



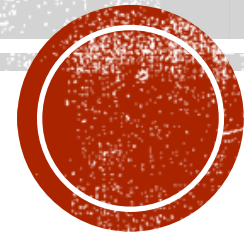
**IT SHOULD BE OBVIOUS
TO EVEN THE MOST
DIMWITTED INDIVIDUAL
(WHO HOLDS AN
ADVANCED DEGREE IN
HYPERBOLIC TOPOLOGY)
THAT HOMER SIMPSON
HAS STUMBLER INTO...**

**...THE THIRD
DIMENSION!**



3-D Modeling

On the Cheap (or the Even Cheaper!)



Brian Hirt

 [@brianbuildslego](https://www.instagram.com/brianbuildslego)

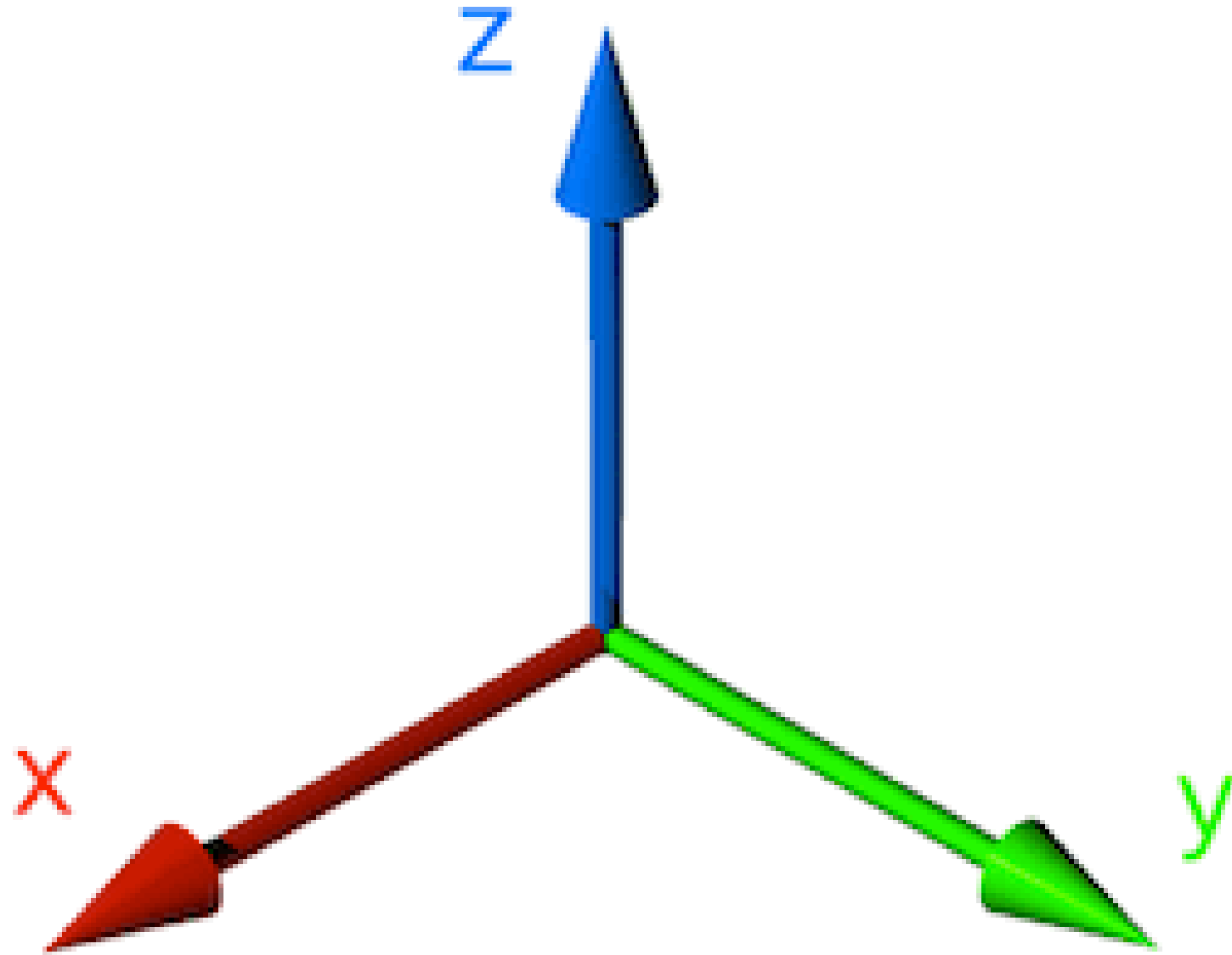
LOLUG (Lincoln and Omaha LEGO User Group)

June 2022



lolugclub.org

TRIVIA!

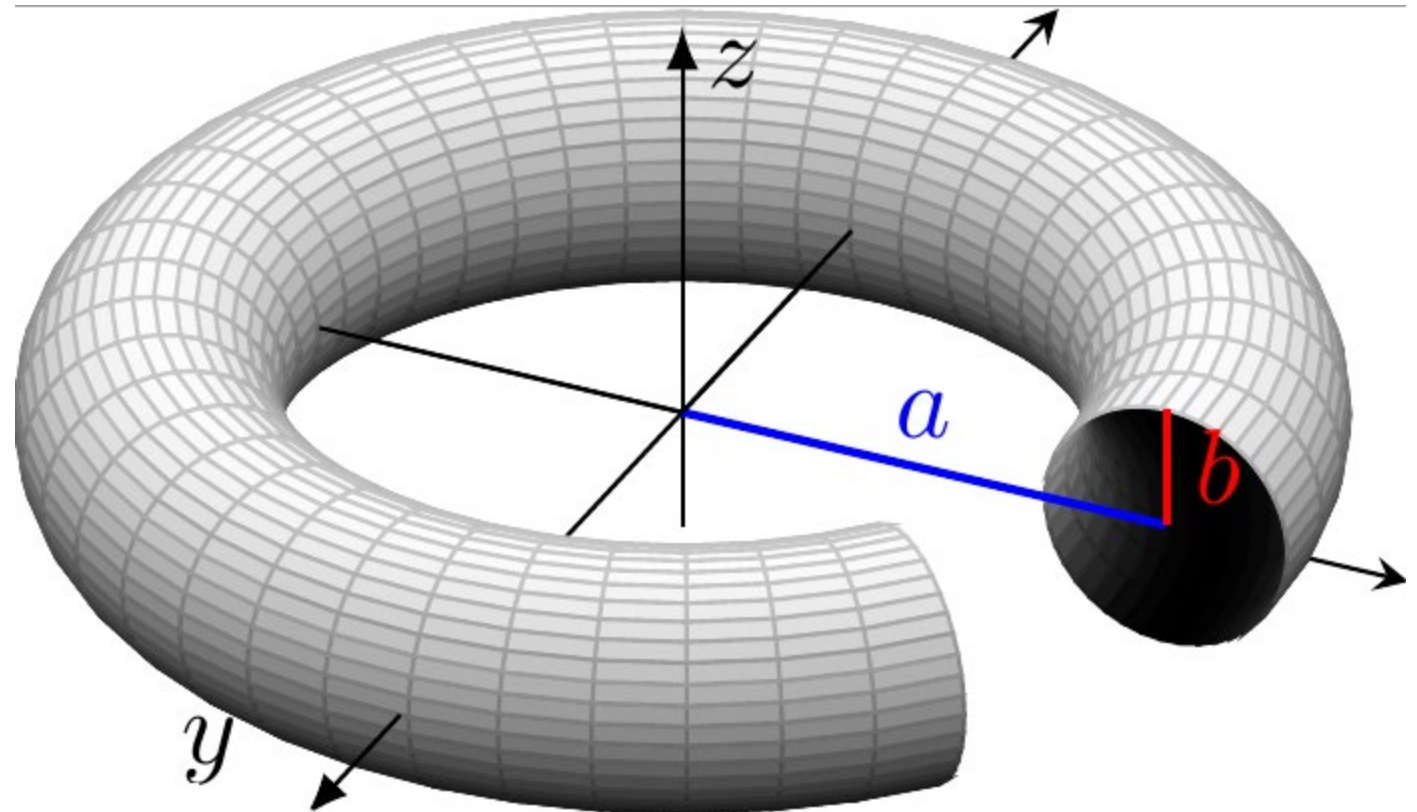


Jay-Zed?



Method 1. NO SOFTWARE REQUIRED

THE TORUS



Method 1. NO SOFTWARE REQUIRED

**MMM...
DONUTS**



A little more mathematically...

- The solution of $f(x, y, z) = 0$, where

$$f(x, y, z) = \left(\sqrt{x^2 + y^2} - R \right)^2 + z^2 - r^2$$

- R is the distance from the center of the tube to the center of the torus,
- r is the radius of the tube.

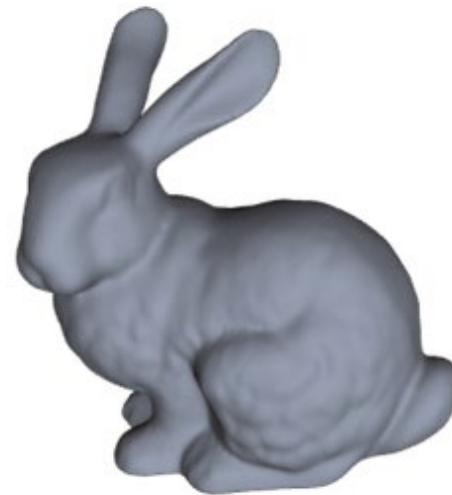


OK, a little *less* mathematically... Break it down!

