3D Printing with Mathematica and TinkerCad

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Topics:

- Geometry for 3D Printing
- STL File
- Surfaces in Mathematica
- Constructive Solid Geometry
- Export to STL
- Basic TinkerCad
- Importing STL files in TinkerCad
- Exporting STL files from TinkerCad

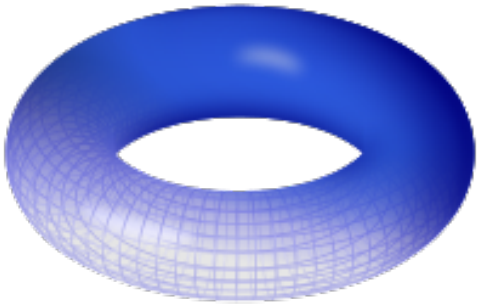
Geometry for 3D Printing

Requires a closed Manifold

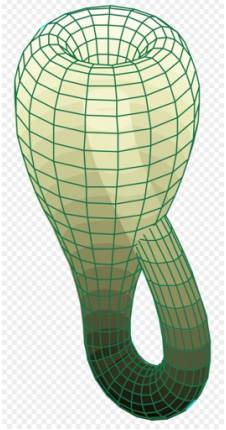
- No dangling vertices
- No dangling edges
- No dangling polygons

Examples:

- Torus

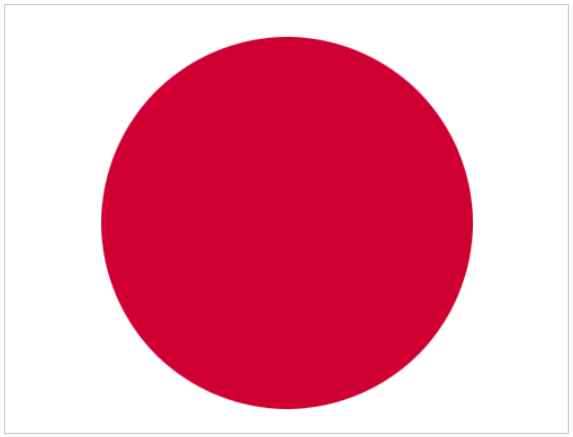


- Klein Bottle

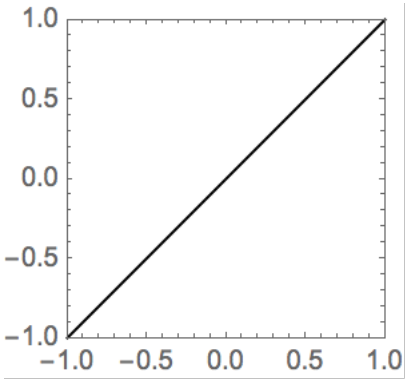


Not Examples:

- Disc



- Infinite Line



STL Files

STL = STereo**L**ithography file
What is Stereolithography?

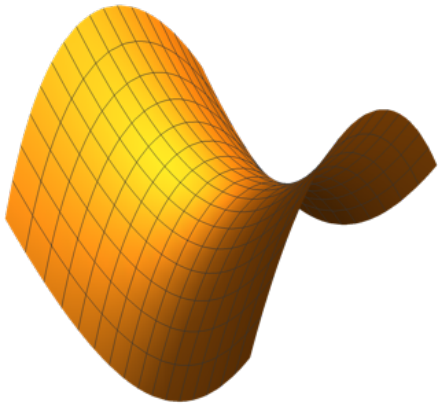
Triangle Example:

```
solid MyObject
    facet normal 0 0 0
        outerloop
            Vertex -0.625 1 0.609
            Vertex -0.714 0.875 0.255
            Vertex 0.625 0.946 0.505
        endloop
    endfacet
endsolid MyObject
```

Surfaces in Mathematica

The “Plot” commands can generate 3D surfaces.
Example:

ParametricPlot3D[{x,y,y^2-x^2},{x,-1,1}, {y,-1,1}, boxed->False, Ticks->False, AspectRatio->Automatic, Axes->False]

