Exploring Visualizations

An Overview of a Seminar in 3D Modeling and Printing

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- Used Rhino 5 for Windows (30 license school lab $975)
- Local company, owned by an alumnus, let us use his Makerbot Replicator 2 at cost of material

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Let everyone realize how useful customizable 3D models can be for a mathematician in research or teaching.

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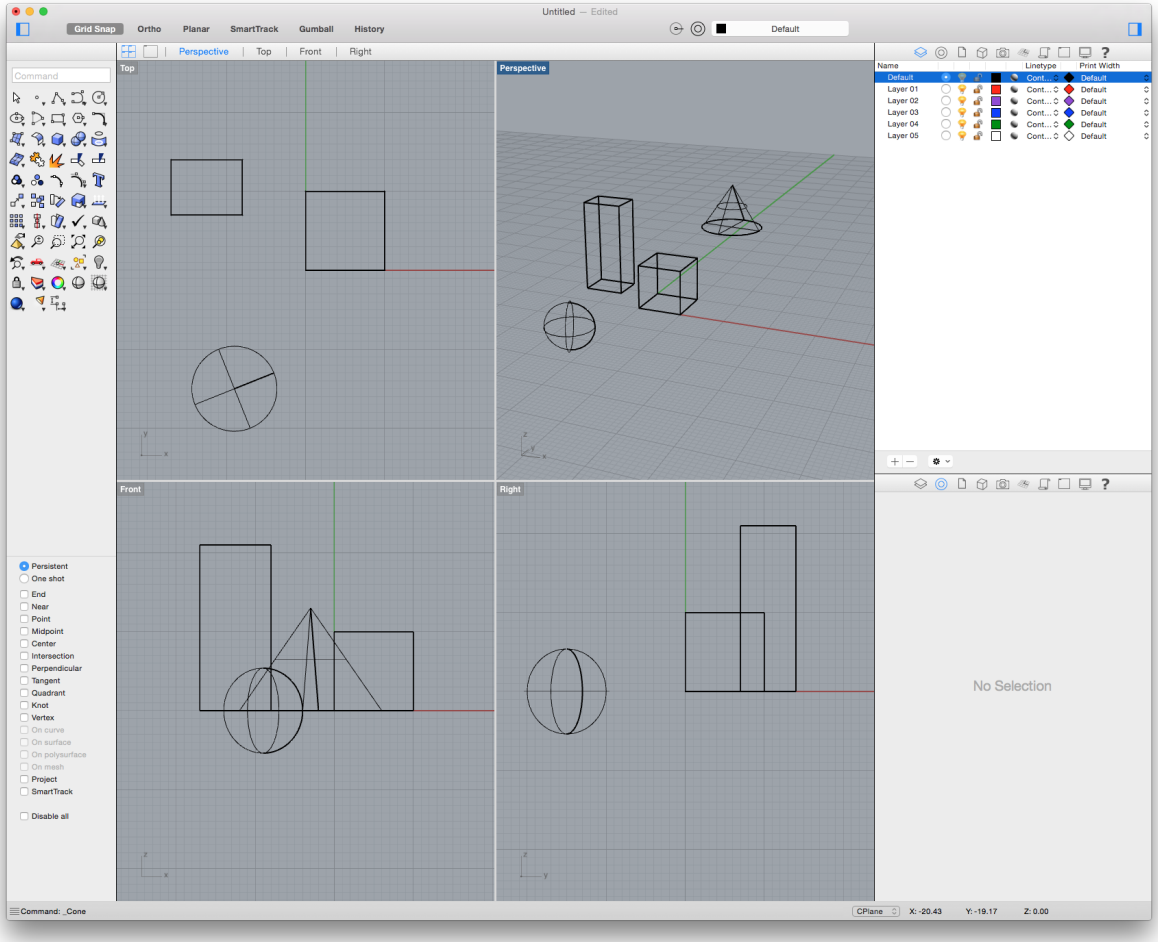
- The following projects were designed to make the user comfortable in this new world

GUI



Castle - Day 1

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Main skill they acquire: Intuition about 3D space they are working in

