DIGITAL TO PHYSICAL

Making things with code.

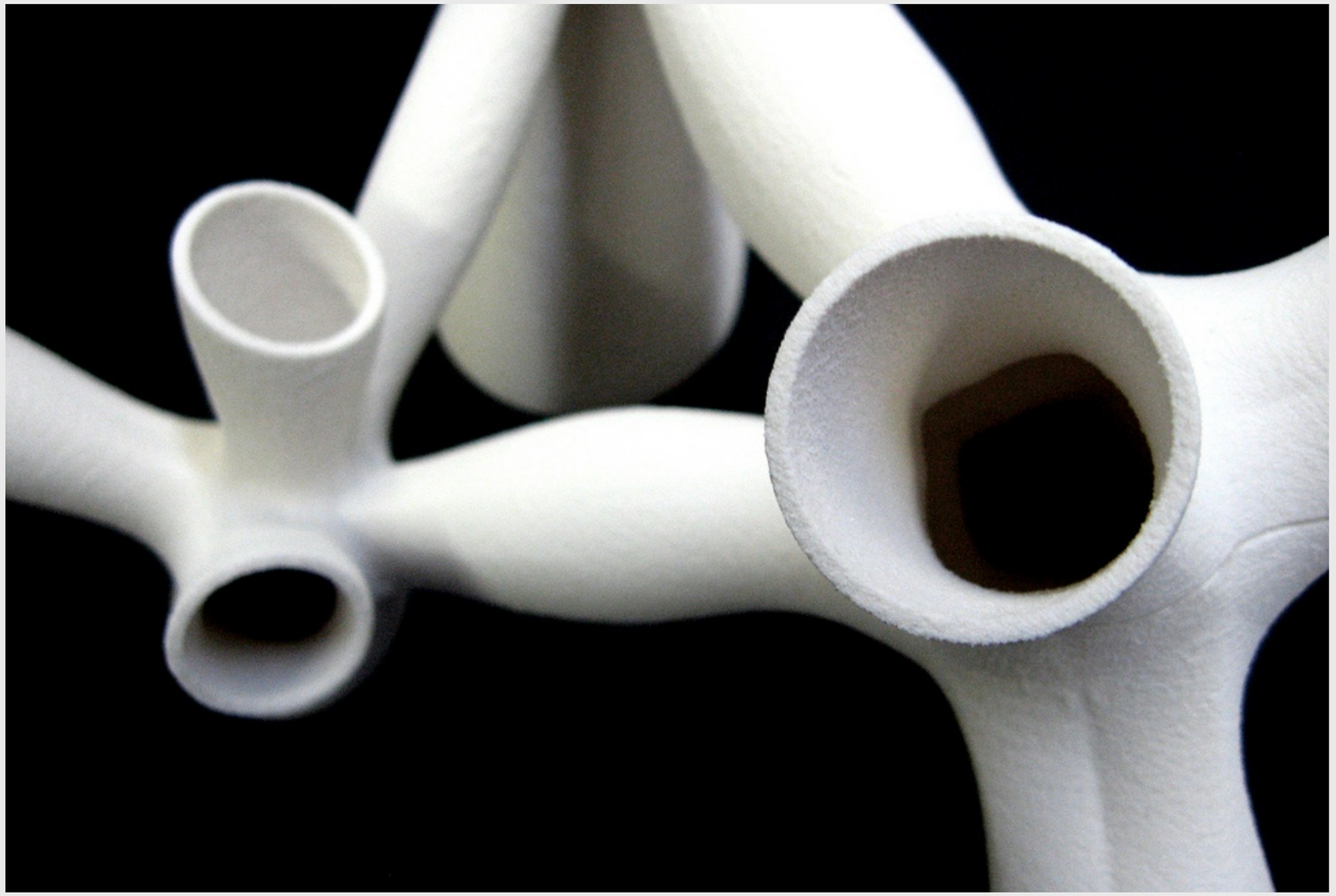
CRAFT IS NOT DEAD

EXPRESS THE MACHINE

Making things with computers and the machines they can control can be every bit as personal, and tactile, as traditional processes.

Each line of code you write and bezier you draw shapes your object in a way that's your own.

3D PRINTING



LASER CUTTING

PEN & KNIFE PLOTTING

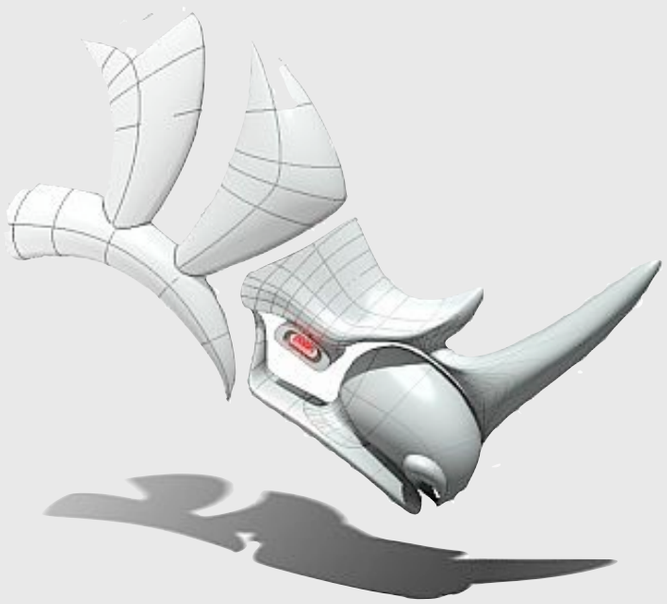
CNC

TOOLS

TO A HAMMER EVERYTHING IS A NAIL

Just because you're using software, doesn't mean you don't need to specialize. What are you making? How should it be represented? What machines will you ultimately be using? All these questions will inform what program(s) and platform(s) you use.

SURFACES



NURBS can generally be thought of as 3D versions of curves and are often built from series of curves in space. Surfaces are great for accurately representing complex and double curved surfaces while retaining a good deal of construction information.

