



Aalto University  
Media Factory

# 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

# 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/7QP73uTJAkw>

# 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

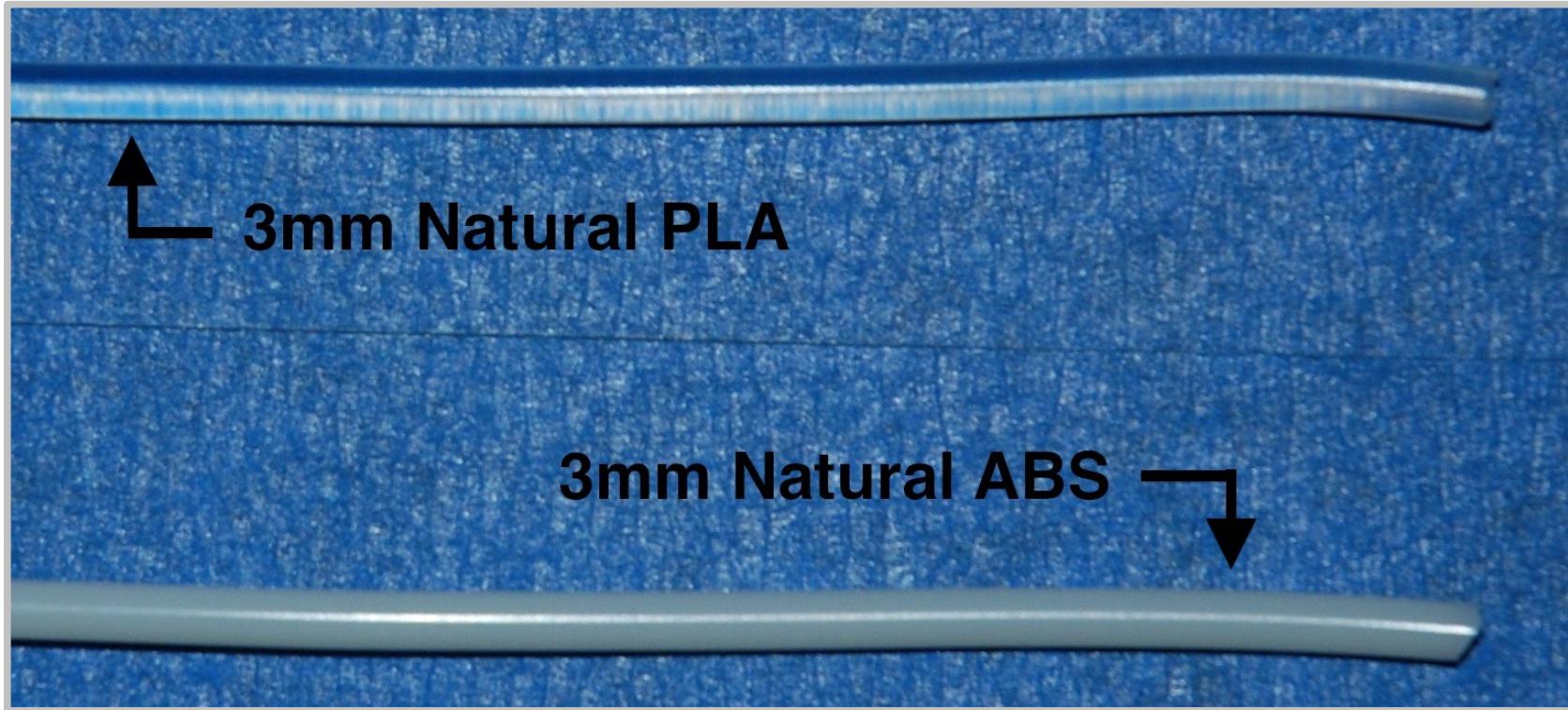


Fused Deposition Modeling (FDM) but with hand control: the first  
3D printing pen.

Source: <http://youtu.be/DQWyhezlze4>

<http://www.the3doodler.com/>

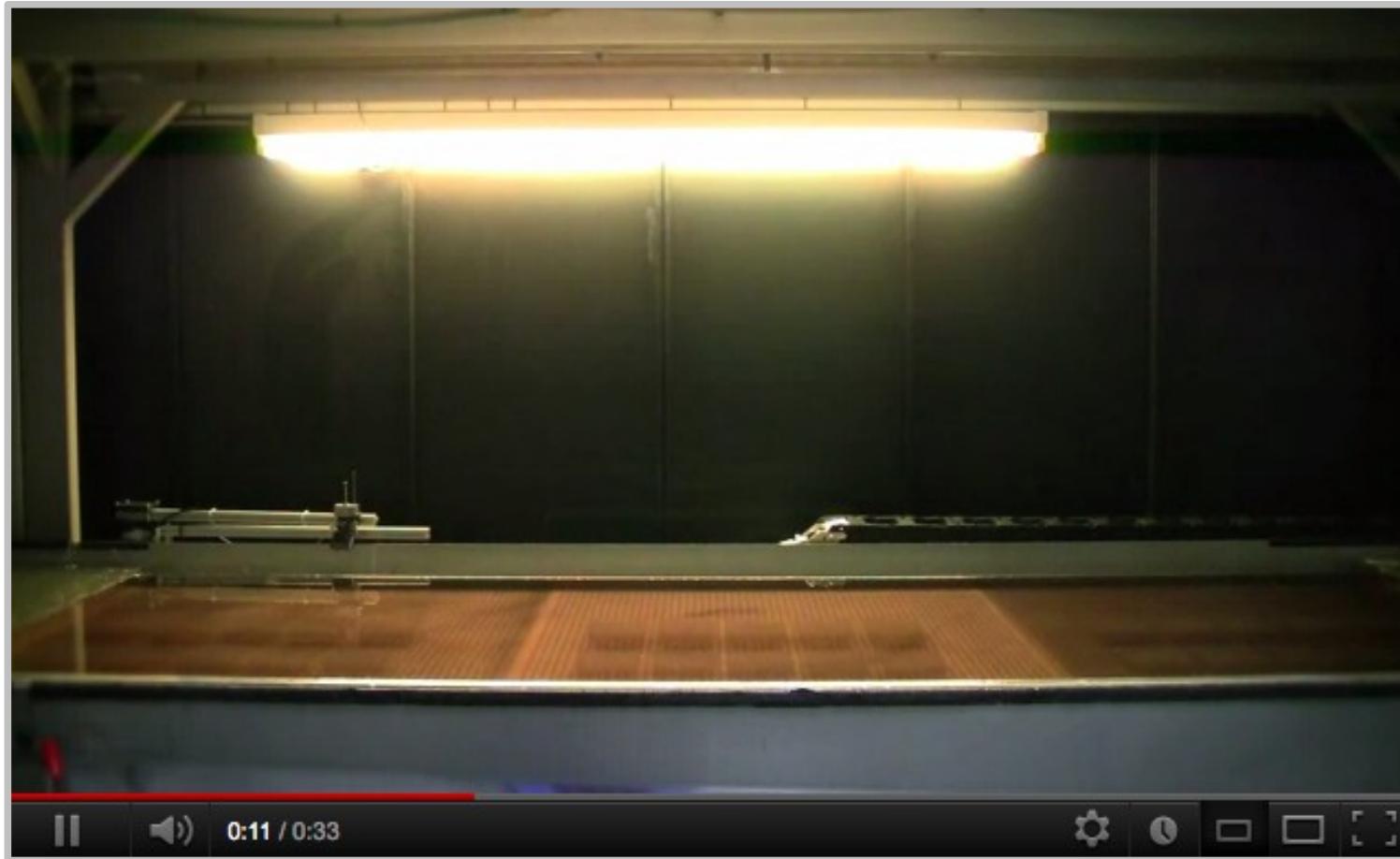
# Technologies: materials for FDM



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: Stereolithography

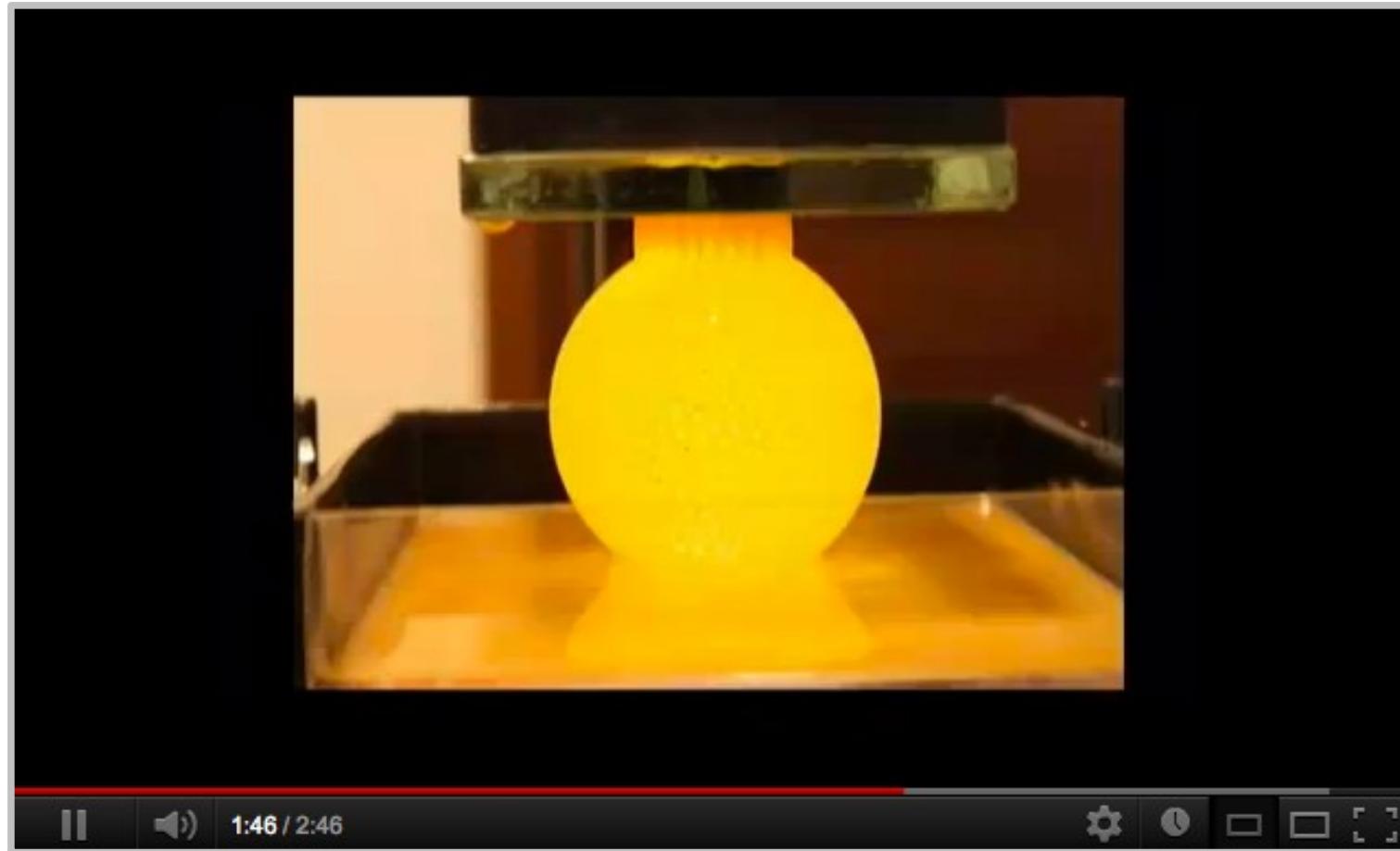


Stereolithography produces models by tracing a beam of UV light over a photosensitive pool of liquid. Over time the part is lowered into the bath.

Source: <http://replicatorinc.com/blog/2009/02/4-types-of-3d-printing/>

<http://youtu.be/ygHVVKKjWlI>

# Technologies: Stereolithography

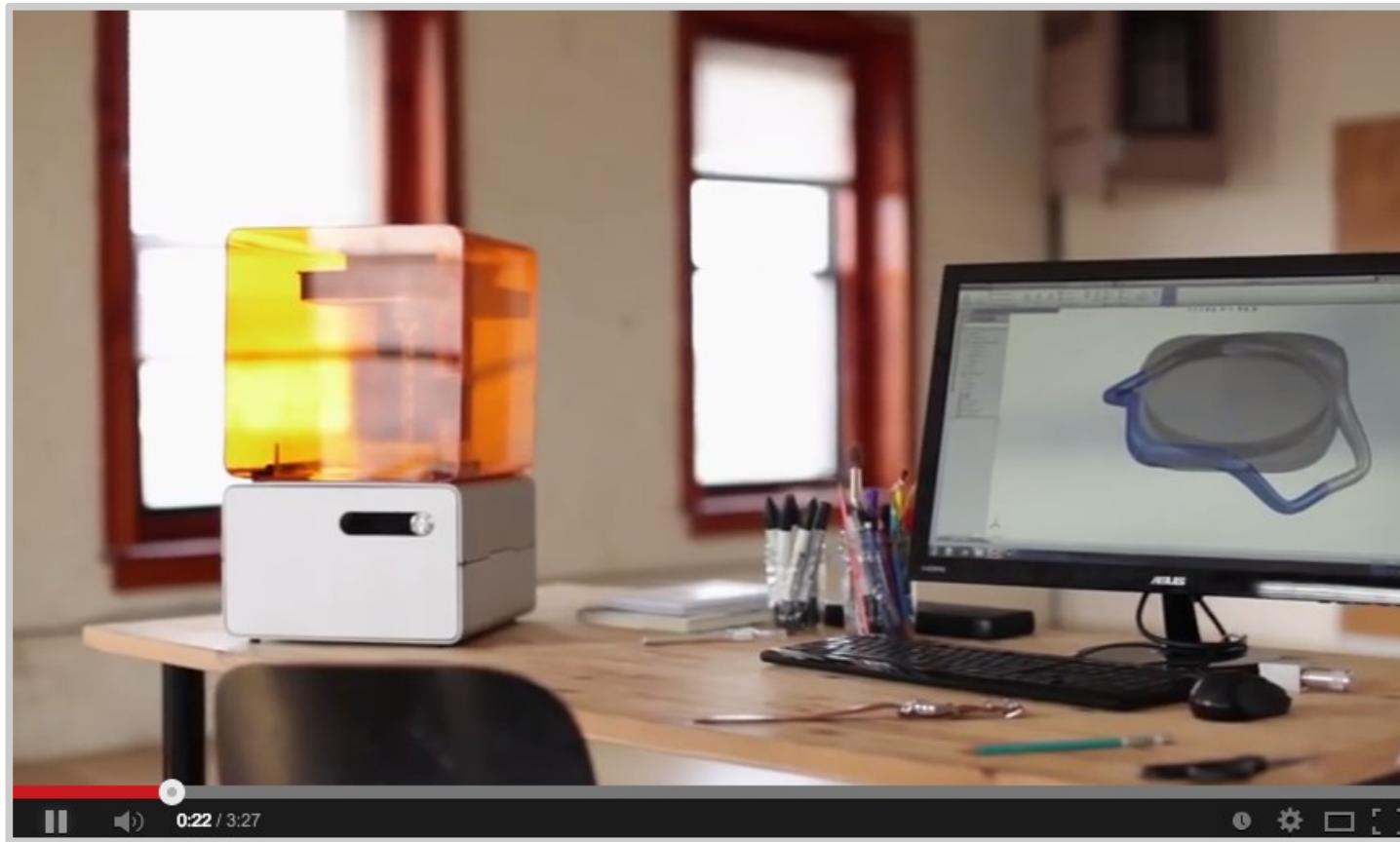


Stereolithography produces models by tracing a beam of UV light over a photosensitive pool of liquid. Over time the part is lowered into the bath.

Source: <http://replicatorinc.com/blog/2009/02/4-types-of-3d-printing/>

<http://youtu.be/snOErpOP5Xk>

# Technologies: Stereolithography



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.

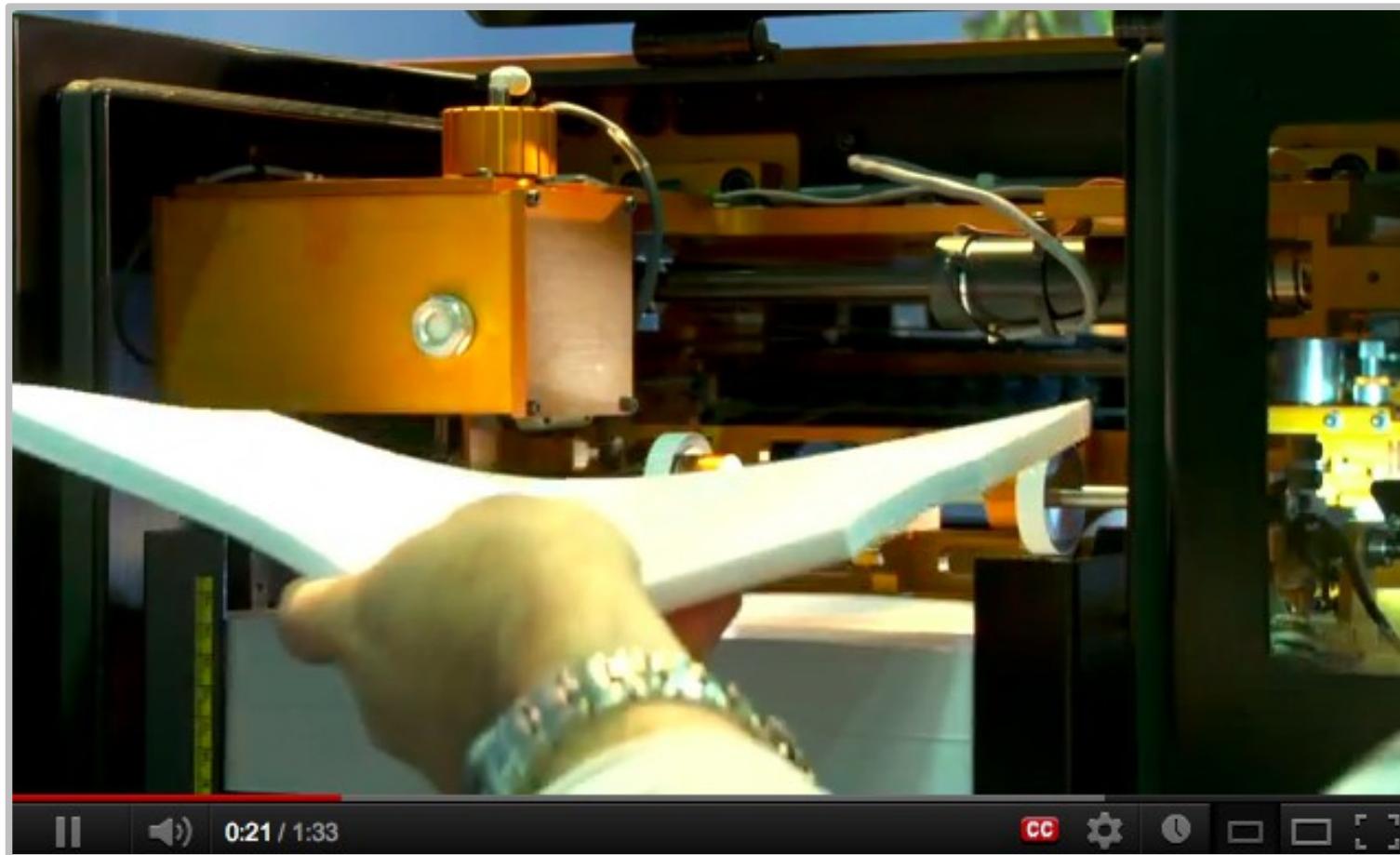
# Technologies: Selective Laser Sintering