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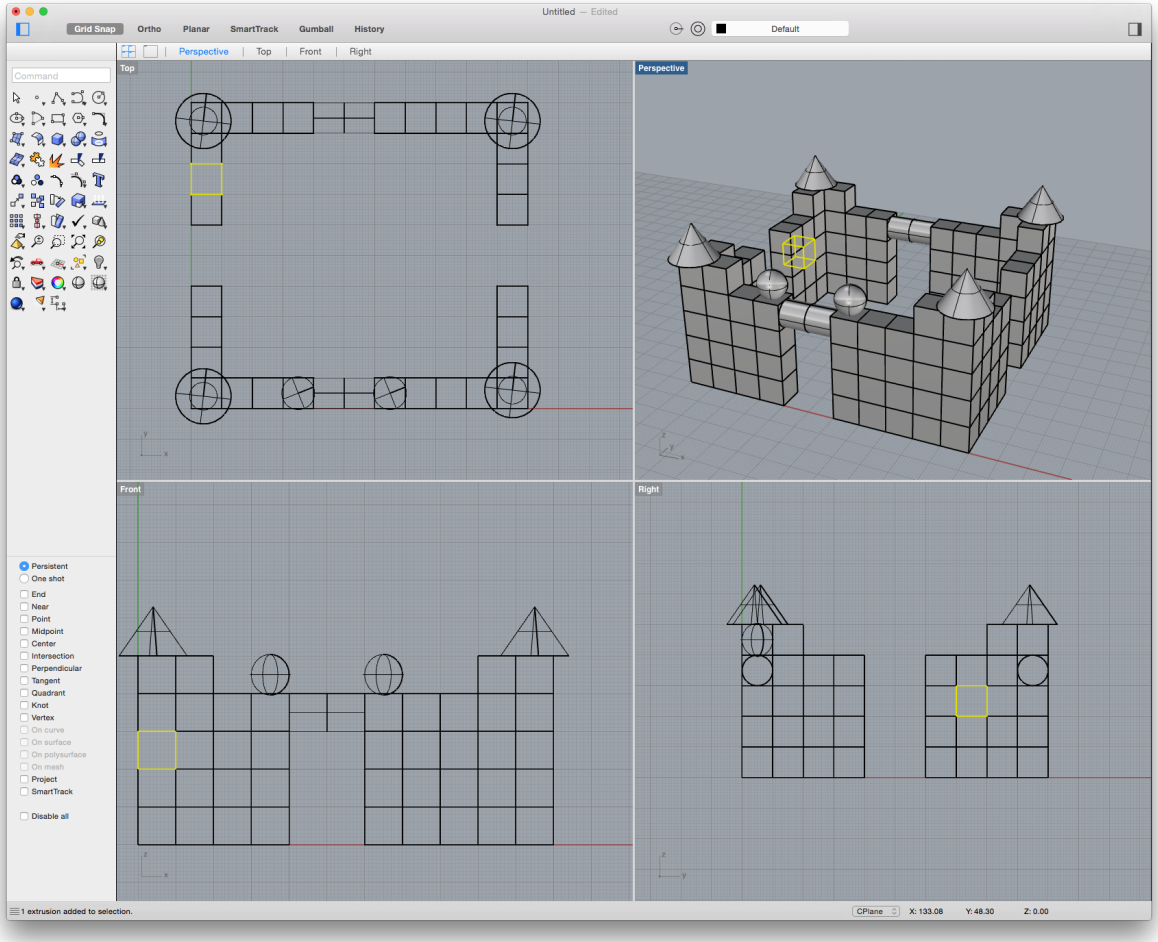

Square Circle Triangle Game - Day 2

Using all 3 dimensions

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Direction 2: Build a single object that can pass through each hole and fill it completely. (Hint: This is possible.)

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Failure - Much to complicated for the second project.

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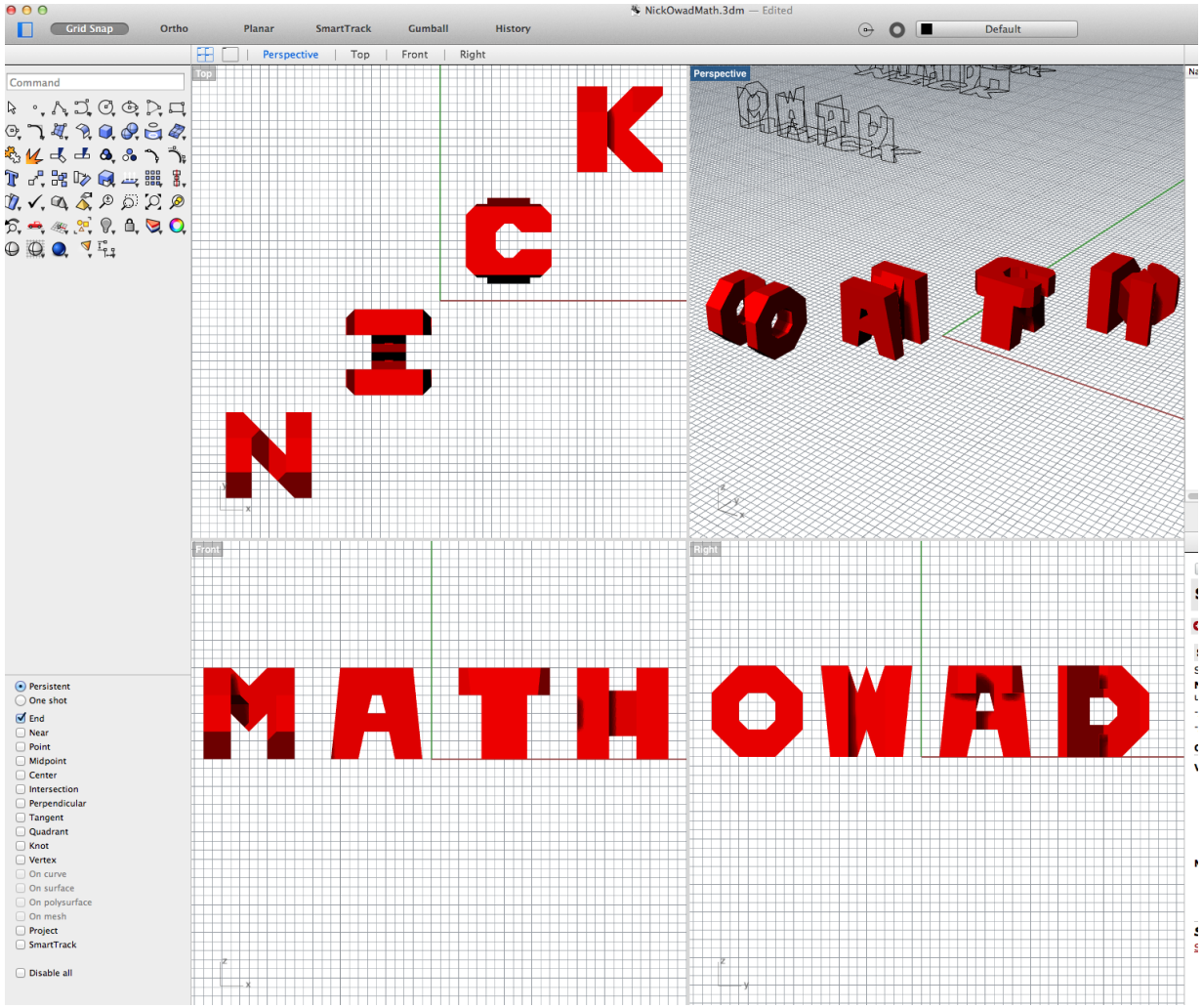

