

The background of the slide features two 3D printed objects with a blue lattice or grid pattern. One object is a semi-circular arch, and the other is a larger, more complex structure with a diamond-shaped grid. They are resting on a light-colored wooden surface.

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AN INTRODUCTION TO 3D PRINTING IN THE STEM CLASSROOM

BASED ON WORK FUNDED BY 4VA

A man with dark hair and a slight smile, wearing a black t-shirt and a red and white stethoscope, stands in front of a light purple wall. In the background, a wooden door and some red flowers are visible.

DOCTOR IN GAZA 3D PRINTS \$5
STETHOSCOPE WITH BETTER
AUDIO QUALITY THAN
STANDARD \$150 VERSION

SUBLIME

WHAT IS THE BIG DEAL ABOUT 3D
PRINTING?



ENABLE VOLUNTEERS PRINT
PROSTHETIC HANDS FOR
CHILDREN

SUBLIME

Pas

WHAT IS THE BIG DEAL ABOUT 3D
PRINTING?

ve

3D-Printed Guns Are Only Getting Better, and Scarier



Adam Clark Estes

Filed to: GUNS 1/06/15 1:15pm

60,520 🔥 3 ⭐



Adam Clark Estes

Filed to: GUNS 1/06/15 1:15pm



THIS IS THE FIRST THING
EVERYONE ASKS ABOUT

3D-PRINTED UNSAVORY

and \$ WHAT IS THE BIG DEAL ABOUT 3D
PRINTING?



Adam

Filed to

3D-printed TSA master keys put travellers' luggage at risk

Lockpickers took advantage of US Transportation Security Administration breach in which photos of its 'approved' locks were posted online



A TSA officer inspecting a passenger's luggage at an airport security checkpoint.

3D-printed TSA master keys put travellers' luggage at risk

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Lockpickers took advantage of US Transportation Security Administration

Lockpickers took advantage of US Transportation

UNSAVORY


WHAT IS THE BIG DEAL ABOUT 3D PRINTING?



3D PRINTED SUGAR CUBES,
CHOCOLATES, MARZIPAN, AND
OTHER FOODS ARE ALL A
REALITY

RIDICULOUS

WHAT IS THE BIG DEAL ABOUT 3D
PRINTING?




"THINGS MADE WITH 3D-
PRINTERS TEND TO FALL INTO
TWO BROAD CATEGORIES: ONE
IS SILLY BORDERING ON
USELESS—INCREDIBLY
DETAILED CHESS PIECES, A
MUG THAT LOOKS SURPRISED, A
MASK THAT LOOKS LIKE TOM
HANKS, WHAT HAVE YOU. THE
OTHER IS LIVE-SAVING
BORDERING ON FROM THE
FUTURE, LIKE THE IDEA THAT
WE MIGHT SOON HAVE 3D-
PRINTED ORGANS."
OLGA KAZHAN, THE ATLANTIC



RIDICULOUS (I ADMIT IT, I MADE ONE OF THESE)

WHAT IS THE BIG DEAL ABOUT 3D
PRINTING?



THE PROCESS OF MODELING IS
ESSENTIALLY THE SAME
WHETHER IT IS THE
DESCRIPTION OF A HUMAN
ORGAN, AN IPHONE CASE, OR
A TOOTHPASTE SQUEEZER, AND
WHETHER THE PRINTER IS AN
\$800 PRINTER OR A MILLION
DOLLAR PRINTER



RIDICULOUS (I ADMIT IT, I MADE ONE OF THESE)
WHAT IS THE BIG DEAL ABOUT 3D
PRINTING?