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](http://youtu.be/lC0uVO_uT0s)

# Technologies: Laminated Object Manufacturing

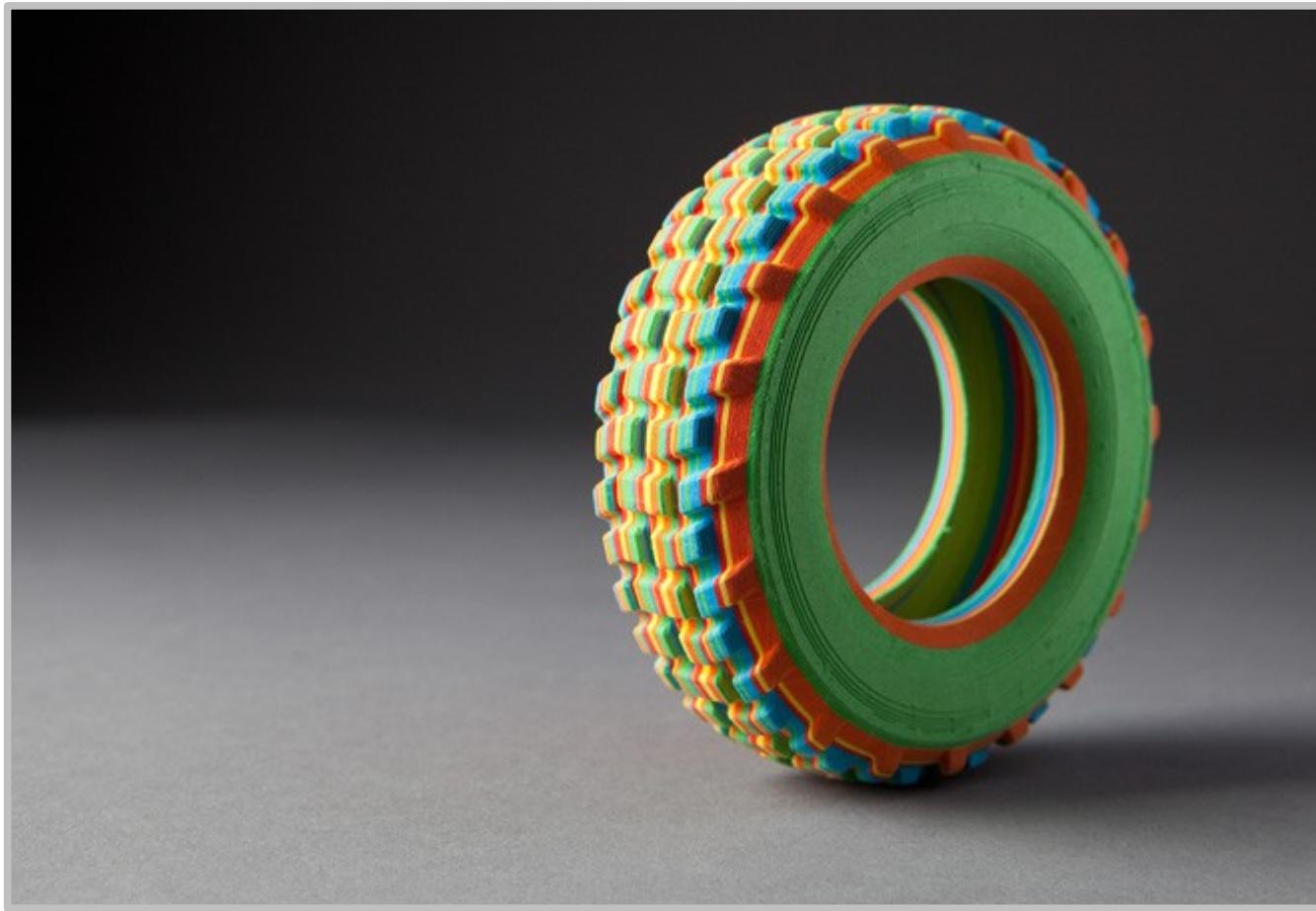


Laminated Object Manufacturing (LOM) machines cut and glue thousands of sheets of material together to form solids, sometimes with standard A4 paper.

Source: <http://replicatorinc.com/blog/2009/02/4-types-of-3d-printing/>

<http://youtu.be/FjxI2HszHzo>

# Technologies: Laminated Object Manufacturing

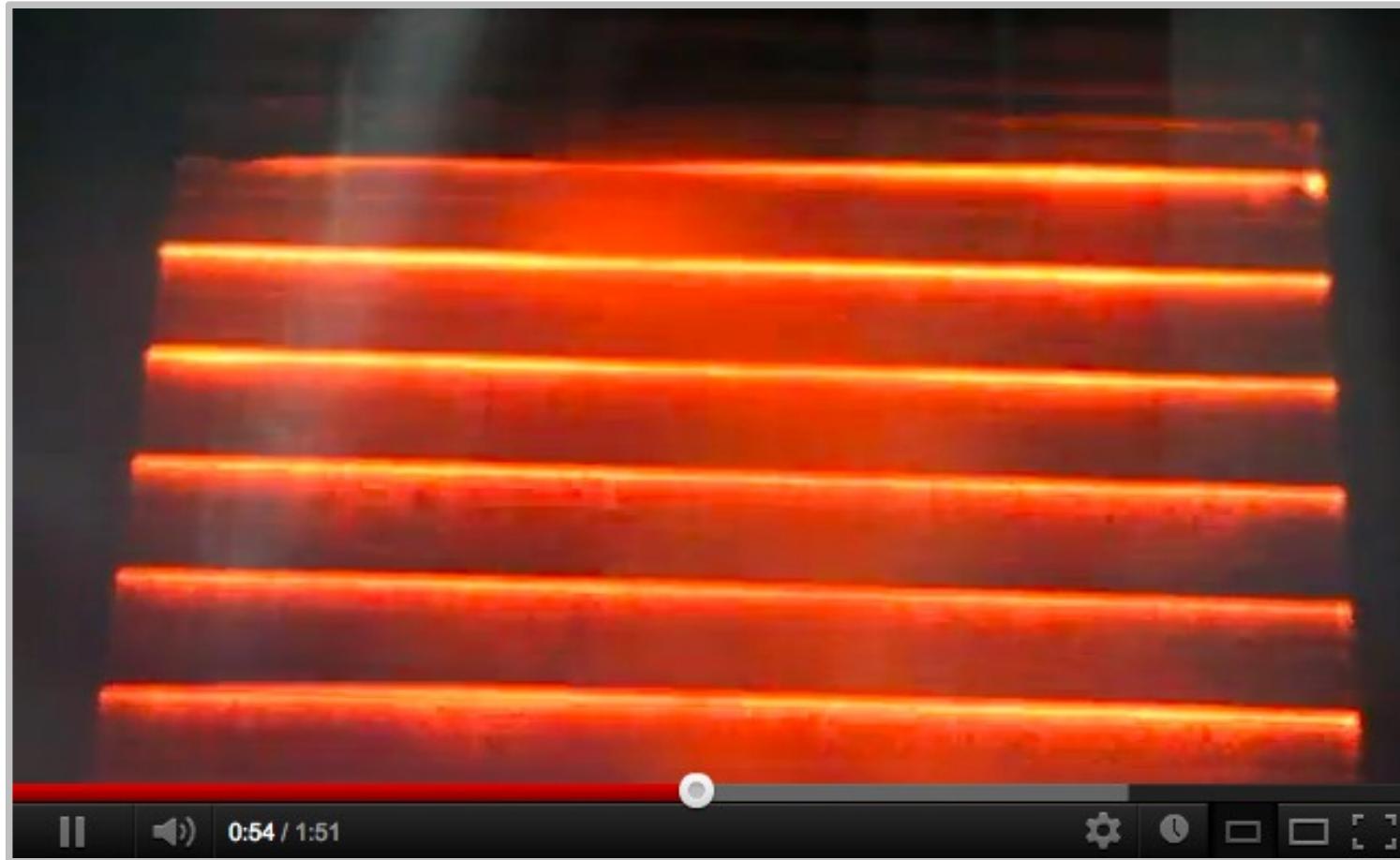


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Laminated Object Manufacturing (LOM) machines cut and glue thousands of sheets of material together to form solids, sometimes with standard A4 paper.

Source: <http://replicatorinc.com/blog/2009/02/4-types-of-3d-printing/>  
<http://www.mcrotechnologies.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 / cm<sup>3</sup>.

Source: <http://youtu.be/B9VOwqtOglg>

[http://www.shapeways.com/themes/stainless\\_steel\\_3dprinting\\_gallery](http://www.shapeways.com/themes/stainless_steel_3dprinting_gallery)

# 3D Glass printing

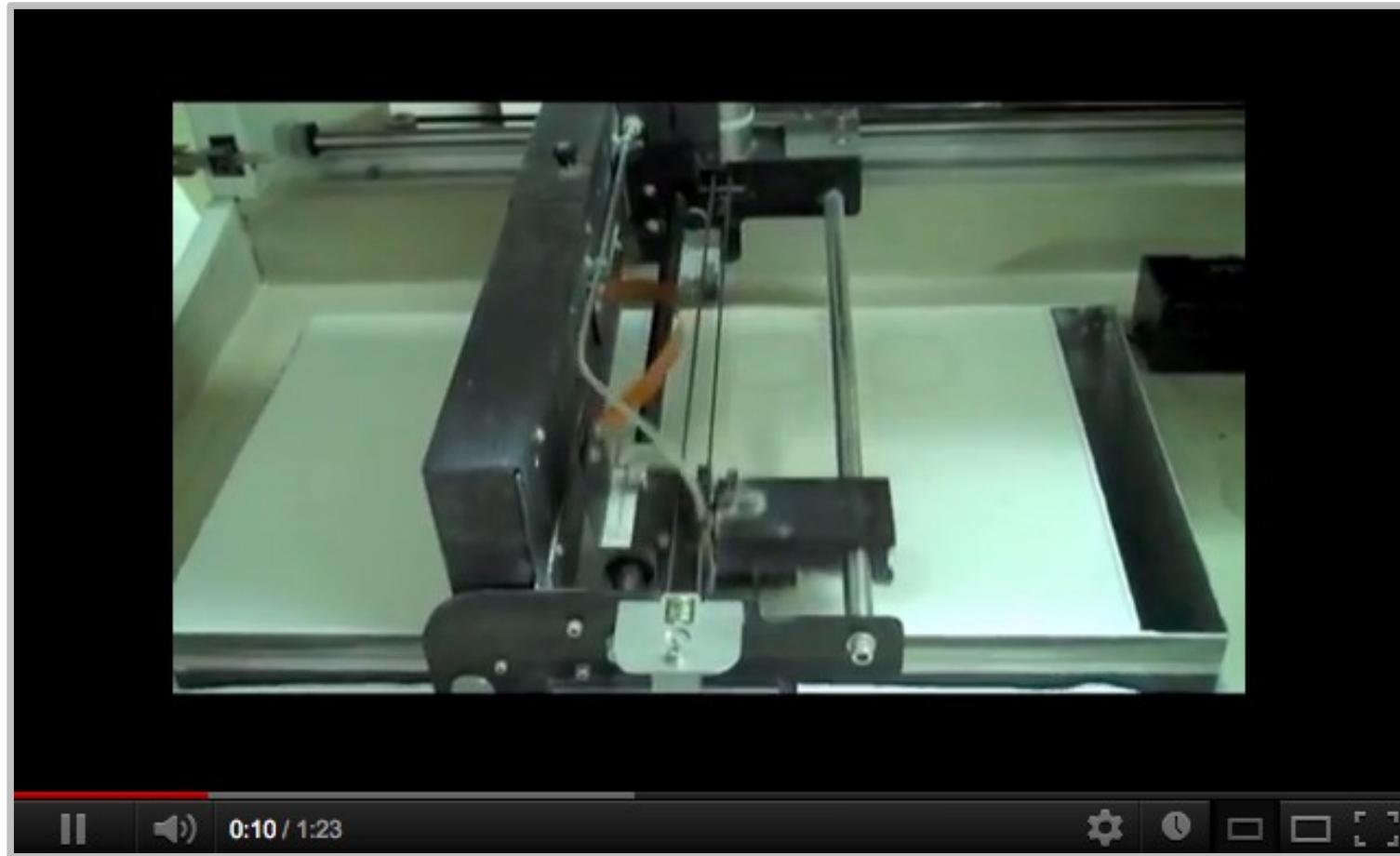


The material is porous, opaque and fragile and made from recycled soda-lime glass, the fine glass powder is glued together with a binder and then sintered.

Source: <http://youtu.be/BtK-Hqd6Q2I>

[http://www.shapeways.com/materials/milky\\_white\\_matte\\_glass](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>

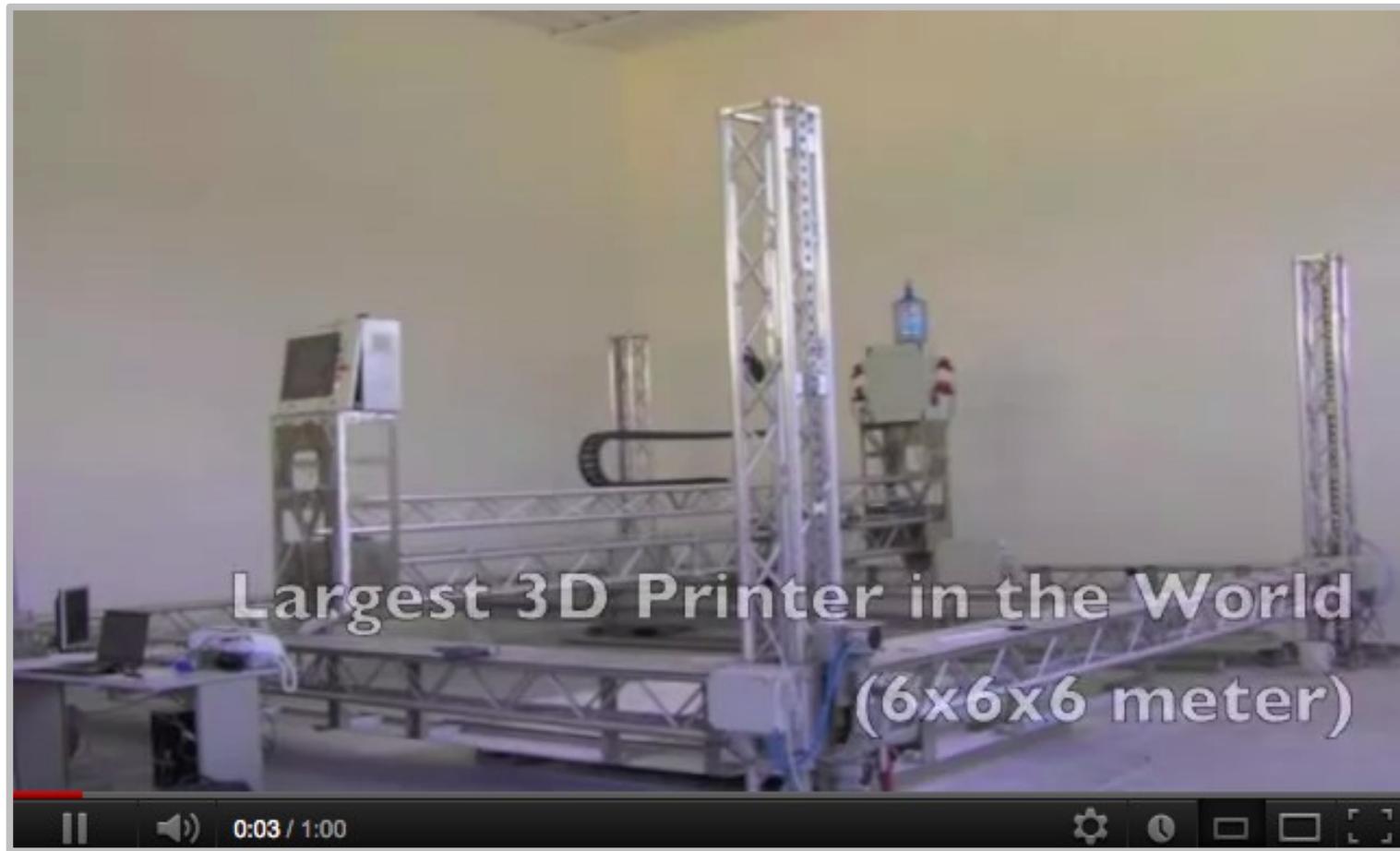
# Big size 3D printing: Endless chair



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

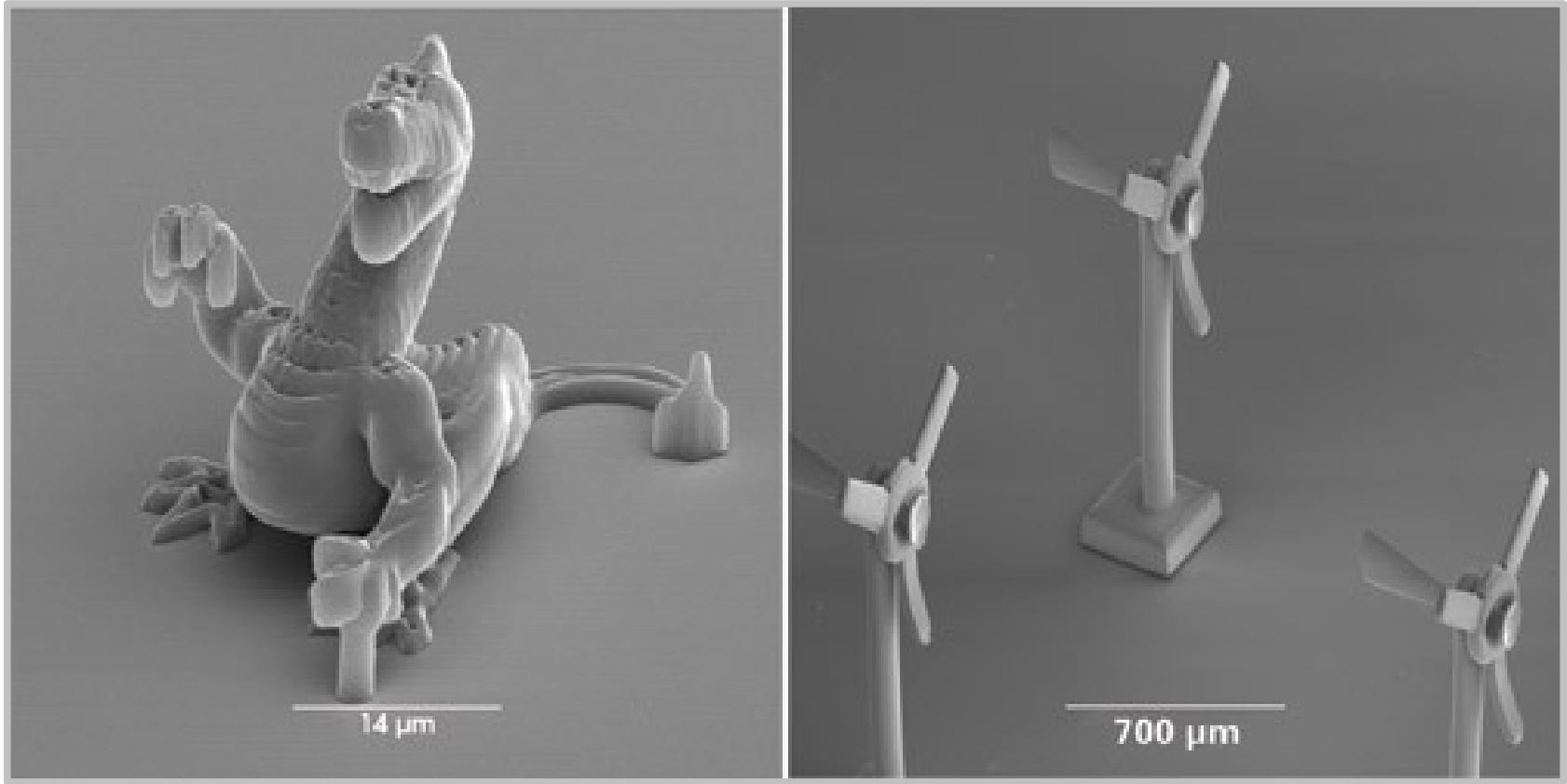


D-Shape is a new robotic building system using new materials to create superior stone-like structures.