Osnap Ortho Planar Snap Gumball History

Top

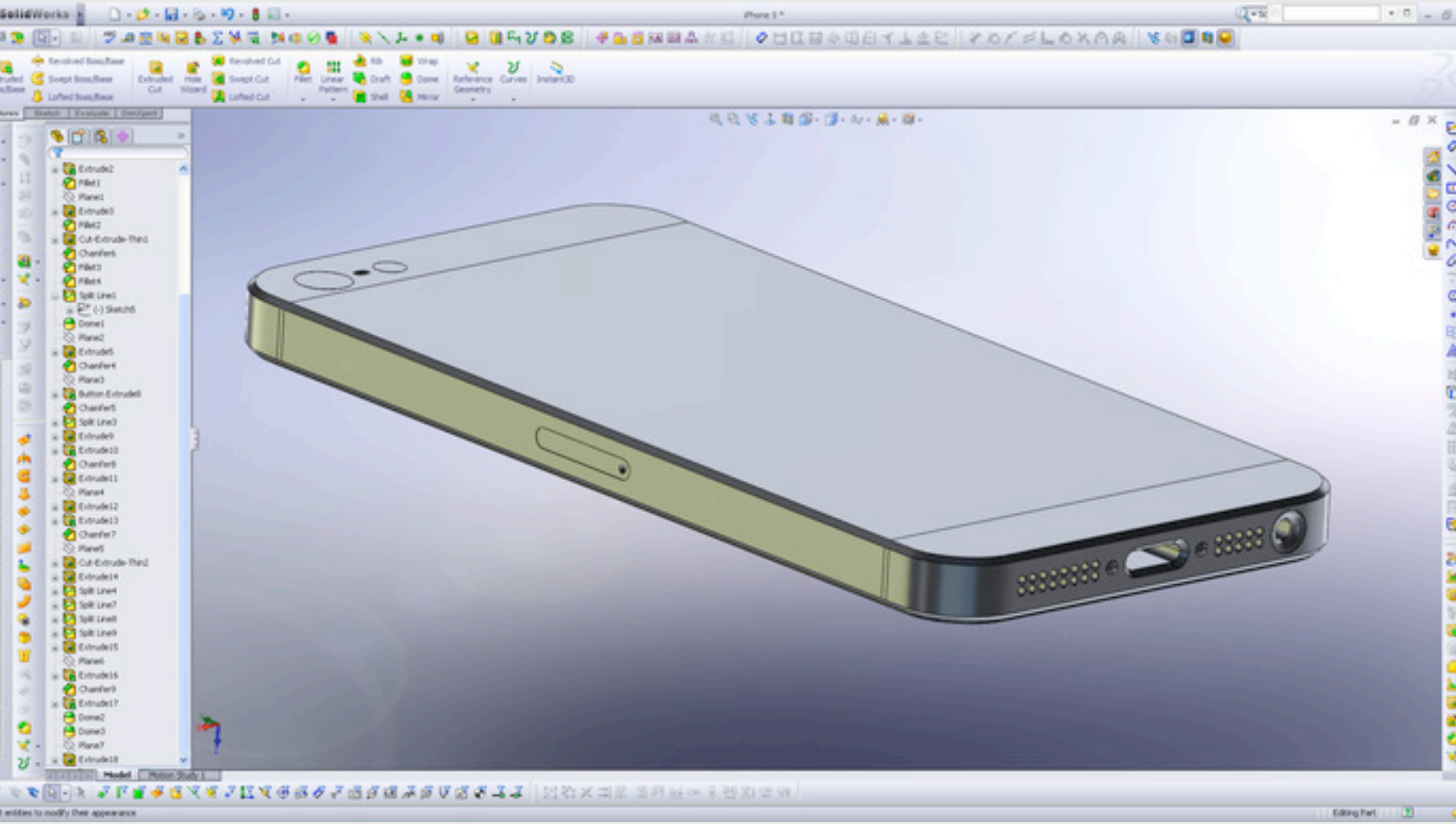
Perspective

Right

Perspective

SOLIDS

Solid modeling is more common in industrial design and most applicable to complex milling projects or for objects that will be mass manufactured. Solids are easily parameterizeable which can lead to great flexibility in well designed models.


SolidWorks
iPhone 5 *
Revolved Boss/Base
Swept Boss/Base
Lofted Boss/Base
Extruded Cut
Hole Wizard
Revolved Cut
Swept Cut
Lofted Cut
Fillet
Linear Pattern
Rib
Draft
Shell
Wrap
Dome
Mirror
Reference Geometry
Curves
Instant3D
Extrude2
Fillet1
Plane1
Extrude3
Fillet2
Cut-Extrude-Thin1
Chamfer6
Fillet3
Fillet4
Split Line1
(-) Sketch5
Dome1
Plane2
Extrude6
Chamfer4
Plane3
Button Extrude8
Chamfer5
Split Line3
Extrude9
Extrude10
Chamfer8
Extrude11
Plane4
Extrude12
Extrude13
Chamfer7
Plane5
Cut-Extrude-Thin2
Extrude14
Split Line4
Split Line7
Split Line8
Split Line9
Extrude15
Plane6
Extrude16
Chamfer9
Extrude17
Dome2
Dome3
Plane7
Extrude18
Model
Motion Study 1
Editing Part

MESHES

Meshes are possibly the most conceptually simple of the standard 3D representations. While they can be used in precision modeling–usually they would be created directly from data or code–meshes are great for representing complex surfaces for rendering and printing. And, just like all computer graphics are eventually pixels, all 3D files are, eventually, triangles.

