

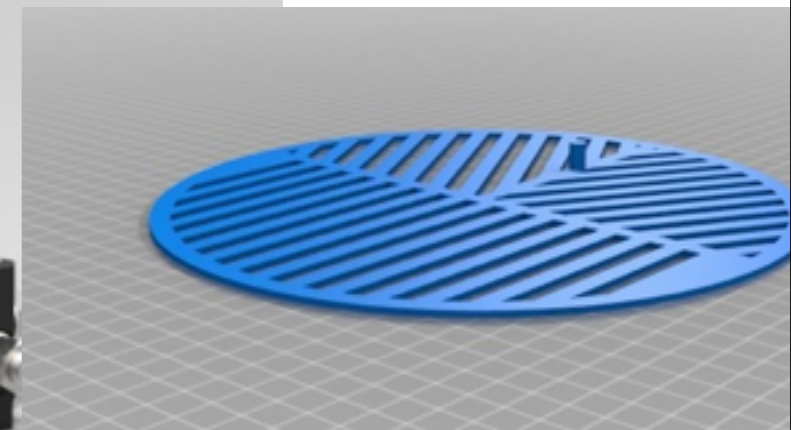
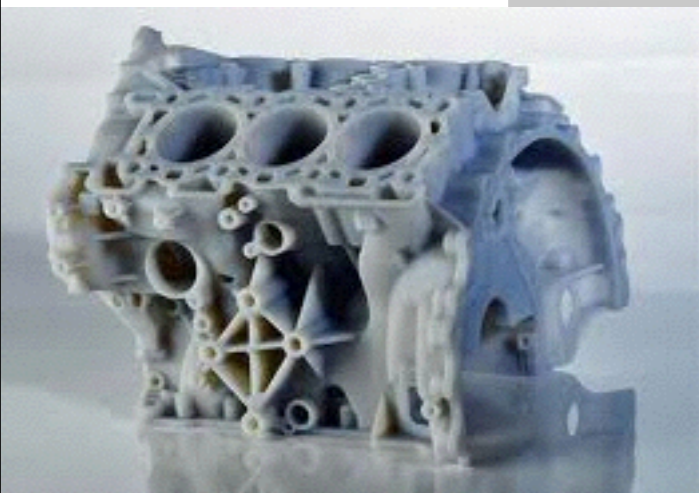
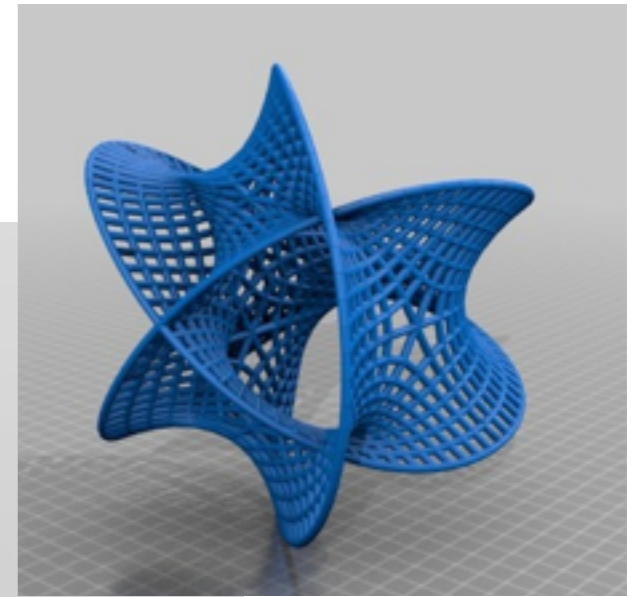