IN THE CLASSROOM:
TACTILE LEARNING
VISUALIZATION
FAITHFUL RENDERING



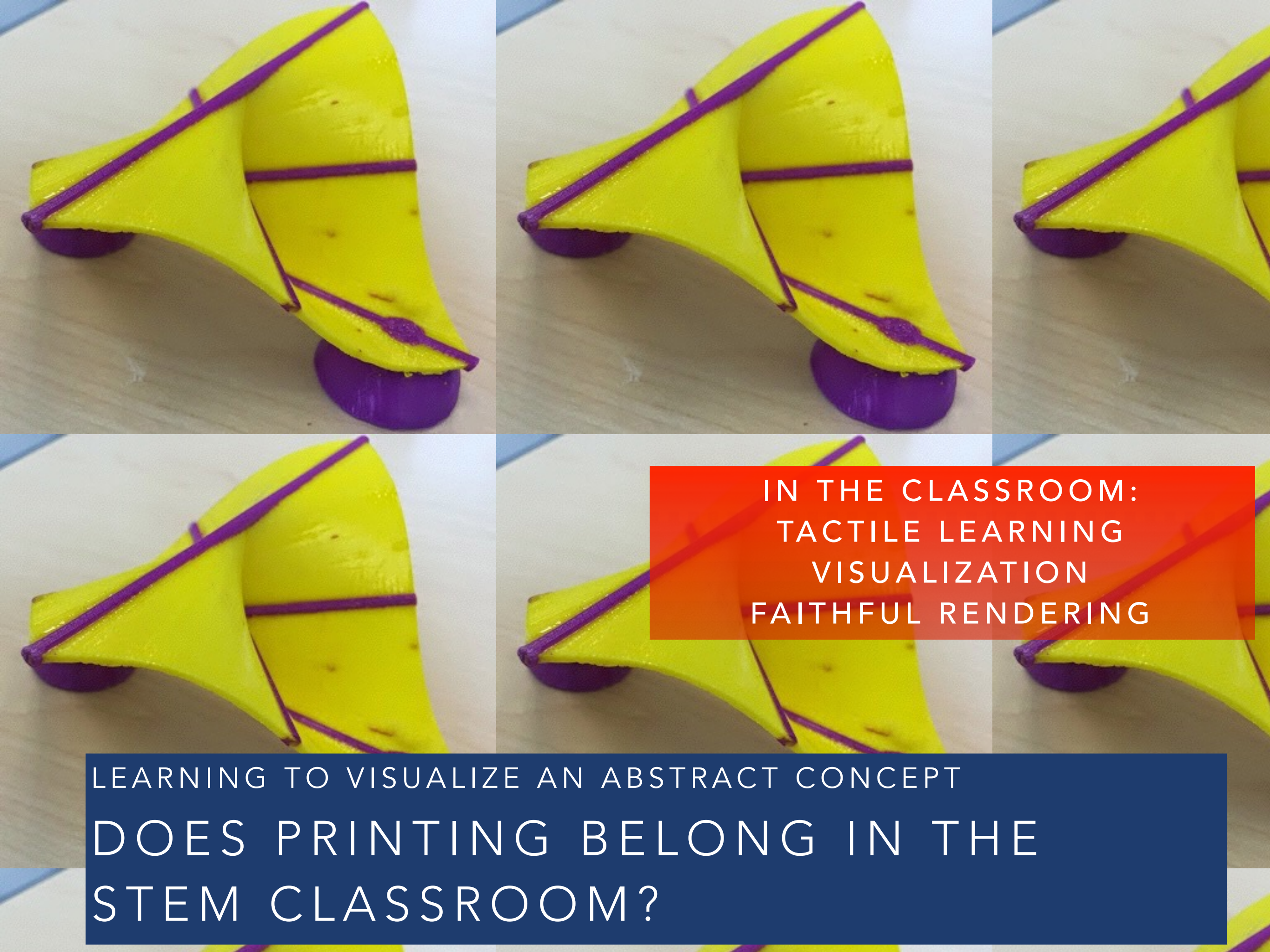
LEARNING TO DISSECT A FROG

DOES PRINTING BELONG IN THE
STEM CLASSROOM?



IN THE CLASSROOM:
TACTILE LEARNING
VISUALIZATION
FAITHFUL RENDERING

LEARNING TO PERFORM SURGERY ON A PARTICULAR PATIENT
DOES PRINTING BELONG IN THE
STEM CLASSROOM?



IN THE CLASSROOM:
TACTILE LEARNING
VISUALIZATION
FAITHFUL RENDERING

LEARNING TO VISUALIZE AN ABSTRACT CONCEPT
DOES PRINTING BELONG IN THE
STEM CLASSROOM?



LEARNING BY CREATING

DOES PRINTING BELONG STEM CLASSROOM?



IN THE CLASSROOM:
TACTILE LEARNING
VISUALIZATION
FAITHFUL RENDERING

3D ARCHIVING OF RESEARCH

DOES PRINTING BELONG IN THE
STEM CLASSROOM?

FUSED DEPOSITION MODELING

HOW DOES A 3D PRINTER WORK?

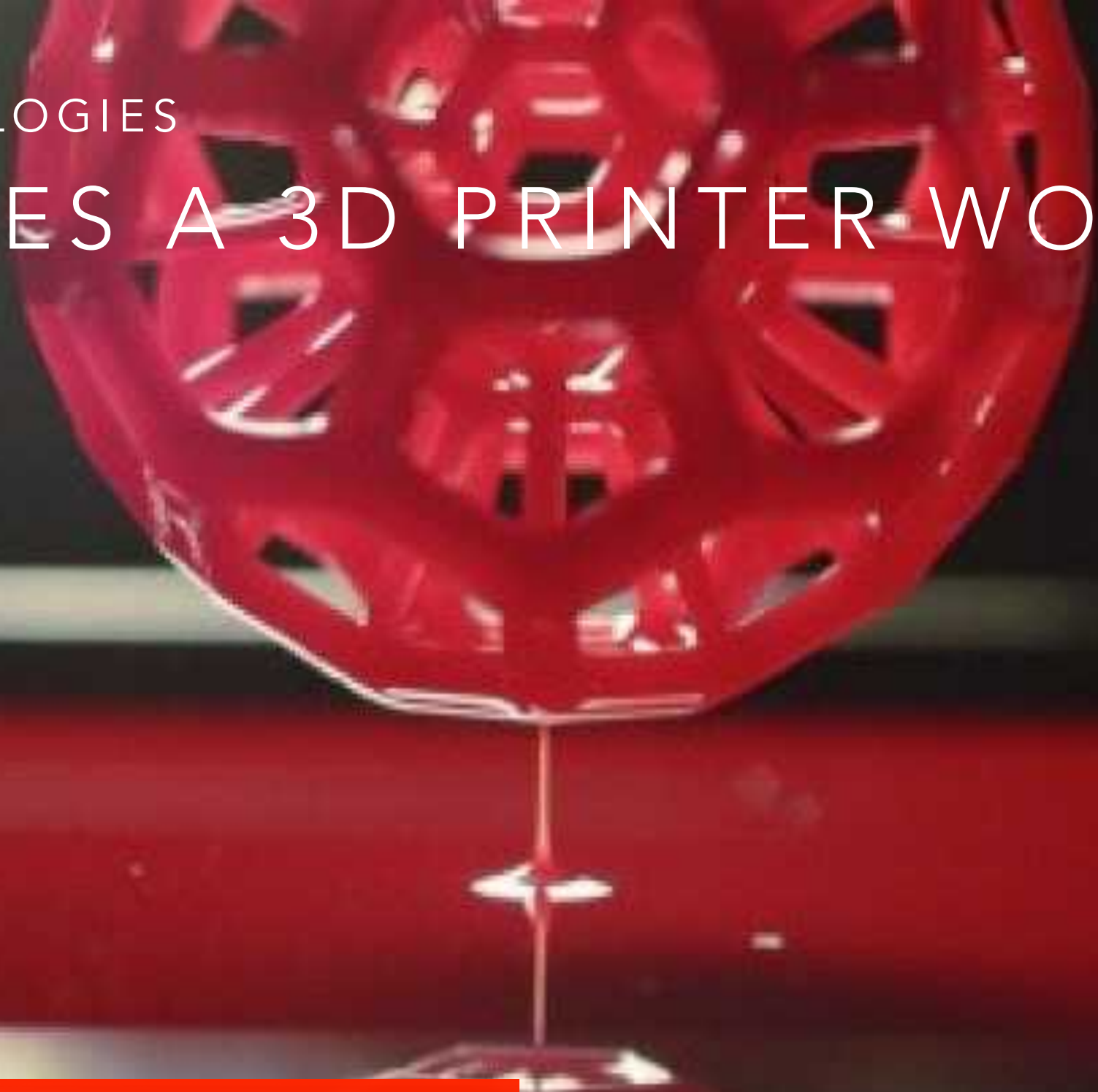
A 3D printer is shown in operation, printing a yellow, geometric, spherical object on a blue surface. The printer's head is positioned above the object, and the object is composed of many thin layers of plastic. The printer is a large, industrial-looking machine with a blue frame and a yellow print head. The background is dark, and the lighting is focused on the printer and the object being printed. The text "FUSED DEPOSITION MODELING" is at the top, and "HOW DOES A 3D PRINTER WORK?" is below it. A red box at the bottom contains the text "MOST 3D HOME OR OFFICE PRINTERS WORK BY EXTRUDING MANY THIN LAYERS OF HOT PLASTIC ON TOP OF EACH OTHER." The printer's brand name, "WishLabBot", is visible in red on the base.