2D image \rightarrow pixel



3D solid \rightarrow voxel



Fine examples



Nathan Sawaya



Fine examples



Sean Kenney



Fine examples



BRICKLIVE Group /
Bright Bricks



SOOT =
Studs ONLY On Top

**A brilliant example
adapted by LOLUG's
Jim Harrison**

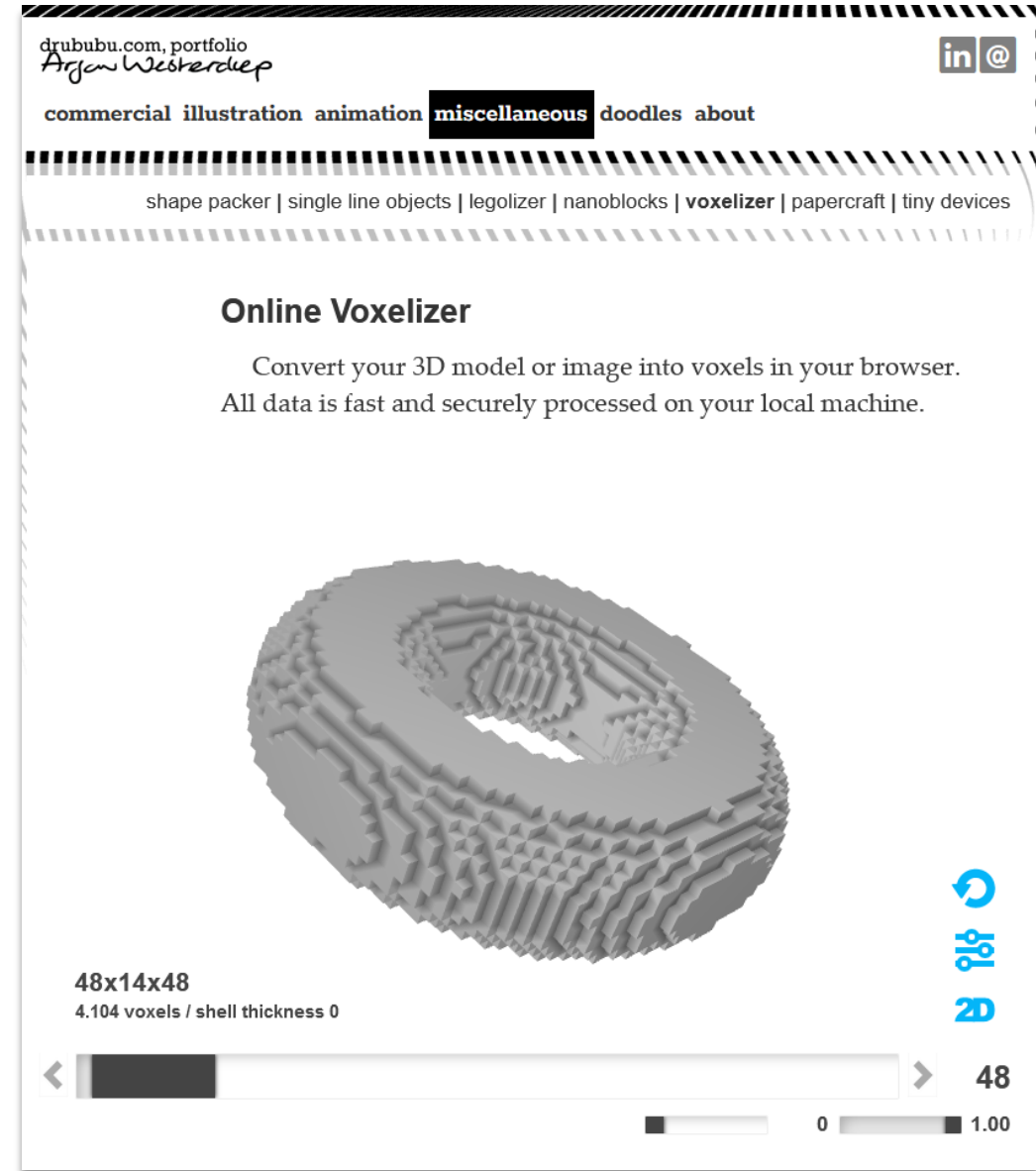


And a brilliant counterexample by LOLUG's Marshall Stoneman



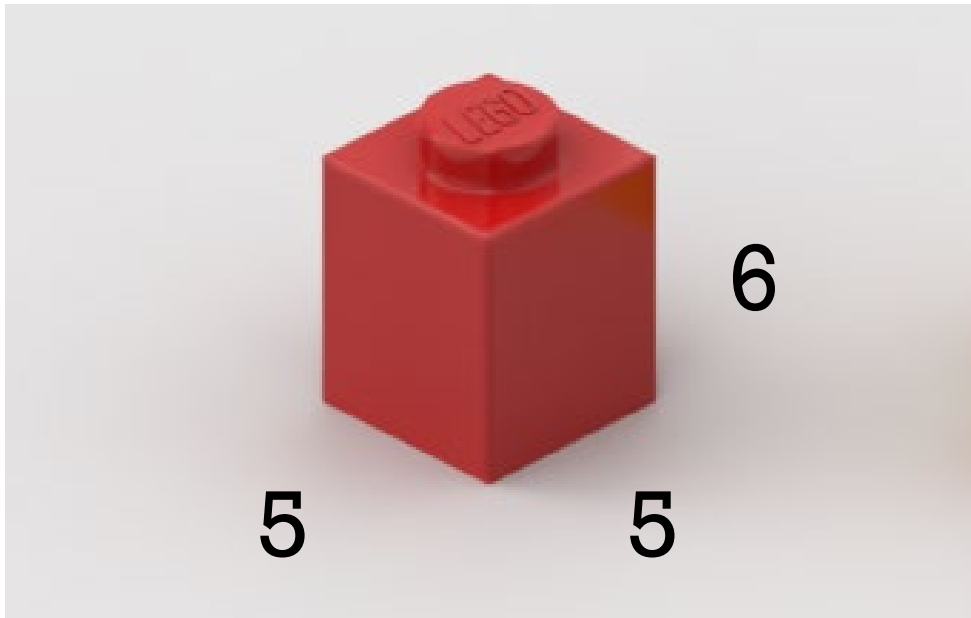
Drububu

- drububu.com/miscellaneous/voxelizer
- A free web-based tool
- Cubes! **Great**, right!
- (Well...)



The Cube that Isn't...

- The 1x1x1 brick
- **The FUNDAMENTAL LEGO UNIT**



Solution: Squish our plan!

- $5 \div 6 = 83.3\%$
- That is, multiply the height of a model by a **factor of 0.833**
- When you build it with non-square (tall) bricks, it will stretch itself back out



And how, exactly...?

- Drububu with some help from <https://www.tinkercad.com/>
- This is a free web tool provided by AutoDesk (the company that makes AutoCAD)



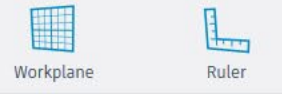
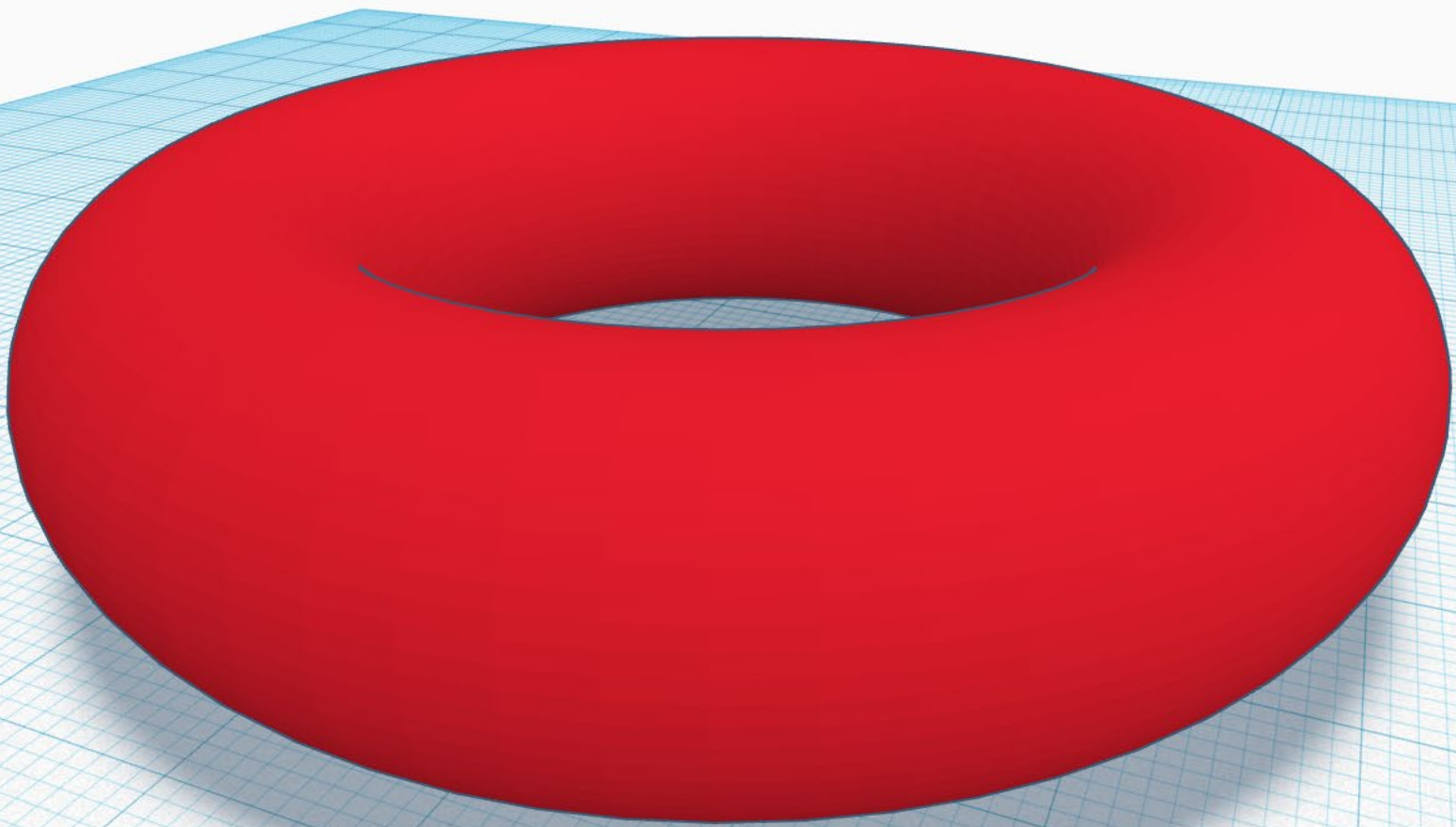