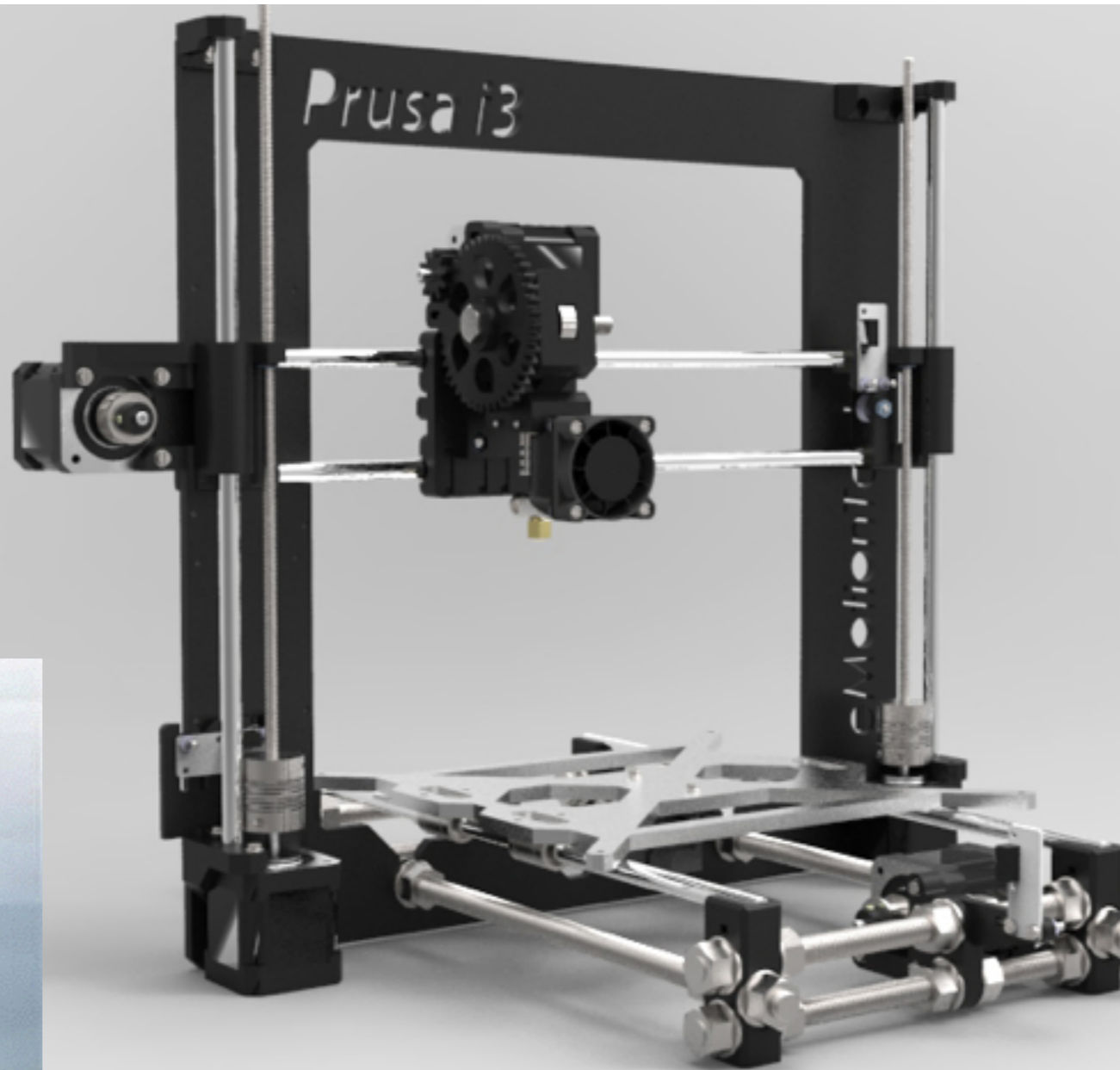
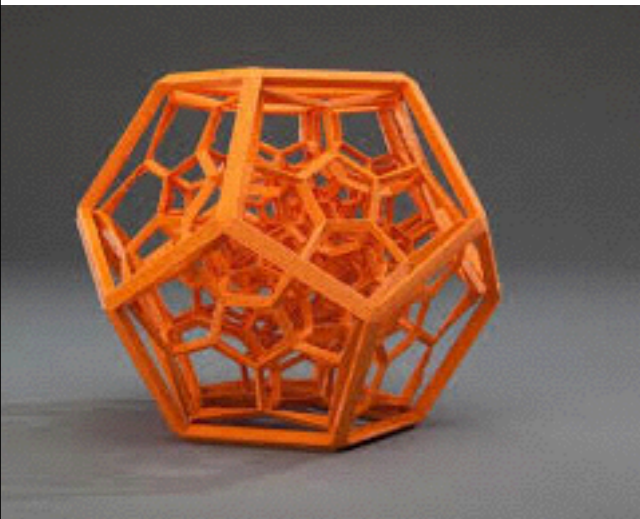
3D PRINTING:

Student Projects and Undergraduate Research

Andrew M.C. Dawes
Pacific University



3D PRINTING:



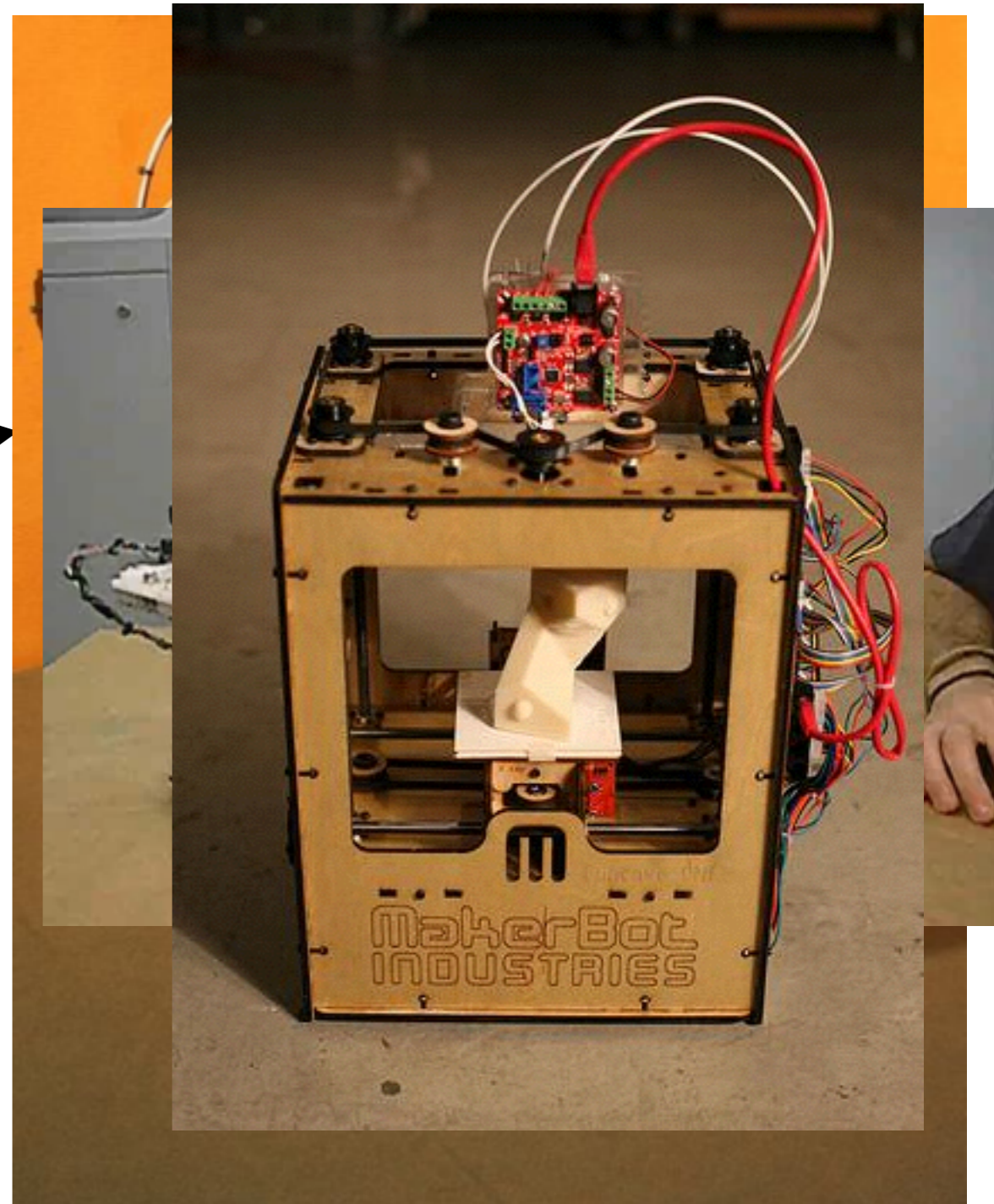
3D PRINTING:

“We see it as more of a lifestyle”

–Alyssa Reichental [3D Systems](#)

History

- Additive manufacturing — 1984
- Commercial systems