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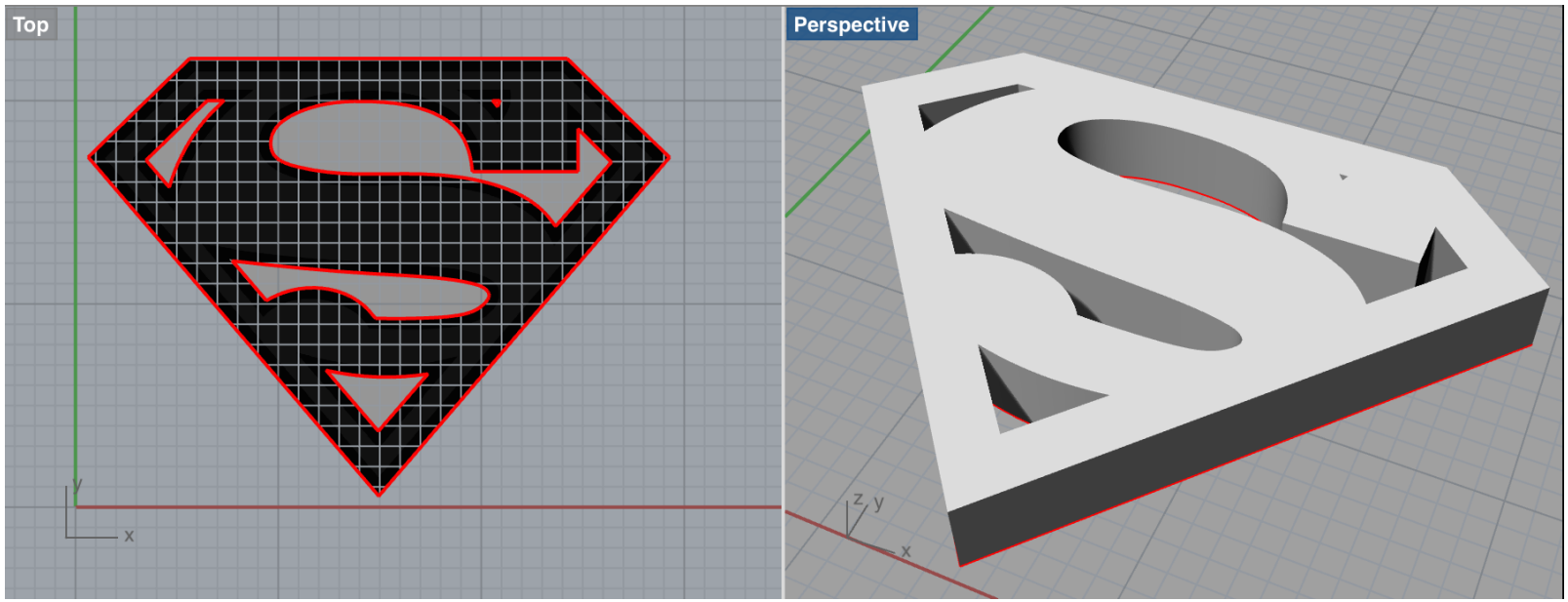