From mind to design in minutes

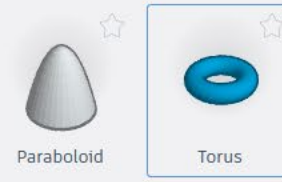
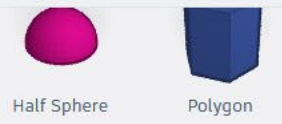
Tinkercad is a free, easy-to-use app for 3D design, electronics, and coding. It's used by teachers, kids, hobbyists, and designers to imagine, design, and make anything!

[Start Tinkering](#)

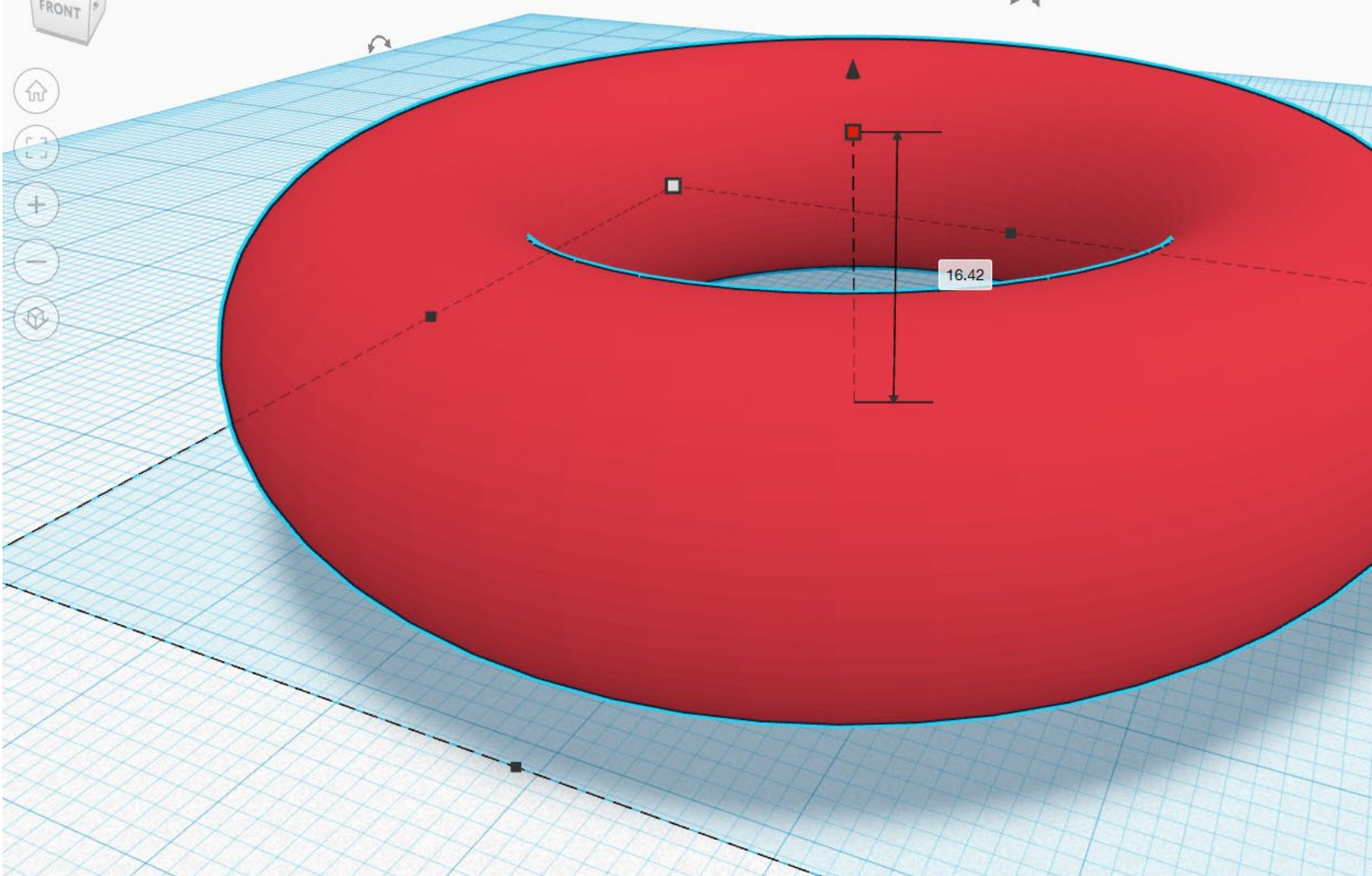
[Join your class](#)



Tinkercad Basic Shapes



Edit Grid
Snap Grid 1.0 mm



HD Torus (overl...

Solid Hole

Torus Radius 32.24

Torus Sides 64

Tube Radius 8.21

Tube Sides 64

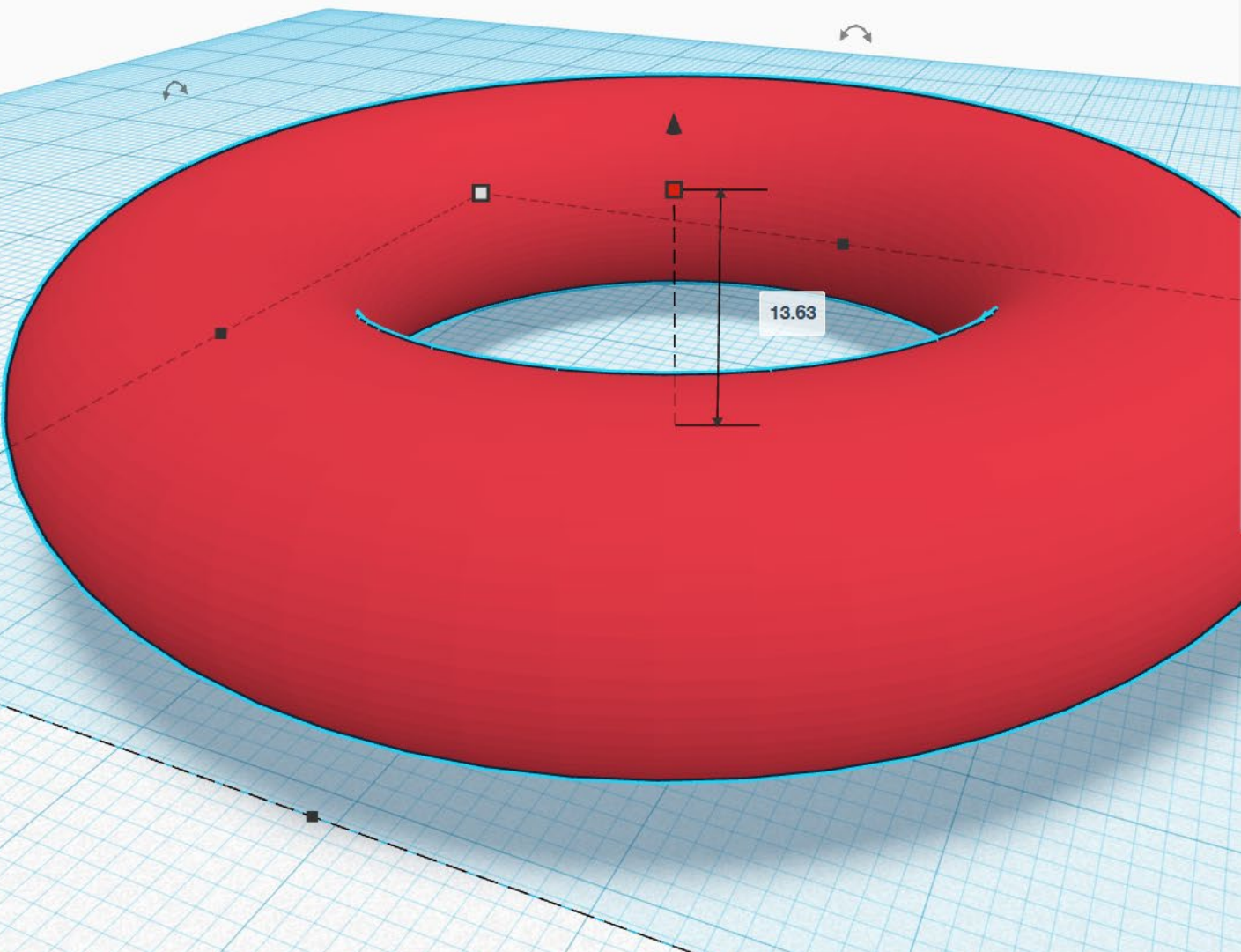
Developed by [this tinkerer](#)