- Maker movement ~ late 2000s
- Reprap — 2007
- Makerbot and many others



Our story

Pacific
University
Oregon



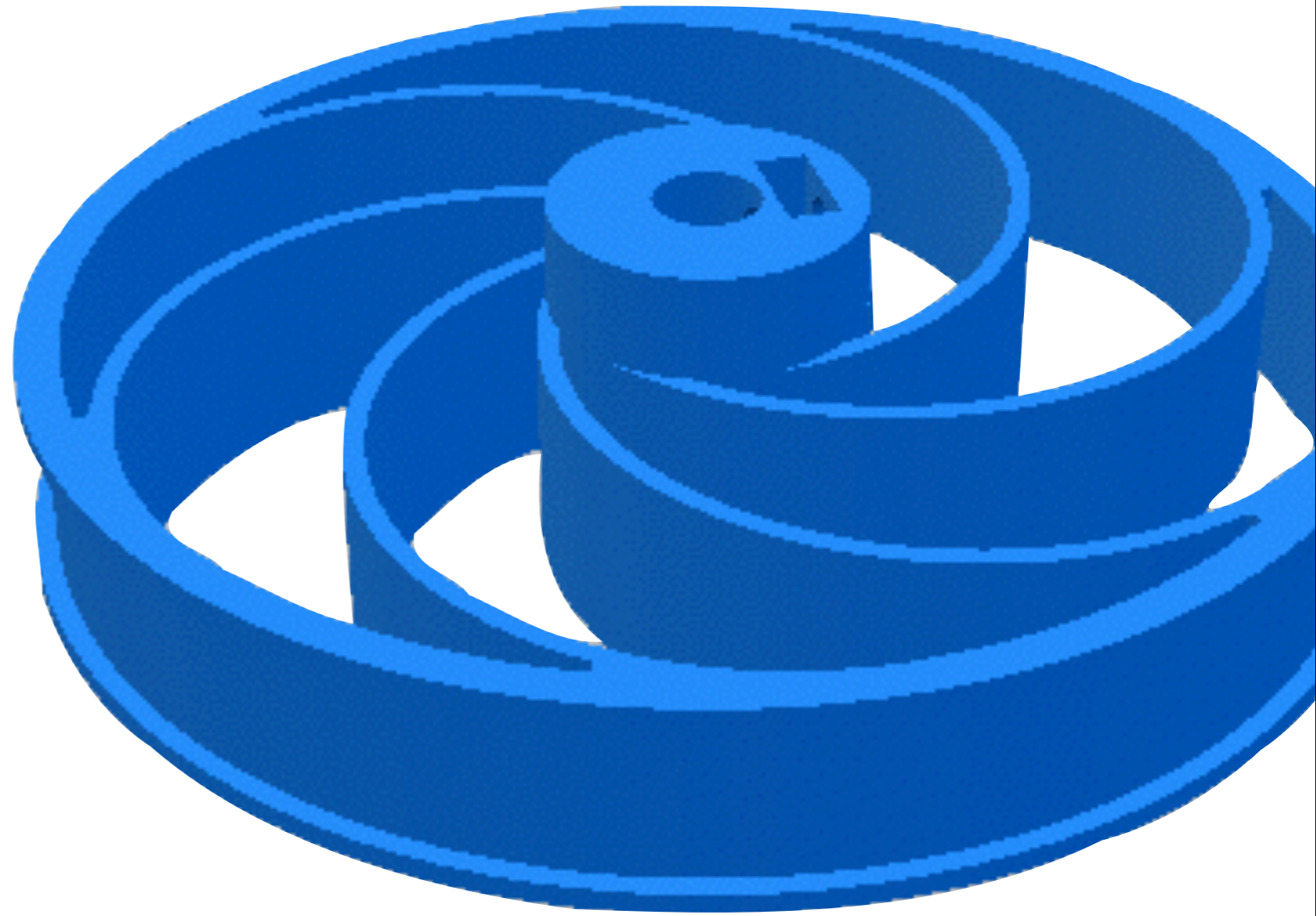
- Thing-o-matic #006696 —
January 2012
- club project
- four-day build
- installed in dept. computer lab
- 24/7 student access