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/YOnlxcc0DW8>

# Bio 3D Printing: Organovo

The image shows the homepage of the Organovo website. At the top, the Organovo logo is displayed with the tagline "CHANGING THE SHAPE OF MEDICAL RESEARCH AND PRACTICE". A search bar is located in the top right corner. Below the header, a navigation menu includes links for "3D HUMAN TISSUES", "SCIENCE & TECHNOLOGY", "PARTNERSHIP", "COMPANY", "INVESTORS", "NEWS", and "CONTACT". The main content area features a large image of a bio-printed tissue sample, showing complex cellular structures in green and blue. Overlaid on this image is the text "MIMIC *in vivo* COMPLEXITY" in white. To the right of this text, a descriptive paragraph reads: "Organovo makes **functional human tissues** using three-dimensional bioprinting technology. Imagine the questions you can answer in 3D." Below this paragraph, the text "ACTUAL BIOPRINTED TISSUE" is visible. At the bottom left, a statement says "Structurally and functionally accurate bioprinted human tissue models". On the right side, there is a smaller image showing a 3D printer in operation.

organovo® CHANGING THE SHAPE OF MEDICAL RESEARCH AND PRACTICE

3D HUMAN TISSUES SCIENCE & TECHNOLOGY PARTNERSHIP COMPANY INVESTORS NEWS CONTACT

MIMIC *in vivo* COMPLEXITY

Organovo makes **functional human tissues** using three-dimensional bioprinting technology. Imagine the questions you can answer in 3D.

ACTUAL BIOPRINTED TISSUE

Structurally and functionally accurate bioprinted human tissue models

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 screenshot shows the Organovo website's products page. At the top, there is a navigation bar with links for ABOUT, PRODUCTS, SCIENCE, NEWSROOM, INVESTORS, and CONTACT. Below the navigation bar, the word "products" is displayed in white text on a dark blue background. To the right of the text, there is a photograph of the NovoGen MMX Bioprinter, a complex piece of laboratory equipment with various components and a computer monitor showing software interface.

**Overview**

**NovoGen MMX Bioprinter™**

**Support**

**NovoGen MMX Bioprinter™**

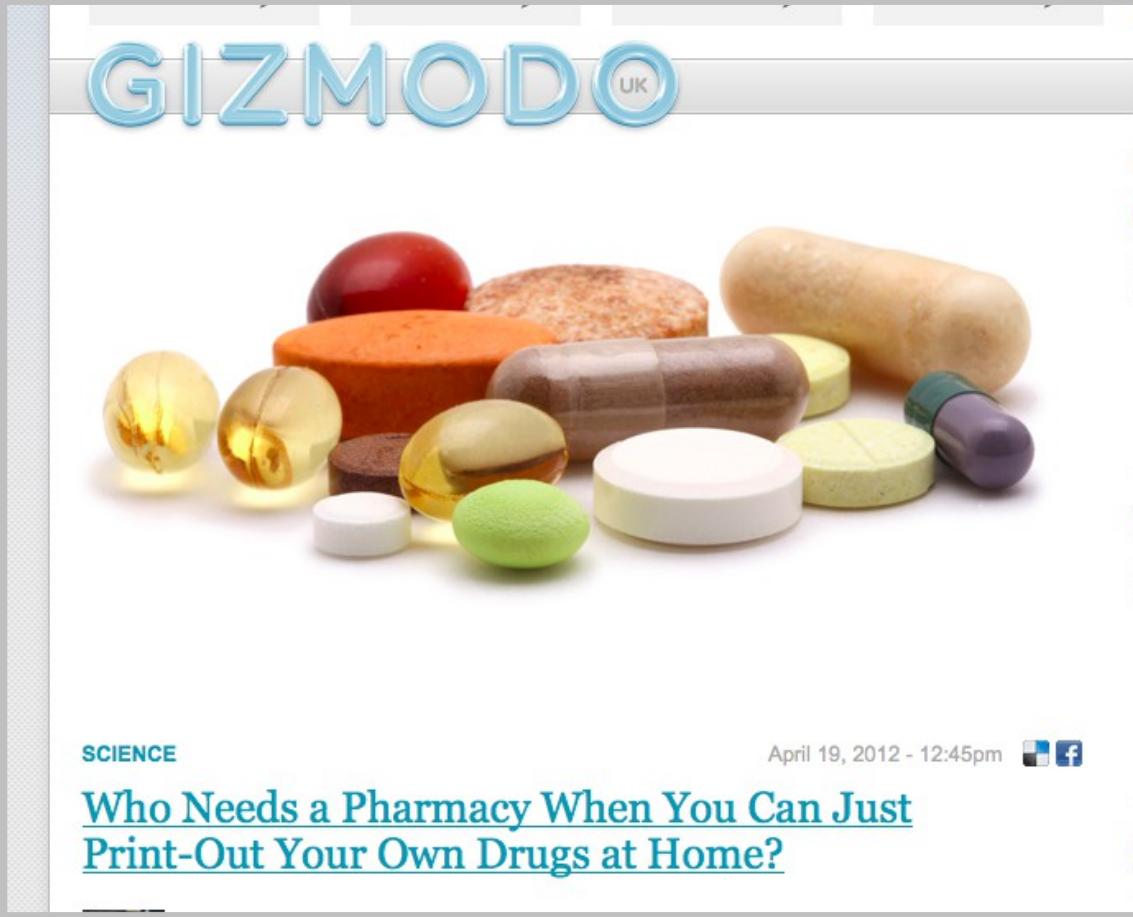
*Human biology, in vitro convenience.*

The NovoGen MMX Bioprinter™ is a novel hardware and software platform at the forefront of bioprinting research and development. The NovoGen MMX™ was developed to meet challenges in biological research. The platform takes primary or other human cells and shapes them into 3D tissue, with tremendous cellular viability and biology that is superior to even an animal model. The platform is being used by Organovo's Pharma partners today to enable cutting edge research into drug discovery.

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



The image is a screenshot of a news article from Gizmodo UK. At the top, the "GIZMODO" logo is displayed in blue, stylized letters with a "UK" subtext. Below the logo is a photograph of various pharmaceutical drugs, including several large, colorful capsules and smaller tablets in shades of yellow, green, brown, and white. The article is categorized under "SCIENCE". The date and time of publication are listed as "April 19, 2012 - 12:45pm". Social sharing icons for Google+ and Facebook are visible. The main headline reads: "Who Needs a Pharmacy When You Can Just Print-Out Your Own Drugs at Home?"

SCIENCE

April 19, 2012 - 12:45pm

[Who Needs a Pharmacy When You Can Just Print-Out Your Own Drugs at Home?](#)

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

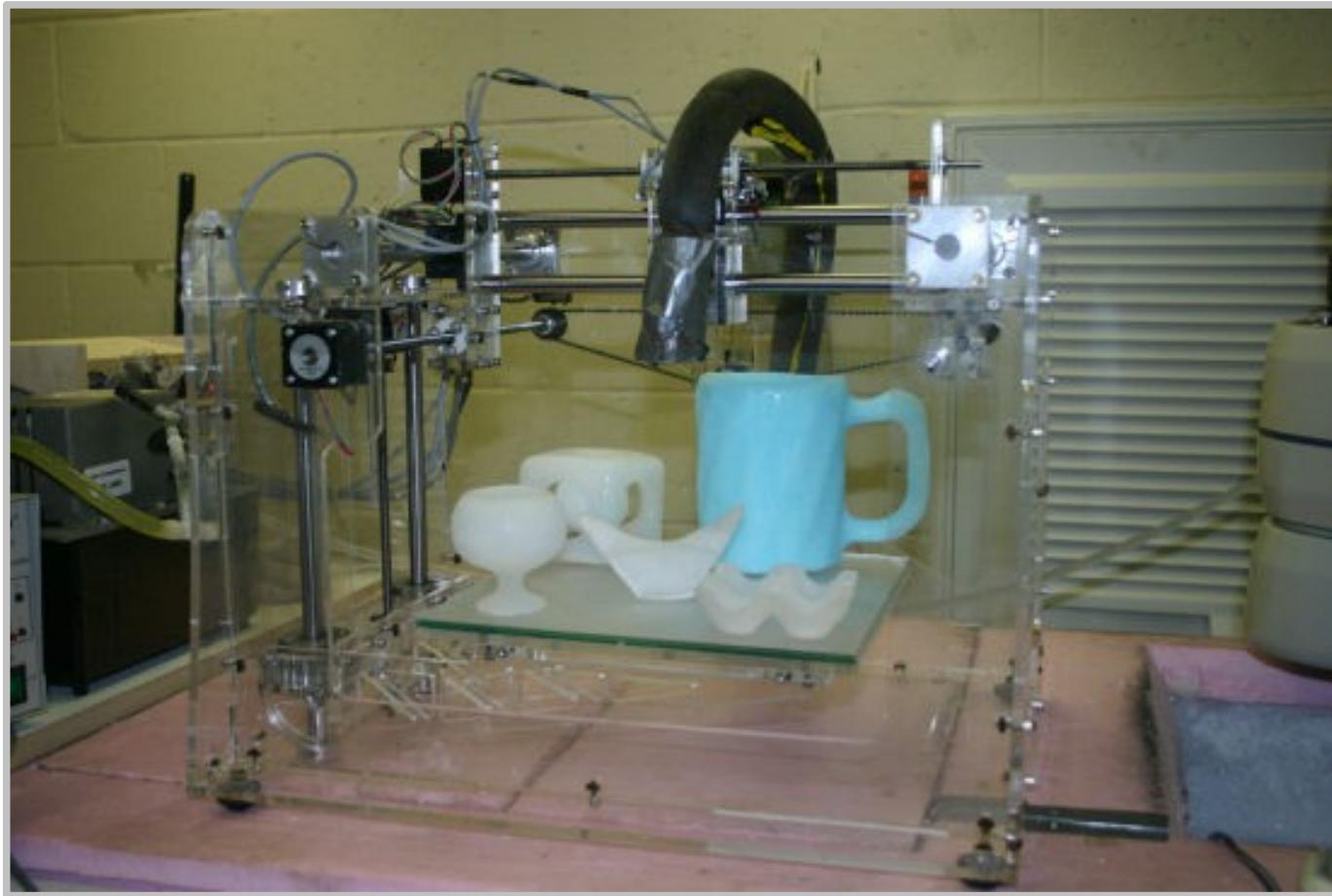


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CandyFab is a machine that can make arbitrary 3D solid objects at low cost from a variety of low-melting point materials including pure sugar.

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

# Ice 3D Printing



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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.wired.com/magazine/2011/12/st_3diceprinting/)

<http://www.3ders.org/articles/20120103-3d-ice-printer.html>

# Recycle plastic for your FDM machine

KICKSTARTER Discover Start BLOG HELP SIGN UP LOG IN

## Filabot: Plastic Filament Maker

A Technology project in Milton, VT by Tyler McNaney • send message

PROJECT HOME UPDATES 14 BACKERS 156 COMMENTS 239



156 BACKERS  
\$32,330 PLEDGED OF \$10,000 GOAL  
0 SECONDS TO GO

**FUNDING SUCCESSFUL**  
This project successfully raised its funding goal on January 23.

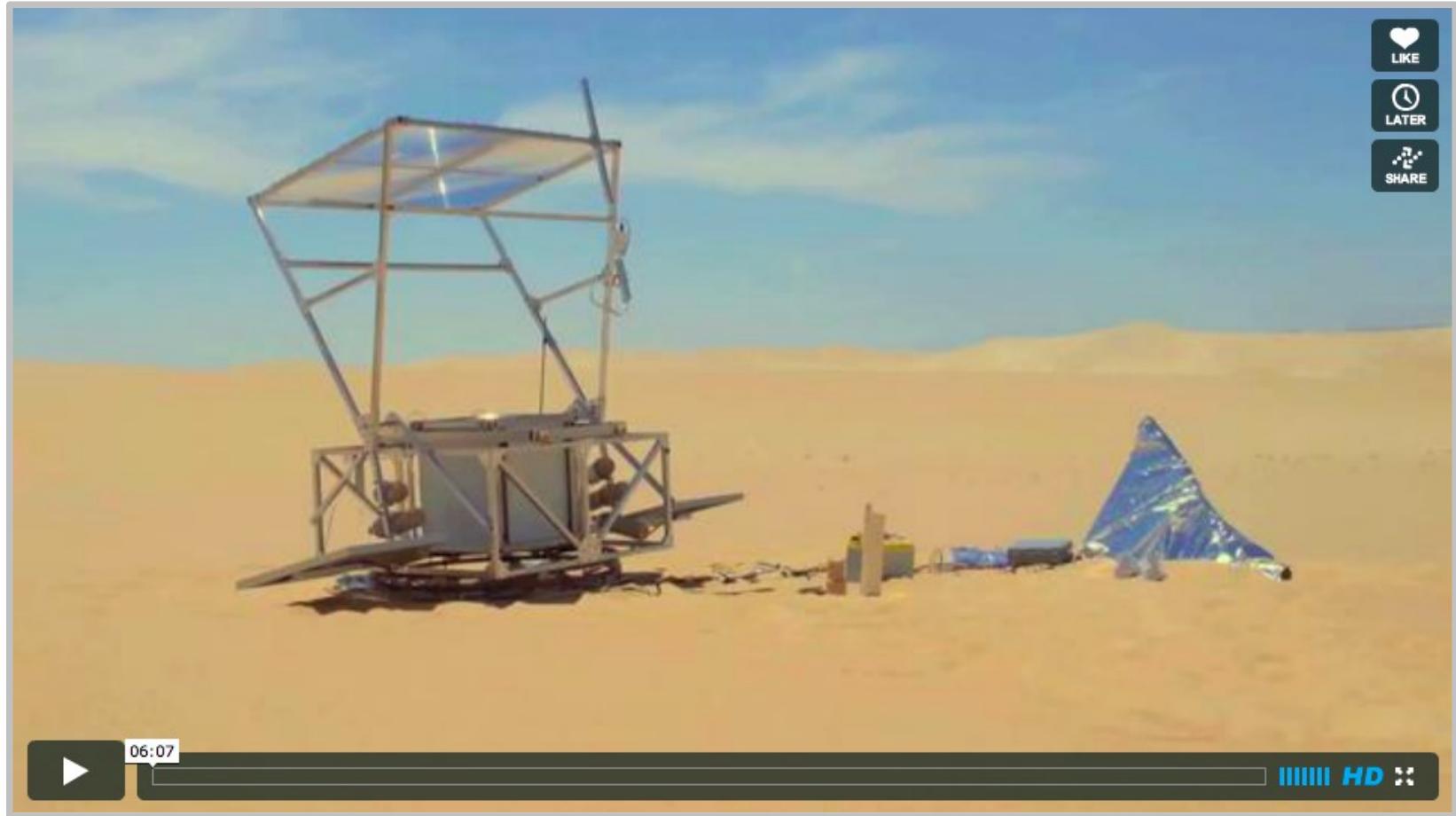
**PLEDGE \$1 OR MORE**  
41 BACKERS

Like 243 people like this. Be the first of your friends. Tweet Embed http://kck.st/uYHFdj