Tinkercad Basic Shapes

- Half Sphere
- Polygon
- Paraboloid
- Torus
- Tube
- Heart
- Star
- Star
- Icosahedron
- Ring

Edit Grid
Snap Grid 1.0 mm



HD Torus (overl...

Solid Hole

Torus Radius 32.24

Torus Sides 64

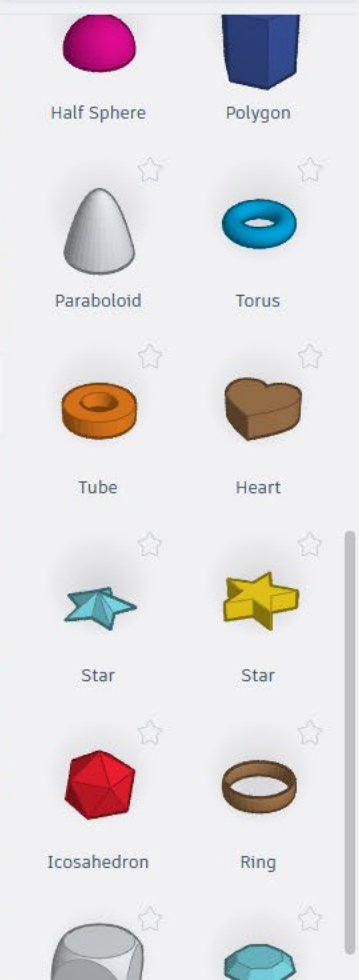
Tube Radius 8.21

Tube Sides 64

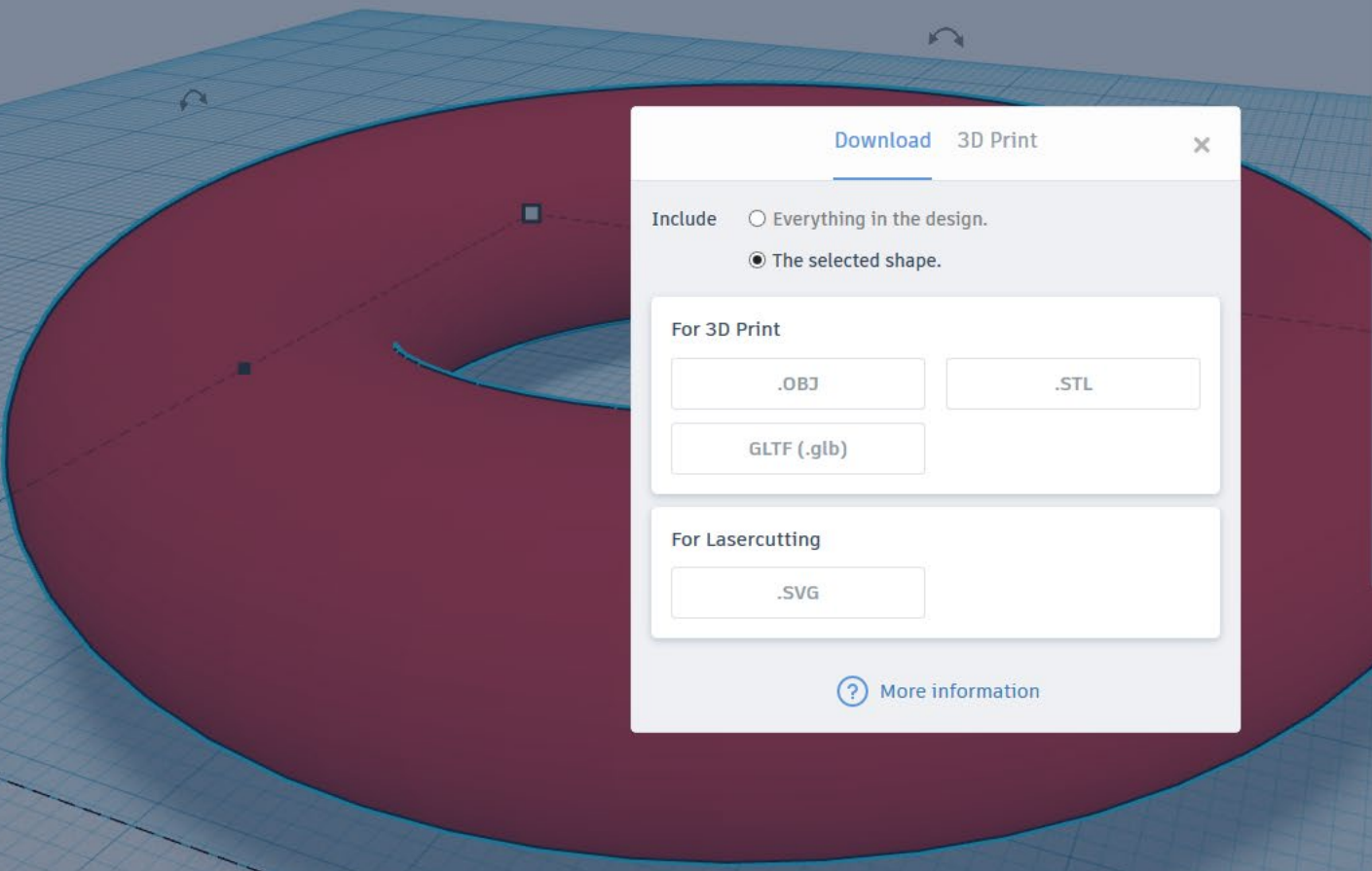
Developed by [this tinkerer](#)



Tinkercad Basic Shapes



Edit Grid
Snap Grid 1.0 mm



HD Torus (overl...

Solid Hole

Torus Radius 32.24

Torus Sides 64

Tube Radius 8.21

Tube Sides 64

Developed by this tinkerer

- Half Sphere
- Polygon
- Paraboloid
- Torus
- Tube
- Heart
- Star
- Star
- Icosahedron
- Ring

Download 3D Print

Include Everything in the design.
 The selected shape.

For 3D Print

For Lasercutting

[More information](#)

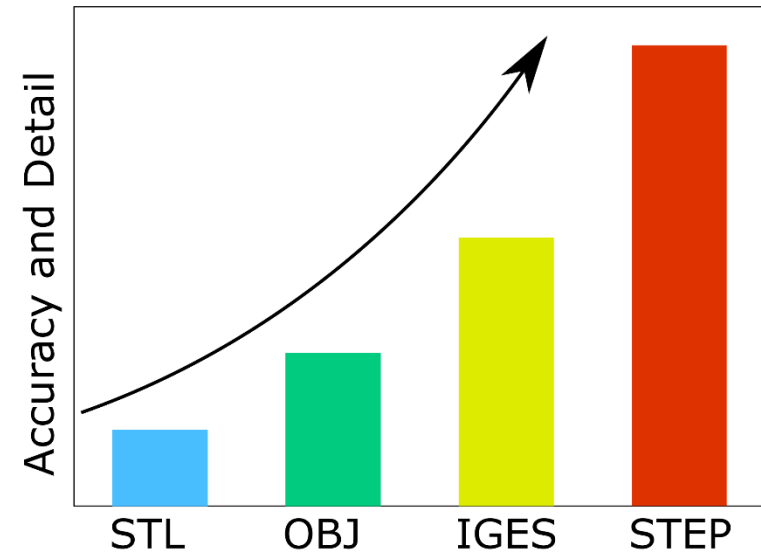
3-D File types

- OBJ = “**OB**Ject file”
- STL = “**ST**ereo**L**ithography” file

OBJ and STL are equally useful for LEGO – use whichever your program will use

Convert between these with online tool

<https://imagetostl.com/>



1. Import STL or OBJ file into Drububu

2. Tweak the resolution (how many voxels)

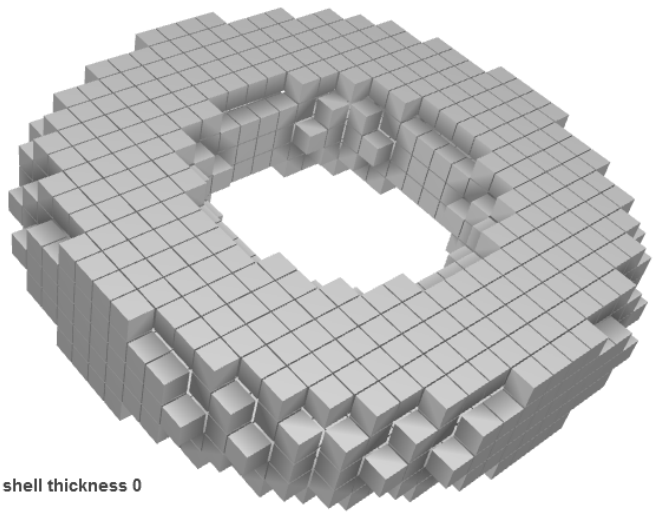
drububu.com, portfolio Arjen Westerdiep

commercial illustration animation **miscellaneous** doodles about

shape packer | single line objects | legalizer | nanoblocks | voxelizer | papercraft | tiny devices

Online Voxelizer

Convert your 3D model or image into voxels in your browser.
All data is fast and securely processed on your local machine.