Classroom use

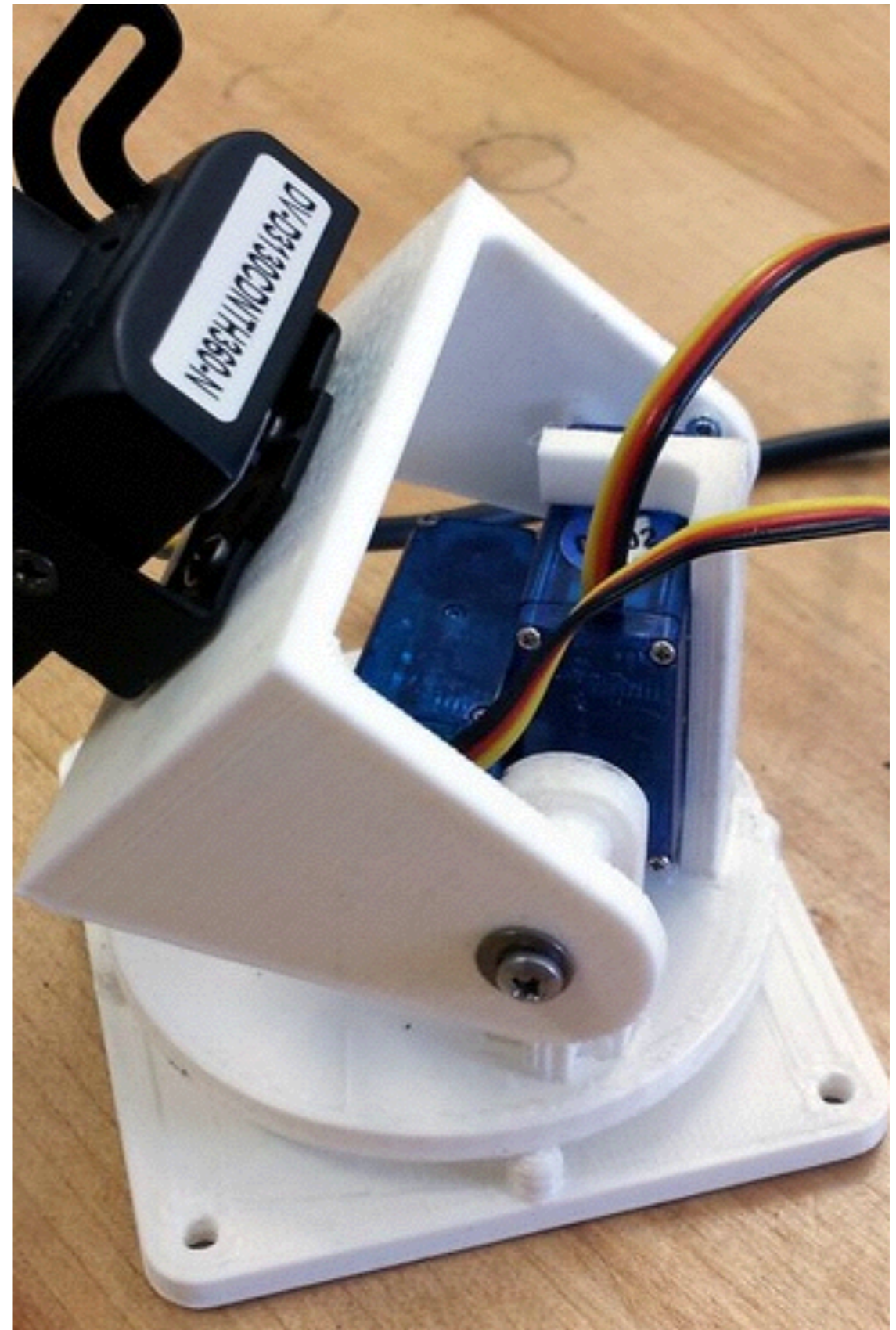
Wheel for mousetrap car

suspension built-in
scalable design
hub fits round stock