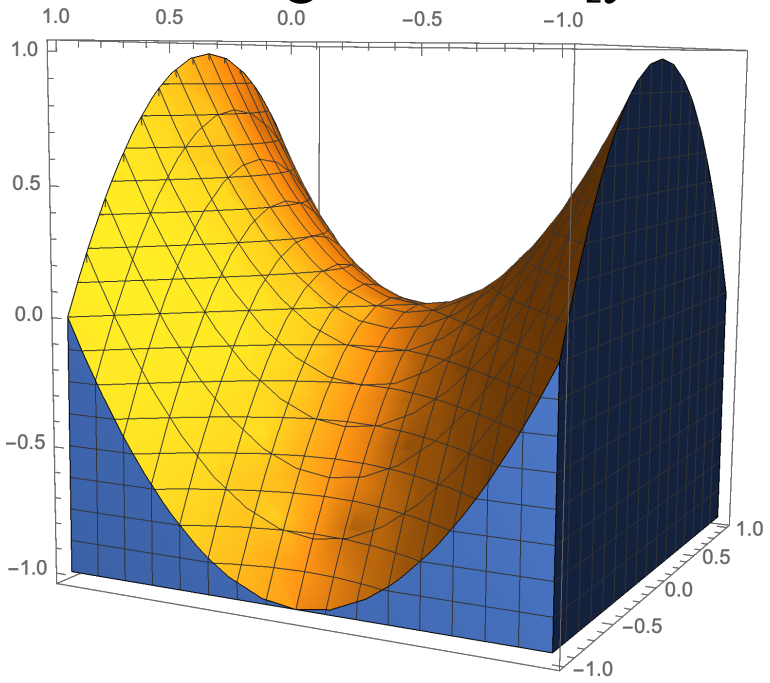


This violates the requirements for an STL file for 3D printing! Why?

Constructive Solid Geometry

Defines geometry in such a way that objects can be closed. Implemented in Mathematica using RegionPlot.

Saddle=RegionPlot3D[y^2-x^2>z, {x,-1,1},{y,-1,1},{z,-1,1}]



Meets requirements of being closed, no dangling vertices, no dangling edges, no dangling faces.

Export to STL

Mathematica makes generating STL files easy!

Export["~/Saddle_Ascii.stl", Saddle, {"STL", "BinaryFormat" -> False}]

Ascii text output is human readable:

```
solid Created_by_the_Wolfram_Language_:_www.wolfram.com
 facet
  normal 0 0 0
  outer loop
    vertex -0.589286 0.125 -0.331633
    vertex -0.571428 0.125 -0.310906
    vertex -0.571428 0.142857 -0.306122
  endloop
 endfacet
```

```
facet
  normal 0 0 0
  outer loop
    vertex -0.5 -0.571428 0.0765306
    vertex -0.5 -0.5 0
    vertex -0.571428 -0.571428 0
  endloop
 endfacet

facet
  normal 0 0 0
  outer loop
    vertex -0.928571 -0.5 -0.612245
    vertex -0.875 -0.5 -0.515625
    vertex -0.875 -0.446429 -0.566326
  endloop
 endfacet

 facet
  normal 0 0 0
  outer loop
    vertex -0.785714 -0.5 -0.367347
    vertex -0.75 -0.5 -0.3125
    vertex -0.75 -0.464286 -0.346939
  endloop
 endfacet

 …
Endsolid Created_by_the_Wolfram_Language_:_www.wolfram.com
```

Basic TinkerCad

Tinkercad is a beginner-level Autodesk web-based cad package.
https://www.tinkercad.com/

Basic tutorial:
https://maker.math.uconn.edu/3d-printing-for-mathematics/tinkercad-for-mathematics/tutorial-for-annotating-3d-models/

Example model:
https://www.tinkercad.com/things/aCkT4ohjIcl

A challenging example:
https://www.tinkercad.com/things/aKMpAQMPnEW

Discussion