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>

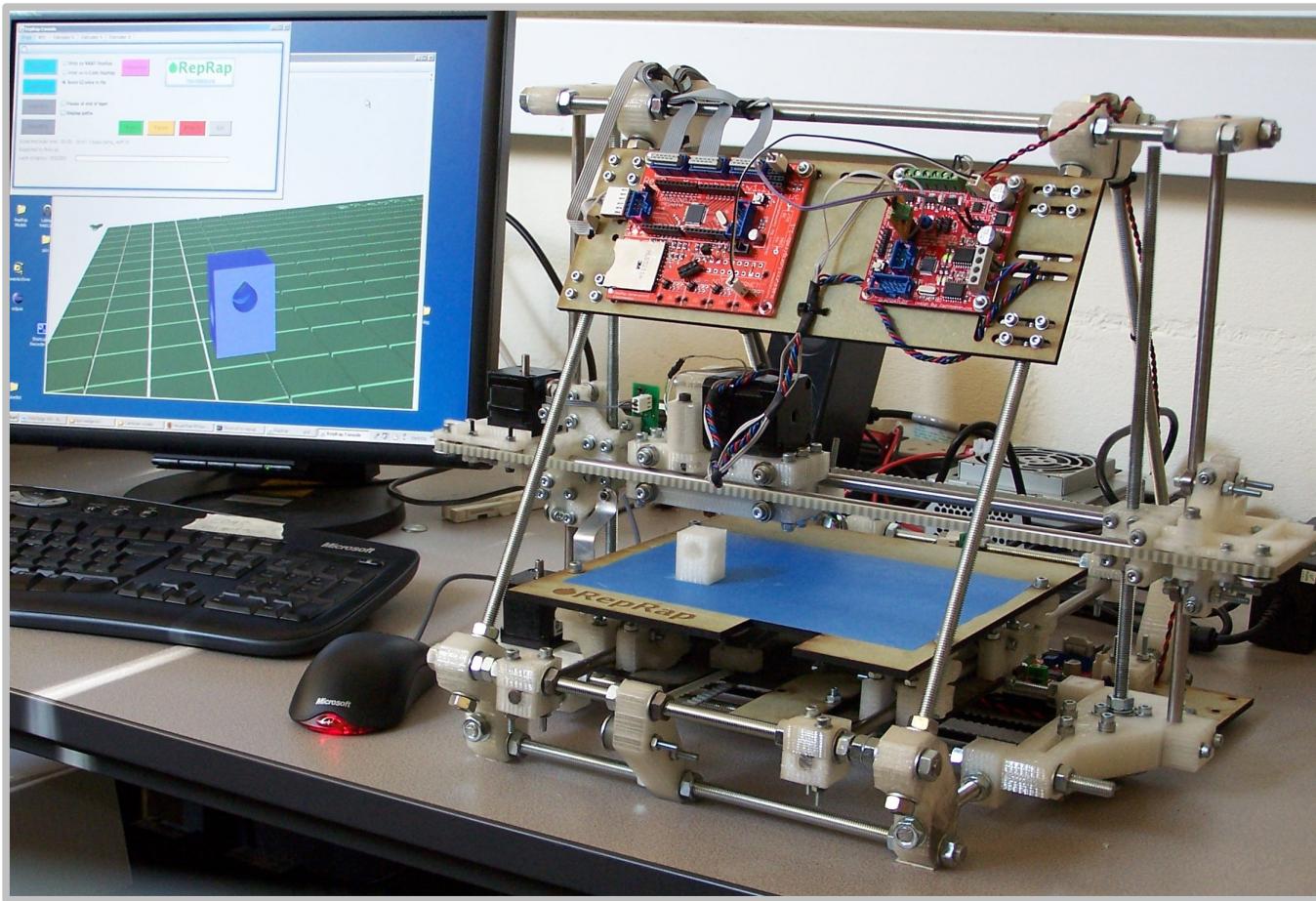
# Markus Kayser - Solar Sinter Project



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

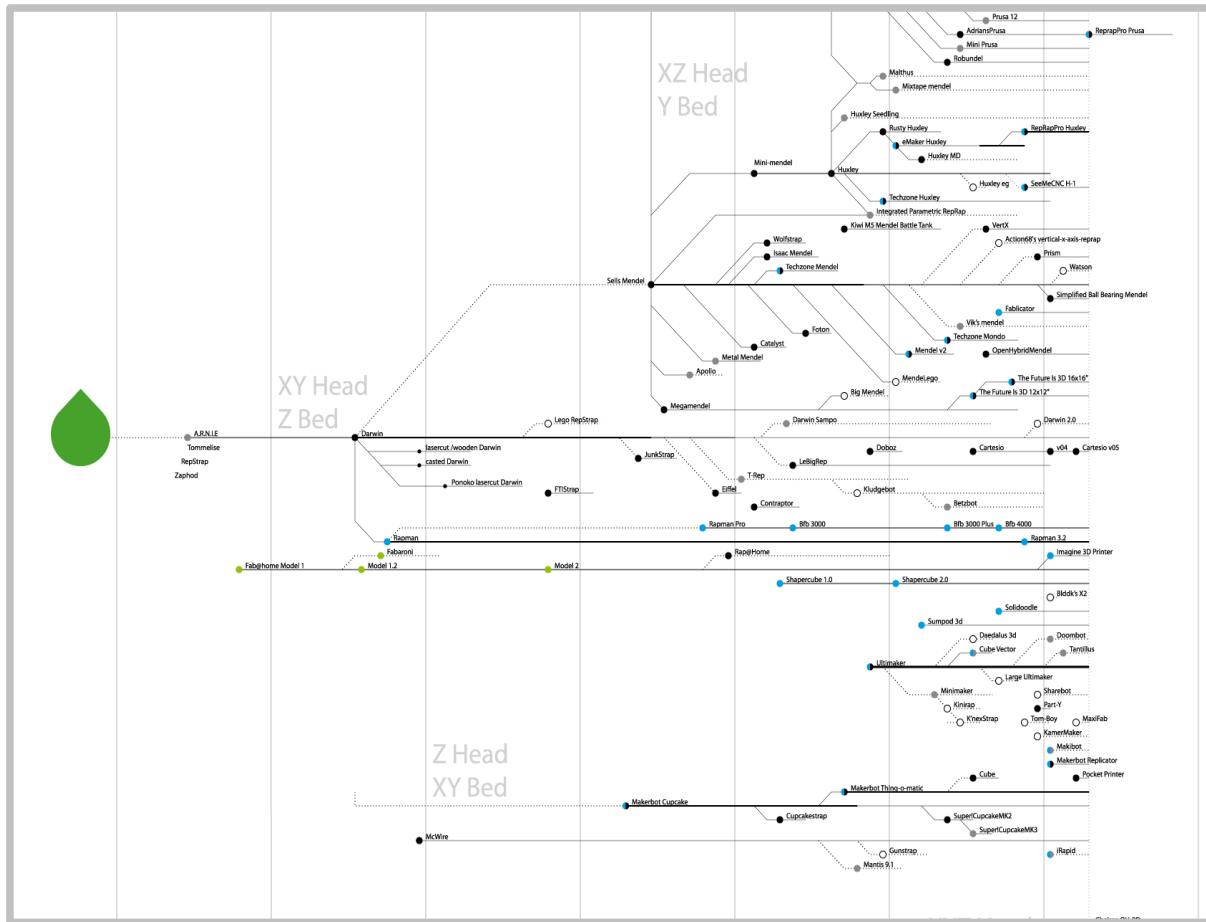


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It's the second, improved version of RepRap: small enough to fit on your desk, but with a print volume large enough for you to make big things.

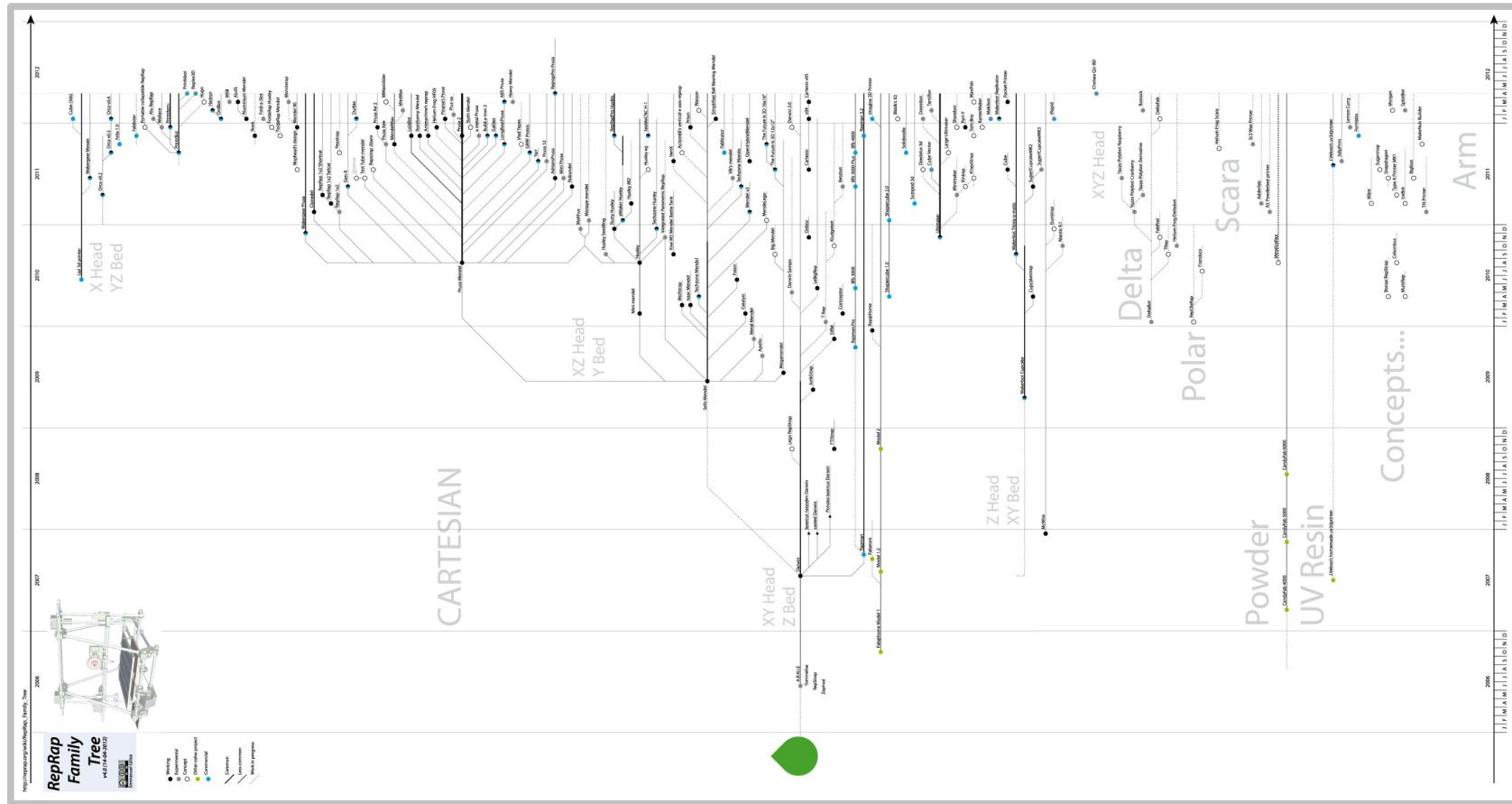
Source: <http://reprap.org/wiki/Mendel>

# Open Source 3D printers: RepRap



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

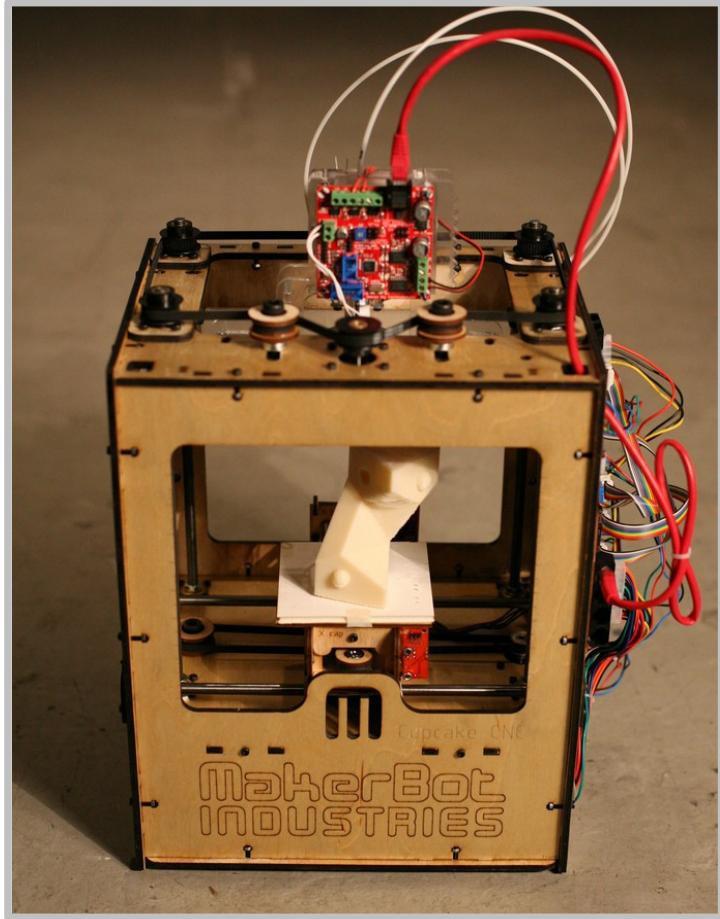
# Open Source 3D printers: RepRap



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](http://reprap.org/wiki/RepRap_Family_Tree)

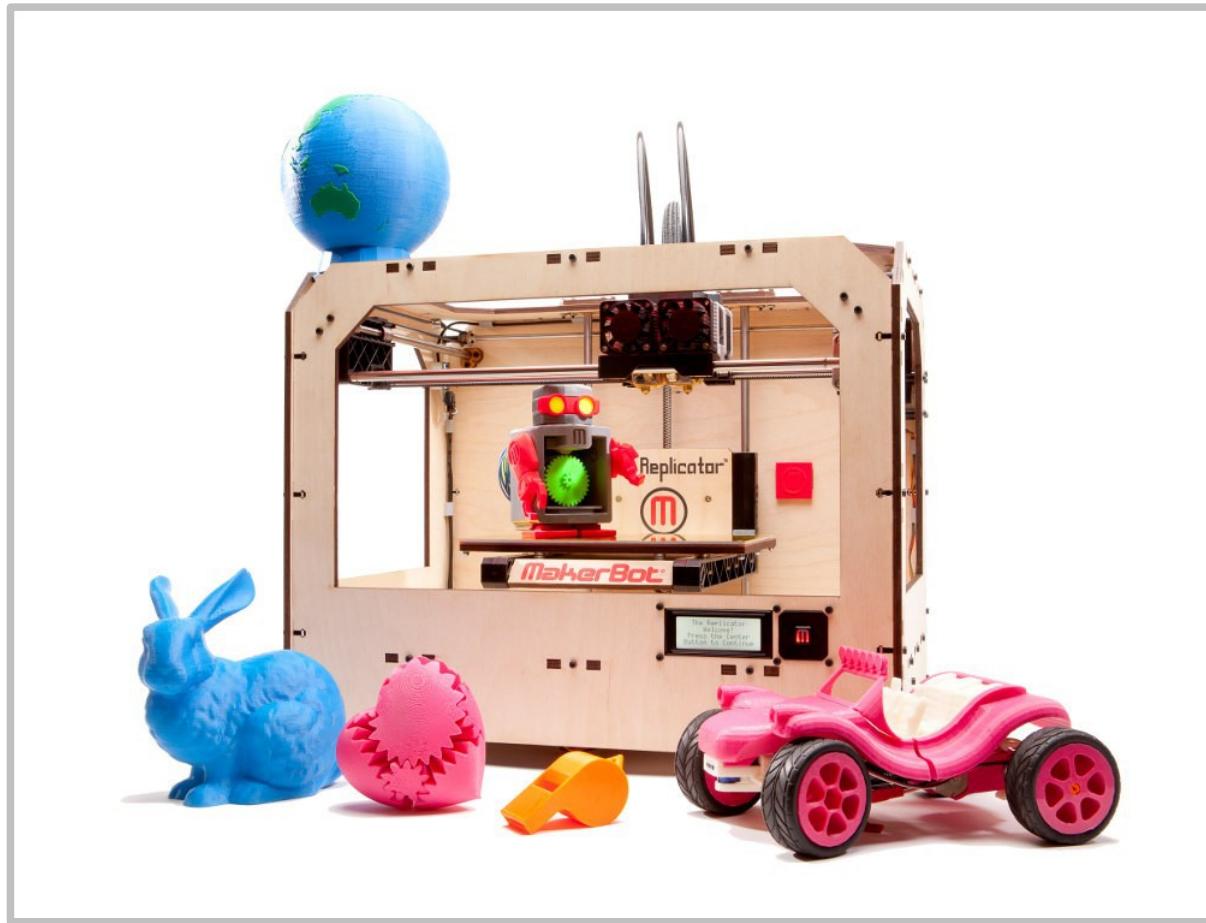
# RepRap and its children... Makerbot



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

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

# RepRap and its children... Makerbot



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The second edition of the Makerbot

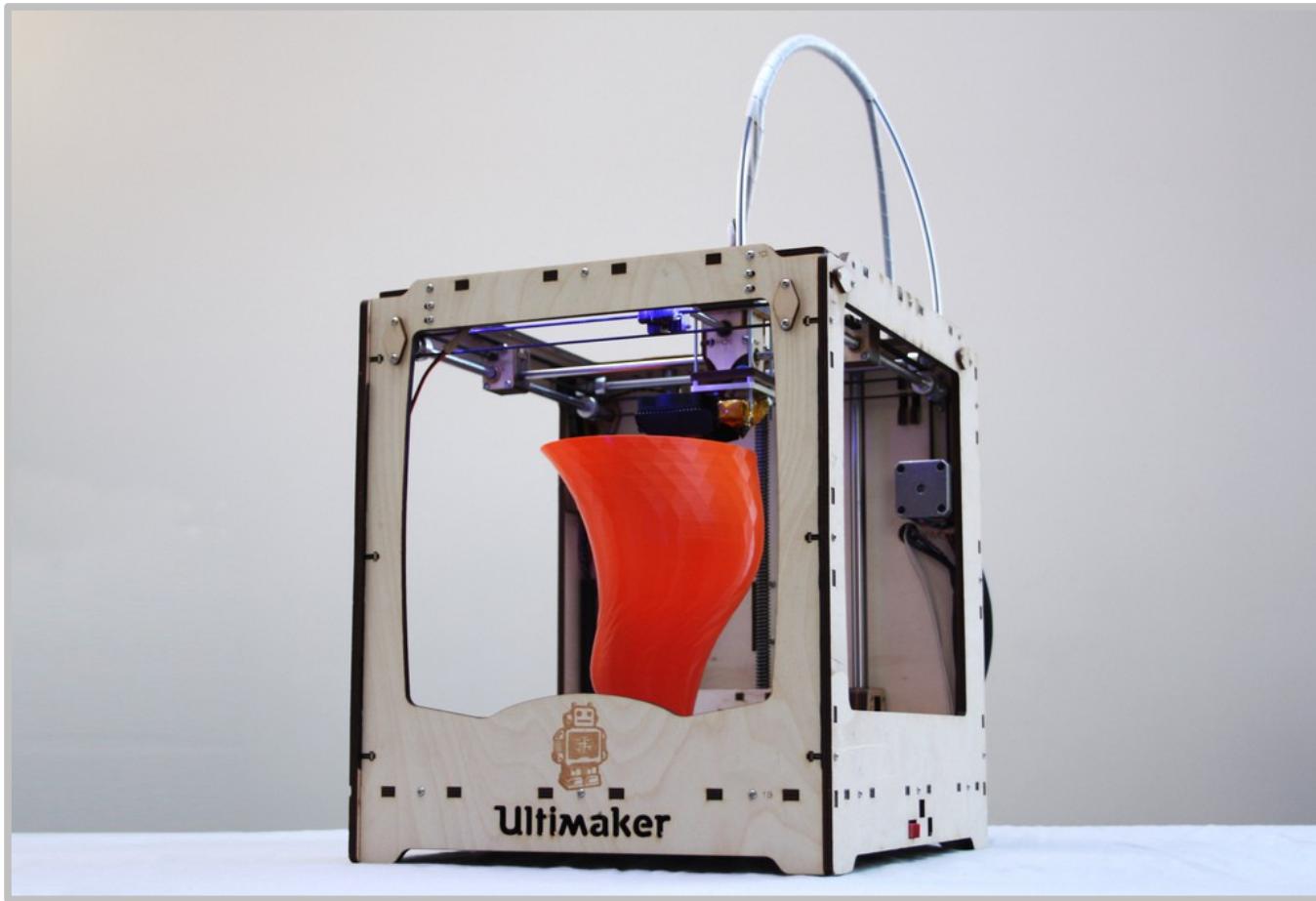
Source: <http://store.makerbot.com/replicator-404.html>

# RepRap and its children... Makerbot



The current range of the Makerbot family

# RepRap and its children... Ultimaker



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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

