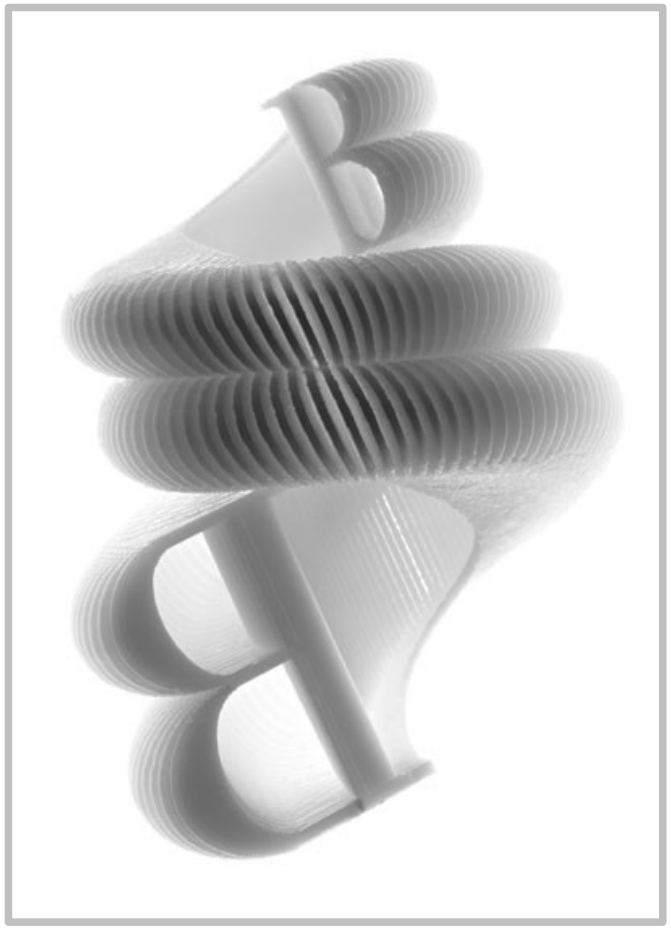
3D printing in media: Print magazine cover

Print magazine August 2008 cover design generated with Processing and 3D printed.

Source: http://postspectacular.com/process/20080702_printmagcover

3D printing in media: Arkitypo

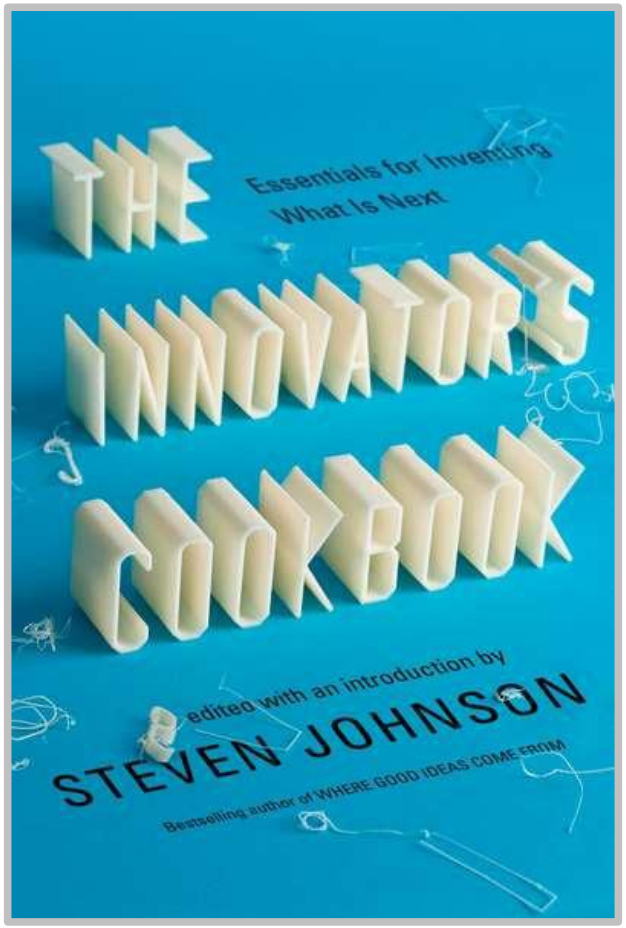




The idea was to 3D-print an entire alphabet derived from the historical story of how a typeface beginning with the same letter came to be.

Source: http://johnsonbanks.co.uk/thoughtfortheweek/index.php?thoughtid=711

3D printing in media



Printing the cover of the book *The Innovator's Cookbook* by Steven Johnson with a Makerbot.

Source: http://www.casualoptimist.com/2011/10/18/the-innovators-cookbook/

3D printing in media

Book with 3D printed / downloadable content.

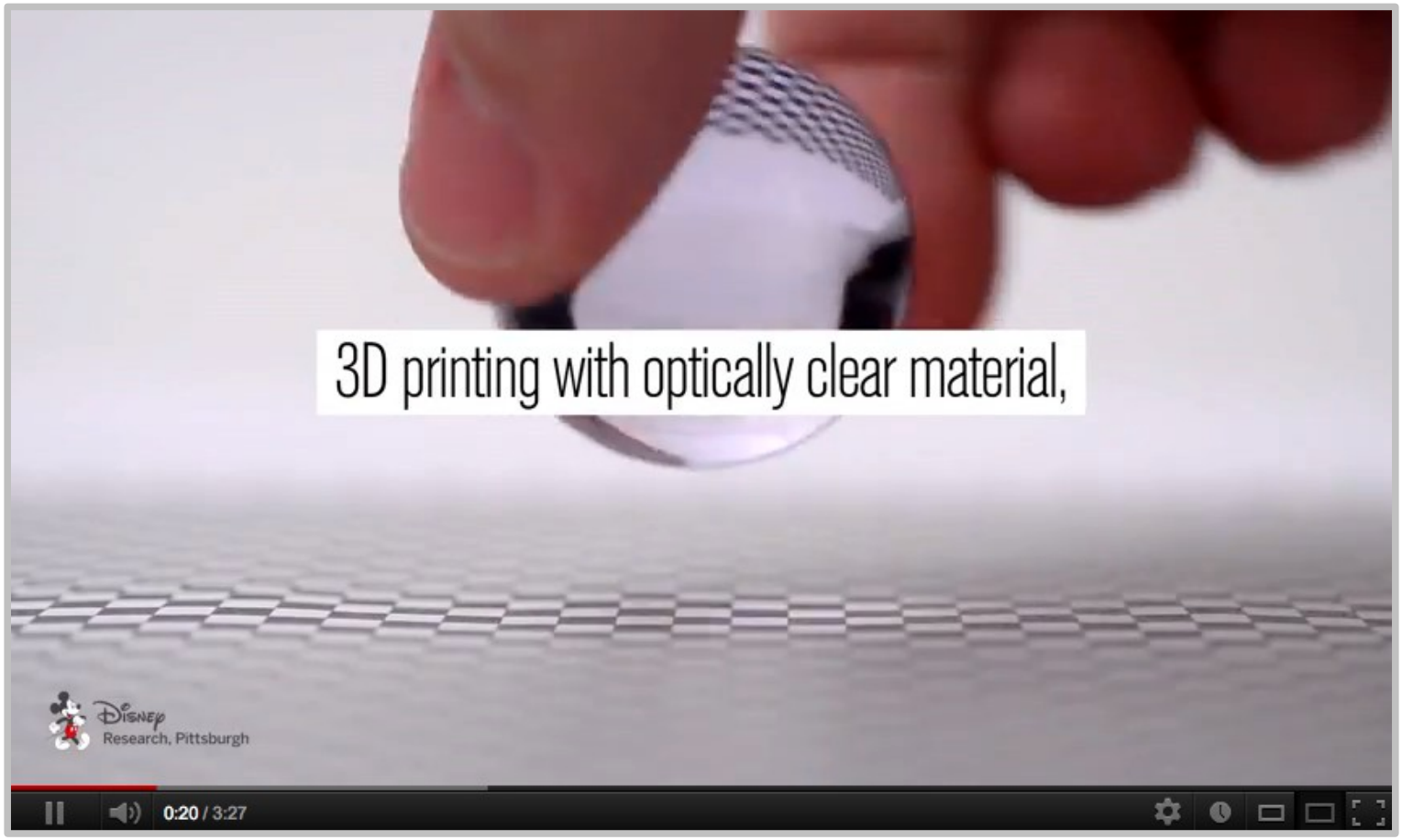
Source: http://www.leothemakerprince.com/