MOST 3D HOME OR OFFICE
PRINTERS WORK BY EXTRUDING
MANY THIN LAYERS OF HOT
PLASTIC ON TOP OF EACH OTHER.

OTHER TECHNOLOGIES

HOW DOES A 3D PRINTER WORK?

OTHER TECHNOLOGIES ALSO
EXIST, SUCH AS THIS, INSPIRED BY
TERMINATOR 2



DESIGN

THE KEY TO CREATING A 3D MODEL



THERE ARE A VARIETY OF
DIFFERENT METHODS TO DESIGN
PRINTS. THEY INVOLVE VARYING
DEGREE OF MATHEMATICAL
SOPHISTICATION.

THINGIVERSE

PUBLIC REPOSITORIES



SMITHSONIAN

PUBLIC REPOSITORIES



MAJOR MUSEUMS (BRITISH, LOUVRE, NY METROPOLITAN, ...)

PUBLIC REPOSITORIES



DESIGN SOFTWARE

SCANNING



DESIGN SOFTWARE

SCANNING

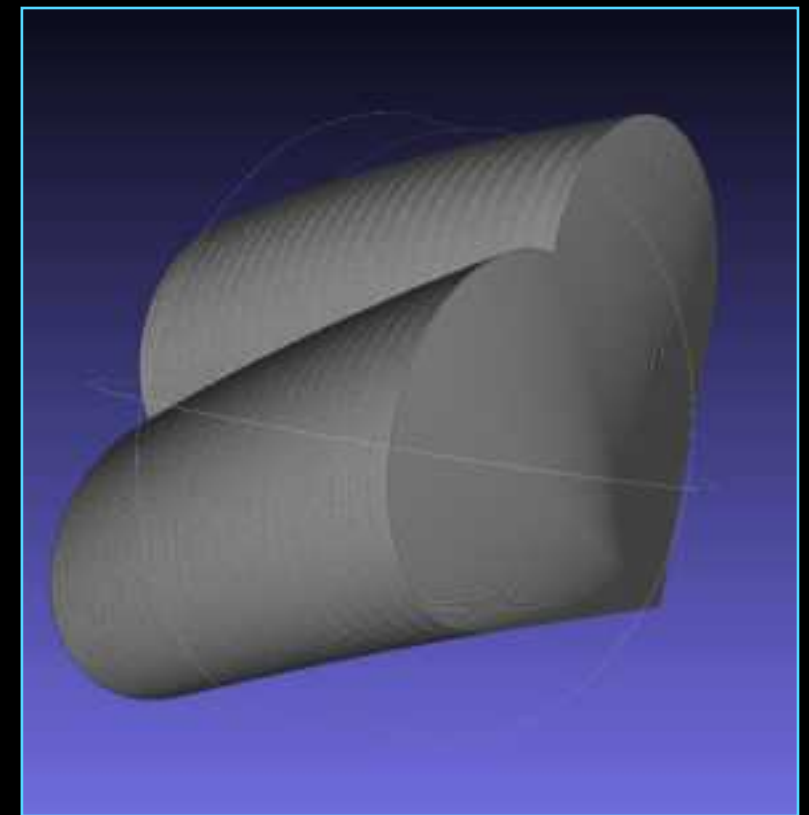
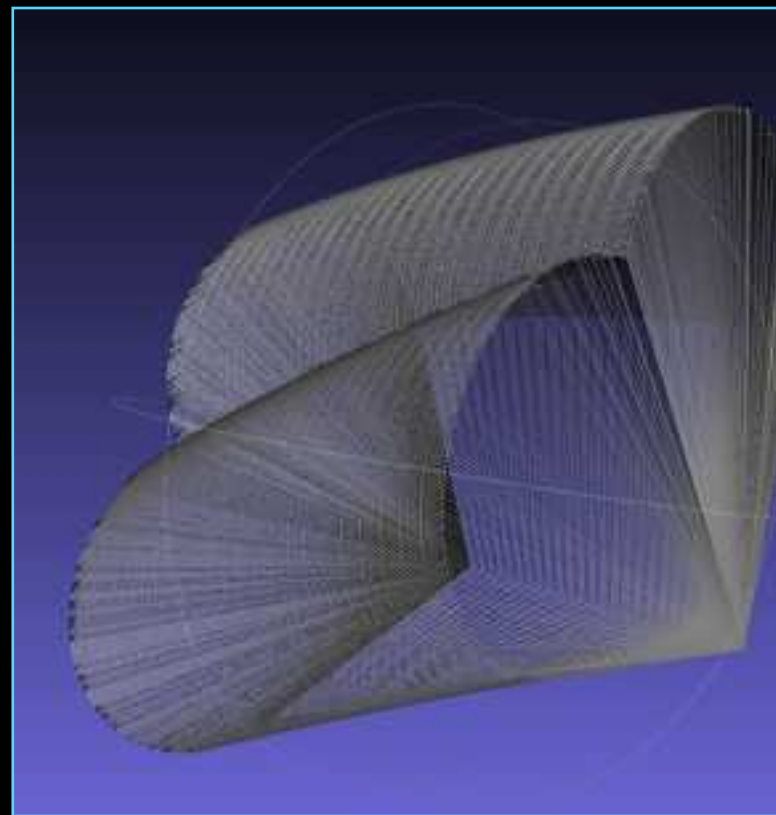
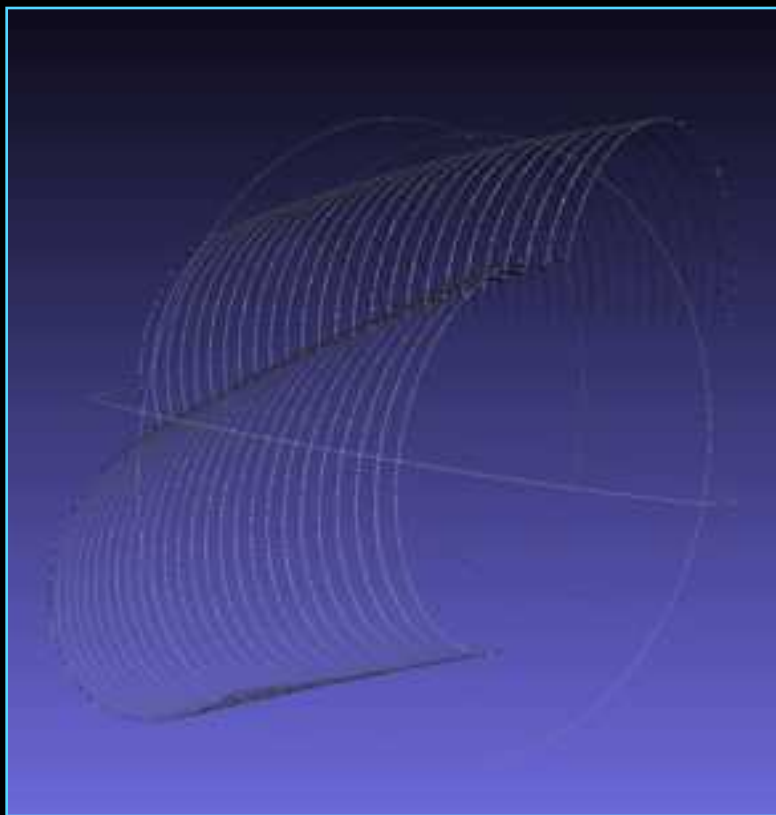
LASER / PHOTOGRAMMETRY TO CREATE A MODEL:

LASER SCANNER/CAMERA FINDS A SET OF POINTS ON THE OBJECT.

ERRORS AND HAVE TO BE CORRECTED.

POINTS ARE CONVERTED INTO A SOLID OBJECT: MESHING

DESIGN SOFTWARE MESHING



DESCRIBING THE OBJECT AS A POLYHEDRON WITH BOUNDING
VERTICES (7852), EDGES, AND FACES (15700).

DESIGN SOFTWARE

IPHONE APP



123D SCULPT USES THE IPHONE TO DESIGN 3D OBJECTS WITH
VERY LITTLE KNOWLEDGE. THIS PRINT WAS DESIGNED BY A THIRD
GRADER.

DESIGN SOFTWARE

IPHONE APP



THIS PRINT WAS DESIGNED BY A SIXTH GRADER.

THE DOWNSIDE OF THIS METHOD: THE MODELER HAS LIMITED CONTROL OVER THE EXACT SPECIFICATIONS OF THE MODEL.



COMPUTER AIDED DESIGN SOFTWARE

TINKERCAD/OPENSCAD

CAD SYSTEMS WORK BY ALLOWING MANIPULATION OF BASIC OBJECTS. THIS MARDI GRAS HAT CONSISTS OF INTERSECTIONS, UNIONS, TRANSLATIONS, AND SCALING OF SPHERES AND CYLINDERS.

COMPUTER AIDED DESIGN SOFTWARE

TINKERCAD/OPENSCAD

PRINTS DESIGNED IN TINKERCAD BY MIDDLE SCHOOL GIRLS AT A
2015 GMU STEM SUMMER CAMP



FOCUS in STEM

STEM Accelerator Program

College of Science



"Learning STEM by Doing"-FOCUS 2015

75 participants, 20 counselors





COMPUTER AIDED DESIGN SOFTWARE

OPENS CAD

THIS HEART IS MADE USING A SQUARE AND TWO CIRCLES:

```
SQUARE(20);  
TRANSLATE([10,20,0]) CIRCLE(10);  
TRANSLATE([20,10,0]) CIRCLE(10);
```


COMPUTER AIDED DESIGN SOFTWARE

OPENCAD



THIS SHAMROCK IS MADE BY COMBINING FOUR HEARTS:

```
HEART();
```

```
ROTATE([0,0,90]) HEART();
```

```
ROTATE([0,0,180]) HEART();
```