File Add Render Window Help Default Scene Blender Render v2.65 | Verts:1/338 | Edges:0/642 | Faces:0/304 | Tris:600 | Plane

User Ortho

(142) Plane

New
New Layer
Delete Frame Convert
View
3D Cursor
Item
Display
Motion Tracking
Mesh Display
Background Images
Add Image
Front.jpg
Axis: Front
Image Movie Clip
ront.jpg F
Source: Single Image
//Front.jpg
Color Space:
sRGB
View as Render
Opacity: 0.629
Back Front
-0.0996 Y: 0.300
Size: 4.500
Side.png
Axis: Right

User Ortho

(142) Plane

Right Ortho

(142) Plane

View Search
Scene
RenderLayers
World
Camera
Lamp
Plane
Add Modifier
Apply Copy
Axis: Options: Textur
X Merge U
Y Clippin V
Z Vertex
Merge Limit: 0.001000
Mirror Object:
Apply Copy
Catmull-Clark Simple
Subdivisions: Options:
View: 1 Subdivi
Render: 2 Optimal

View Select Mesh Edit Mode Global

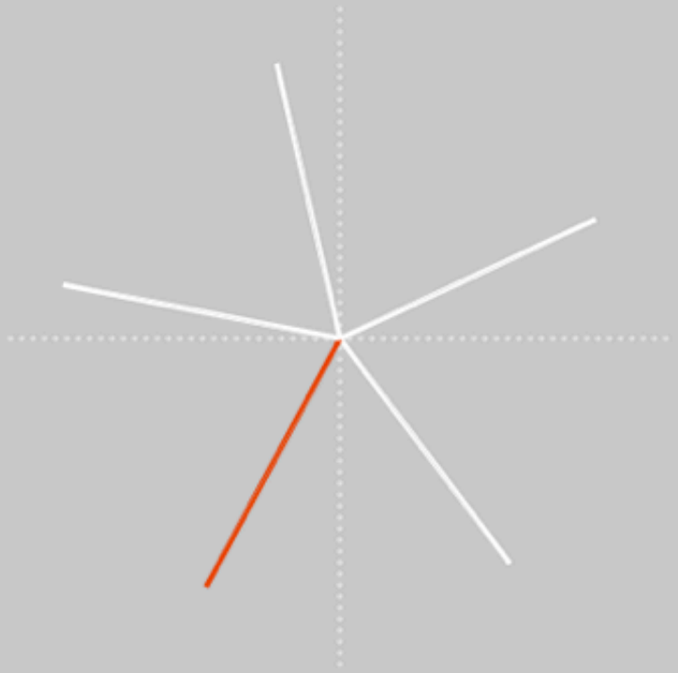
Global

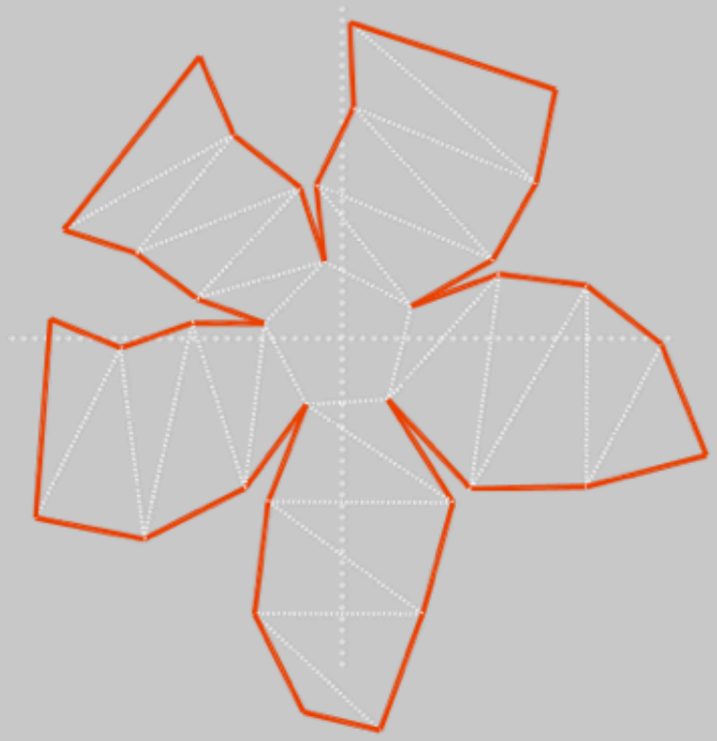
-40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280

View Marker Frame Playback Start: 1 End: 250 142 No Sync

ROLL YOUR OWN

Sometimes existing tools just don't have the data structure or features you want. When that happens, just write your own! Processing and C++ are good places to start.



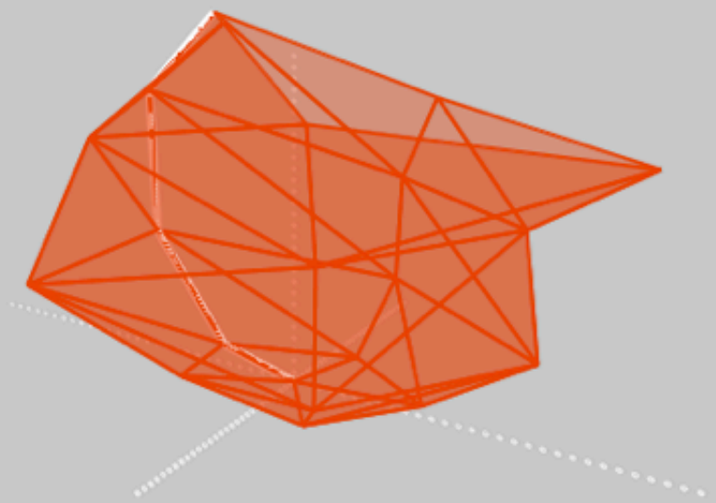


Press ← or → to change the active rib's angle.

Press ↑ or ↓ to change the number of segments.

Press 'e' to remove the active rib

Press '2' to save a cut PDF or '3' to save a DXF.