3D printing in media

Book with a 3D printed cover

Source: http://www.fastcodesign.com/3024627/the-first-3-d-printed-book-cover-is-here

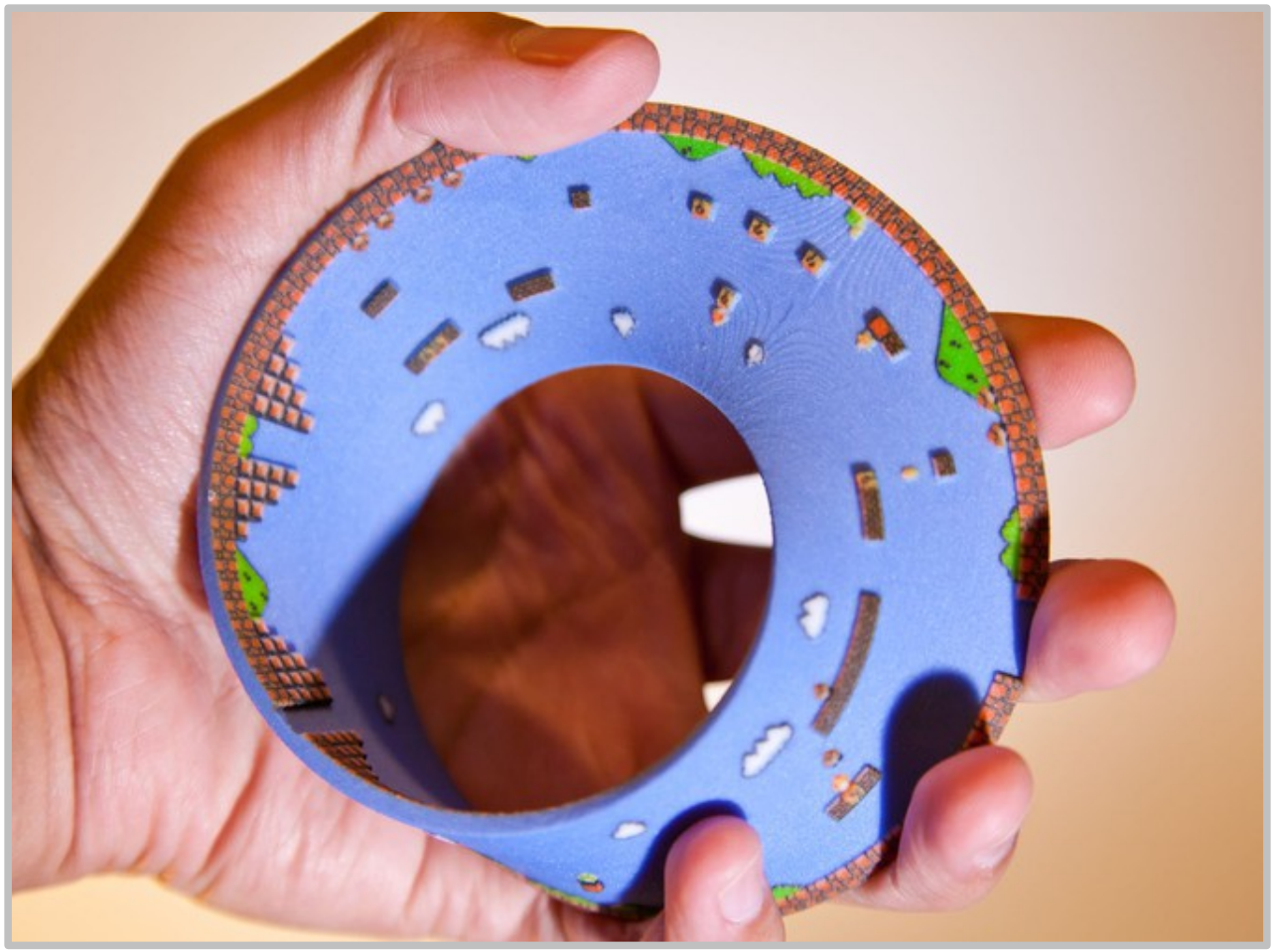
3D printing optics



Disney Research is 3D printing optics, in order to create more interesting and interactive product interface.

Source: http://www.shapeways.com/blog/archives/1671-Disney-Research-3D-Printed-Optics-and-Interfaces-VIDEO.html
http://www.youtube.com/watch?feature=player_embedded&v=eTeXTbXA6-Y

3D printing media from Video games



A moebius strip out of a Super Mario videogame!

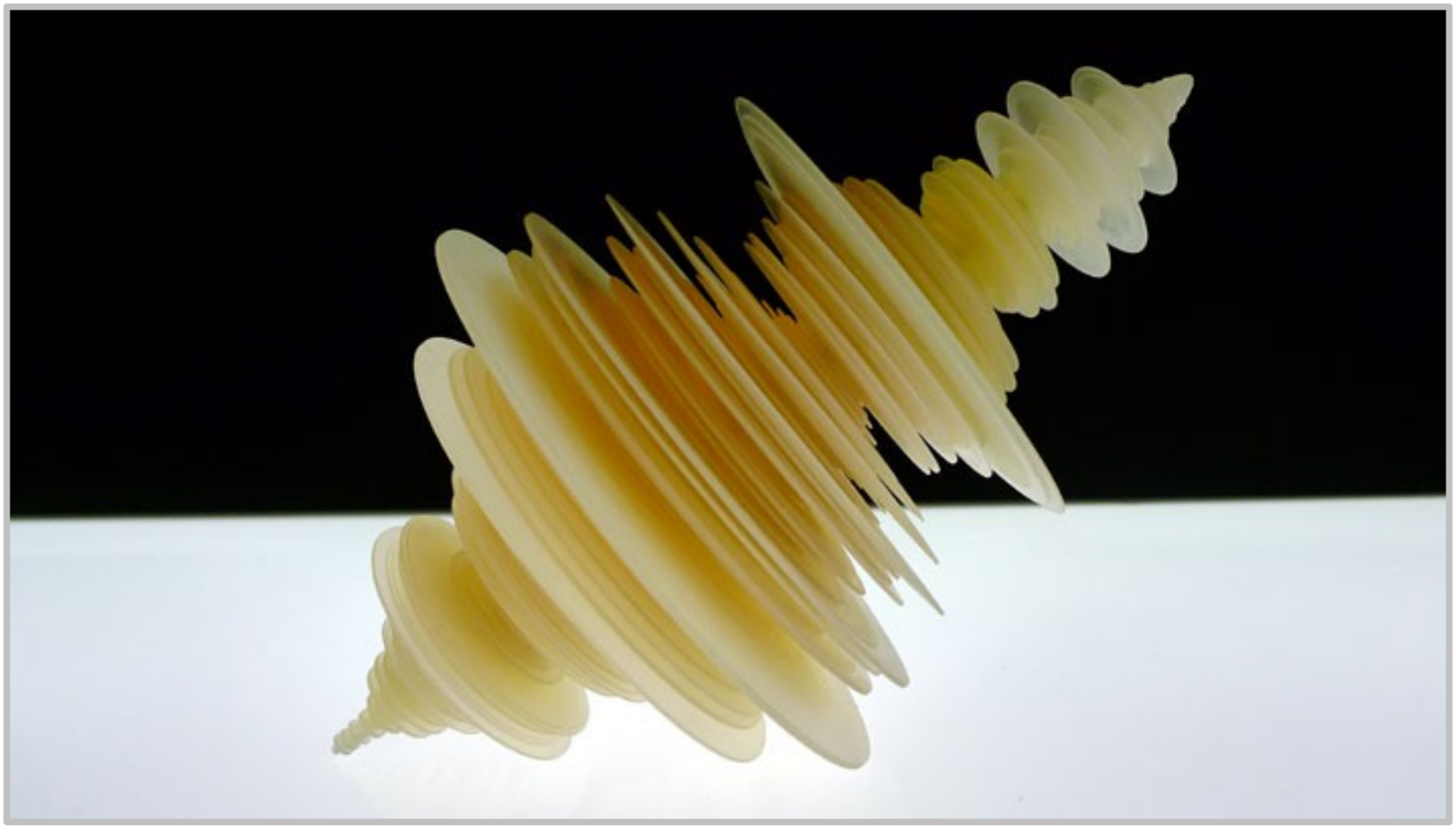
Source: http://www.shapeways.com/blog/archives/1635-Mario-in-a-3D-Printed-Mobius-Strip-Runs-on-Forever,-and-Ever.html

Successful transplant of a 3D printed jaw

A 3D printer-created lower jaw has been fitted to an 83-year-old woman's face in what doctors say is the first operation of its kind.