Platonic Solids

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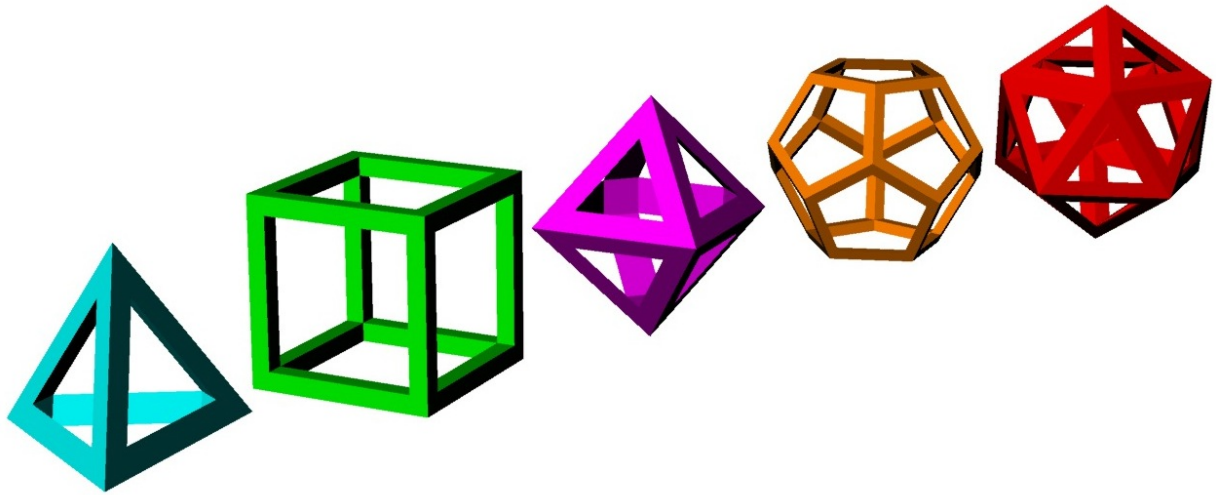
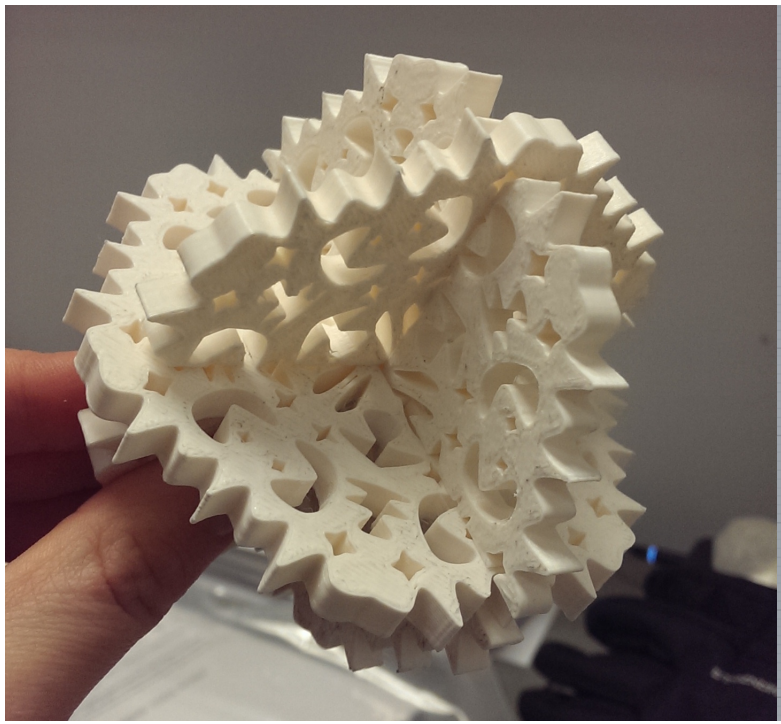
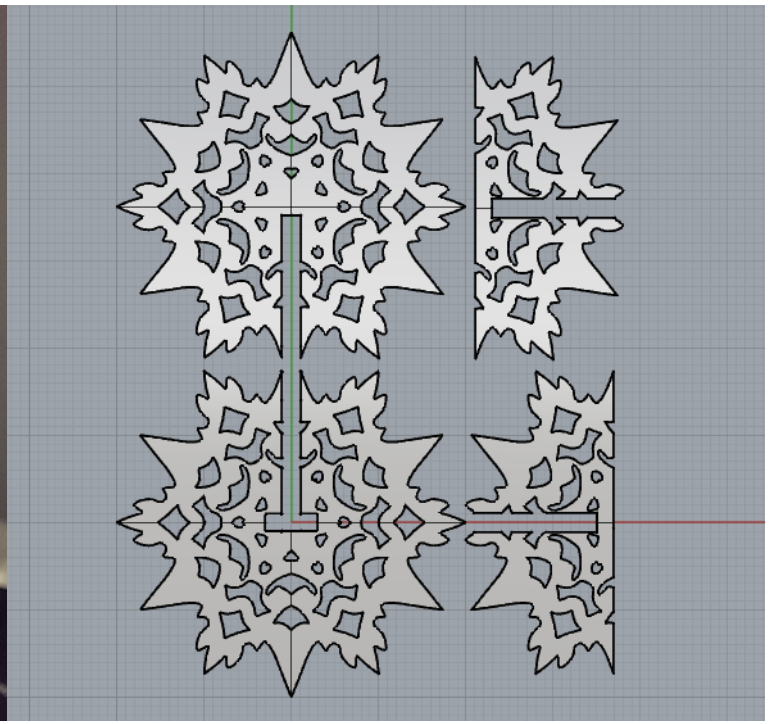
- Commands: Array (polar), 3D rotate, Osnap
- Lots of ways to actually build the models: from faces, vertices, etc
- Spent a month just on these 5 shapes