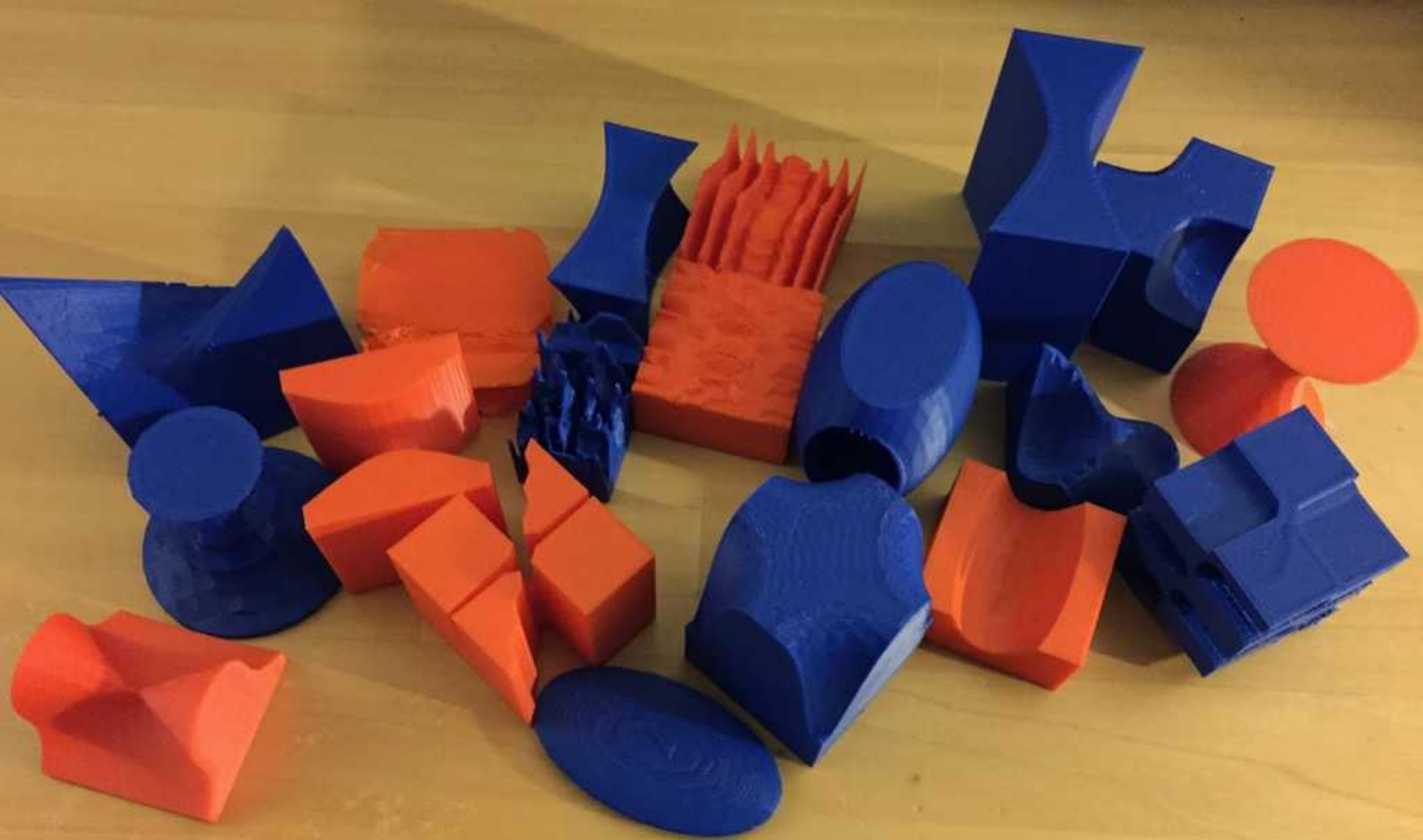
```
ROTATE([0,0,270]) HEART();
```


A blue 3D printed lattice structure, resembling a mesh or basket, is shown on a light-colored wooden surface. The structure is composed of a grid of interconnected blue lines, forming a series of diamond-shaped openings. A blue pen is placed horizontally across the middle of the lattice to provide a sense of scale. The background is a plain wooden surface with a visible grain.

MATHEMATICAL SOFTWARE

MATHEMATICA

MATHEMATICA IS SPECIALLY DESIGNED FOR MATHEMATICAL MODELING. THIS ALLOWS FOR OBJECTS THAT COULD NOT EASILY BE MADE IN A CAD SYSTEM.