Source: http://www.bbc.co.uk/news/technology-16907104

3D printing data: Luke Jerram



To create the sculpture a seismogram of the earthquake, was rotated and then printed in 3 dimensions using rapid prototyping technology.

Source: http://www.lukejerram.com/projects/t%C5%8Dhoku_earthquake

3D printing data: Facebook

Turn your Facebook data in a custom 3D printed sculpture.

Source: http://www.shapeways.com/blog/archives/1881-turn-your-facebook-profile-into-3d-printed-art-with-the-creators-project-shapeways.html

3D printing data: sound

"Welcome to the era of mass customization in which anyone can build a unique iPhone case for $25."

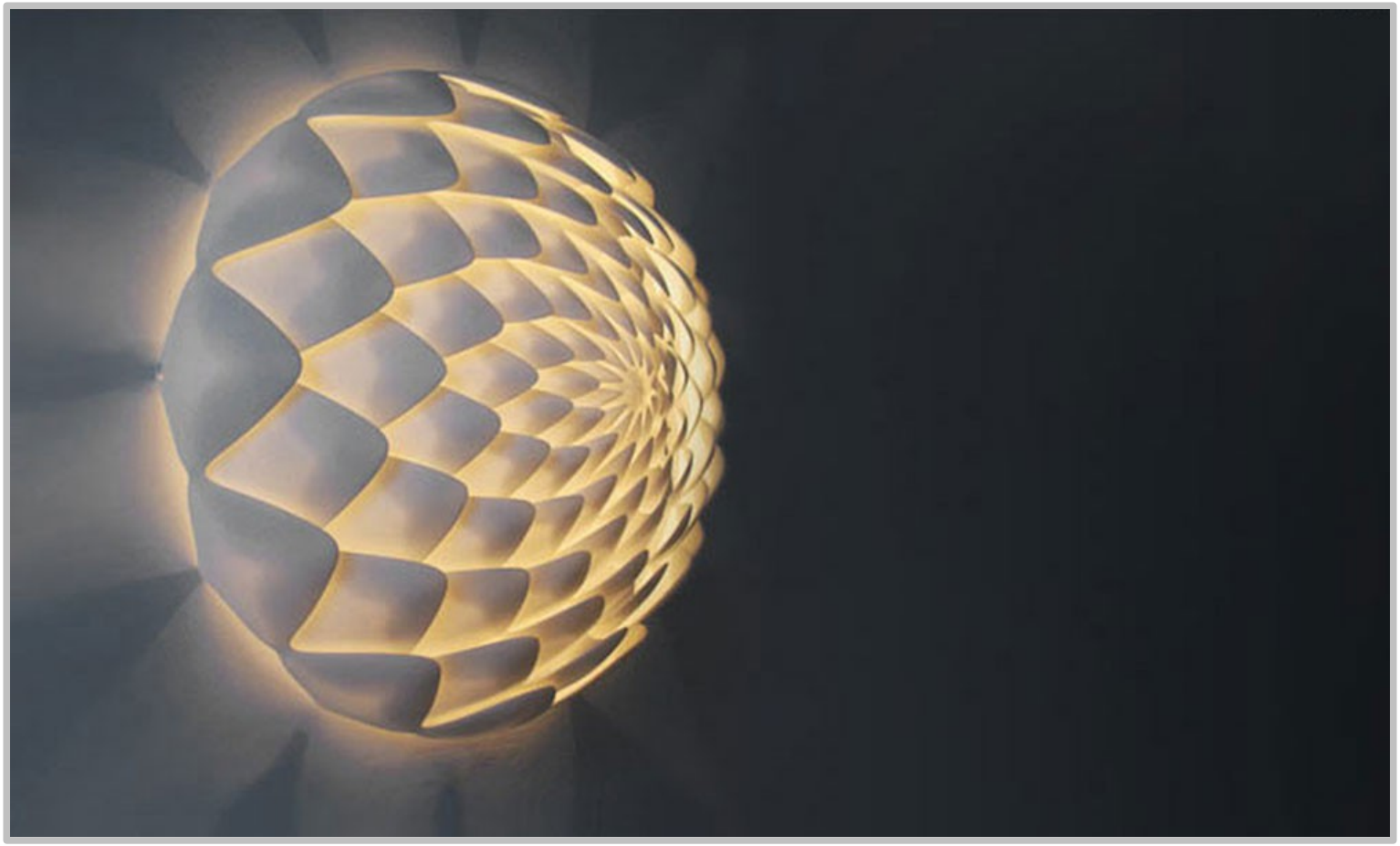
Source: http://www.shapeways.com/creator/thevibe

3D printing data: sound

"Welcome to the era of mass customization in which anyone can build a unique iPhone case for $25."

Source: http://www.protoparadigm.com/2011/11/filament-tolerances-and-print-quality/

3D printed lamps



Freedom Of Creation is an edition of exclusive design objects, furnishing complements, lighting and accessories.

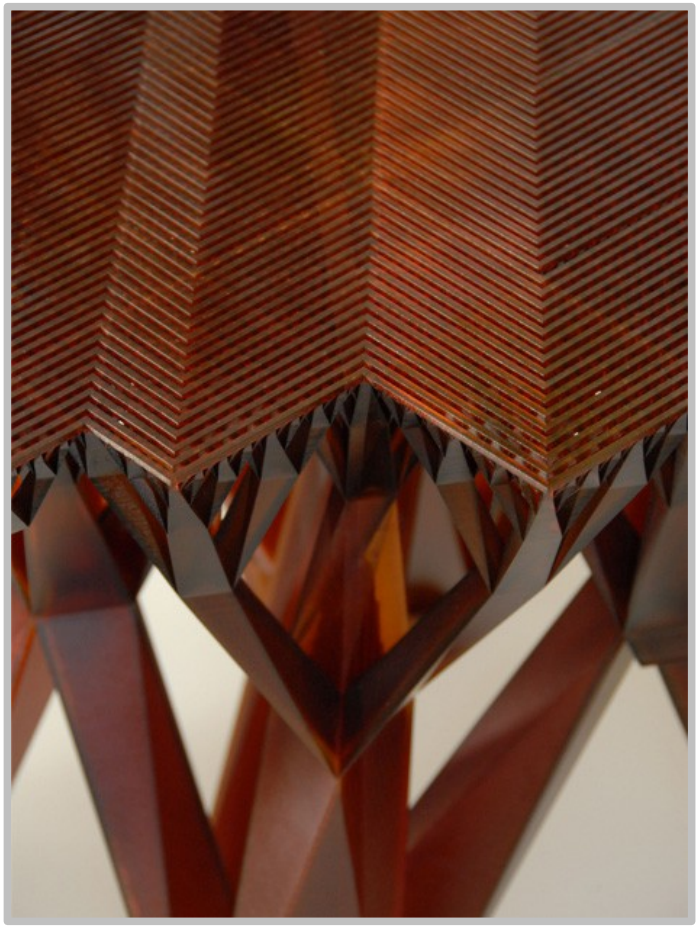
Source: http://www.freedomofcreation.com/

3D fractal furniture design

Fractal Table is a generative design table produced by Materialise as a single piece SLA in epoxy resin. Its dimensions in cm are: L98 x W61 x H42.