Seasonal

Pumpkins and Snowflakes





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This talk will be much more Rhino specific now.

Graphs

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Rhino command: AddInterpCurve

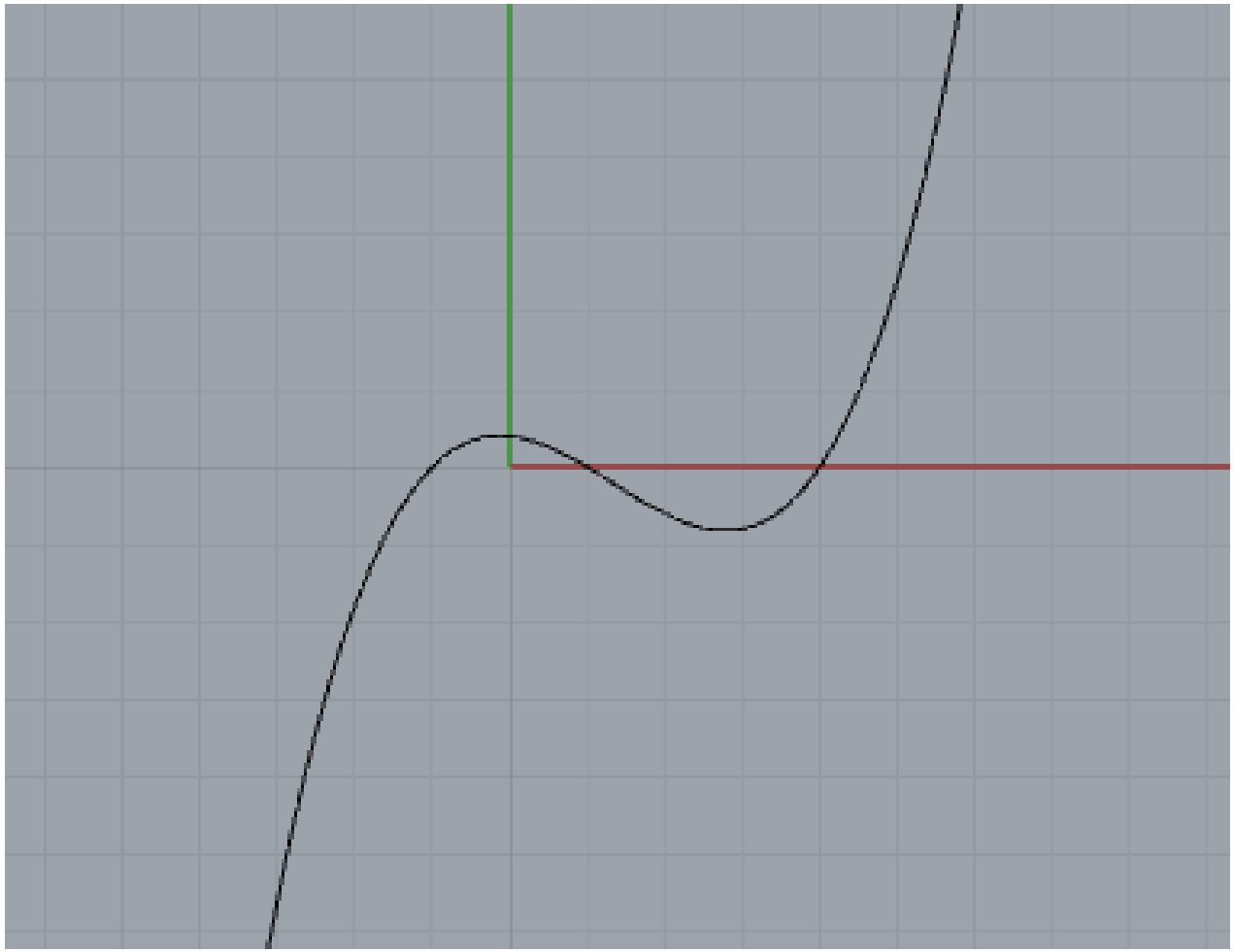
Graphs

The code from Henry that we use:

```
import sys, os
import rhinoscriptsyntax as rhino
from math import *

def draw_parametric_curve(function, param_range, num_points = 64):
  curve_pts = []
  for i in range(num_points):
    x = param_range[0] + (param_range[1] - param_range[0]) * float(i)/float(num_
    point = function(x)
    if point != None:
      curve_pts.append( rhino.AddPoint(point) )
  out = rhino.AddInterpCurve(curve_pts)
  rhino.DeleteObjects(curve_pts)
  return out


def cubic(x):
        return [x,.1*(x+1)*(x-1)*(x-4),0]


draw_parametric_curve(cubic, (-5,10))
```