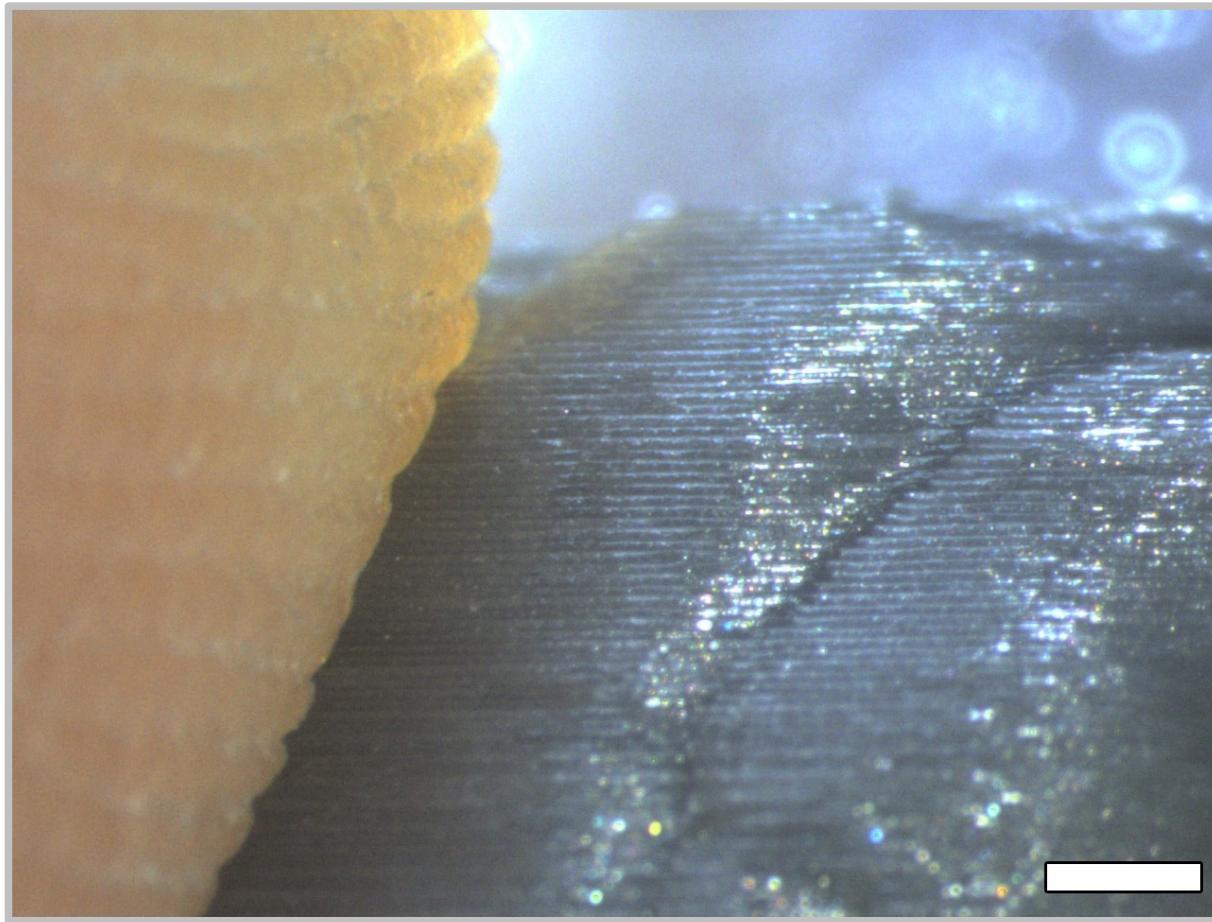


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Ultimaker, the second edition

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

# RepRap and its children... Ultimaker



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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://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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## 3D printing: examples what people are doing with it

# Printable VELCRO

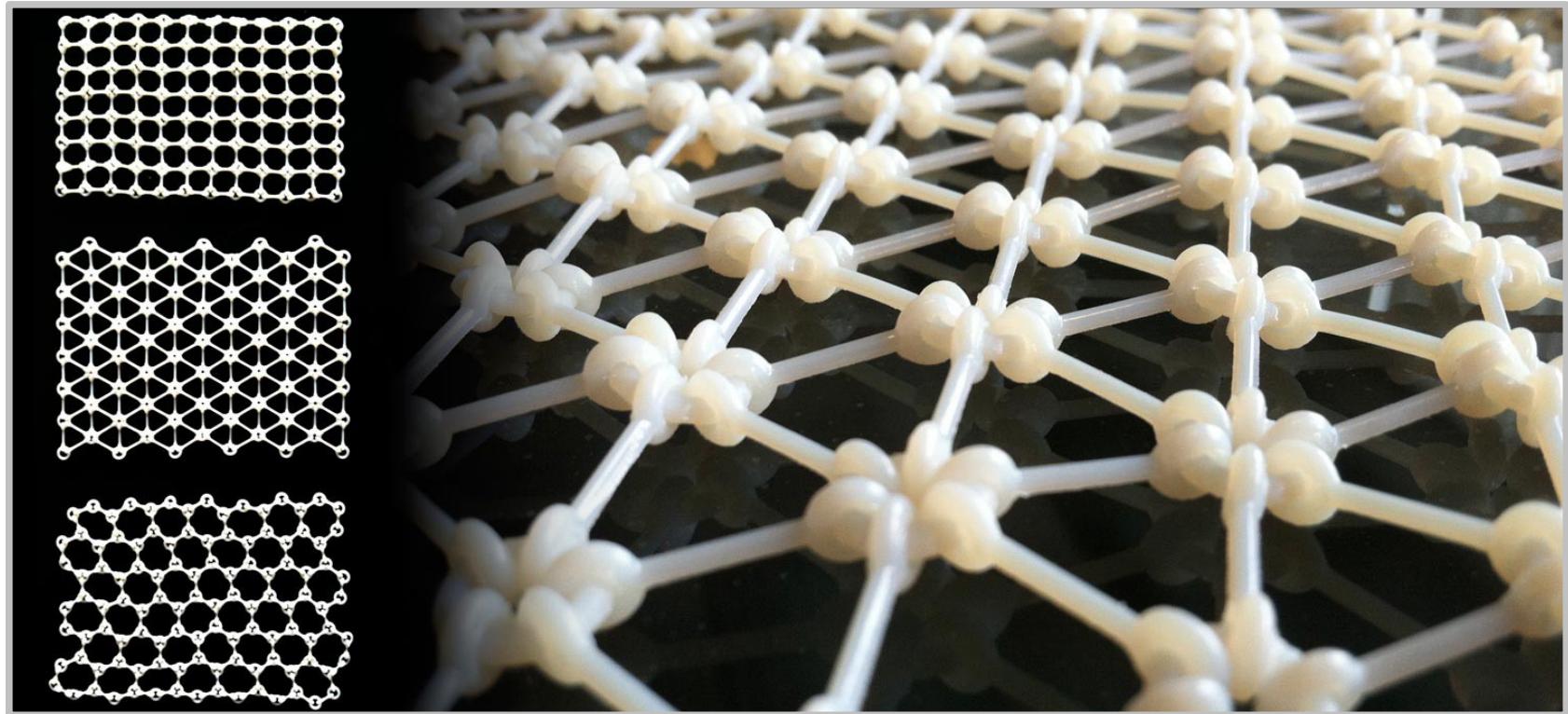


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The velcro is printed with 0.3mm ABS with a  
MK6 extruder on a Makerbot.

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

# 3D Printing Flexible Grids

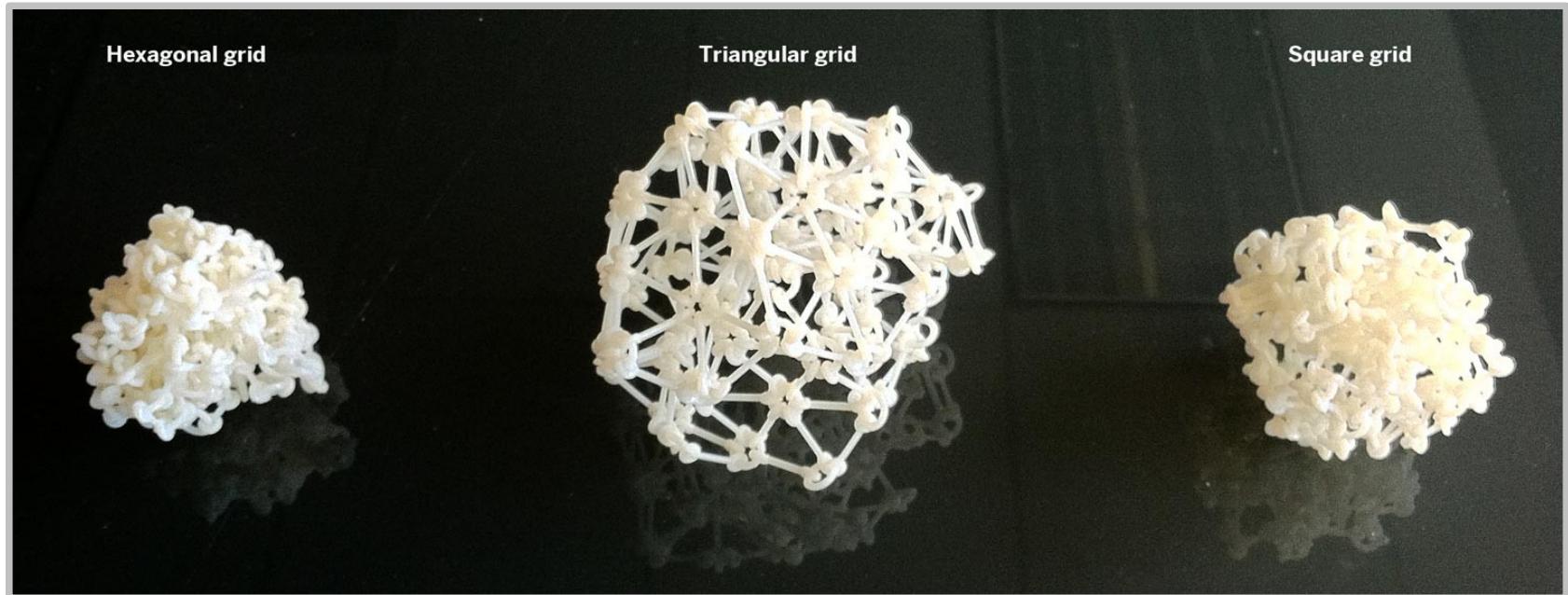


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Done with a Grasshopper definition that used the grid components to create a set of flexible triangular, square, and hexagonal grids.

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

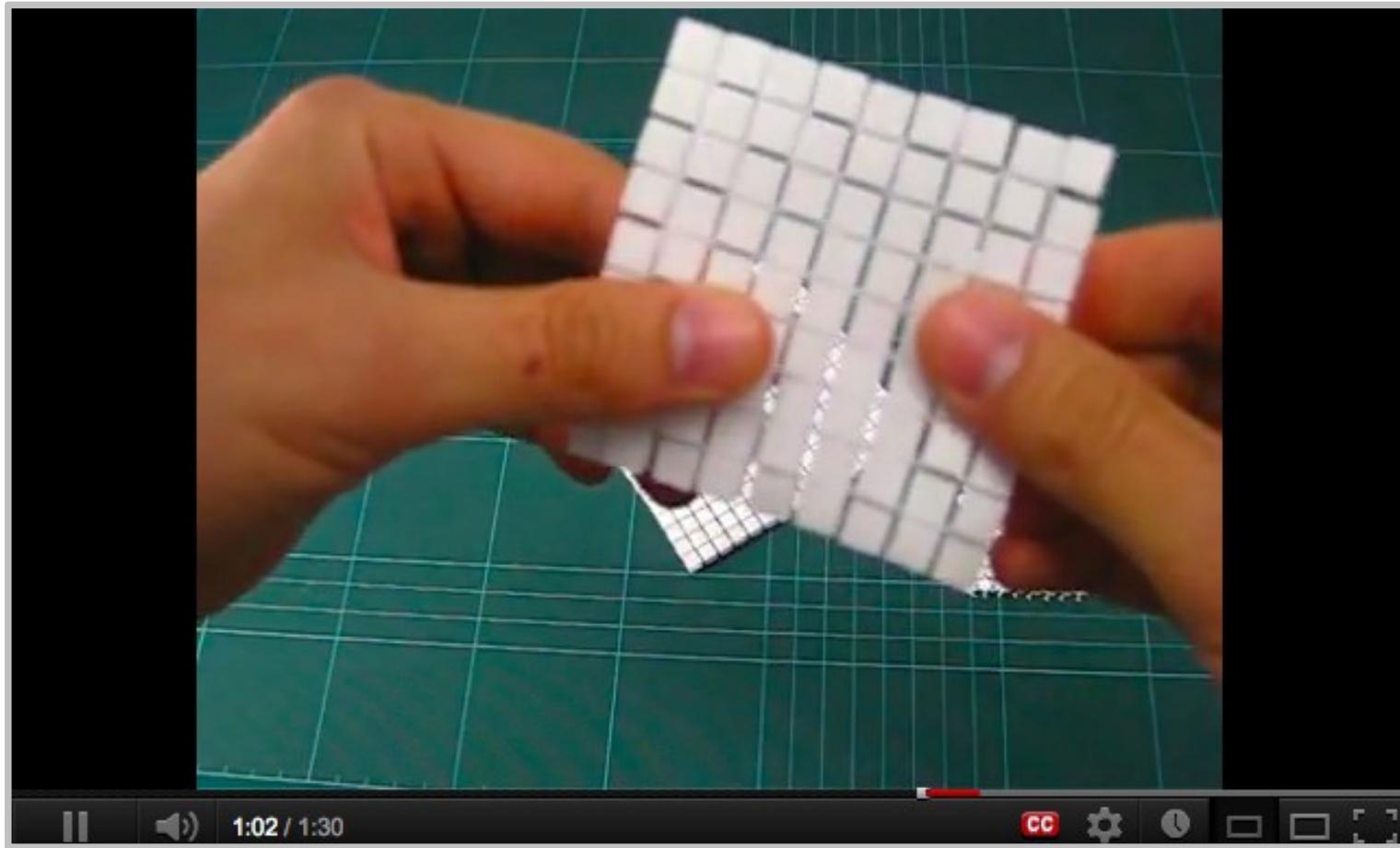
# 3D Printing Flexible Grids



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/>

# 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-Suuuper-Flexible..html>

# 3D printed bikini



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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



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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



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A collection of 3D printed hats and accessories 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



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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/>

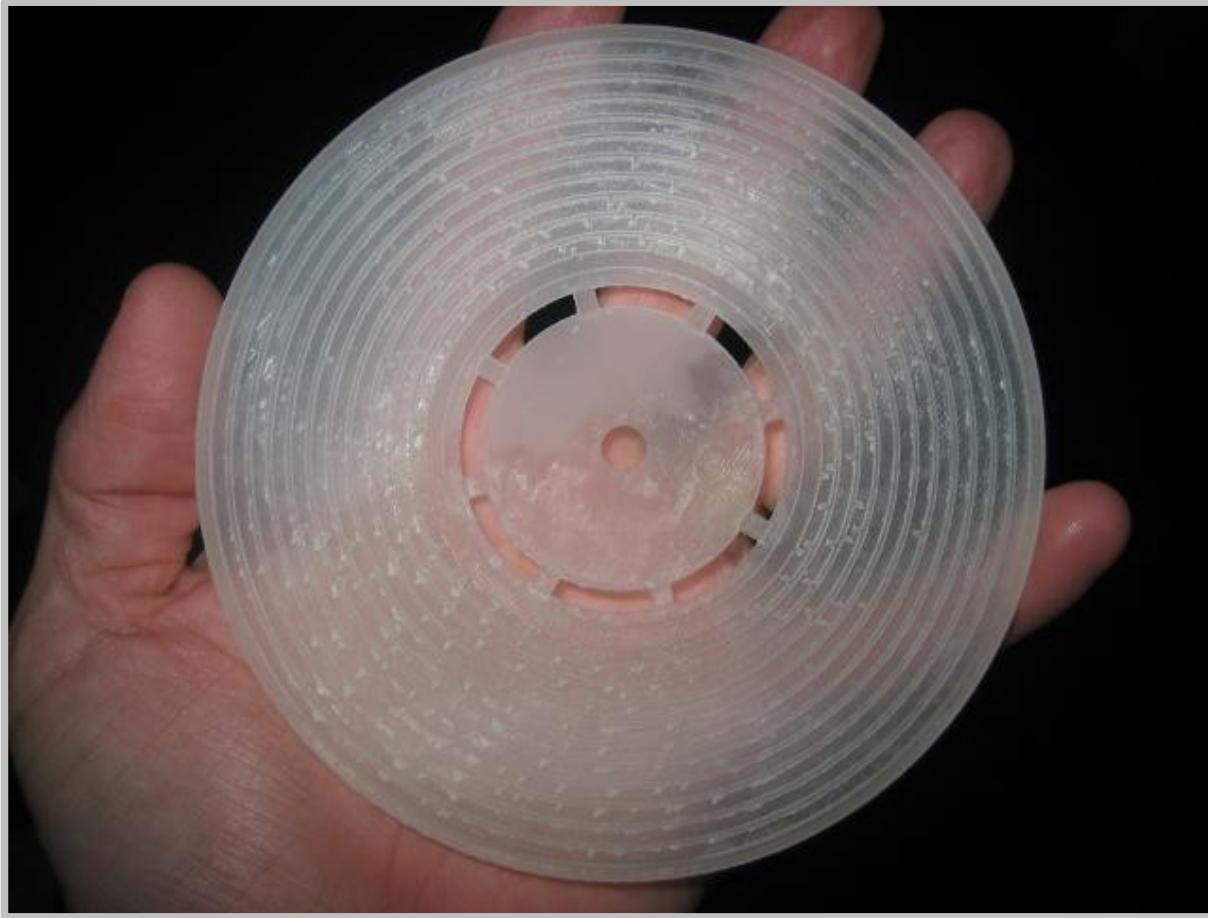
# 3D printed characters



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...



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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.