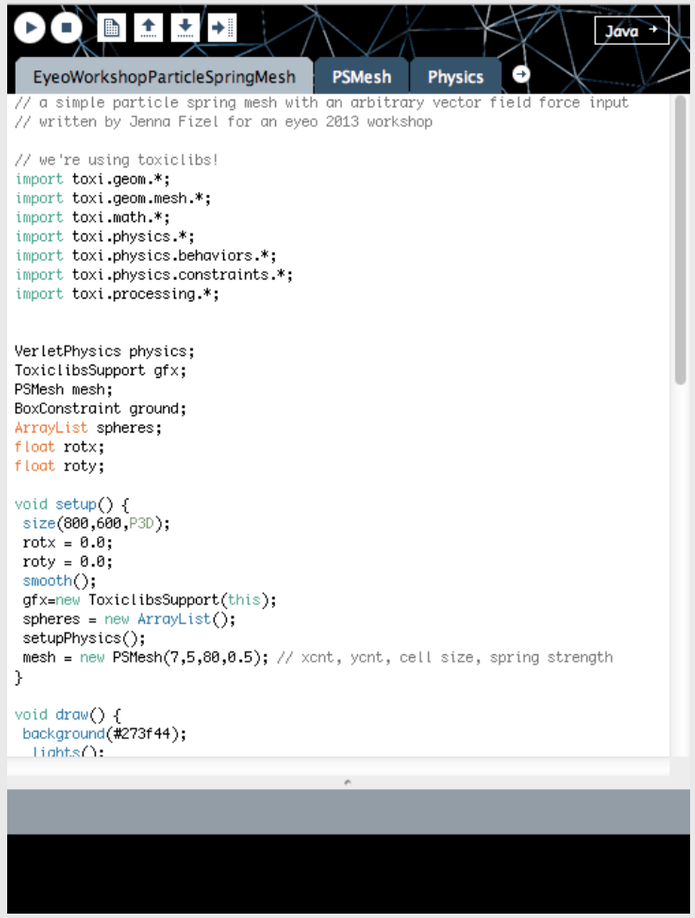
D.bowl

LETS MAKE SOMETHING

go to digitaltophysical.tumblr.com

PROCESSING

Not only a popular way to learn to code, Processing is a great tool for creating producible geometry. Combined with the toxiclibs library, it’s a flexible modeler and simple physics simulator.



WHAT YOU'LL NEED

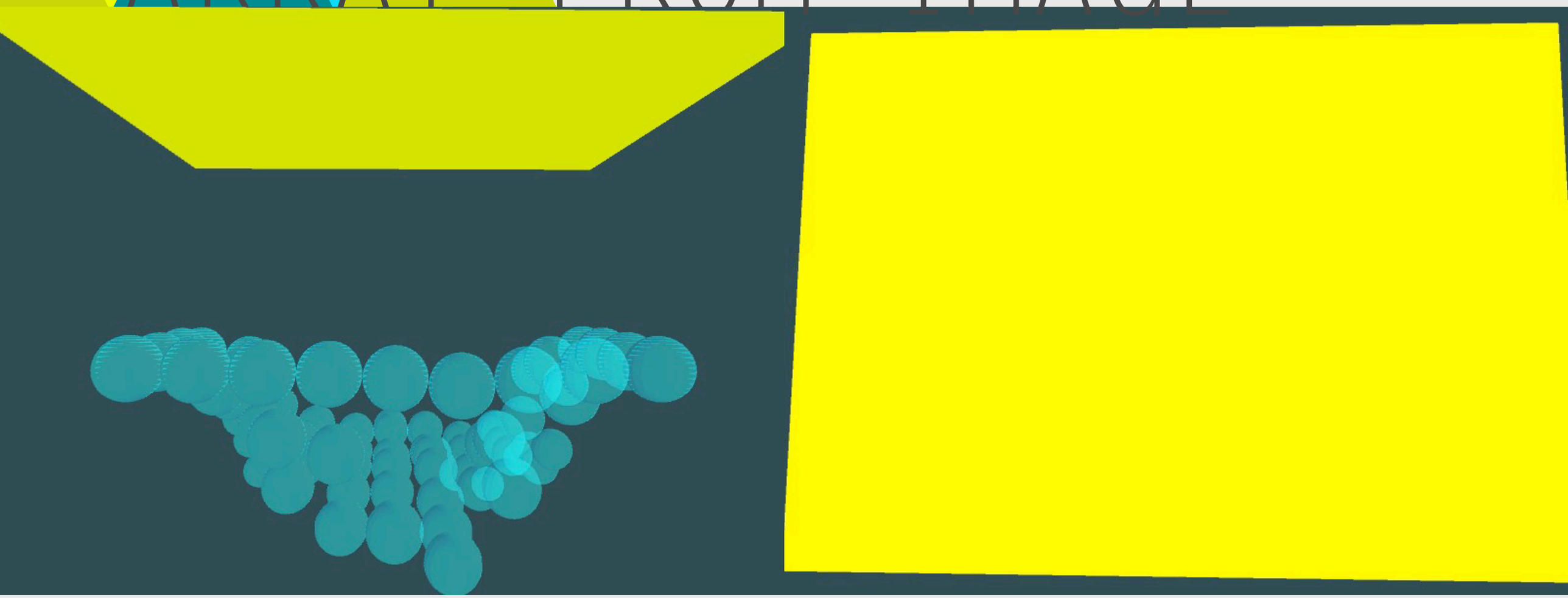
Processing
processing.org

Toxiclibs
http://
hg.postspectacular.com/
toxiclibs/downloads/
toxiclibs-complete-0020.zip

Sketch
http://
trianglesandcurves.com/
eyeo/
EyeoWorkshopParticleSpring
Mesh.zip

You may also want an image to generate a height field or, if you're feeling ambitious, some other data source like an mp3 or an rss feed.