22x5x22
800 voxels / shell thickness 0

22

0 0.95

open file

save as pdf

<input type="radio"/> .obj (tris)	<input type="radio"/> .obj (quads)	<input type="radio"/> .dae (tris)	<input type="radio"/> .stl	<input type="radio"/> .schematic
<input type="radio"/> blender.py	<input type="radio"/> C4D.py	<input type="radio"/> .json	<input type="radio"/> .xml	<input type="radio"/> .py
<input type="radio"/> .js	<input type="radio"/> .ts	<input type="radio"/> .png	<input type="radio"/> avorion	<input type="radio"/> avorion
<input type="radio"/> .vox	<input type="radio"/> .scad	<input type="radio"/> .qb	<input type="radio"/> .txt	<input checked="" type="radio"/> .pdf
<input type="radio"/> .pdf	<input type="radio"/> .kvx	<input type="radio"/> .occ	<input type="radio"/> .occ	<input type="radio"/> pixel art
<input type="radio"/> .binvox	<input type="radio"/> sprite stack	<input type="radio"/> hexahedral	<input type="radio"/> povray	<input type="radio"/> img seq.

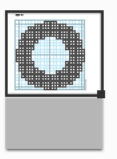
Export as Single Object

<input type="radio"/> obj (tris)	<input type="radio"/> obj (quads)	<input type="radio"/> dae (tris)	<input type="radio"/> glb	<input type="radio"/> minecraft
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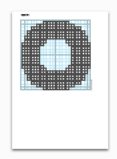
3. Then output as a PDF



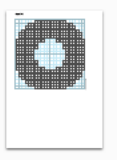
Page Thumbnails



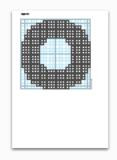
1



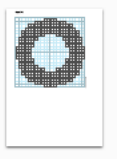
2



3

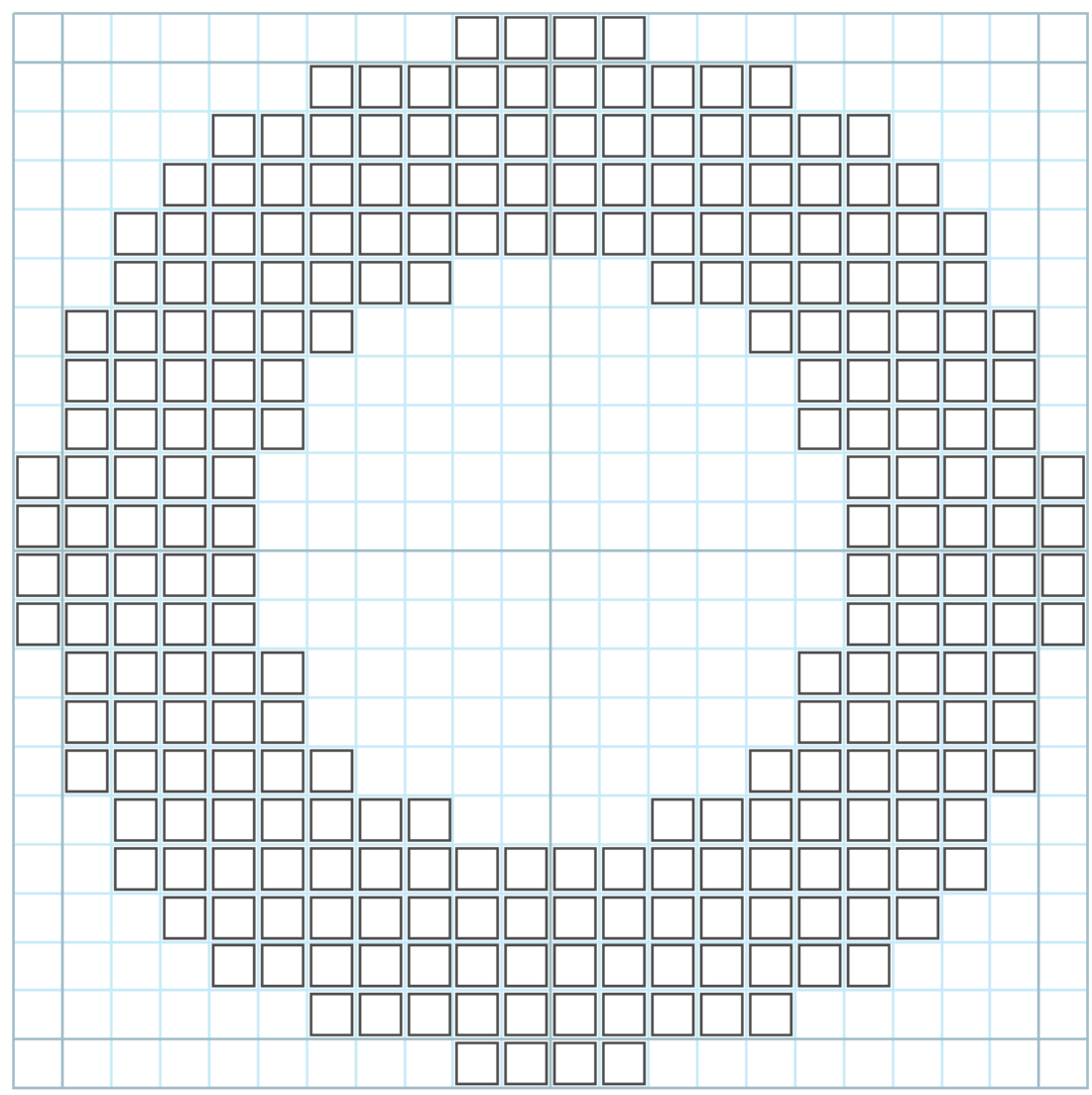


4



5

layer 1/5



generated at drububu.com



Et voilà!



Method 1.5. **NO SOFTWARE REQUIRED** (but maybe a few shekels...)

Drububu redux

- drububu.com/miscellaneous/legolizer
 - Not quite so free
 - Your mileage may vary – I have never tried this!