Source: http://www.platform-net.com/

3D fractal furniture design



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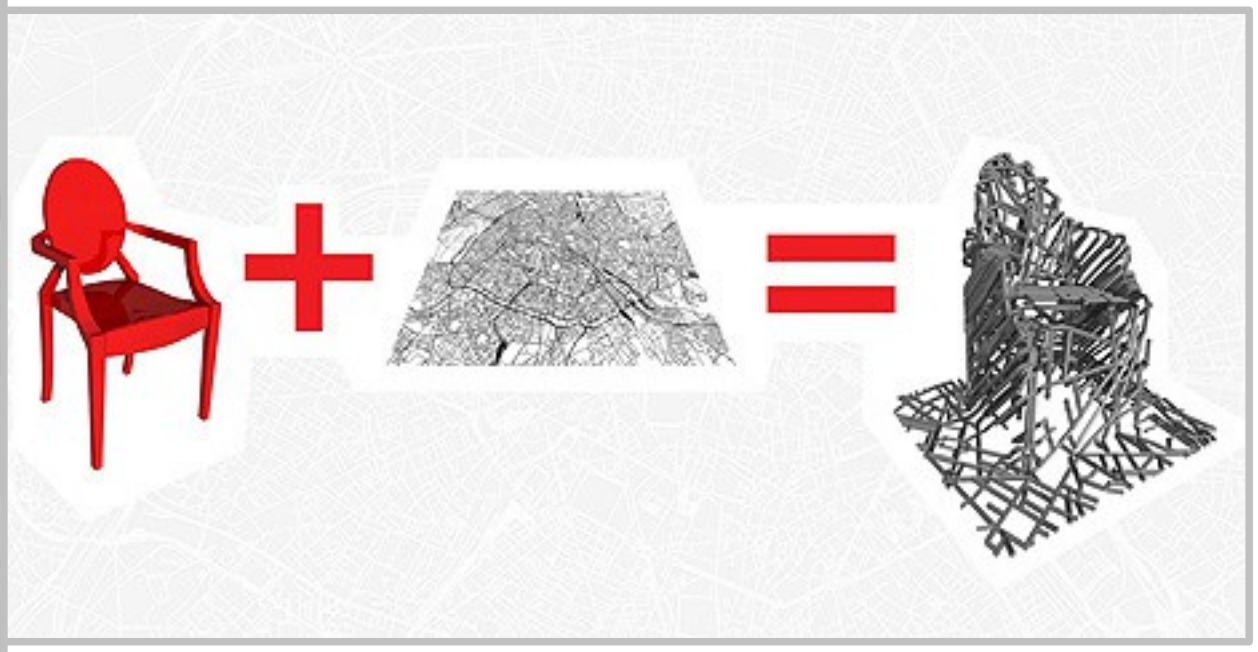
3D printed furniture design



The Throne of Paris (John Briscella)

Source: http://i.materialise.com/blog/entry/5-amazing-full-sized-furniture-pieces-made-with-3d-printing

3D printed guitar

Each guitar is fully customizable, as the designers remove or insert various segments from the 3D model before each printing, with selectable colour.

Source: http://www.designboom.com/weblog/cat/16/view/20135/skeletal-3d-printed-guitar.html

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03.
3D printing: design techniques things to consider...

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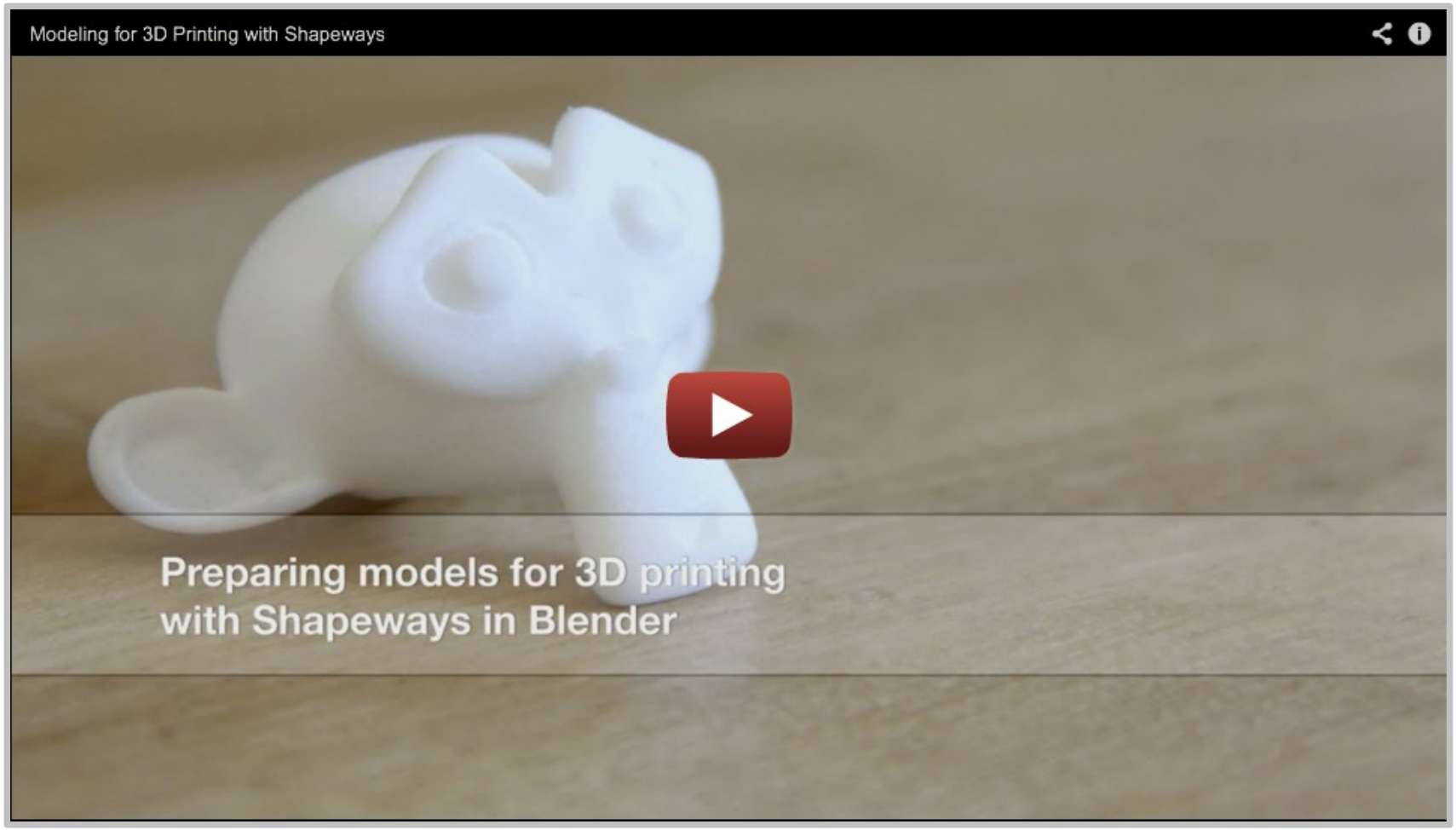
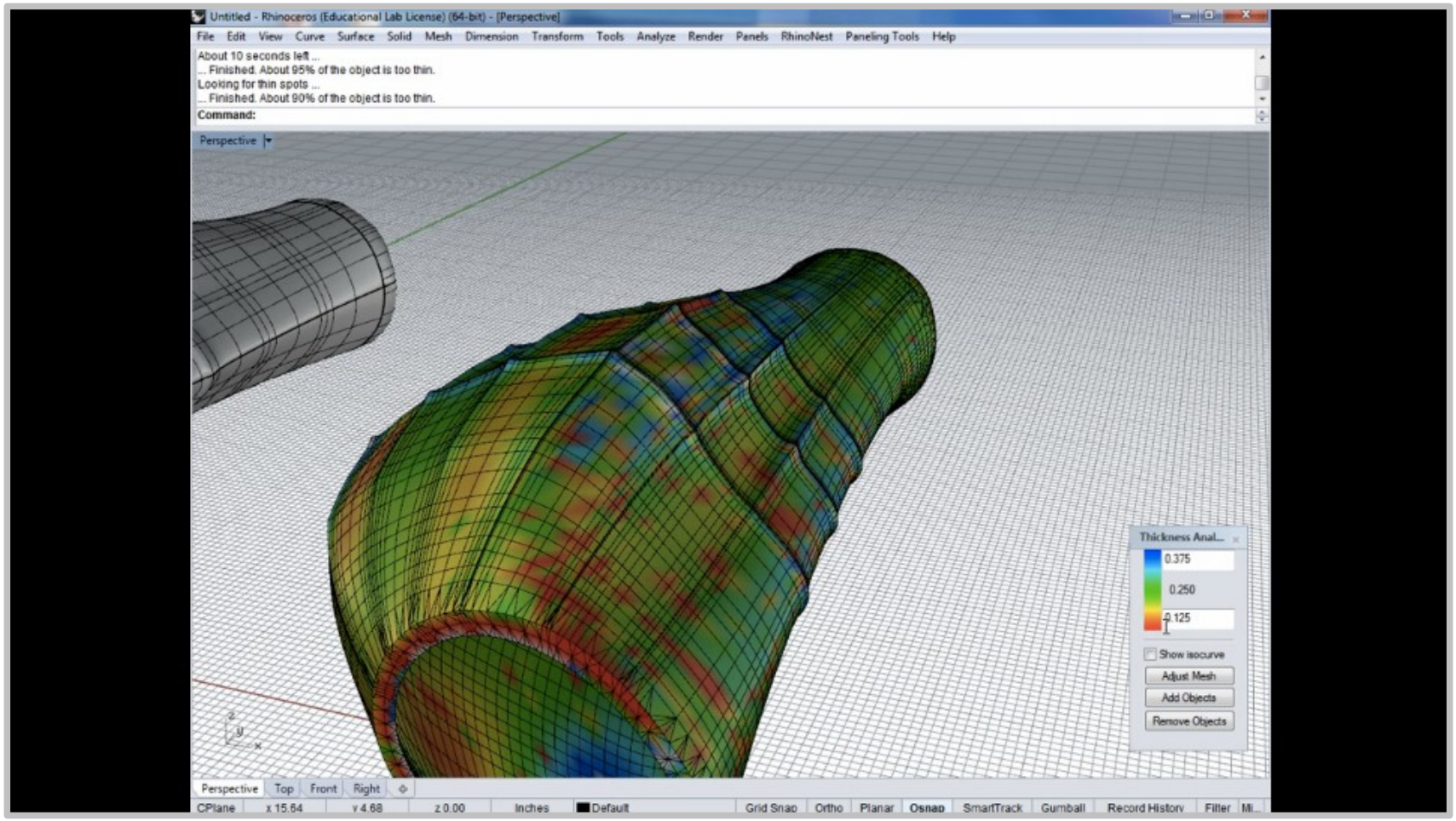
00: design with Blender