Graphs

The result:



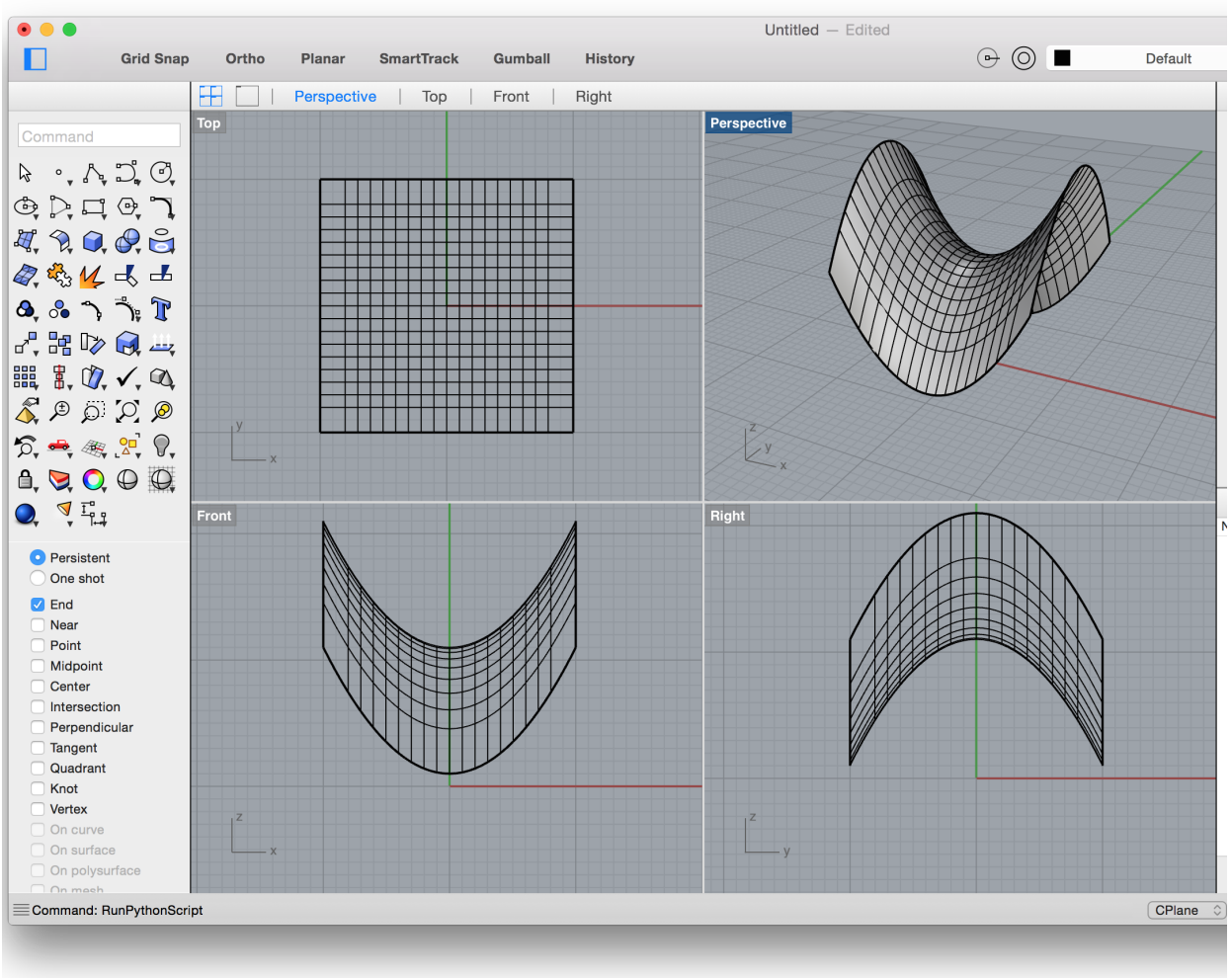
Graphs

For surfaces, graph:

$$z = \frac{1}{10}\left(x^2 - y^2\right)$$

```
import rhinoscriptsyntax as rs

count = 21,21

def s(x,y):
        return (.1*((x-10)**2-(y-10)**2)+11)


points = []

for i in range(count[0]):

    for j in range(count[1]):

        pt = i-10, j-10, s(i,j)

        points.append(pt)

rs.AddSrfPtGrid(count, points)
```