Method 2. OPEN SOURCE SOFTWARE

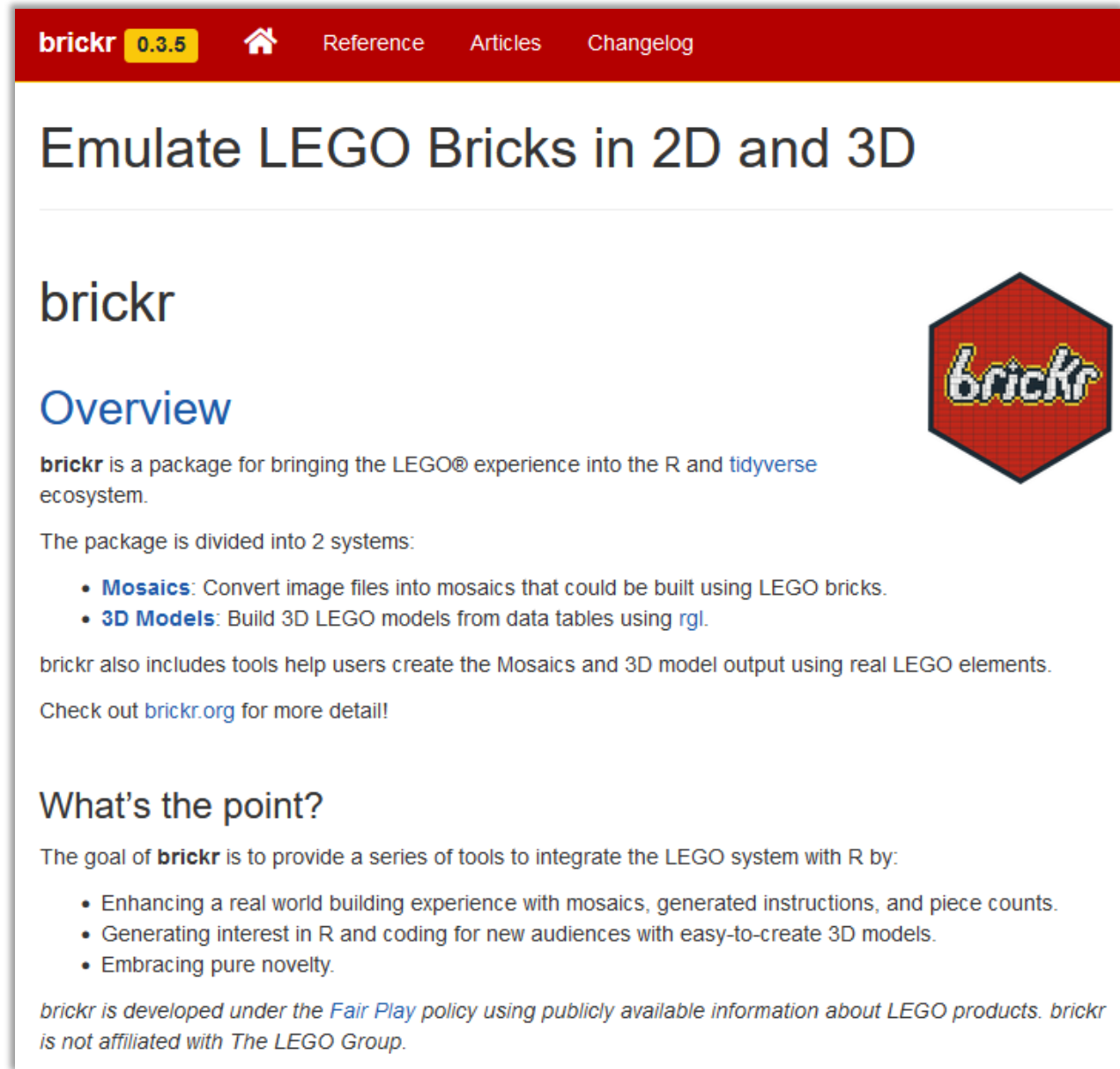


Beware!!!



brickr

- brickr.org
- Renders images in 5 x 5 x 6 fundamental LEGO units
 - No squishing or stretching
- Creates layer-by-layer maps

The image is a screenshot of the brickr website. At the top, there is a dark red navigation bar with the text 'brickr 0.3.5' on the left, a home icon, and links for 'Reference', 'Articles', and 'Changelog'. Below the navigation bar, the main heading reads 'Emulate LEGO Bricks in 2D and 3D'. The page content includes the word 'brickr' in a large font, followed by an 'Overview' section. The overview text states that 'brickr' is a package for bringing the LEGO experience into the R and tidyverse ecosystem. It lists two main systems: 'Mosaics' for converting images into mosaics and '3D Models' for building 3D models from data tables. A small red hexagonal logo with the word 'brickr' inside is positioned to the right of the overview text. The page also includes a 'What's the point?' section and a disclaimer at the bottom.

Autodesk Meshmixer

- meshmixer.com
- Manipulate and tweak 3-D image files (STL and OBJ)

Autodesk Meshmixer
free software for making awesome stuff

NEWS (September 2021): Fusion 360 now contains many of the great features you've grown to love in Meshmixer, with continual growth and improvements to its capabilities in mesh coming soon. While we have no current plans to retire Meshmixer, please note that the tool is no longer in development and will not be supported by Autodesk moving forward. As such, we encourage you to download a trial of Fusion 360 to continue getting the most out of what Autodesk has to offer in mesh capabilities, as well as much, much more.

[Download Fusion 360 here](#)

[DOWNLOAD](#) [FORUM](#) [VIDEO](#)

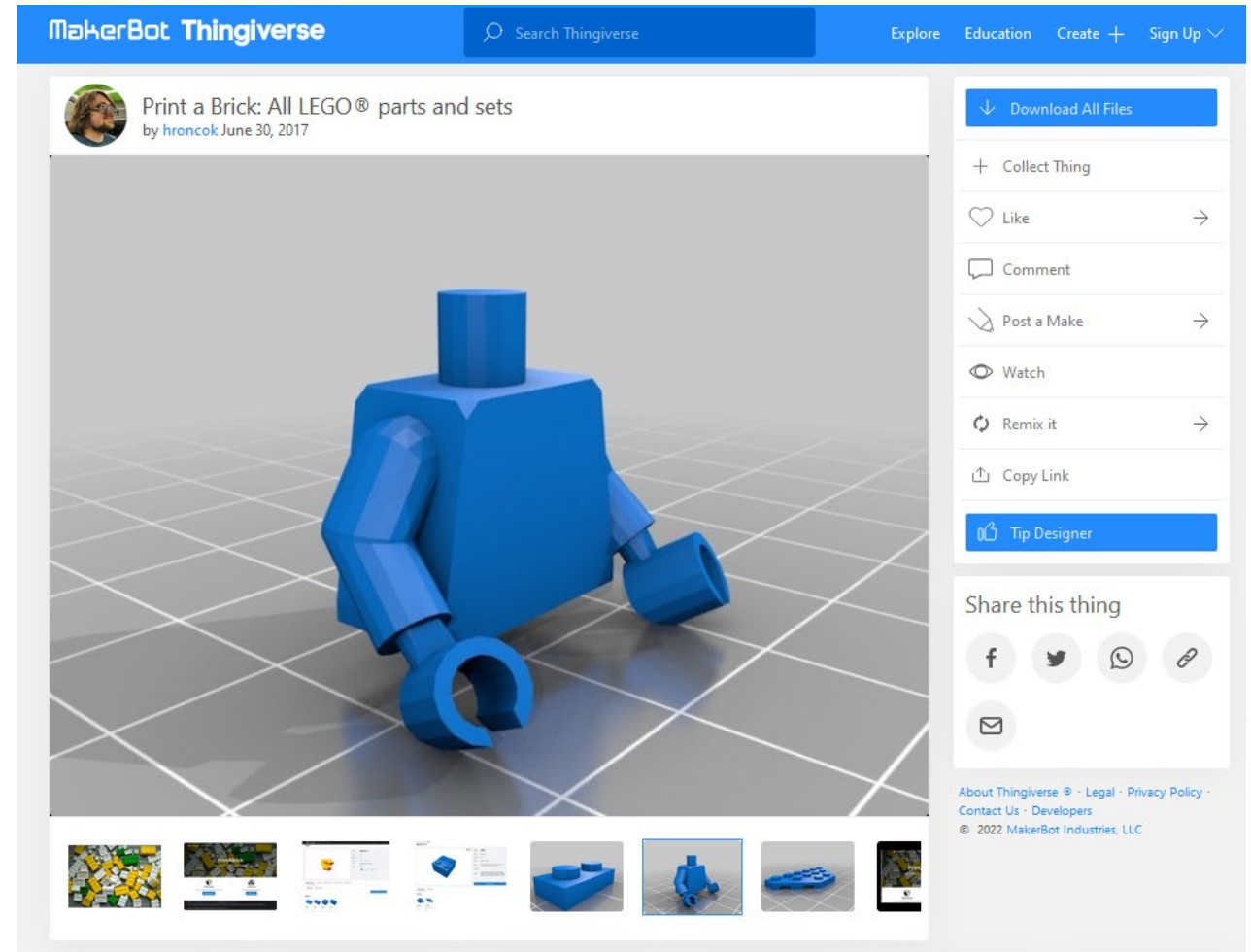
Meshmixer is state-of-the-art software for working with triangle meshes.

Do you need to clean up a 3D scan, do some 3D printing, or design an object that fits something else? Meshmixer can help. Think of it as a sort of "Swiss Army Knife" for 3D meshes.



Example: The Torso

- [thingiverse.com](https://www.thingiverse.com)
- Find other models at
 - Yeggi
 - STLFinder
 - (Google)



(Or... **BUILD** your
model at
Tinkercad)

(Or Tinker cad... **SCAN**
your physical
object!!!)

- UNL innovation studio
 - 3-D laser scanners
 - innovationstudio.unl.edu



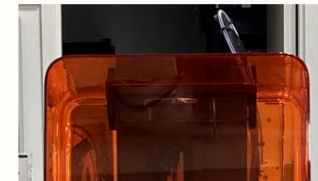
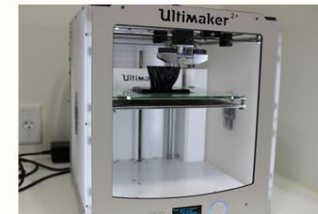
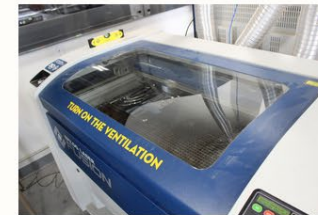
Rapid Prototyping