# 3D printing media...



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

# 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>

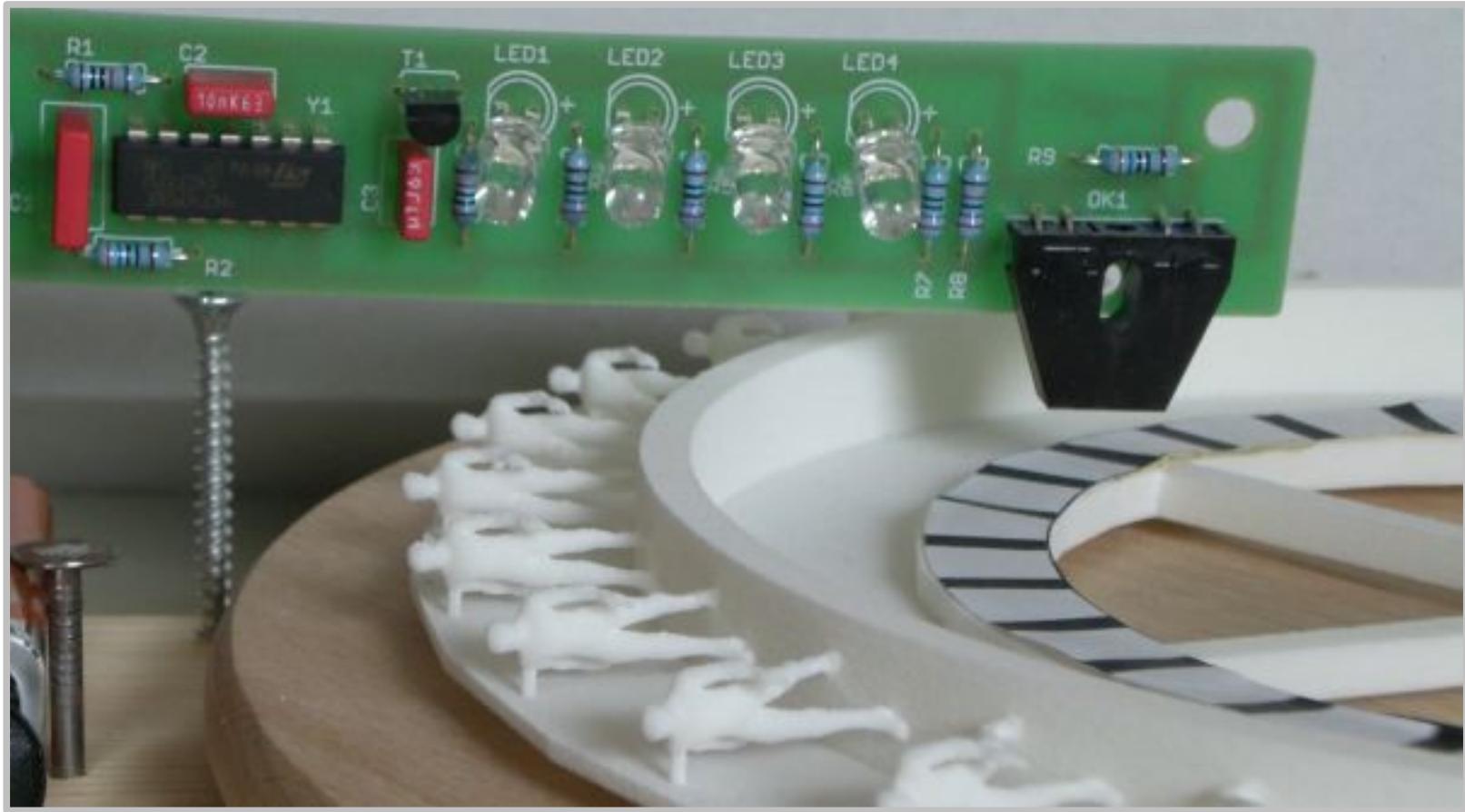
# 3D printing media...



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](http://youtu.be/_2F0PA7qUQE)

# 3D printing media...

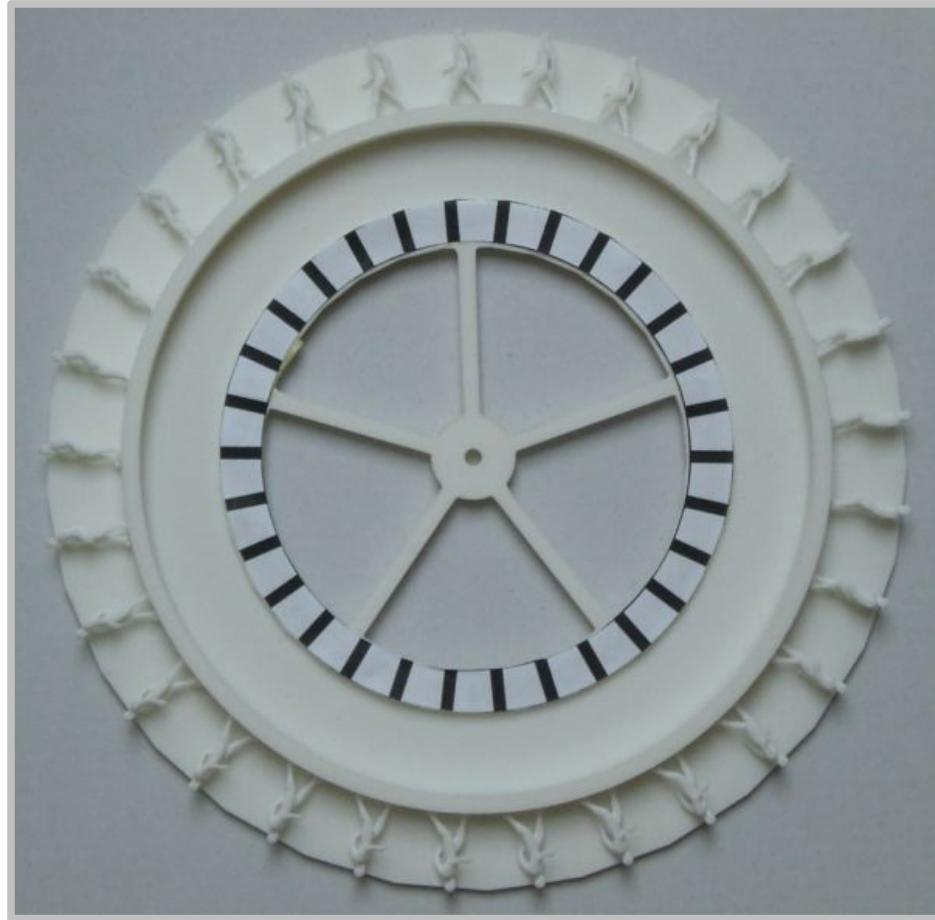


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3Drehkino took an animation in Blender, 3D printed it with Shapeways, hacked some electronics and created his own zeotrope under a CC license.

Source: [http://drehkino.de/3Drehkino\\_en.php](http://drehkino.de/3Drehkino_en.php)

# 3D printing media...



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

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# 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://youtu.be/LVa\\_WwBFtA4](http://youtu.be/LVa_WwBFtA4)

# 3D printing for media...

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

by dtLAB, published Feb 21, 2013



A 3D-printed spherical mount for six GoPro cameras, shown in orange and black, holding two cameras.

Like 103

Collect 84

Comment 22

I Made One 5

Remix It 0

Share

 Download This Thing!



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>

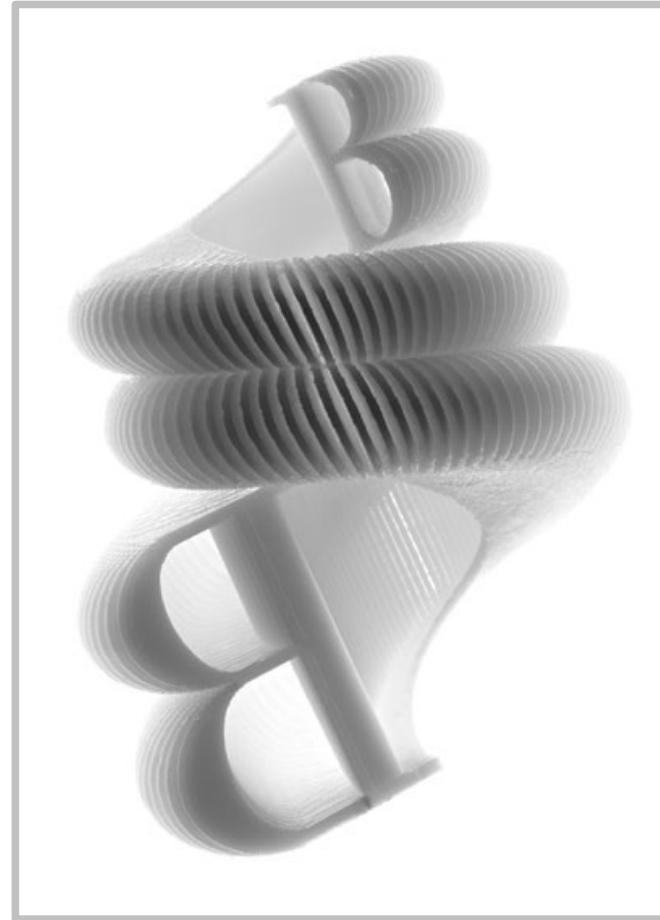
# 3D printing in media: Print magazine cover



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

Source: [http://postspectacular.com/process/20080702\\_printmagcover](http://postspectacular.com/process/20080702_printmagcover)

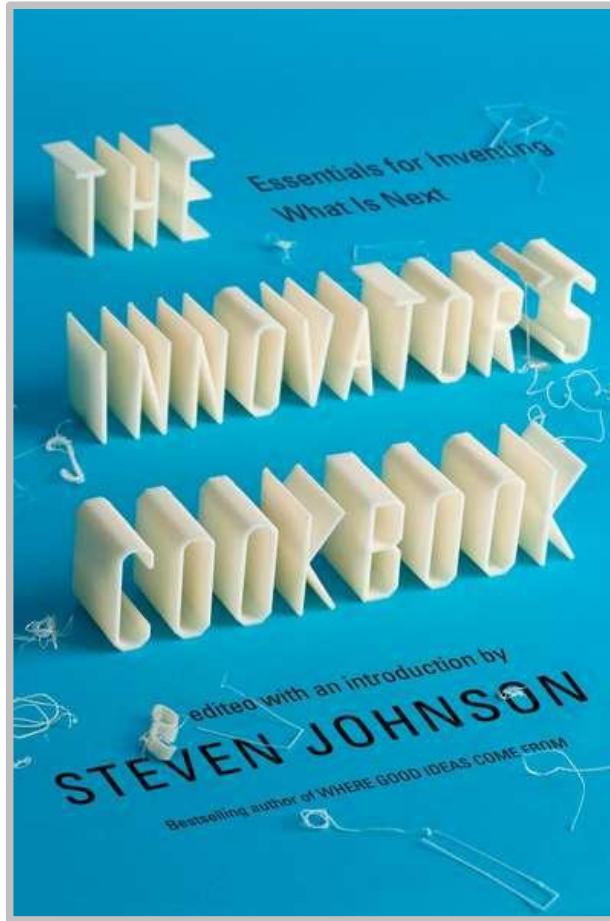
# 3D printing in media: Arkitypo



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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.

# 3D printing in media



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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



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Book with 3D printed / downloadable content.

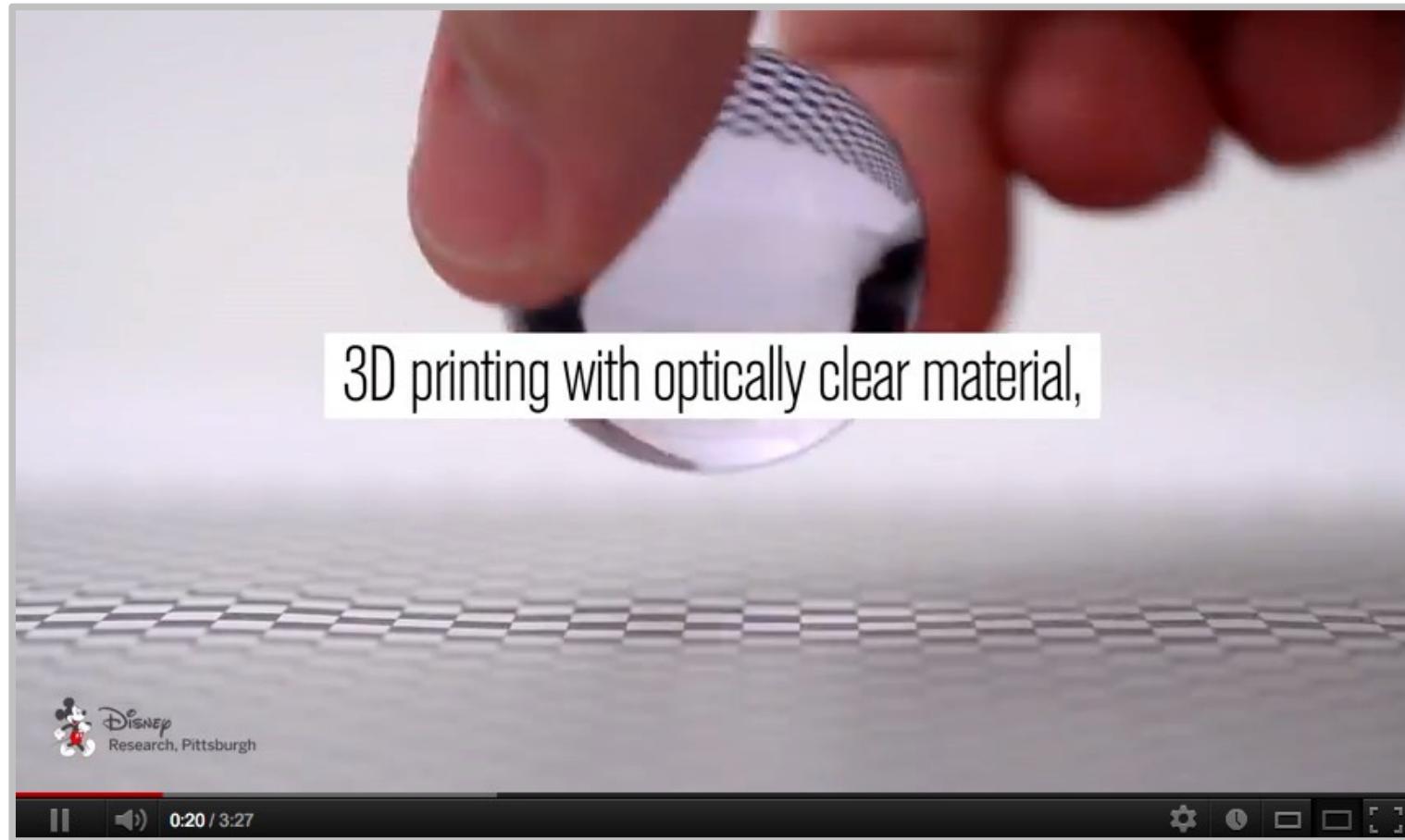
# 3D printing in media



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Book with a 3D printed cover

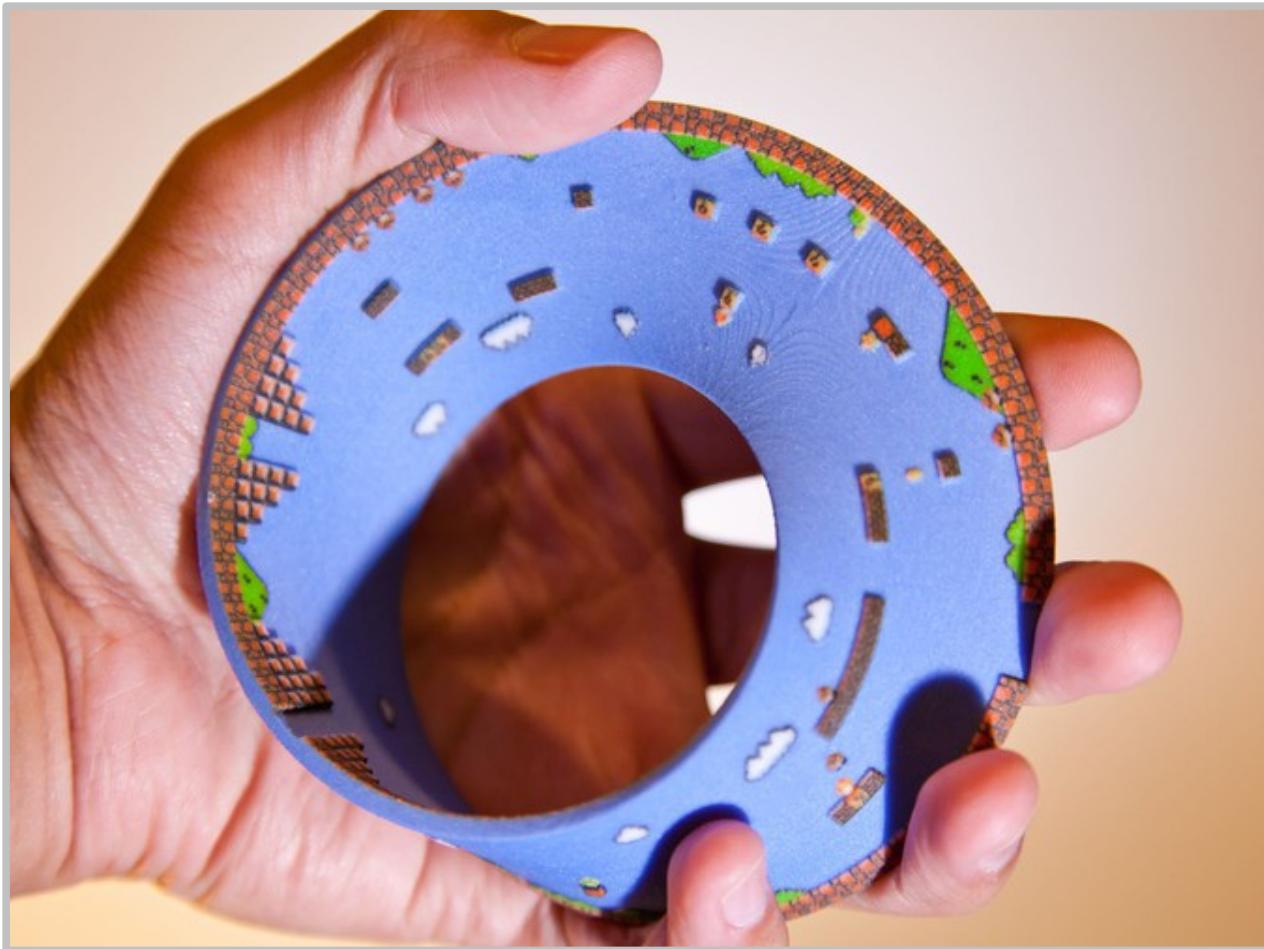
# 3D printing optics



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](http://www.youtube.com/watch?feature=player_embedded&v=eTeXTbXA6-Y)

# 3D printing media from Video games



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A moebius strip out of a Super Mario videogame!