Surface result:



Integration

Lets talk about approximating

$$\int_{x=-10}^{10}\int_{y=-10}^{10}\frac{1}{10}\left(x^2-y^2\right)\mathrm{d}y\mathrm{d}x$$

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from math import*

def s(x,y):
        return (.1*((x-10)**2-(y-10)**2)+11)


count = 20,20

for i in range(count[0]):
        for j in range(count[1]):
                rs.AddBox([ [i-10,j-10,0], [i-9,j-10,0],
                        [i-9,j-9,0], [i-10,j-9,0],
                        [i-10,j-10,s(i,j)], [i-9,j-10,s(i,j)],
                        [i-9,j-9,s(i,j)], [i-10,j-9,s(i,j)] ] )
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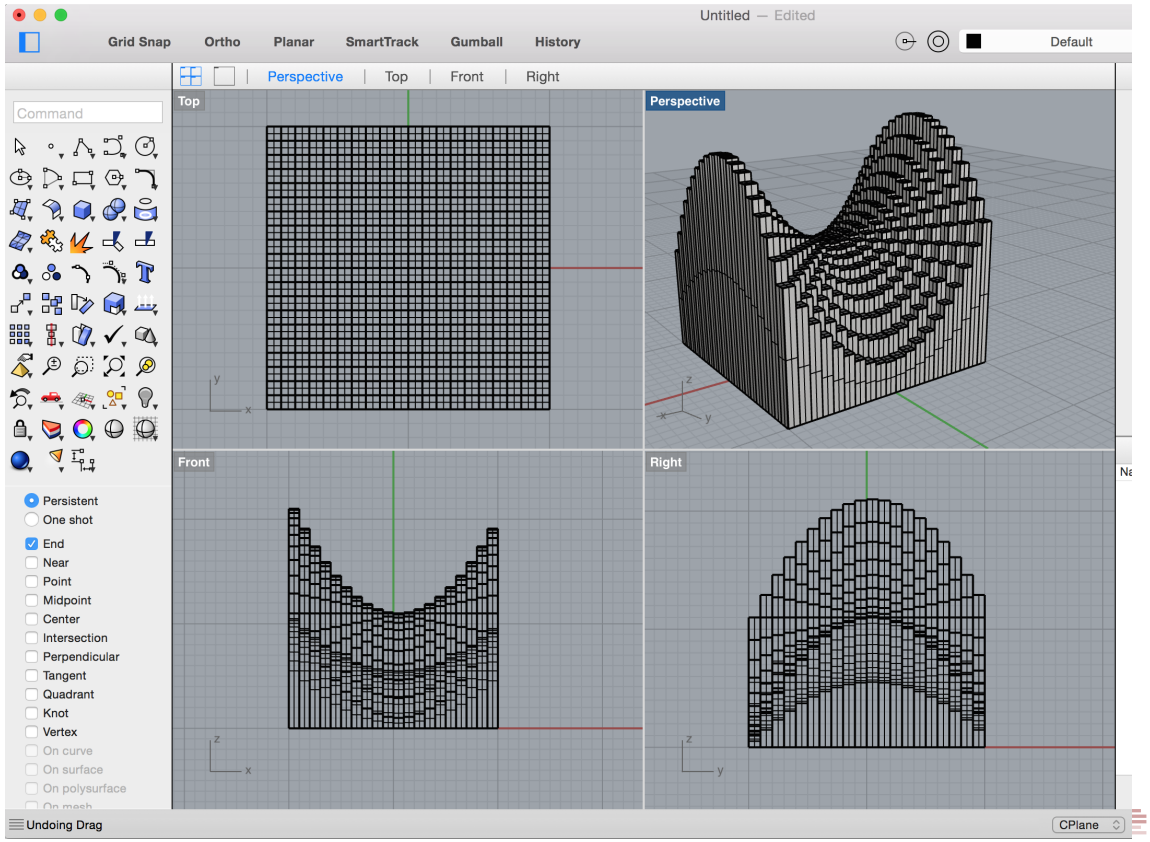
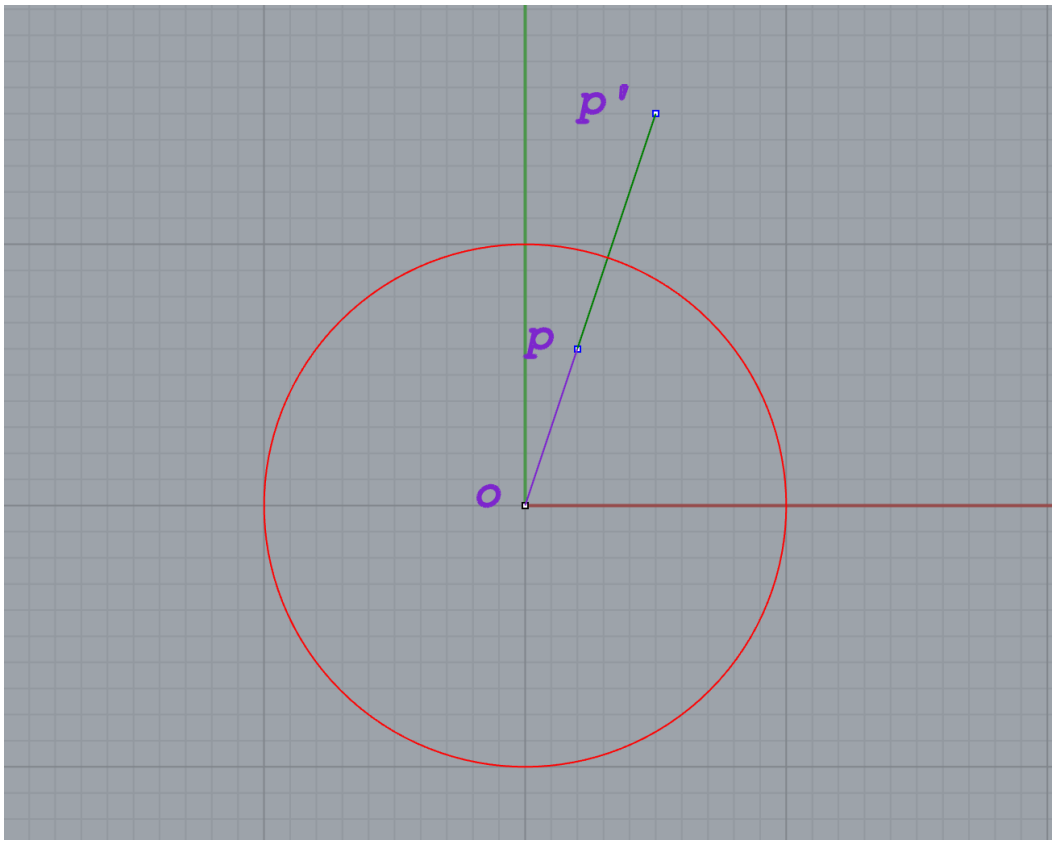