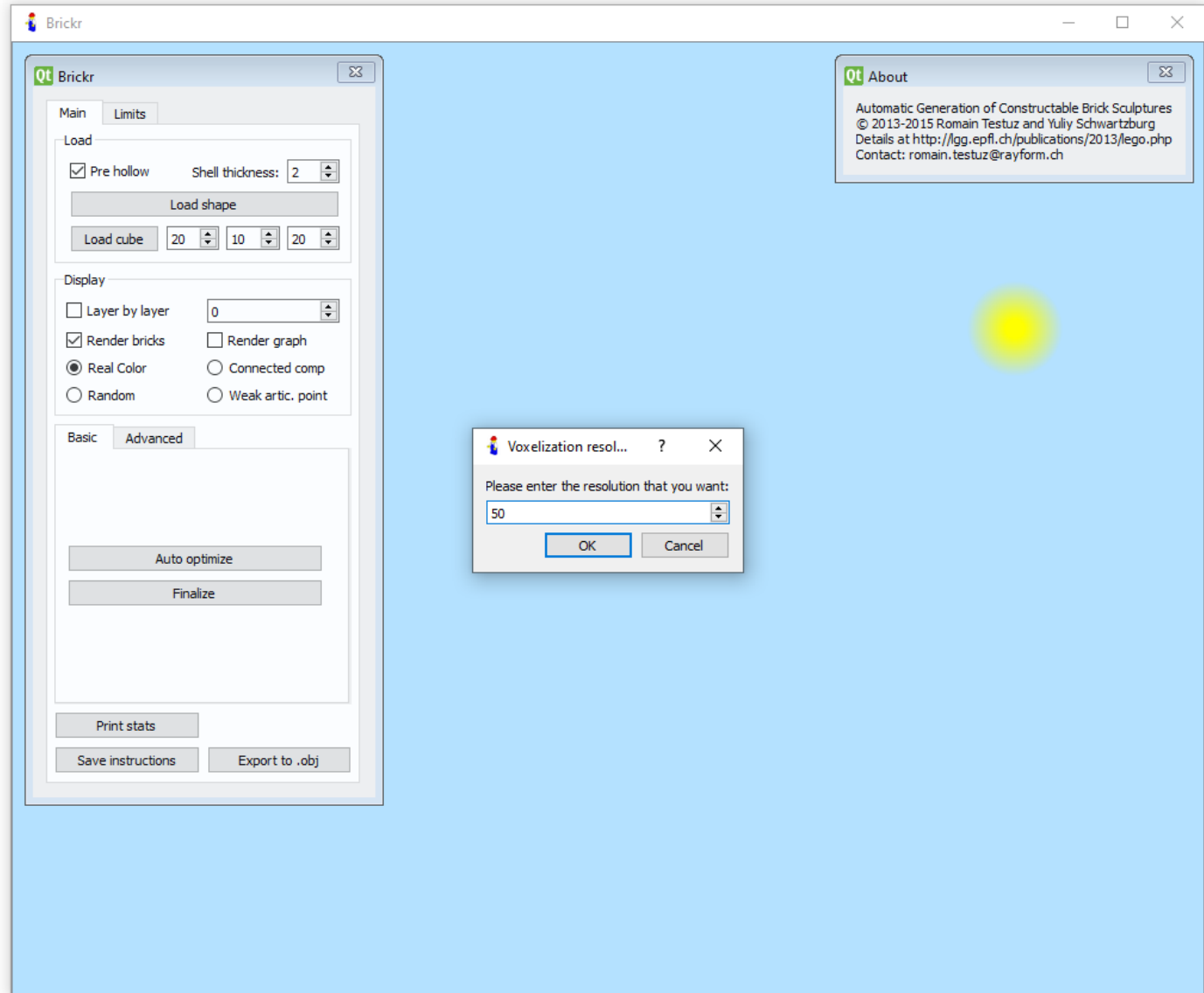
Our CNC equipment can handle a variety of materials in 2D and 3D. Design and modeling software is available at each of our workstations as well as our 12 station computer lab.

Tool List

- ShopBot Alpha CNC Router with a 4' x 8' cuttable area. Capable of cutting 2D designs and 3D models out of wood, foam or plastic. No carbon fiber or fiberglass
- (4) Epilog Fusion Laser Cutters, able to cut up to 1/4" wood as well as acrylic, paper, fabric, leather, rubber and foam. Engraves all cuttable materials as well as stone, metal, and glass. No vinyl, polycarbonate or PVC.
- (6) Ultimaker 2+ and Ultimaker 3 3D printers with an 8" x 8" x 8" printable area. Can print in PLA, ABS, CPE, CPE+, PC, Nylon, TPU 95A plastics.
- (2) Form3 resin 3D printers with a 5.7" x 5.7" x 7.3" print volume. Ultra high resolution printers that print a wide variety of resin materials.
- MarkForged Mark 2 Carbon Fiber 3D printer with a 12.6" x 5.2" x 6" print volume. Can print Onyx, nylon white plastic with carbon fiber, fiberglass, Kevlar®, HSHT fiberglass
- 4' x 4' Lonestar Trooper plasma table
- Artec Eva and NextEngine 3D scanners



brickr in action



Qt Brickr

Main Limits

Load

Pre hollow Shell thickness: 2

Load shape

Load cube 20 10 20

Display

Layer by layer 0

Render bricks Render graph

Real Color Connected comp

Random Weak artic. point

Basic Advanced

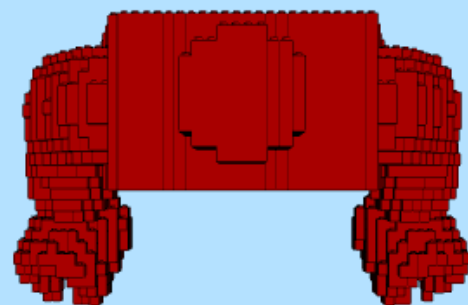
Auto optimize

Finalize

Print stats

Save instructions Export to .obj

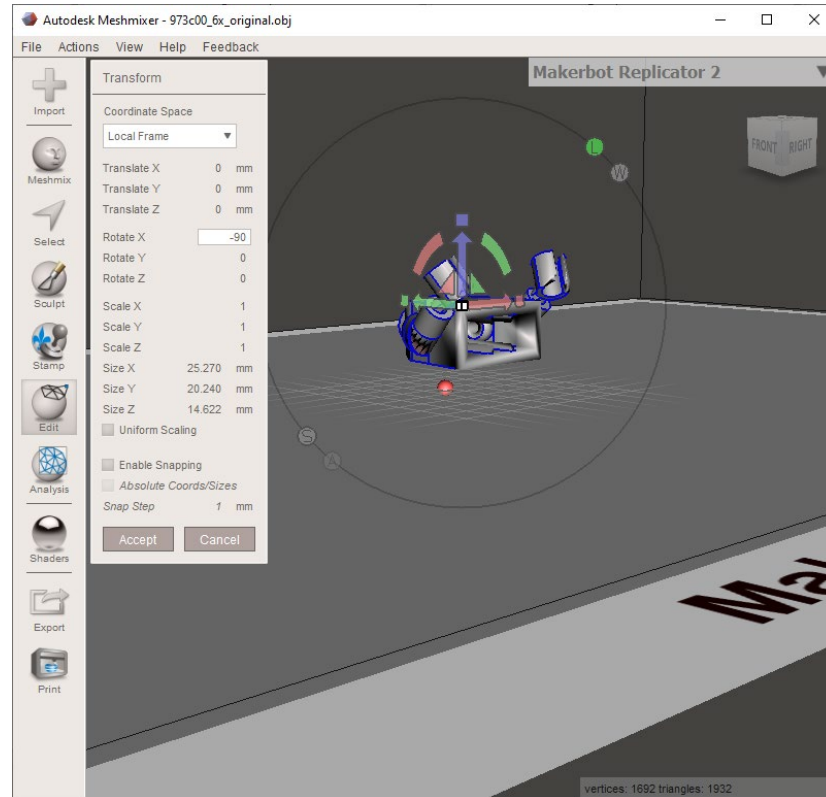
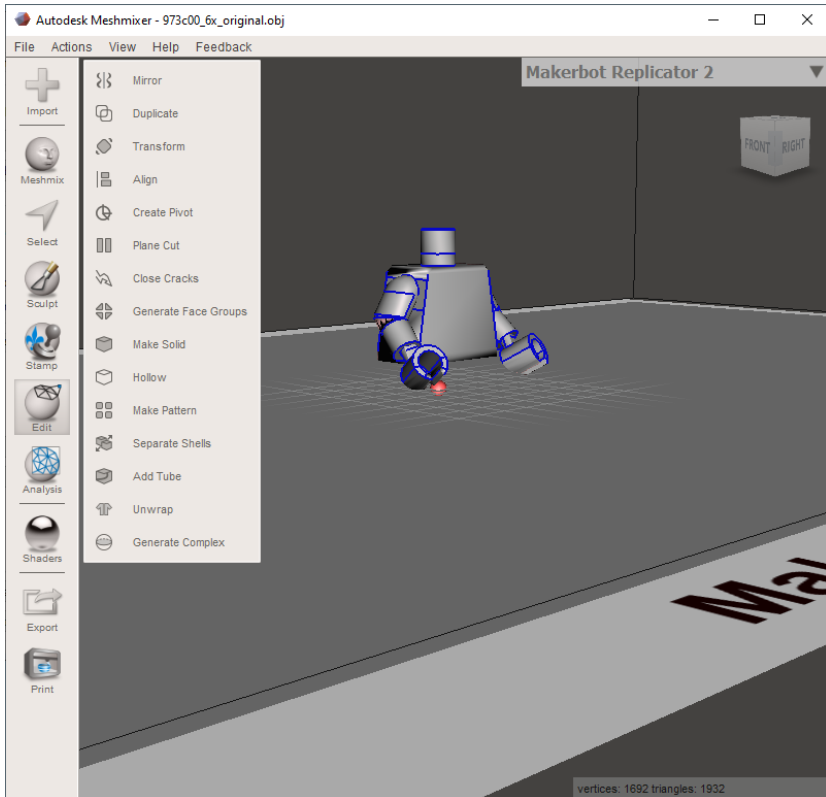
Automatic Generation of Constructable Brick Sculptures
© 2013-2015 Romain Testuz and Yuliy Schwartzburg
Details at <http://gg.epfl.ch/publications/2013/lego.php>
Contact: romain.testuz@rayform.ch



Incorrect orientation!