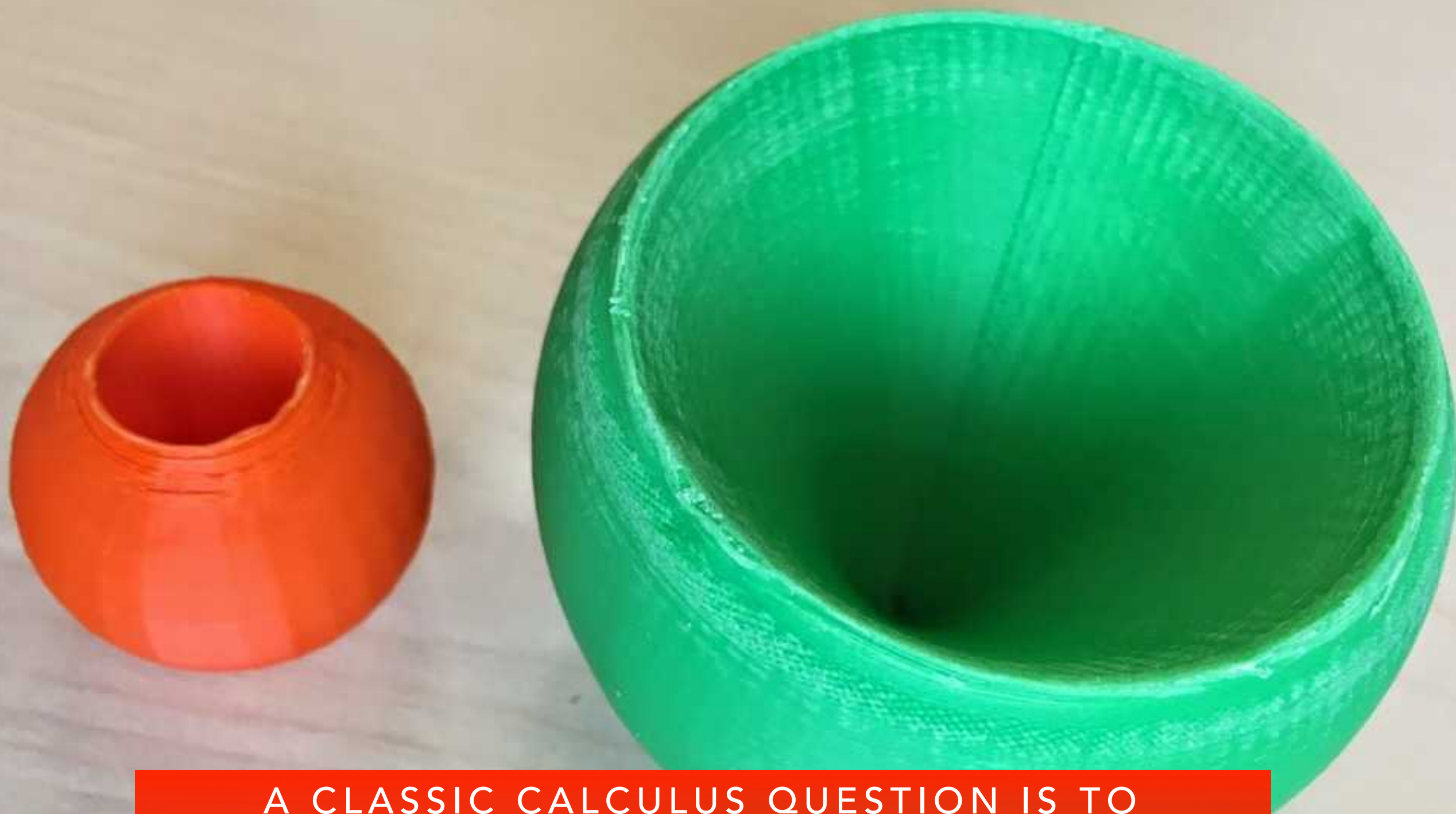
THESE PRINTS ARE CREATED IN MATHEMATICA
BY MULTIVARIABLE CALCULUS STUDENTS

A blue 3D-printed lattice structure, resembling a mesh or a woven pattern, is shown on a light-colored wooden surface. The structure is composed of interconnected blue lines forming a grid of diamond shapes. It is positioned diagonally across the frame, with one end pointing towards the top left and the other towards the bottom right. The lattice is made of a material that looks like plastic or a similar synthetic material, with a slightly textured surface. The background is a plain, light-colored wooden surface with visible grain patterns.

MATHEMATICAL SOFTWARE

MATHEMATICA

MY GOAL IS TO BRING TO LIFE WHAT MATHEMATICIANS SEE IN
THE MIND'S EYE



A CLASSIC CALCULUS QUESTION IS TO
CALCULATE THE VOLUME OF A SPHERE WITH A
CONE DRILLED OUT. IT IS HARD TO VISUALIZE,
BUT HERE IT IS!