A good tutorial for designing the mesh
with Blender.

Source: http://cgcookie.com/blender/2013/02/04/modeling-3d-printing-shapeways/

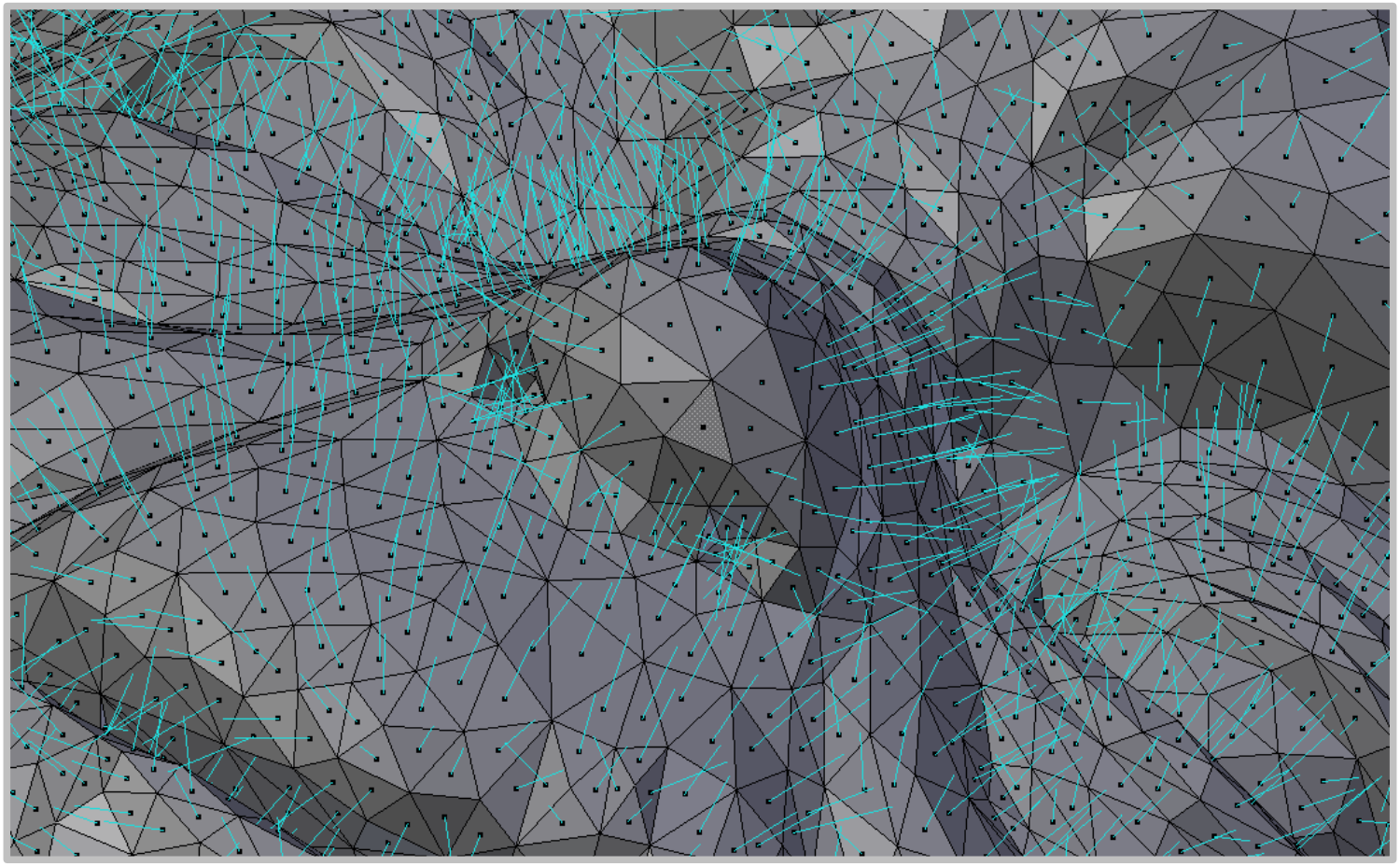
00: check the mesh with Rhino 5



A good tutorial for analysing the mesh
with Rhino 5.