Meshmixer



1. Select all ▶
Edit ▶
Transform ▶
Rotate ▶
Accept
2. Export to
STL or OBJ



Qt Brickr

Main Limits

Load

Pre hollow Shell thickness: 2

Load shape

Load cube 20 10 20

Display

Layer by layer 0

Render bricks Render graph

Real Color Connected comp

Random Weak artic. point

Basic Advanced

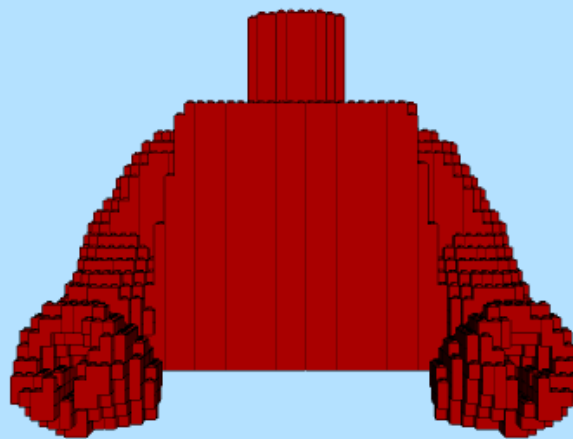
Auto optimize

Finalize

Print stats

Save instructions Export to .obj

Automatic Generation of Constructable Brick Sculptures
© 2013-2015 Romain Testuz and Yuliy Schwartzburg
Details at <http://gg.epfl.ch/publications/2013/lego.php>
Contact: romain.testuz@rayform.ch



Correct orientation!



Qt Brickr

Main Limits

Load

Pre hollow Shell thickness: 2

Load shape

Load cube 20 10 20

Display

Layer by layer 6

Render bricks Render graph

Real Color Connected comp

Random Weak artic. point

Basic Advanced

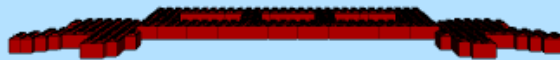
Auto optimize

Finalize

Print stats

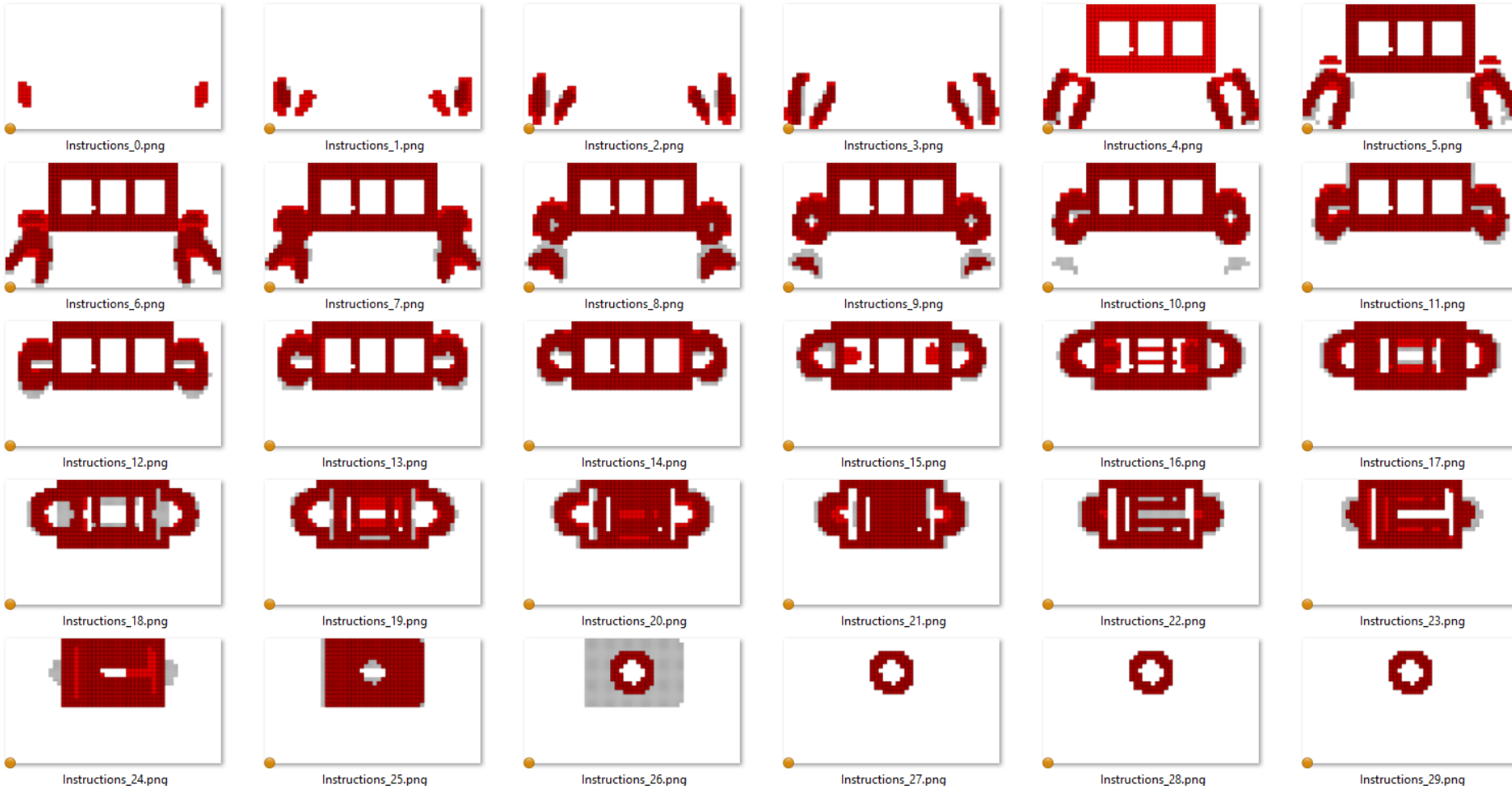
Save instructions Export to .obj

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Contact: romain.testuz@rayform.ch



“Layer by layer” feature



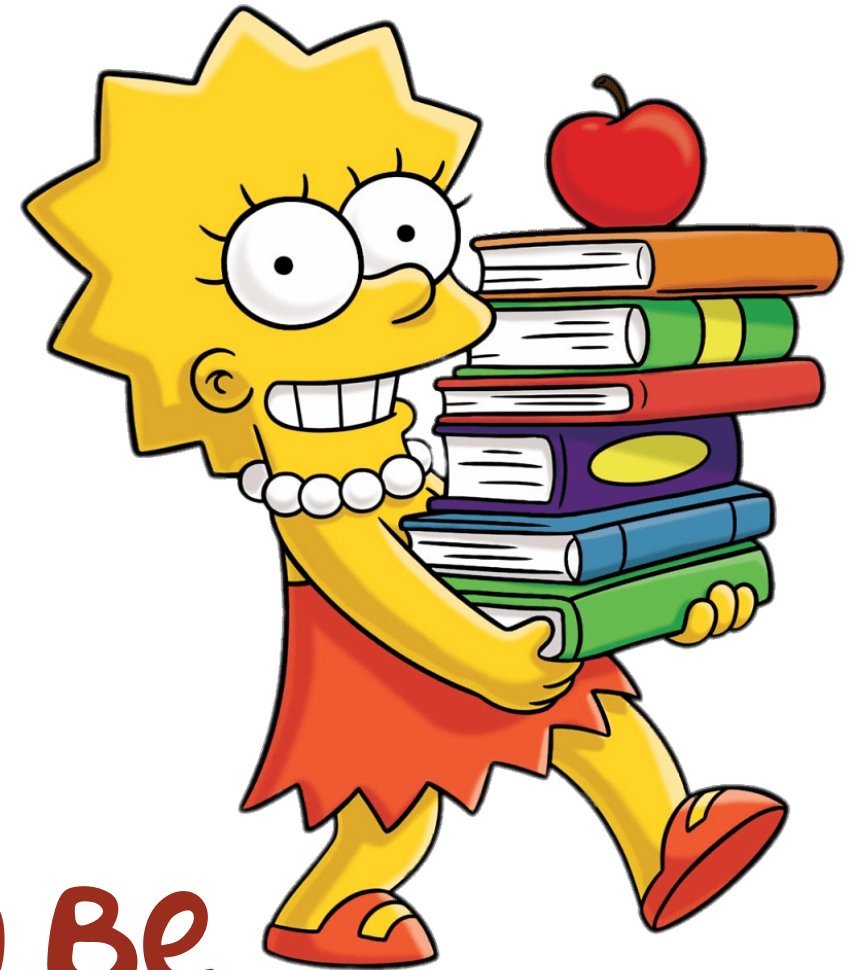


“Save instructions” feature



A final word...

PROGRAMS ARE
STUPID!



You Be
SMART!



Other Questions? You got em!

Answers? Mmmmmaybe.

hirt.brian@gmail.com



lolugclub.org