Hyperbolic Geometry

Hyperbolic Geometry

Given a point P, we can invert it about a circle of radius r and obtain a new point P' by the simple relation $OP \times OP' = r^2$.



Inverting a point about a circle


```
import rhinoscriptsyntax as rs
from math import*

basecircle = rs.GetObject("Select circle to invert about"

if rs.IsCircle(basecircle):

    radius = rs.CircleRadius(basecircle)

    center = rs.CircleCenterPoint(basecircle)

point = rs.GetObject("Select point to invert")

if rs.IsPoint(point):

        dist = rs.Distance( point, center)

a = (radius / dist ) ** 2


rs.ScaleObject( point, center, (a,a,a), True )
```

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Lines in hyperbolic geometry are circles that intersect our red circle perpendicularly. For every two points there is a unique line that passes through them.

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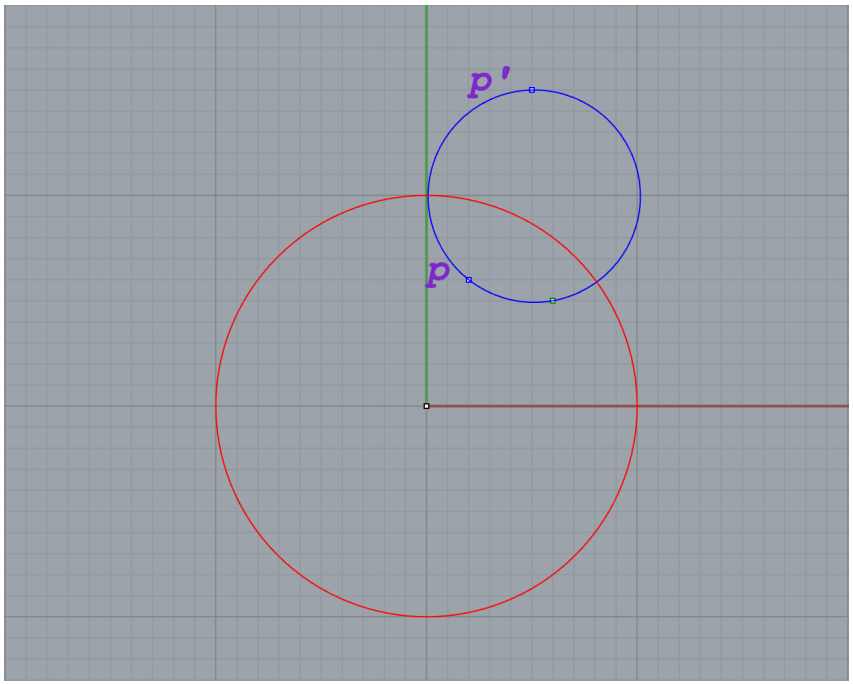

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Thank you!