CLOTH ARRAY SIM ON SPHERE FROM IMAGE

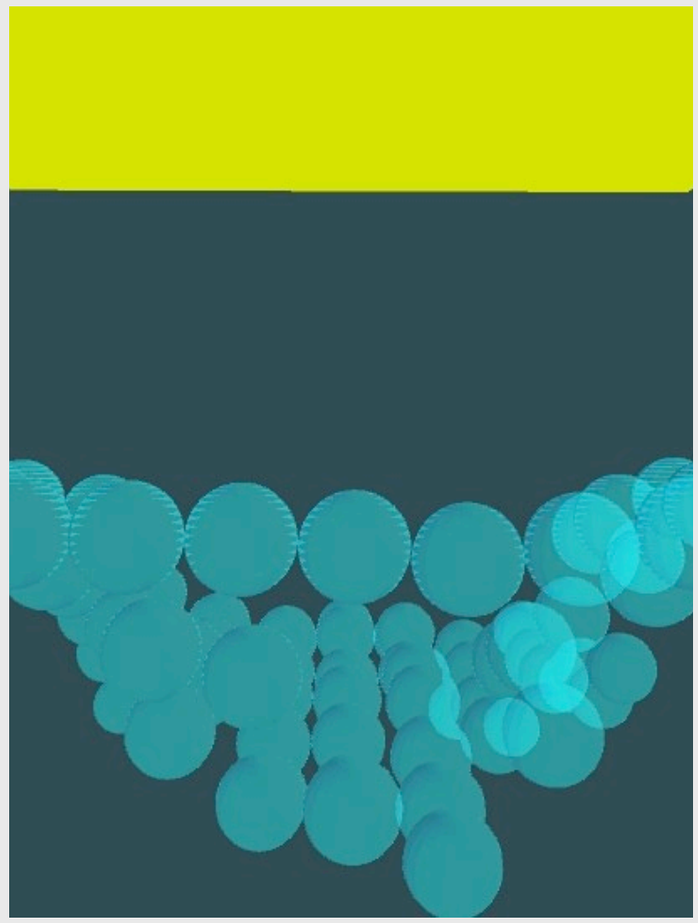


HOW TO USE THE SKETCH

Drag to change your view

Press ‘s’ to save out a data file of the current state

Press ‘f’ to save an image



LETS LOOK AT SOME CODE

EyeoWorkshopParticleSpringMesh | Processing 2.0b9

Java

EyeoWorkshopParticleSpringMesh | PSMesh | Physics §

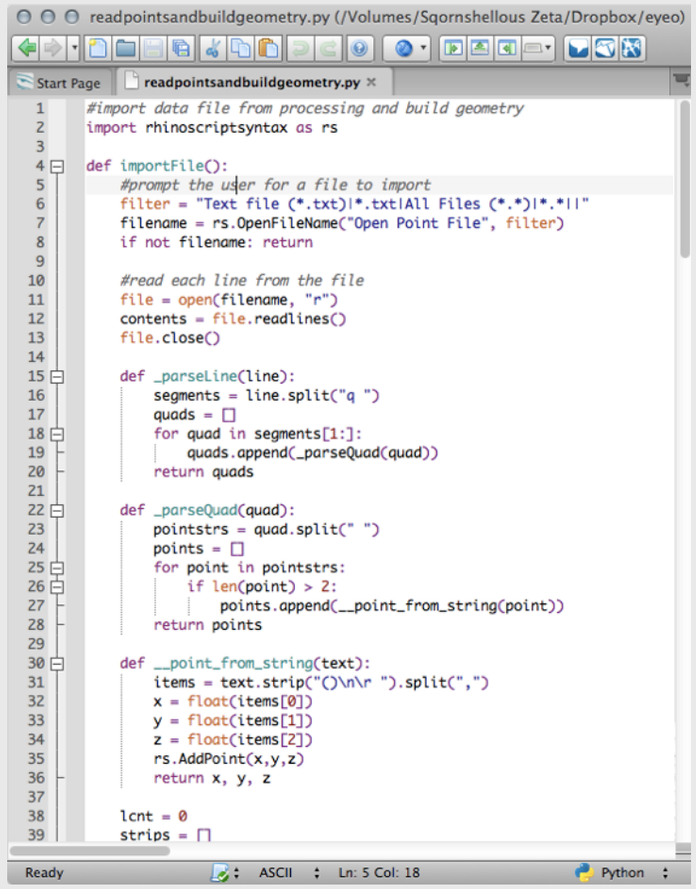
```
void setupPhysics() {
  physics=new VerletPhysics();
  physics.setDrag(0.1);
  physics.setWorldBounds(new AABB(new Vec3D(), width*3));
  physics.addBehavior(new GravityBehavior(new Vec3D(0, 0.3, 0)));
  // overall size of the ground
  float w = 400.0;
  float h = 400.0;
  ground=new BoxConstraint(new AABB(new Vec3D(0,320,0),new Vec3D(w,50,h)));
  ground.setRestitution(0);

  // this is where you can add and change things! I'm going to make a heightfeild form an image
  PImage img = loadImage("eyeoexample.jpg");
  float iw = img.width;
  float ih = img.height;
  float samps = 9.0;
  ih = ih/iw*samps;
  iw = samps;
  img.resize(int(iw),int(ih));
  img.loadPixels();
  for (int i=0;i<iw;i++) {
   for (int j=0;j<ih;j++) {
    Vec3D p0 = new Vec3D((i+0.5)/iw*w-w*0.5,0,(j+0.5)/ih*h-h*0.5);
    color col = img.pixels[int(j*iw+i)];
    float ht = brightness(col)*0.5;
    p0.y = 300-ht*2;
    SphereConstraint s = new SphereConstraint(new Sphere(p0,w/iw*0.5),false);
    spheres.add(s);
   }
  }
}
```

13 - 30

RHINO

Scriptable, robust and surprisingly inexpensive, Rhino is a great tool for turning data and drawings into produceable objects.