Pan/tilt mount

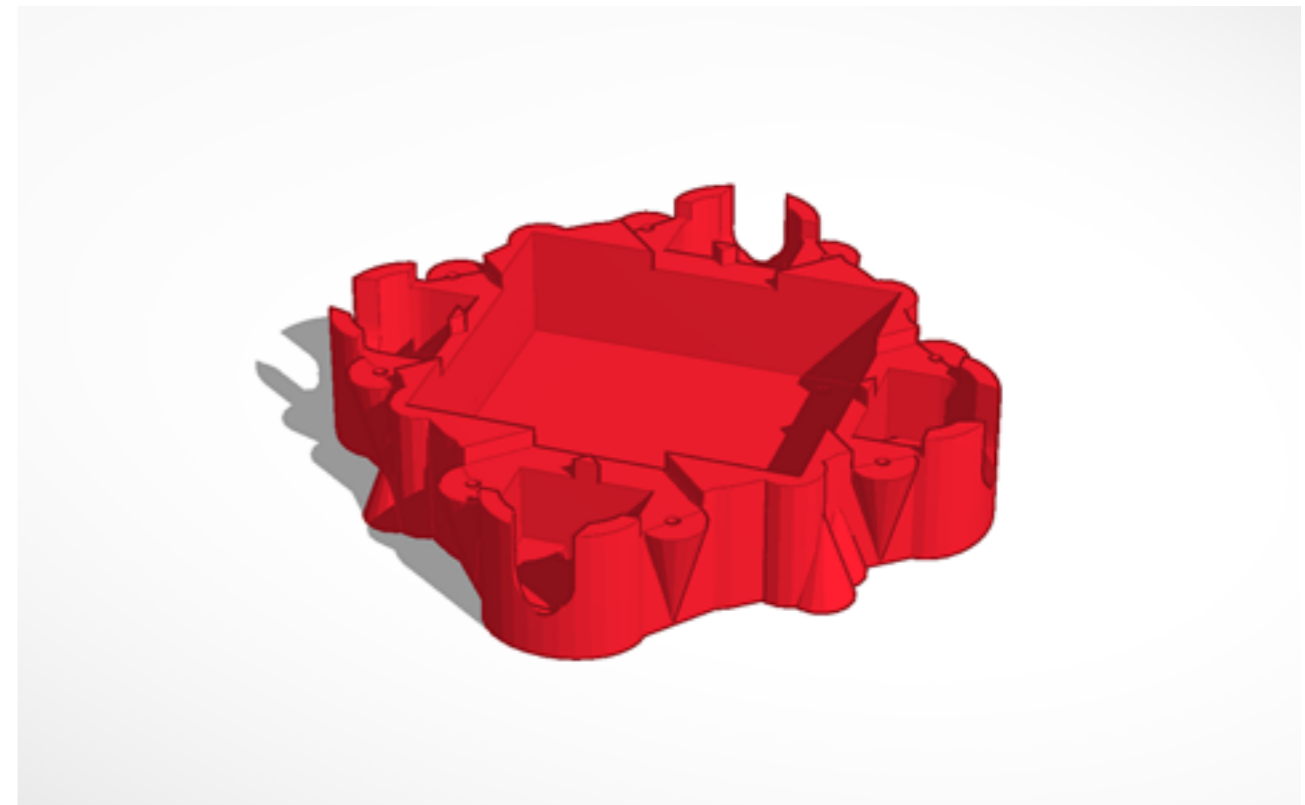
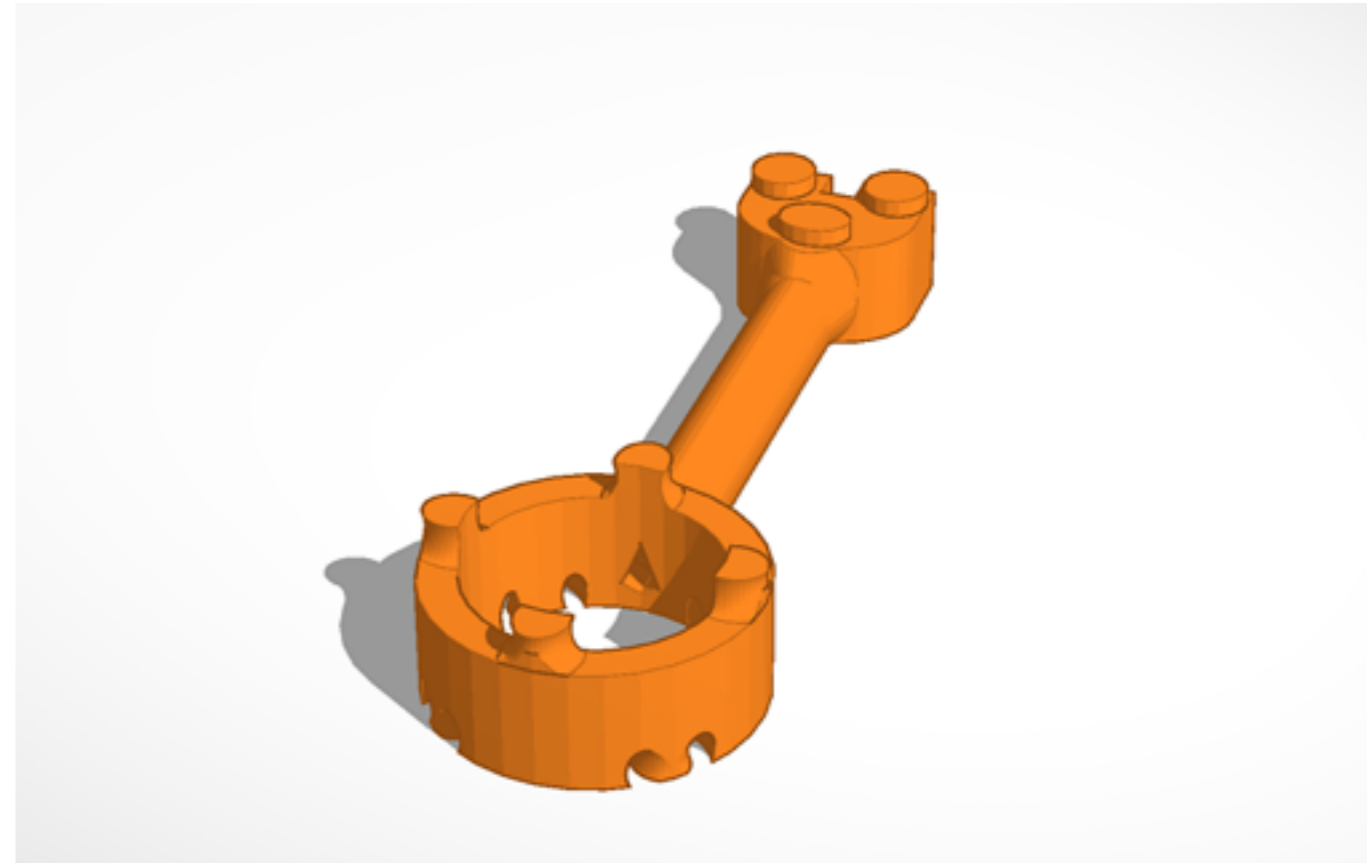
hobby servos
arduino control
2-axis movement