# Successful transplant of a 3D printed jaw

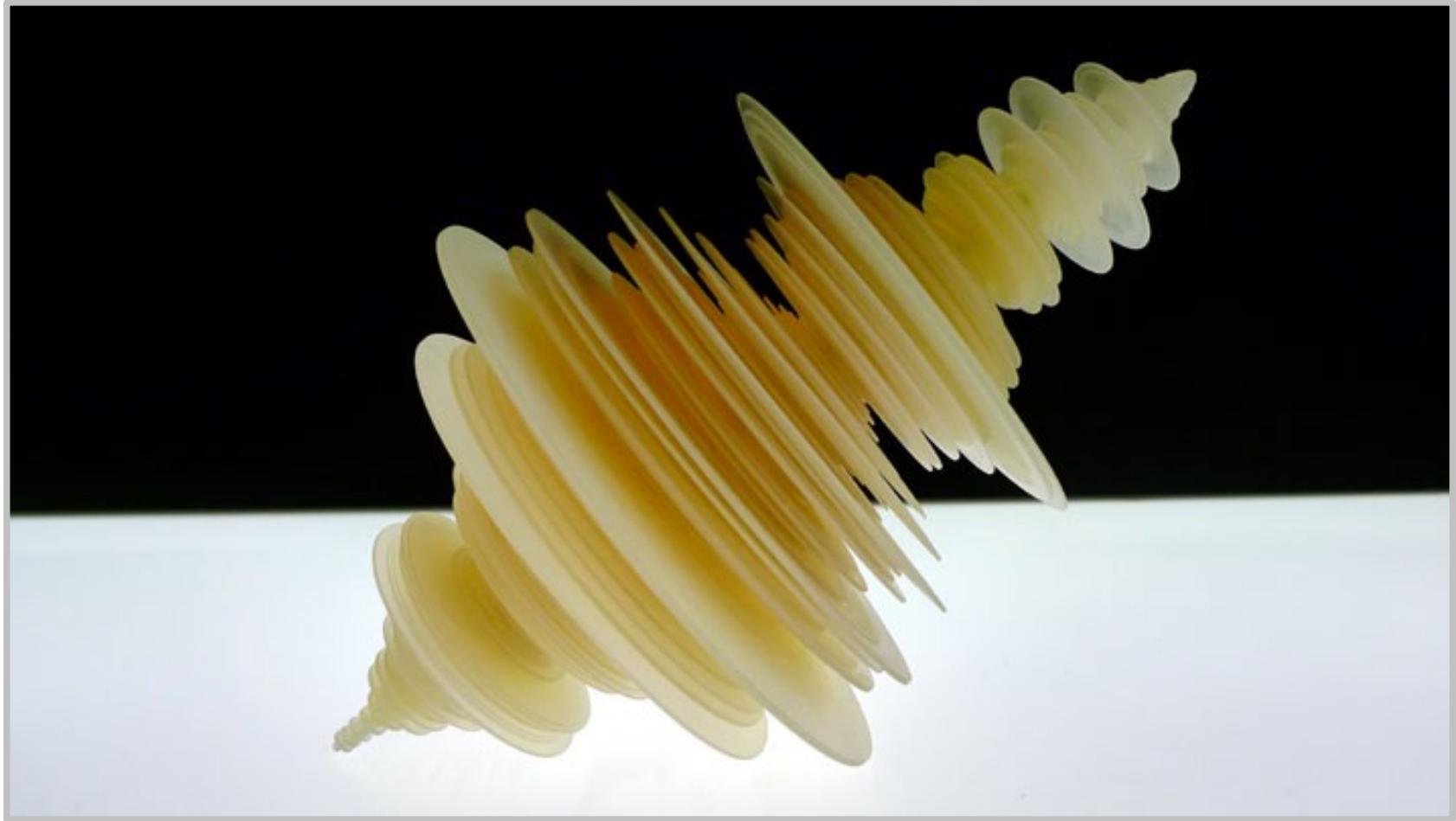


LAYERWISE

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



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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](http://www.lukejerram.com/projects/t%C5%8Dhoku_earthquake)

# 3D printing data: Facebook



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

# 3D printing data: sound

The screenshot shows the homepage of the Shapeways 'the vibe' service. At the top, there's a logo consisting of the Shapeways logo plus the SoundCloud logo equals 'the vibe'. Below it is a large, bold title 'Sound You Can Touch'. Underneath the title is a subtitle: '3D print a custom iPhone case with your favorite sound from SoundCloud'. A prominent orange button with the text 'Get Started!' is centered. Below the button, a link says 'Never heard of SoundCloud? [Find out more.](#)'. The main section is titled 'Here's How It Works...' and contains three steps: 'Connect to SoundCloud.' (with an icon of a plug and a cloud), 'Choose your favorite sound.' (with a screenshot of a Shapeways product page showing a waveform and price), and 'Get your custom iPhone case!' (with an image of a hand holding an iPhone with a unique, textured case). The background features a subtle grayscale waveform pattern.

“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>

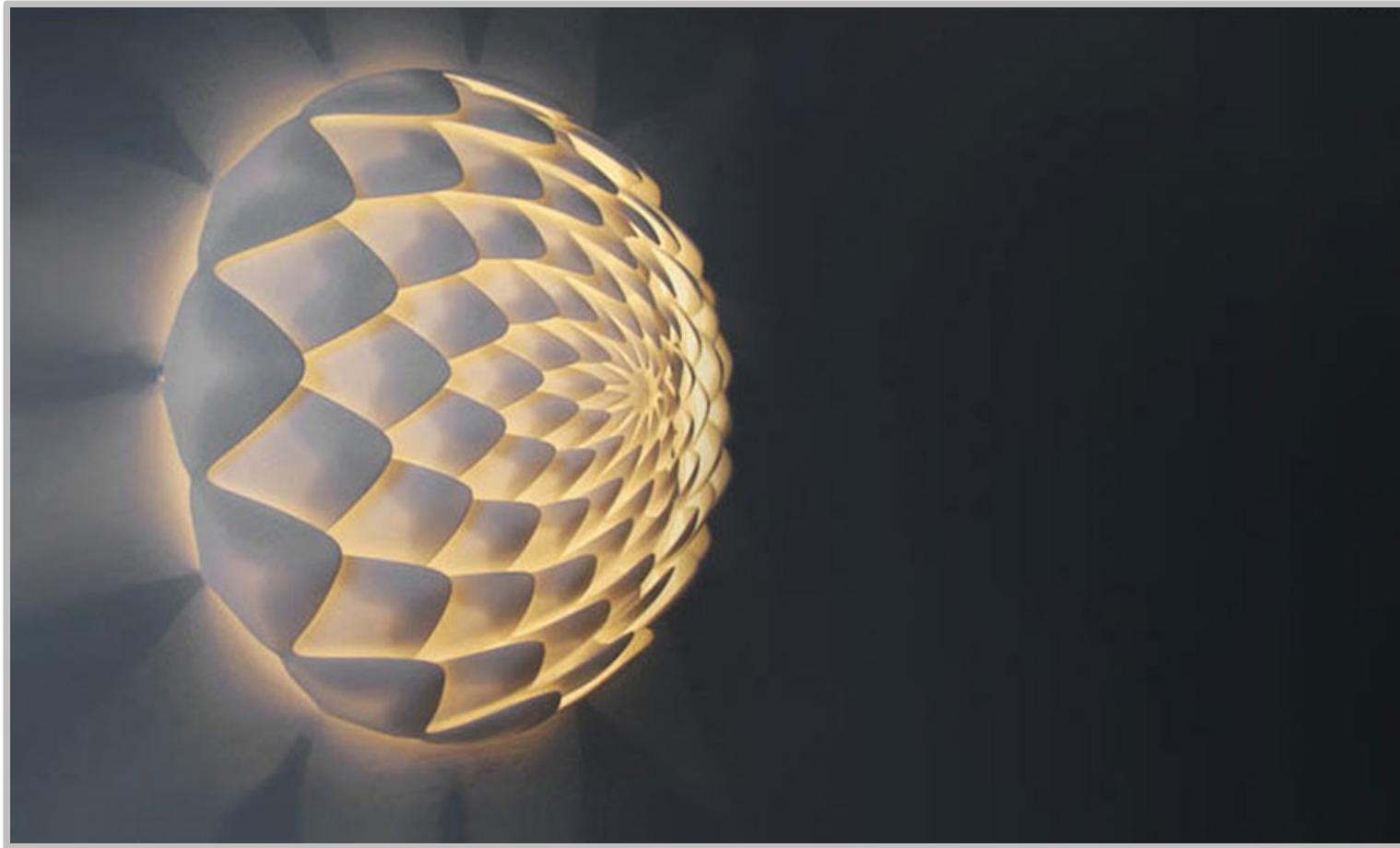
# 3D printing data: sound



“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



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

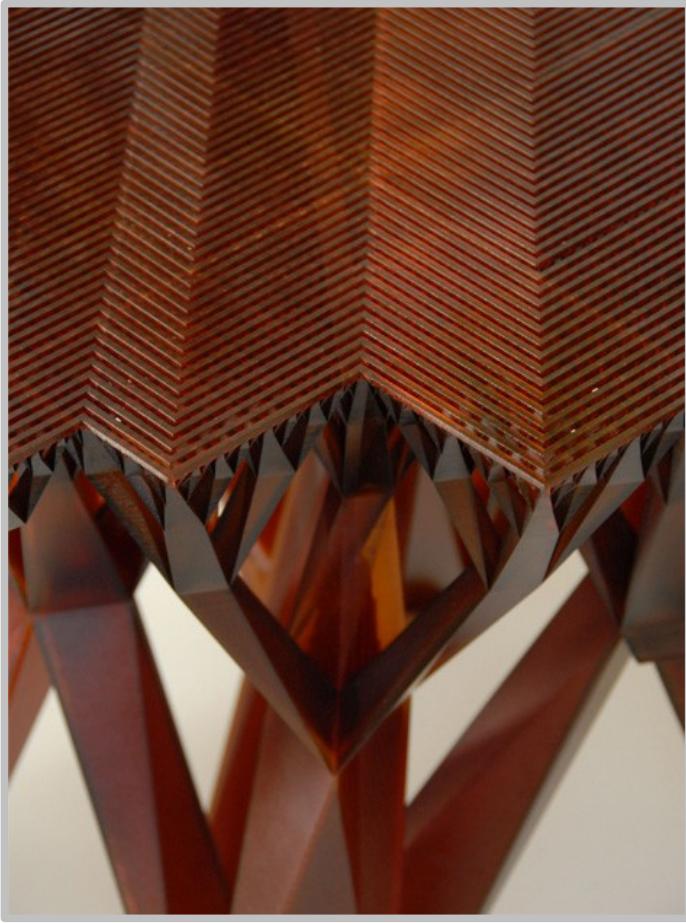
Source: <http://www.freedomofcreation.com/>

# 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.

# 3D fractal furniture design

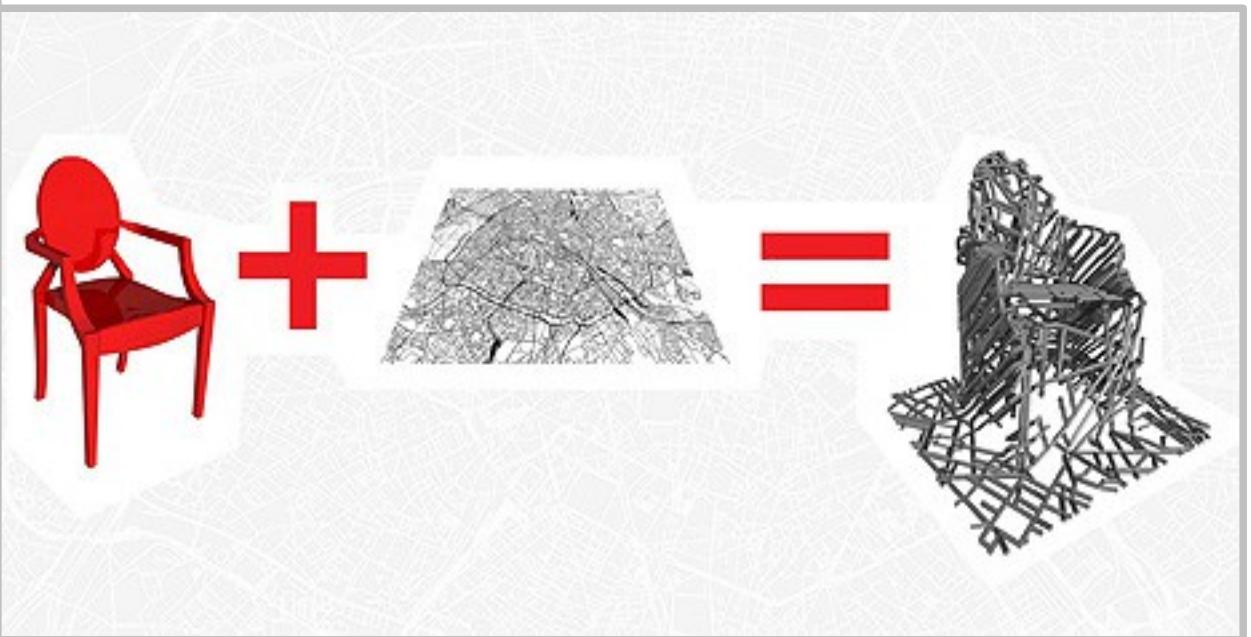


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Fractal Table is a generative design table produced by Materialise as a single piece SLA in epoxy resin. Its dimensions in cm are: L98 x W61 x H42.

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

# 3D printed furniture design



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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>



Aalto University  
Media Factory

03.

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

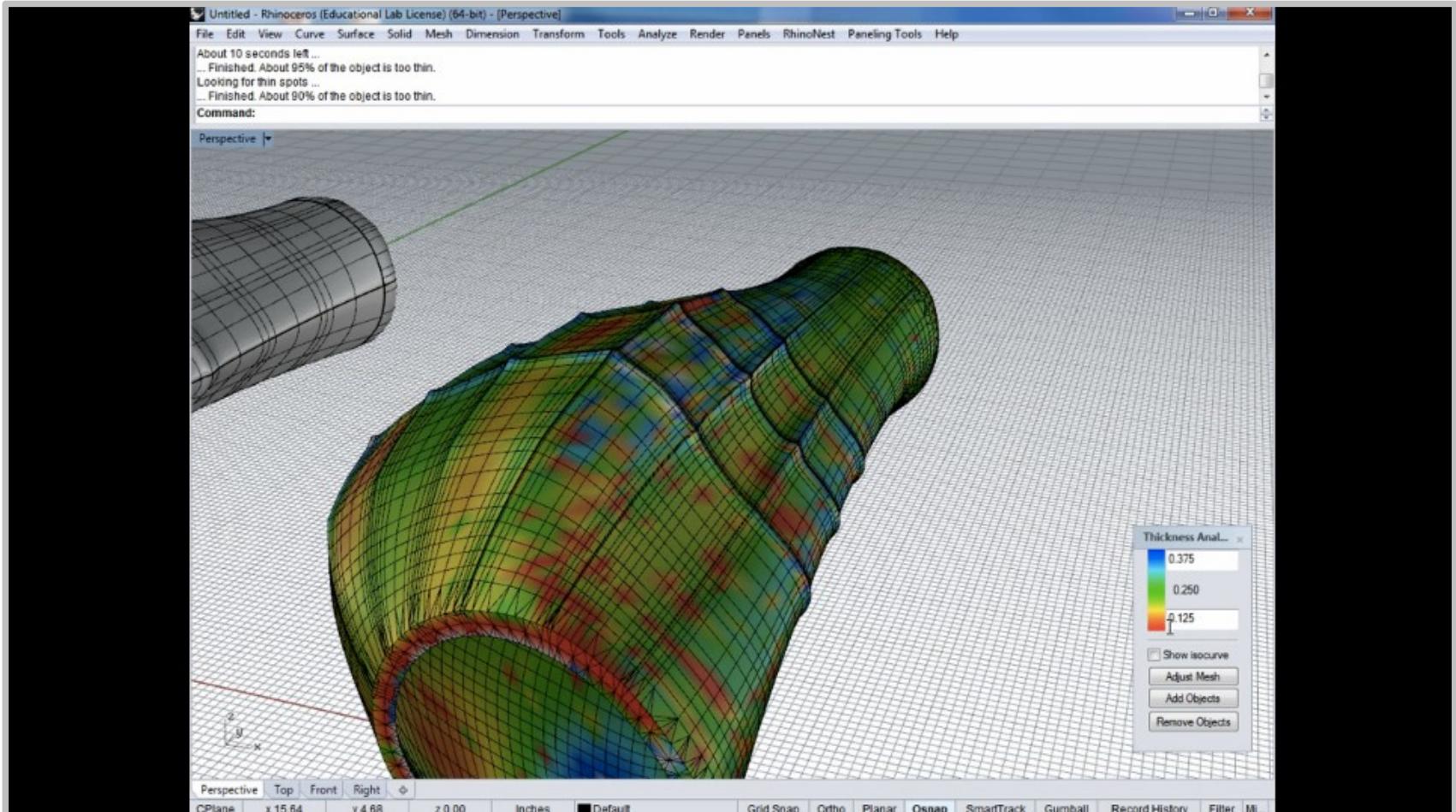
# 00: design with Blender



A good tutorial for designing the mesh  
with Blender.

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

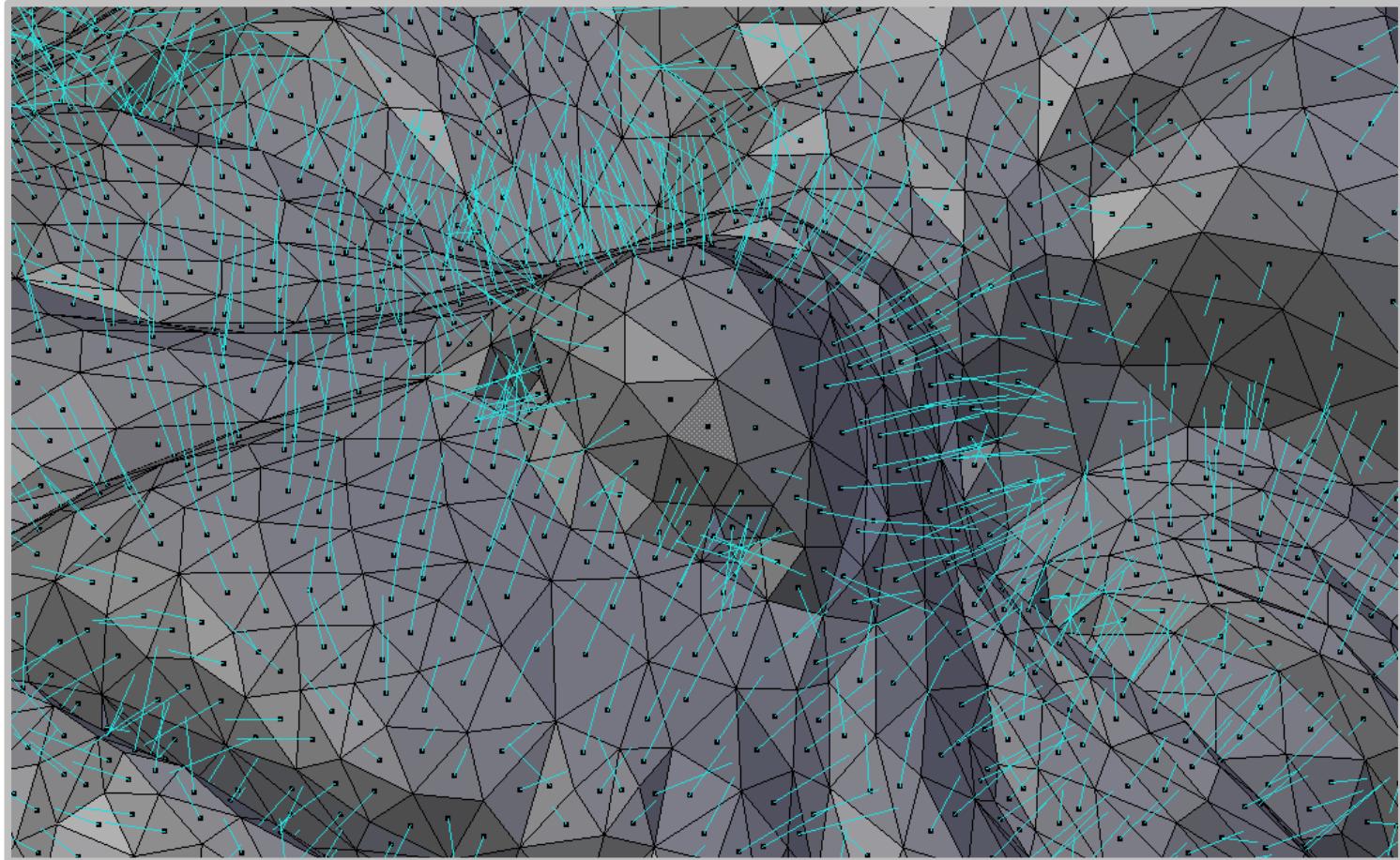
# 00: check the mesh with Rhino 5



A good tutorial for analysing the mesh  
with Rhino 5.