WHAT YOU'LL NEED

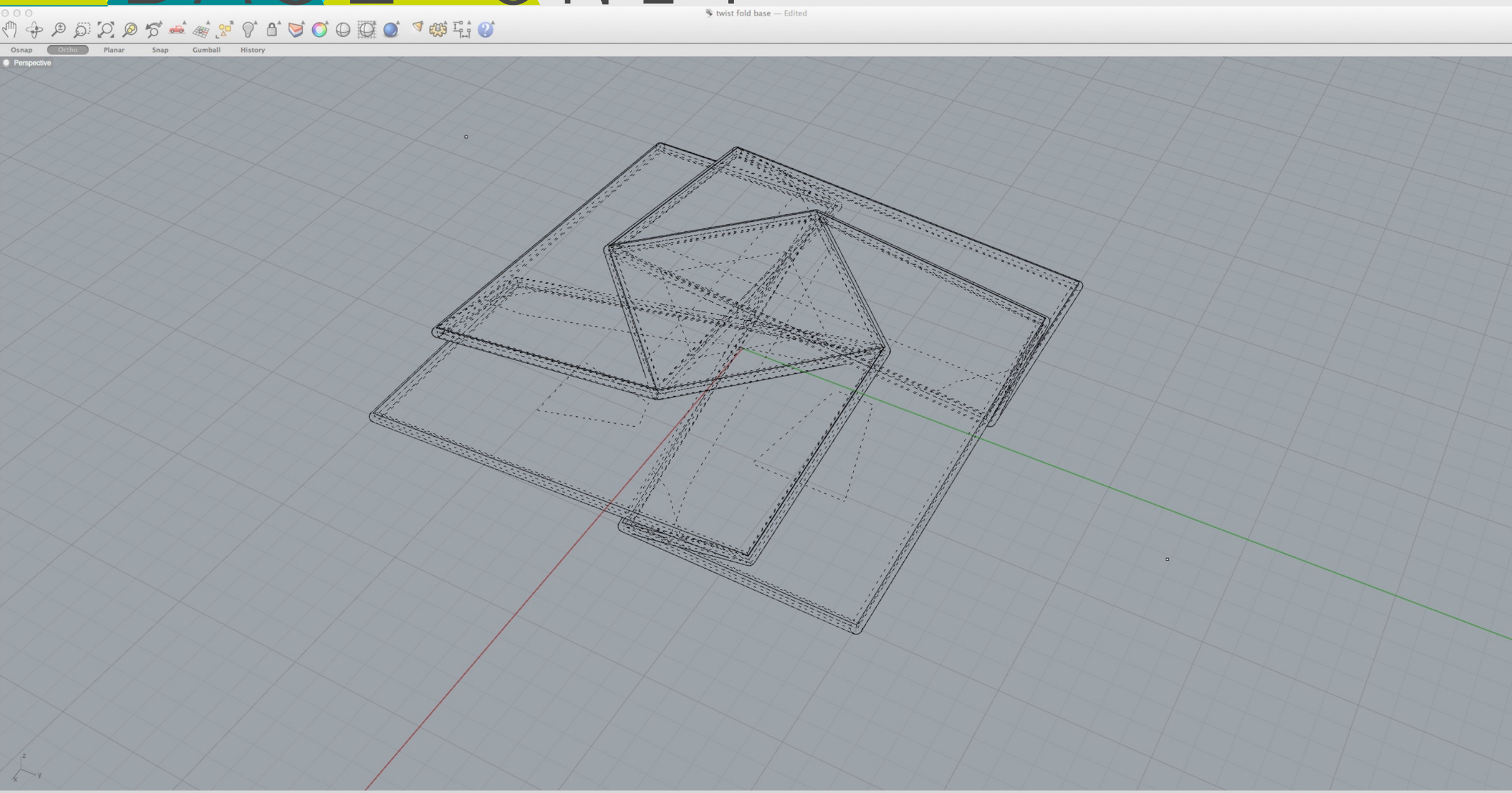
Rhino
http://mac.rhino3d.com/

Python plugin
http://trianglesandcurves.com/eyeo/python20120911.macrhi

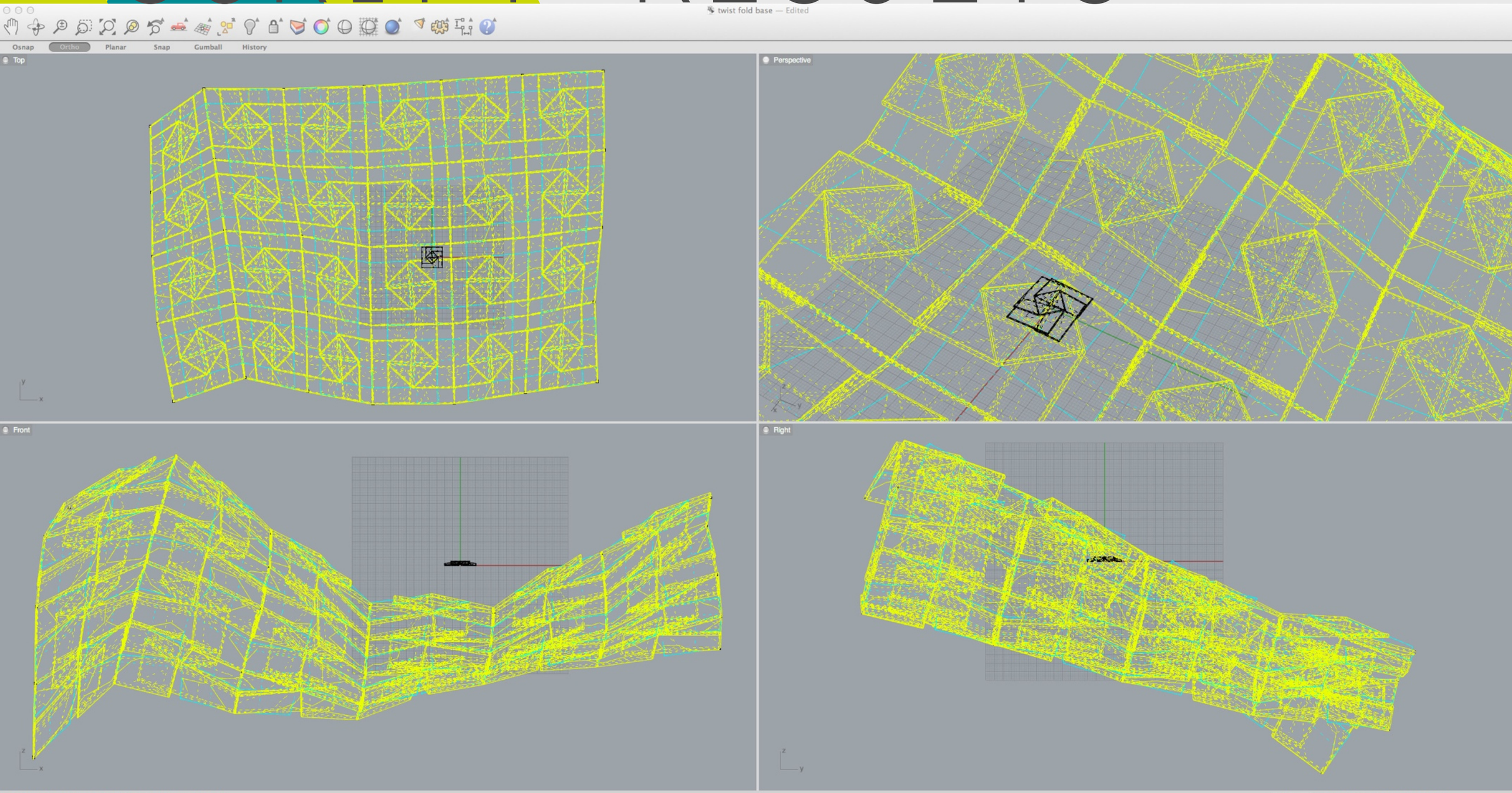
Base file
http://trianglesandcurves.com/eyeo/twist%20fold%20base.3dm