Quadcopter frame

4 arms

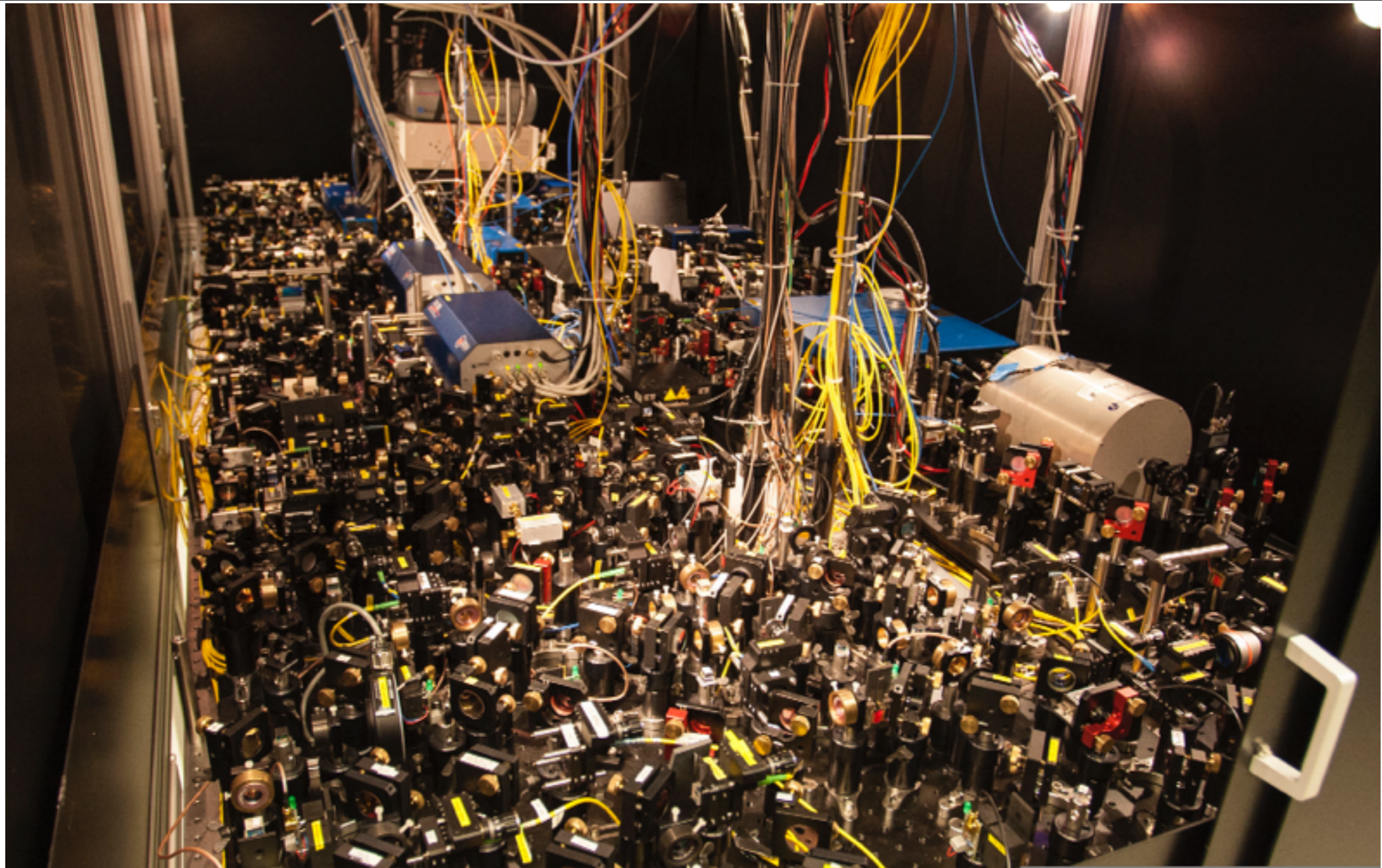
1 hub



Other examples

- Knots (geometry)
- Script for GNUpLOT → 3d surface
- Summer camp G2CS

Research use



Stray light into CCD

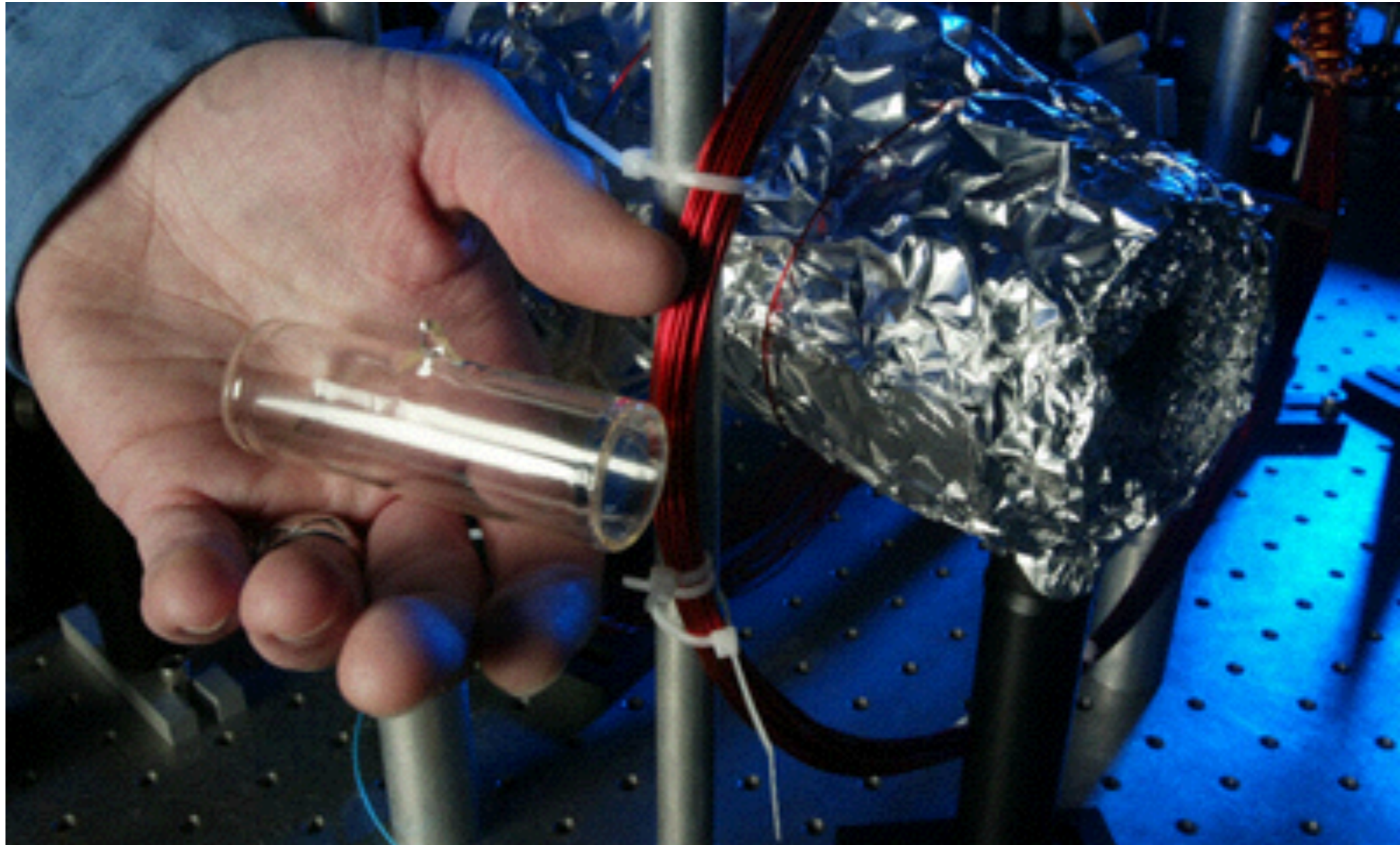
low light imaging disrupted by scatter from prior optics