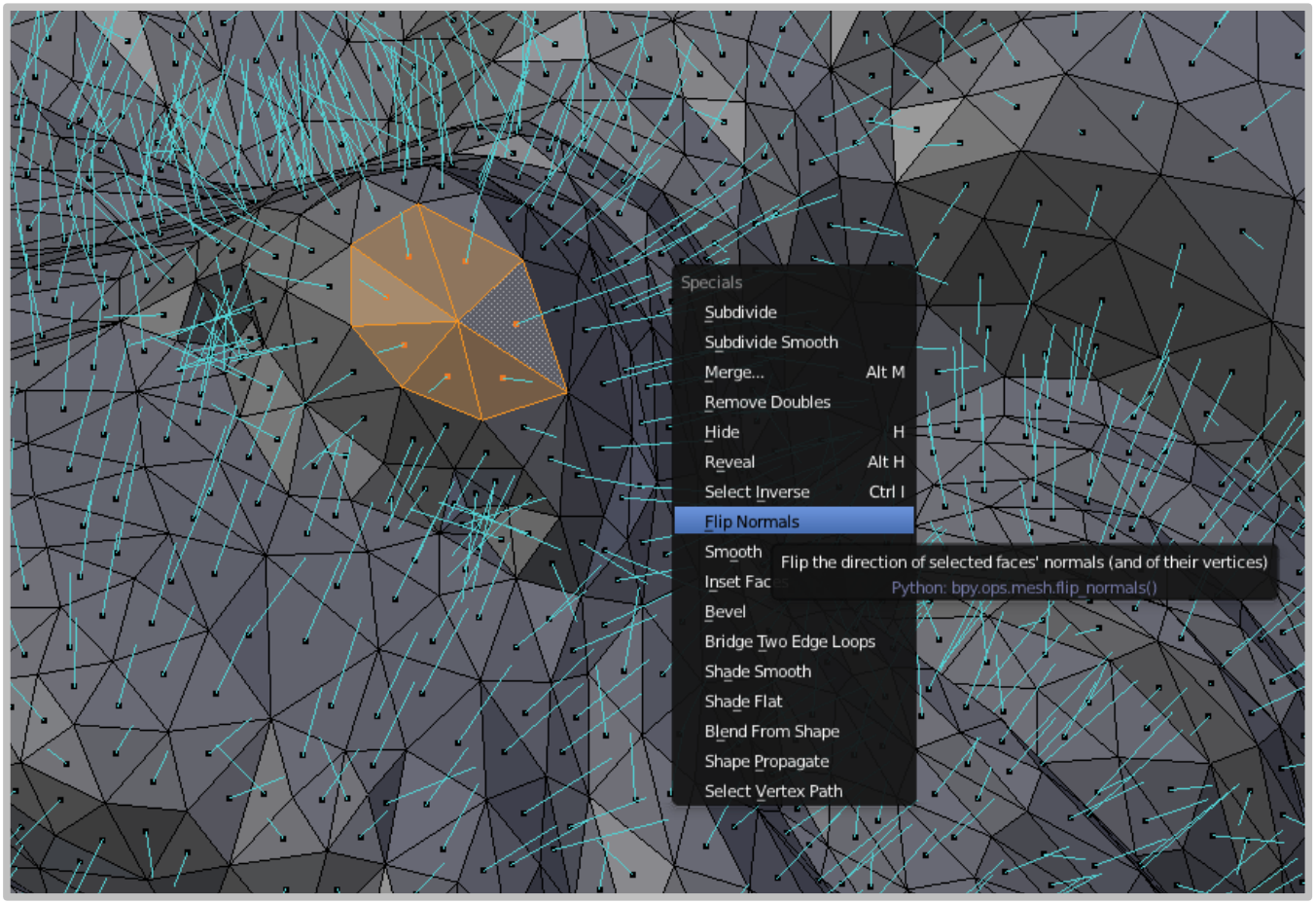
Source: http://vimeo.com/60897890

01: check the normals



They shold point outwards! The faces of
a mesh are only 1-side.

01: check the normals



Edit mode > W > Flip normals

02: check your technology

Watch out with very thin connections

The droplet below necks down to a very thin cross-section. The droplet on the end is too large then goes to a small cross-section. This will crack or tear.

"Water Crown Chopsticks stand", by wuct88

Check your specific material and technology,
Shapeways is a good resource.

Source: http://www.shapeways.com/tutorials/design_rules_for_glass_3d_printing

03: Yes to moving parts and undercuts

But not with FDM!!!

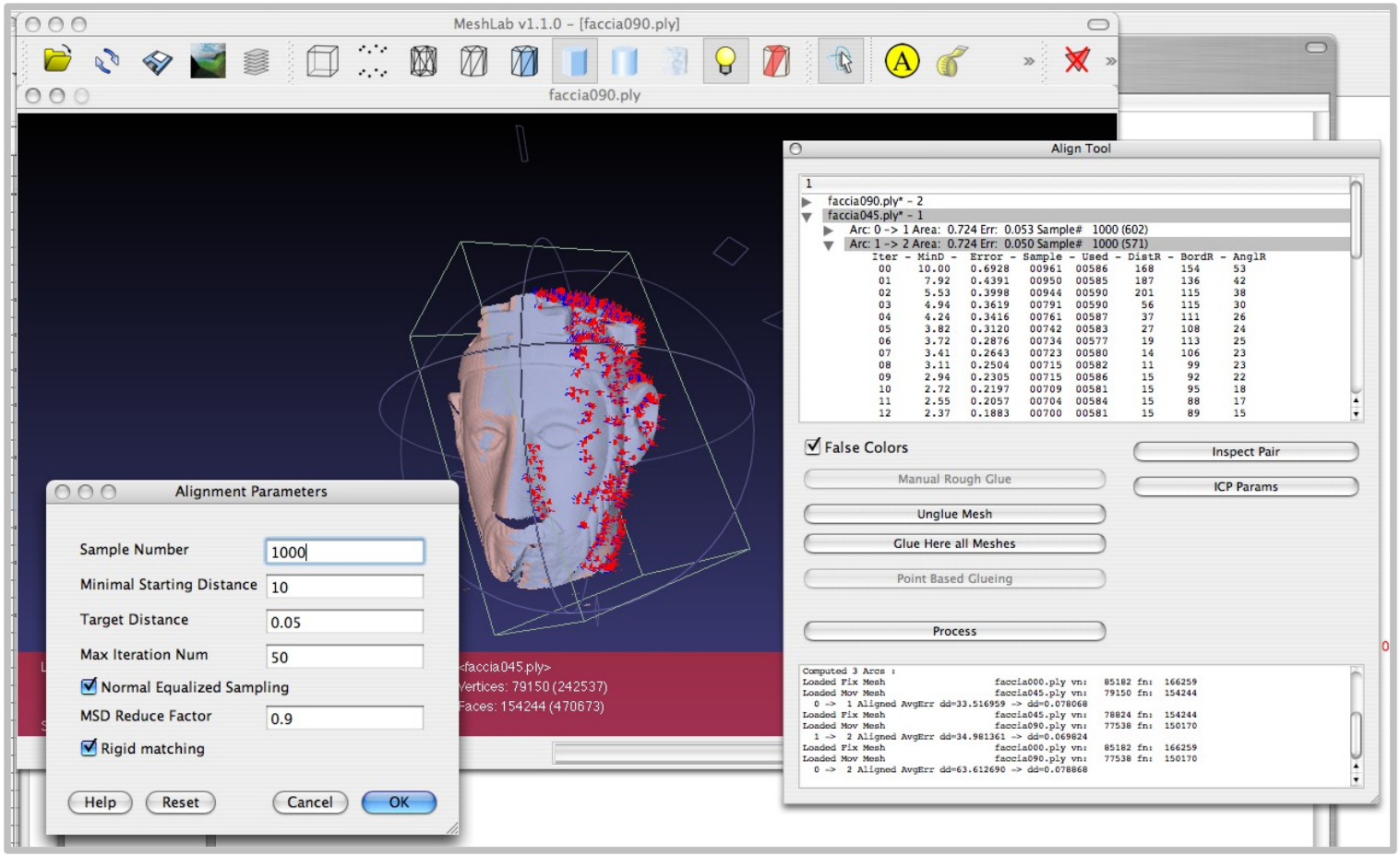
Source: http://youtu.be/guTSrF7J6Y0

03: FDM: use support material

PVA is the best option, it is water soluble.