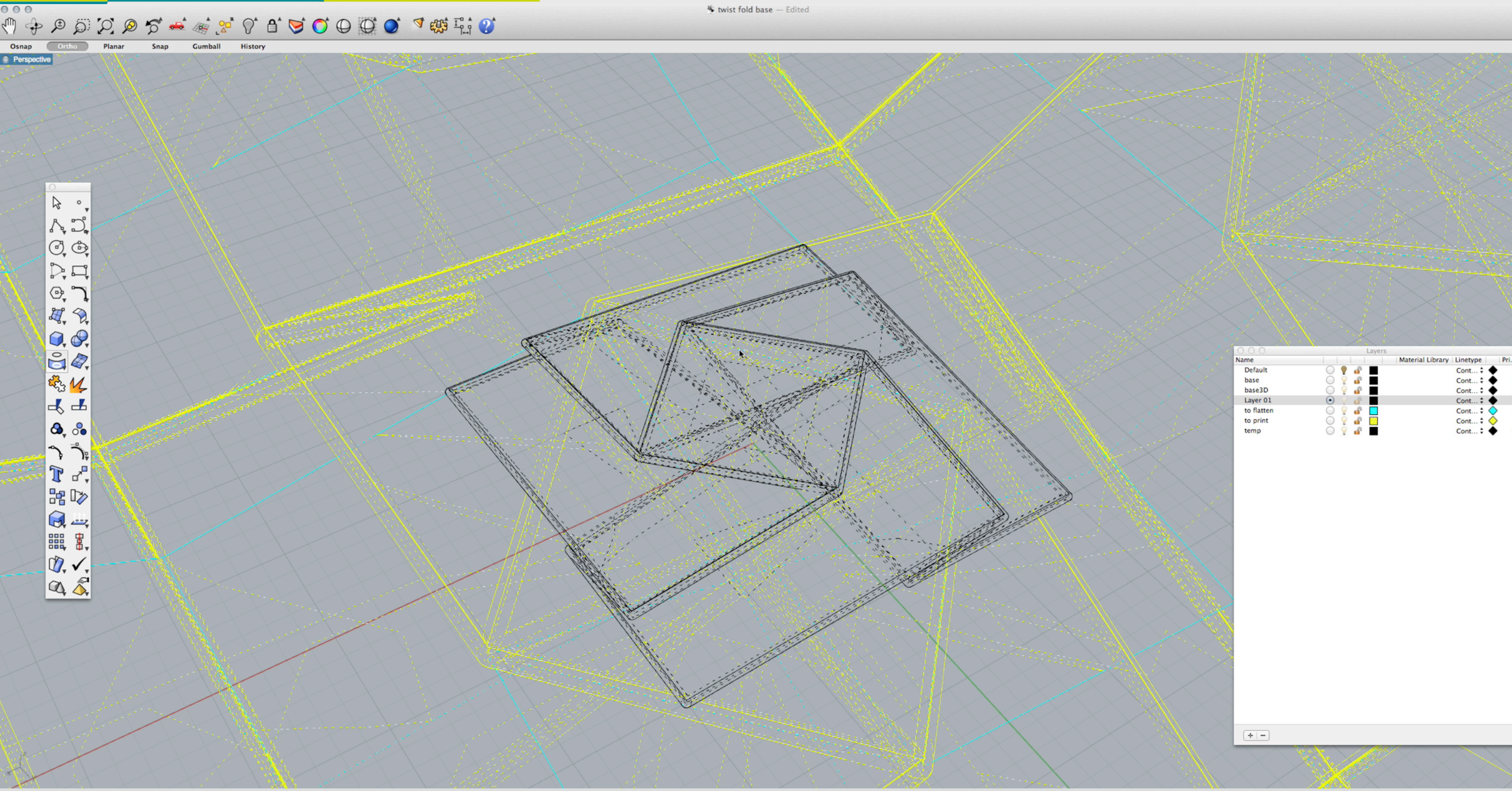
Script
http://trianglesandcurves.com/eyeo/readpointsandbuildgeometry.py