Mathematical saddle



Mathematical saddle: level sets



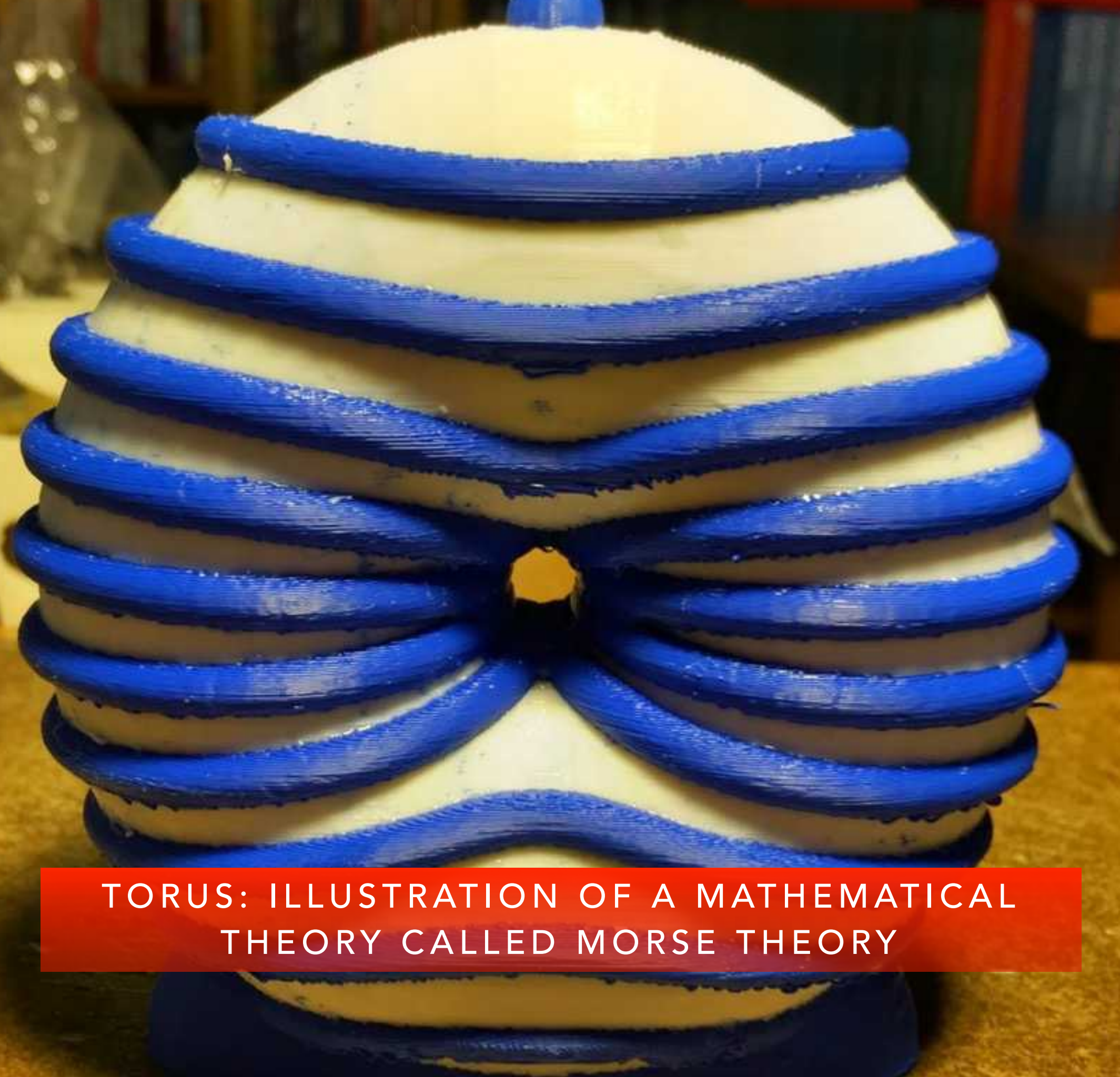
Ellipsoid



Ellipsoid: Different types of level sets



Monkey saddle: room for a monkey's tail



TORUS: ILLUSTRATION OF A MATHEMATICAL
THEORY CALLED MORSE THEORY



A TRIANGULAR TORUS WITH TEN TWISTS AS IT
WRAPS FOUR TIMES.

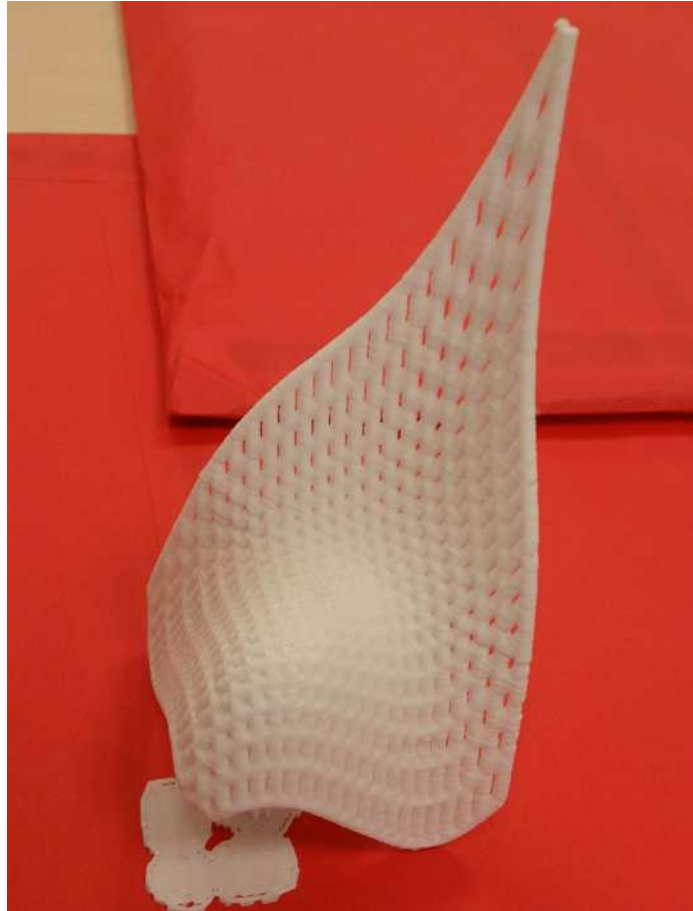
A photograph showing two Möbius strips interlocked on a light-colored wooden surface. One strip is red and the other is white. They are twisted and joined at their ends, forming a continuous loop. The strips are positioned such that they intersect at multiple points, and at each intersection, they appear to be at right angles to each other. The lighting is warm, highlighting the texture of the paper and the wood grain.