Source: <http://vimeo.com/60897890>

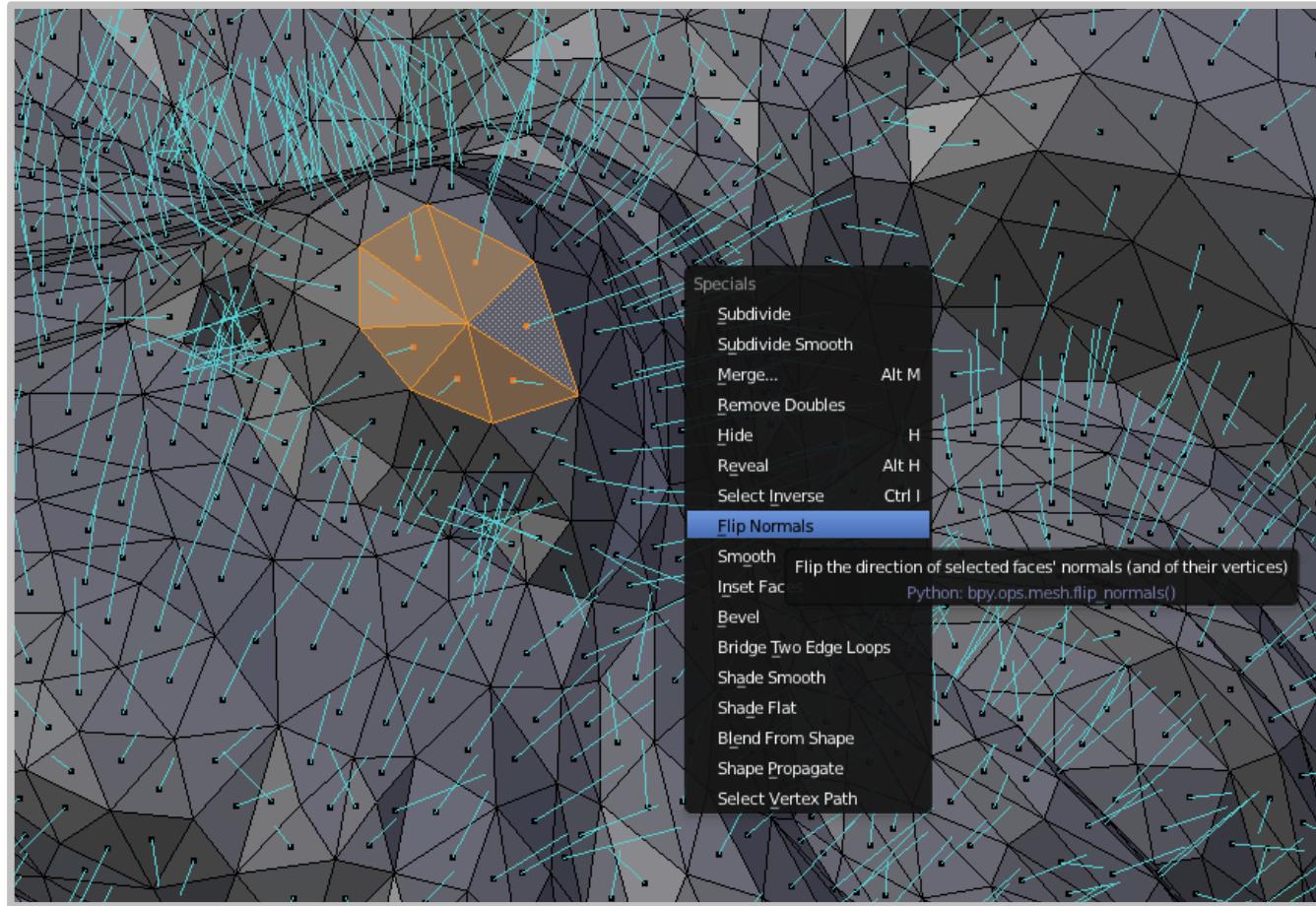
# 01: check the normals



---

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](http://www.shapeways.com/tutorials/design_rules_for_glass_3d_printing)

## 03: Yes to moving parts and undercuts



But not with FDM!!!

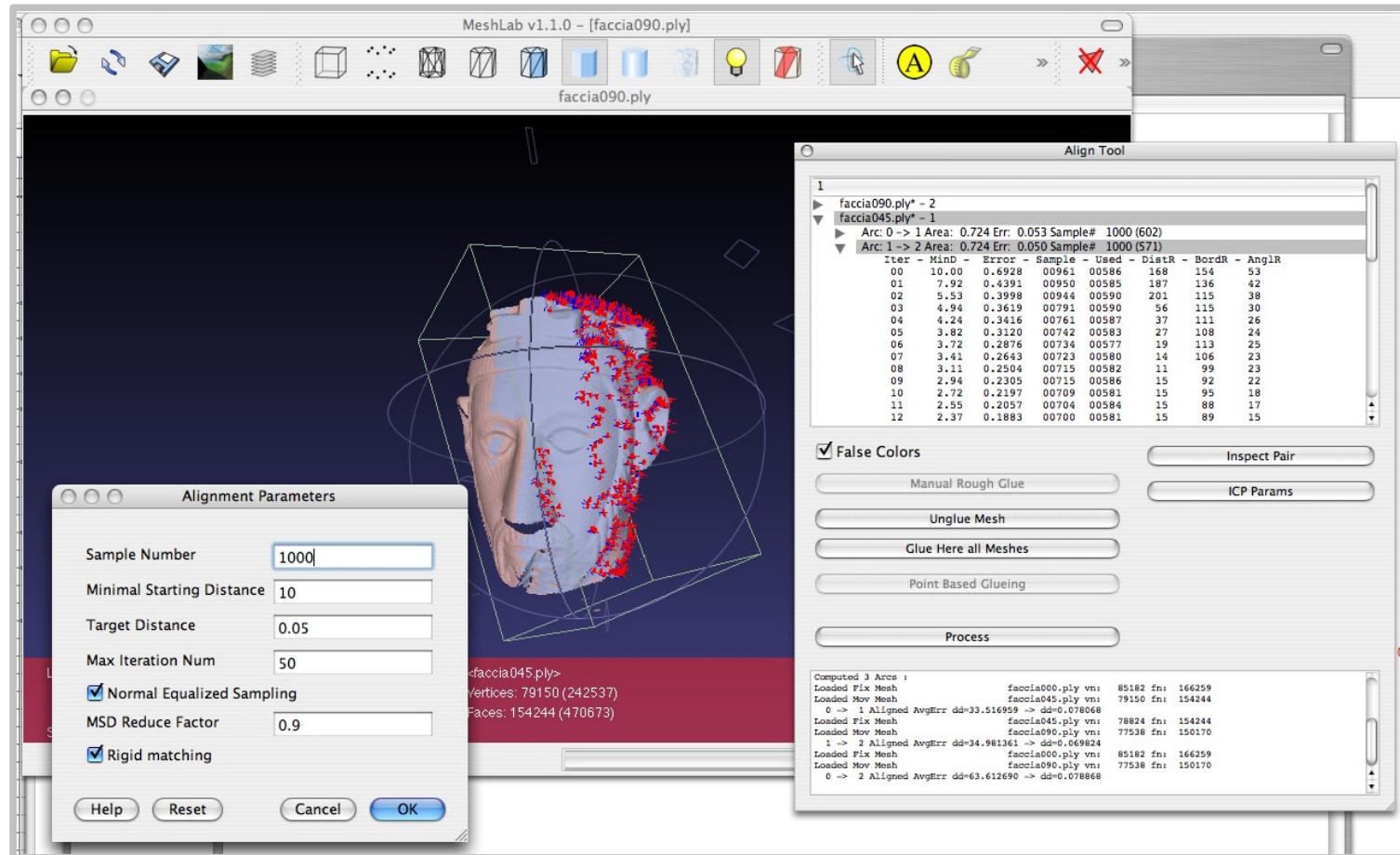
## 03: FDM: use support material



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.

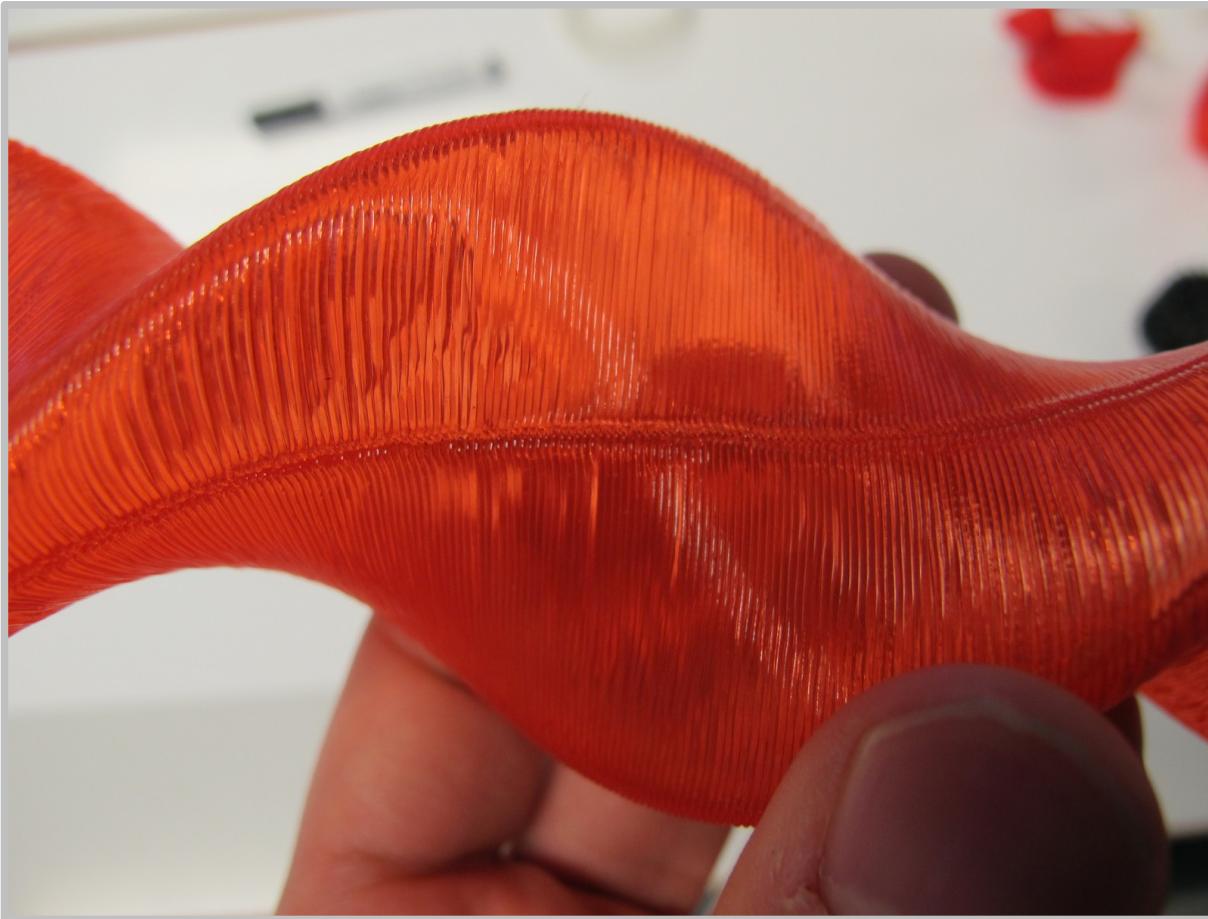
# 3D printing: what could go wrong?



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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.

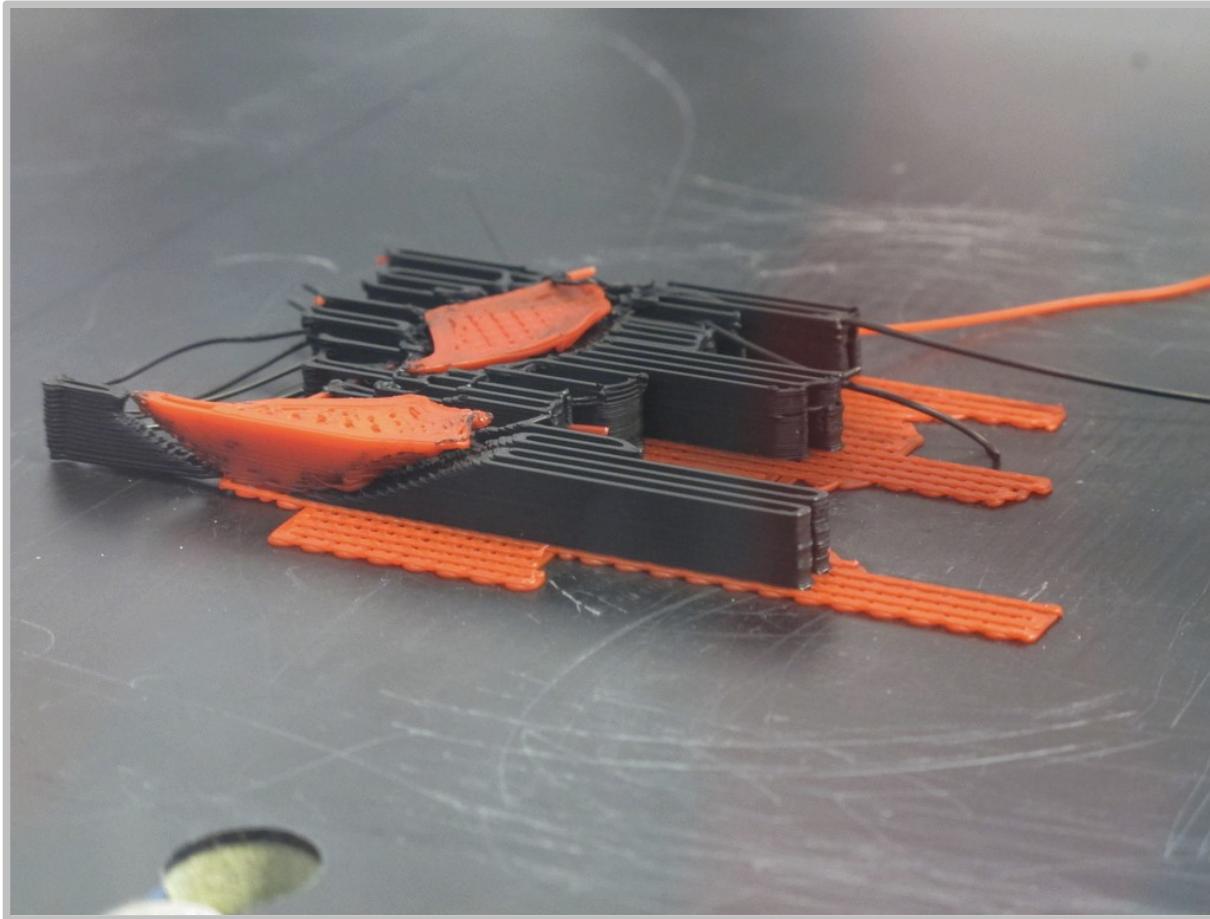
# 3D printing: what could go wrong?



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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



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

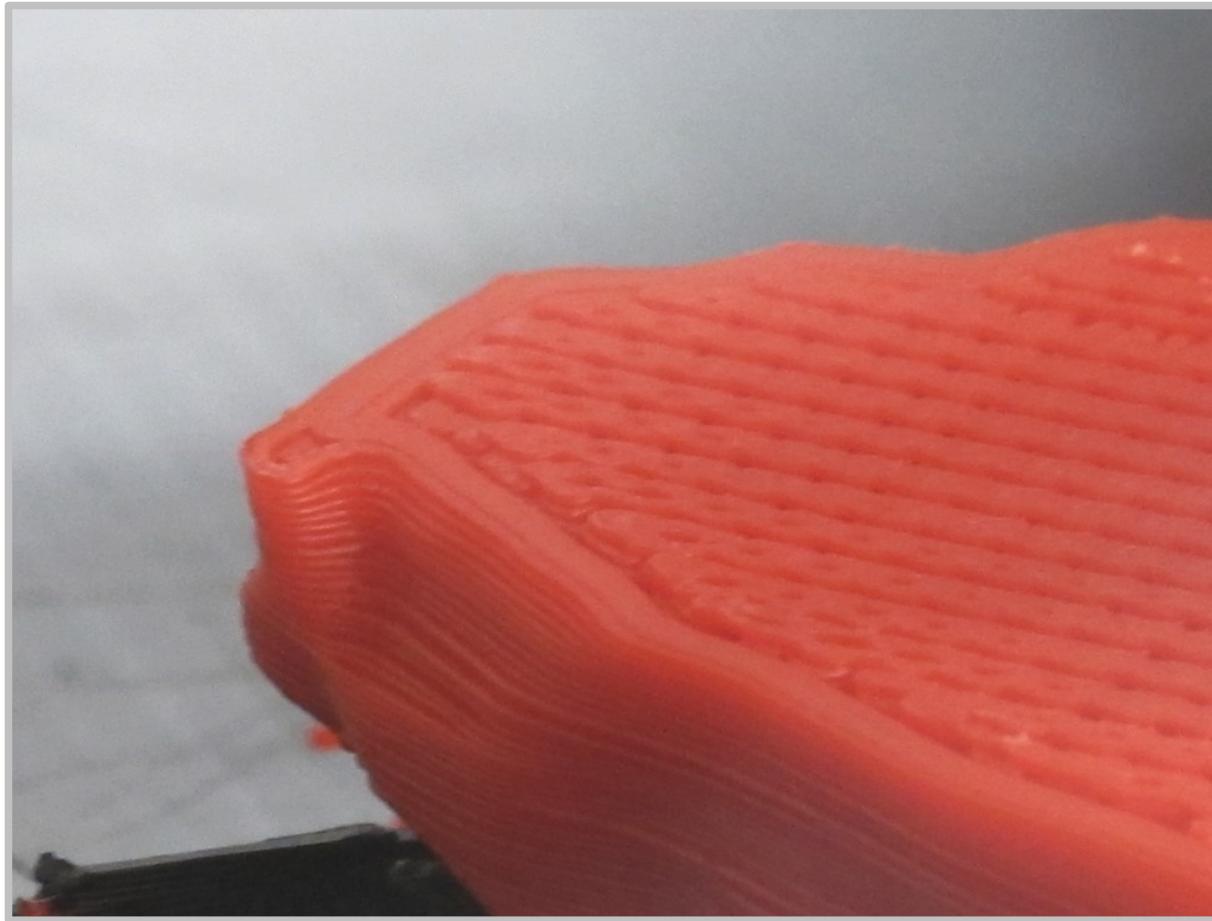
# Resolution



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

# Skins and filling



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

# 123D Catch: result



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See the orientation of the layers?

# 123D Catch: result



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

# A”

Aalto University  
Media Factory

# Thank you!!

Massimo Menichinelli  
Aalto Media Factory  
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[@openp2pdesign](https://twitter.com/openp2pdesign)  
<http://www.slideshare.net/openp2pdesign>