Source: http://youtu.be/FqhBmNyvNhQ
http://store.makerbot.com/makerbot-pva-1kg-spool.html

04: Clean it with Netfabb / Meshlab



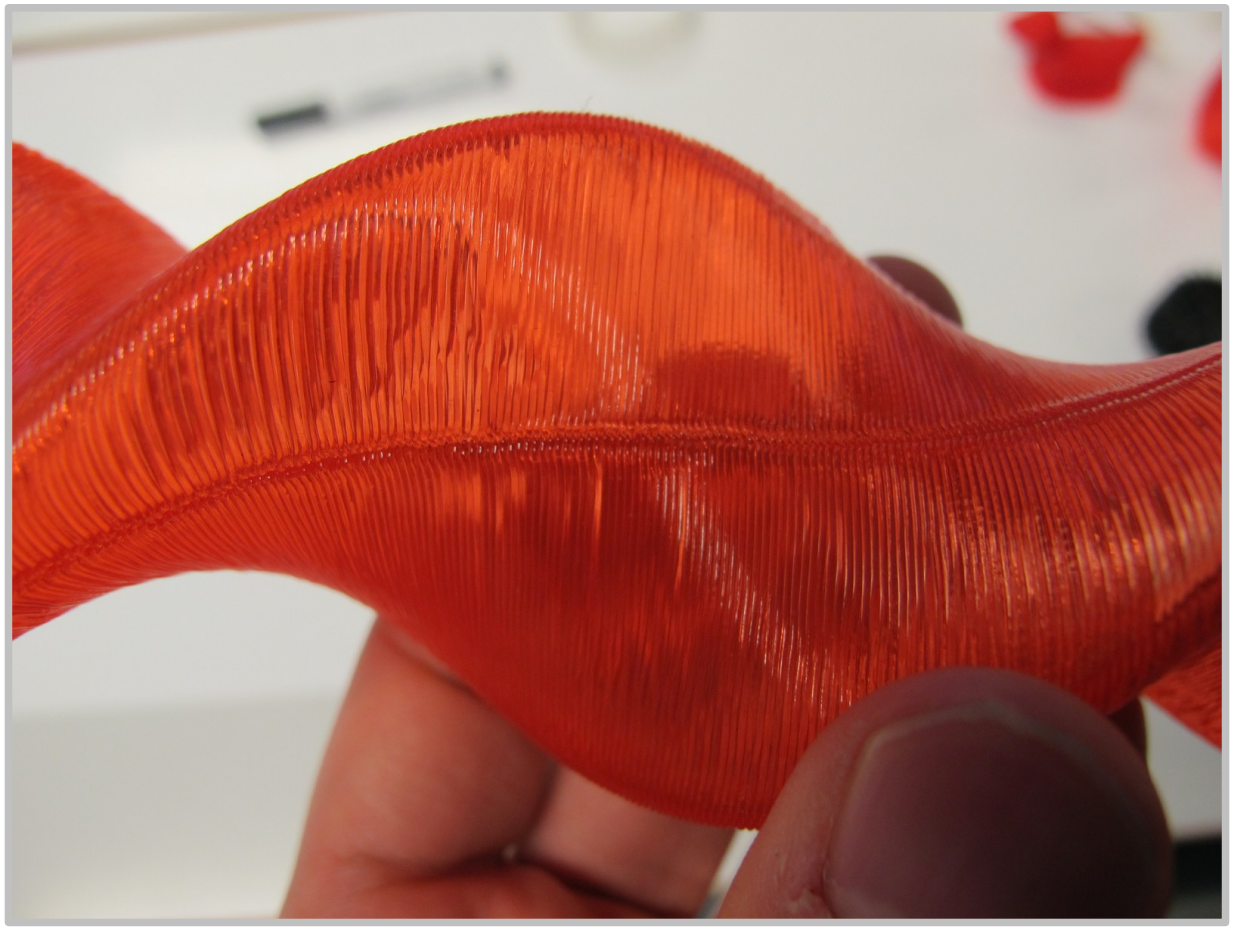
And you may need to import it into Blender again.

Source: http://meshlab.sourceforge.net/

3D printing: what could go wrong?

Too fast: we cannot achieve the full cylinder.
We had to slow the speed down and rise a bit the temperature.

3D printing: what could go wrong?

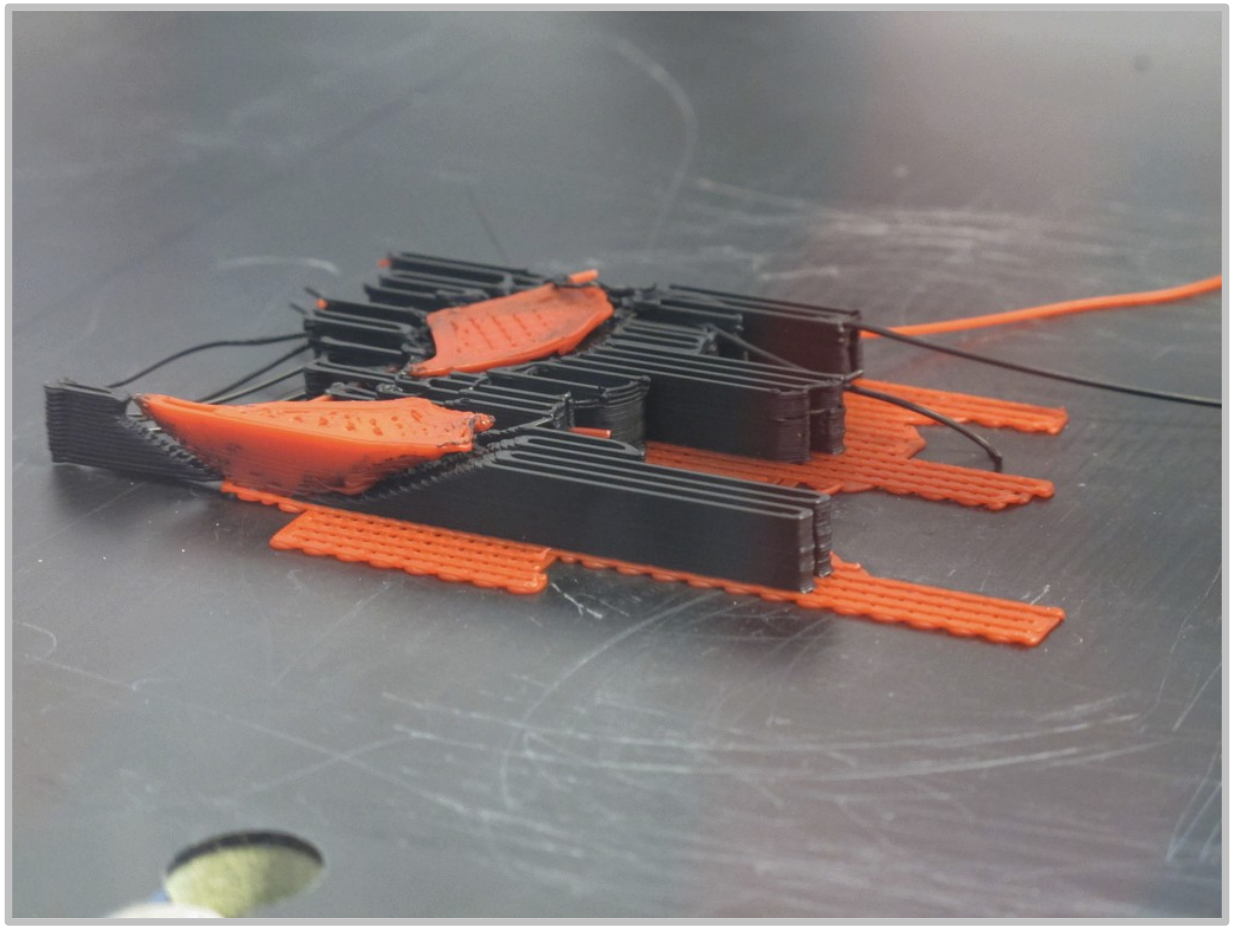


Too fast: we cannot achieve the full cylinder.
We had to slow the speed down and rise a bit the temperature.

3D printing: what could go wrong?

Too fast: the material does not have the time to solidify.
Also: too thin, and the roof collapses. On the right: slower and bigger detail.