TWO MOBIUS STRIPS AT RIGHT ANGLES AT EVERY
INTERSECTION POINT

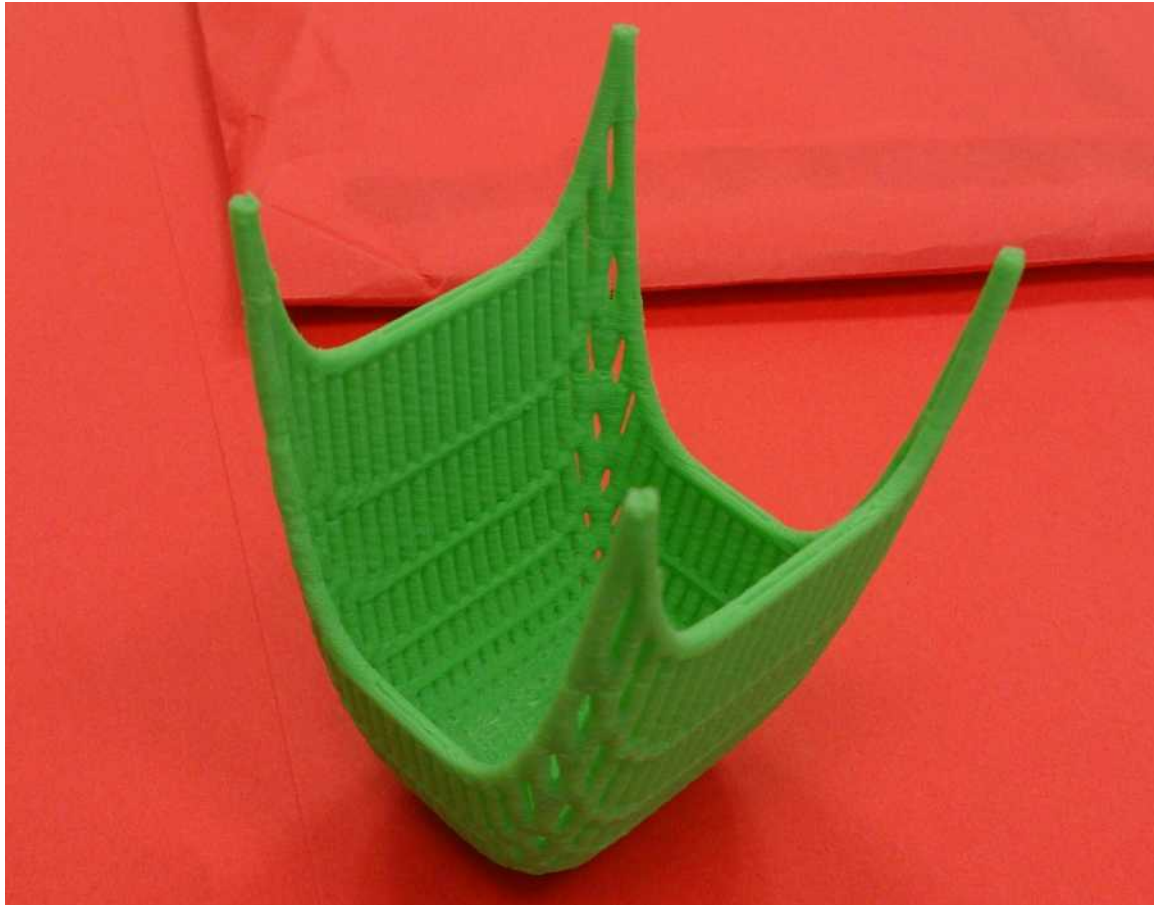


FROM MY OWN RESEARCH:
MATERIALS SCIENCE MICROSTRUCTURES

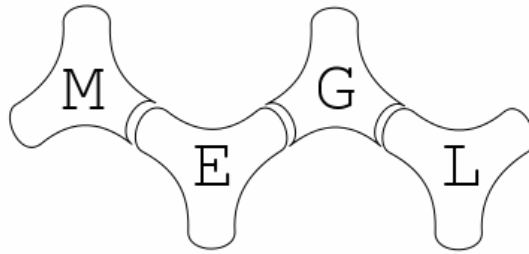
3D printing experiments in Calculus I



3D printing experiments in Calculus I



Mason Experimental Geometry Lab

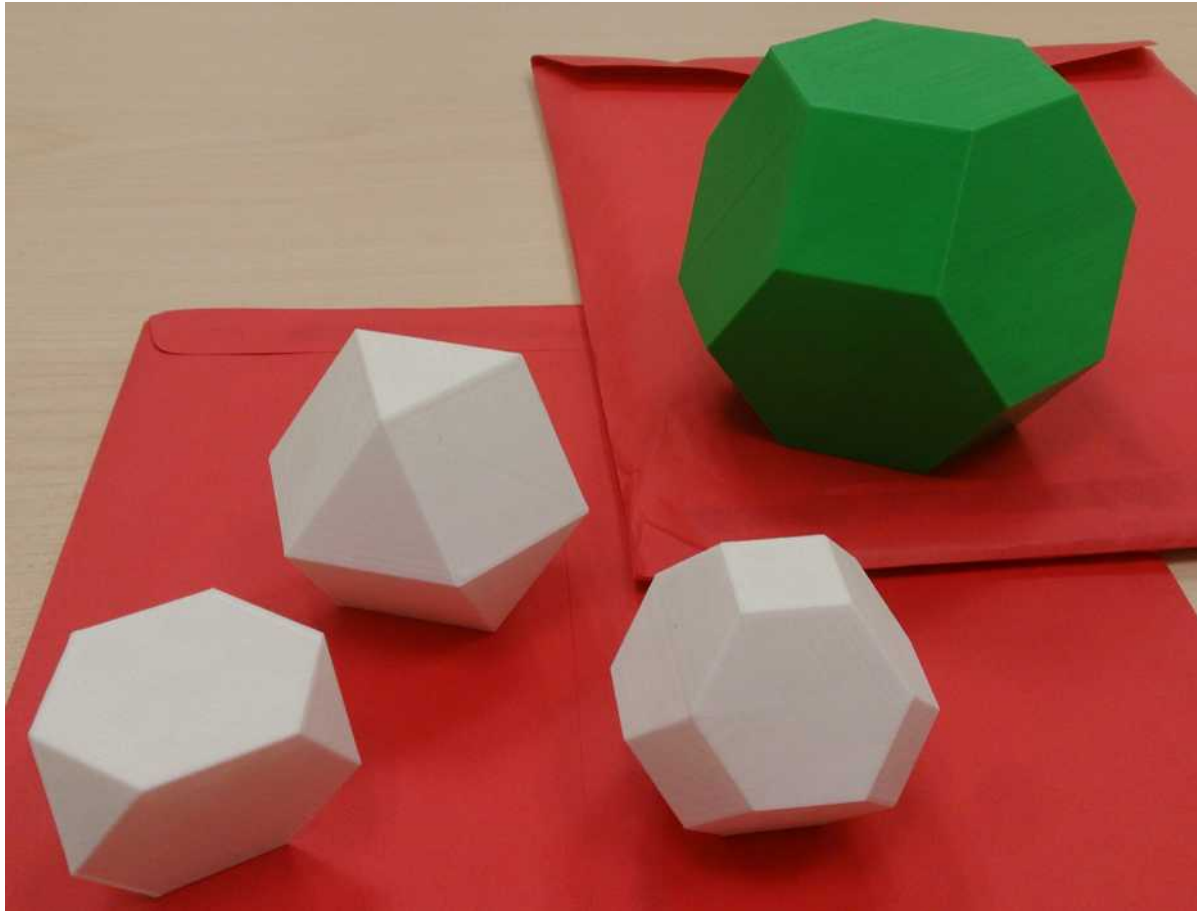


Mason Experimental Geometry Lab

<http://meglab.wikidot.com/visualization>



Mason Experimental Geometry Lab





STILL LOOK IMPOSSIBLE?
HERE'S A STEP BY STEP GUIDE