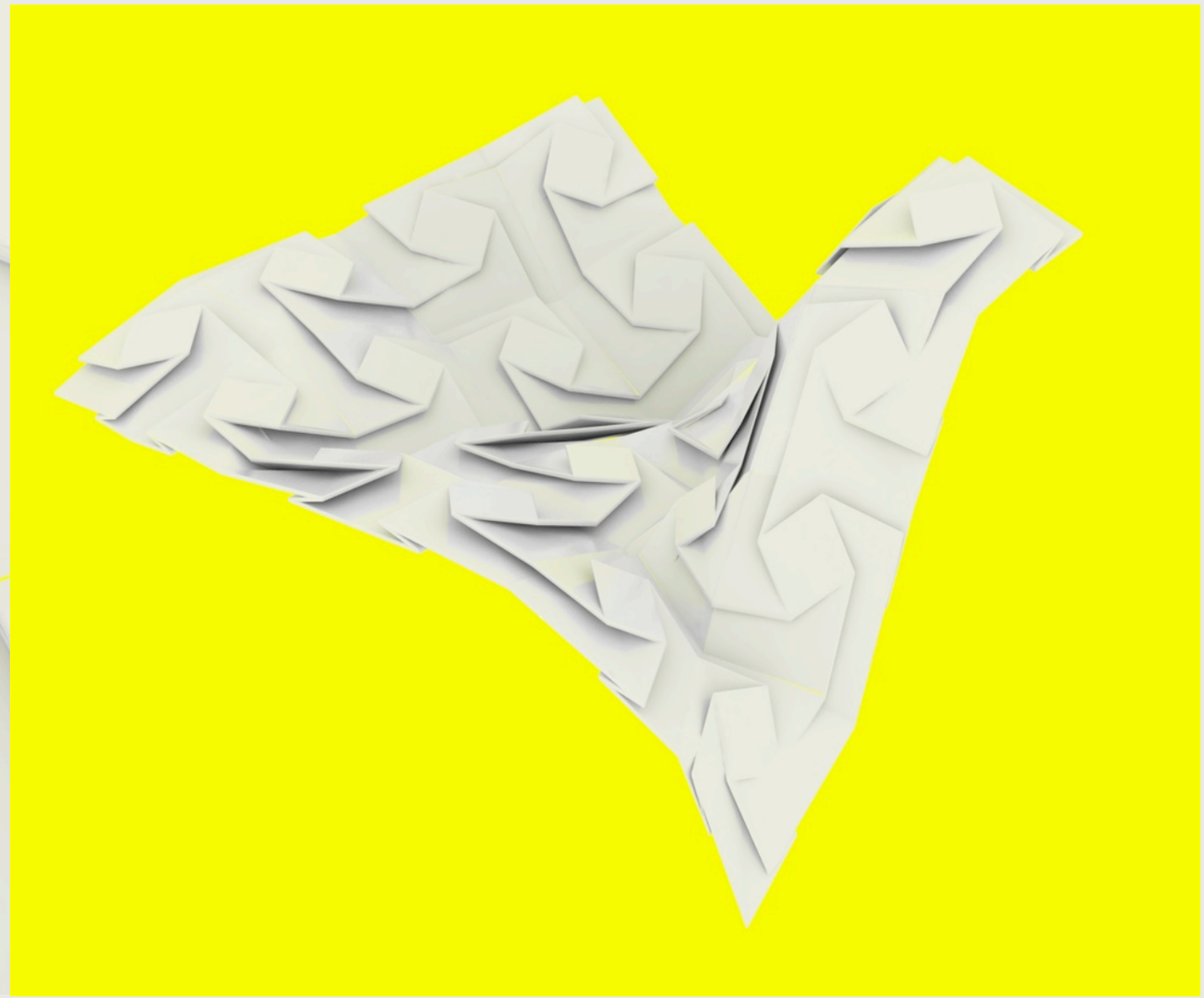
BASE UNIT


twist fold base — Edited
Osnap
Ortho
Planar
Snap
Gumball
History
Perspective
Scale factor or first reference point <5.000> (Copy=No) -_PointsOff
CPlane
X: 7.067
Y: 20.911
Z: 0.000

SCRIPT RESULTS




twist fold base — Edited
Osnap
Ortho
Planar
Snap
Gumball
History
Perspective
Layers
Name
Material Library
Linetype
Default
base
base3D
Layer 01
to flatten
to print
temp
Command: '_Zoom
CPlane
X: -3.399
Y: -5.867
Z: 0.000



MORE RESOURCES

Of course, there are many more programs, plugins and scripts to help you get started making things. And there are a variety of services, labs and co-ops where you can get your things made.

RESOURCES FOR RHINO

Scripting

- Rhino Python website
  http://
  python.rhino3d.com

- Code sharing community
  http://
  www.rhinoscript.org/

Learning

- Tutorials
  http://wiki.mcneel.com/
  rhino/tutoriallinks

- Command List
  http://
  docs.mcneel.com/rhino/
  5/help/en-us/
  commandlist/
  command_list.htm

RESOURCES FOR PROCESSING

Some helpful sketches from us

- http://trianglesandcurves.com/eyeo/etc/

Libraries

- Toxiclibs http://toxiclibs.org/

OTHER USEFUL PROGRAMS

Blender
http://www.blender.org/
free and open source, great for meshes

Solidworks
http://www.solidworks.com
the industry standard for parametric and solid modeling

Maya
http://www.autodesk.com/products/autodesk-maya/overview
professional grade mesh modeler

OpenFrameworks & Cinder
http://www.openframeworks.cc/
http://libcinder.org/
C++ frameworks that can handle 3D geometry well

Unity
http://unity3d.com/
a game engine and simulation environment that can produce 3D printable models

MAKING THINGS

Services

- Shapeways
  http://www.shapeways.com/

- Ponoko
  https://www.ponoko.com/

Places

- Fab Labs
  http://fab.cba.mit.edu/

- Local maker spaces
  http://
  www.dangerawesome.co/

At home

- CraftRobo
  http://
  www.graphtecamerica.com/

- Handibot
  http://www.handibot.com/

- Makerbot/Ultimaker/Up
  http://www.pp3dp.com/
  http://www.ultimaker.com/
  http://www.makerbot.com/