Think about the speed

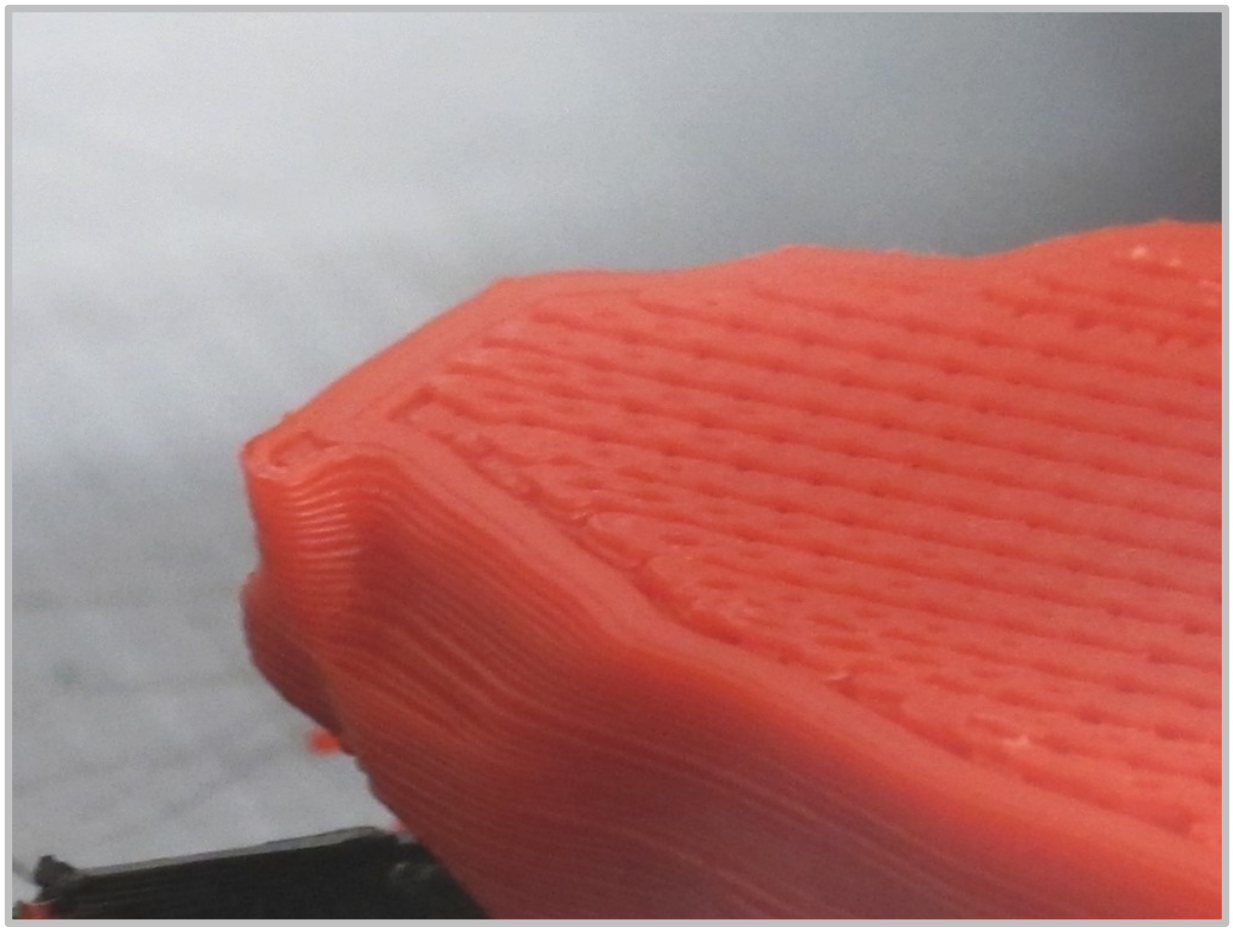


Each different material melt at a different temperature,
mixing them means slowing down the process.

Resolution

0.5 or 0.25 or 0.125 mm? Higher resolution = more time for printing.

Skins and filling

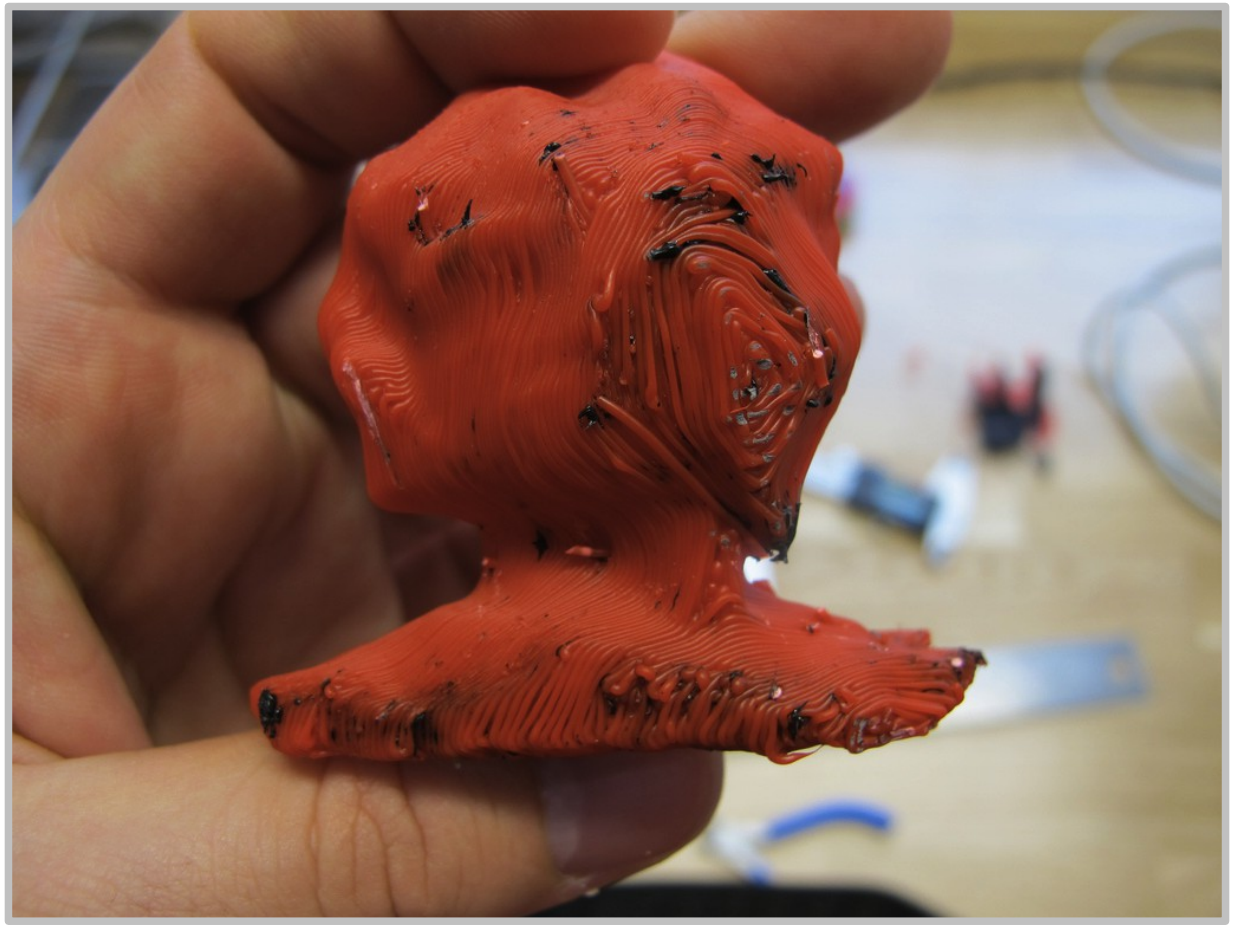


You can add extra skins and reduce the
density of the filling, if you just need a shell.

123D Catch: result

See the orientation of the layers?

123D Catch: result



Support material (PLA) and object material (ABS) mixed a bit.

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Thank you!!

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