CCD camera baffle

standard PVC pipe

aligned mounting holes





Rubidium vapor cell

variable B-field
stable mount

Vapor cell holder

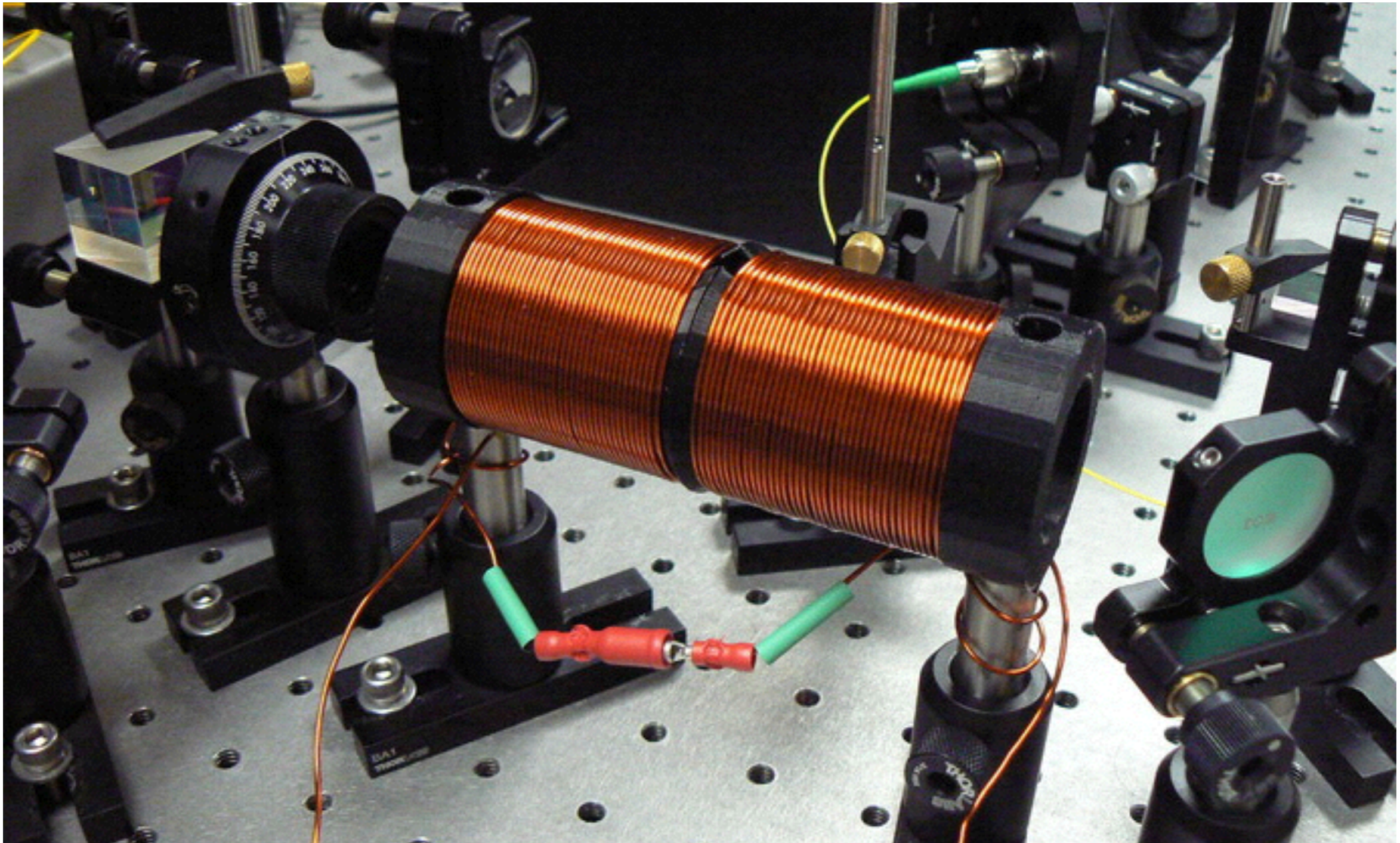
two-piece design

easy assembly

solenoid guides

1/4-20 mounting holes

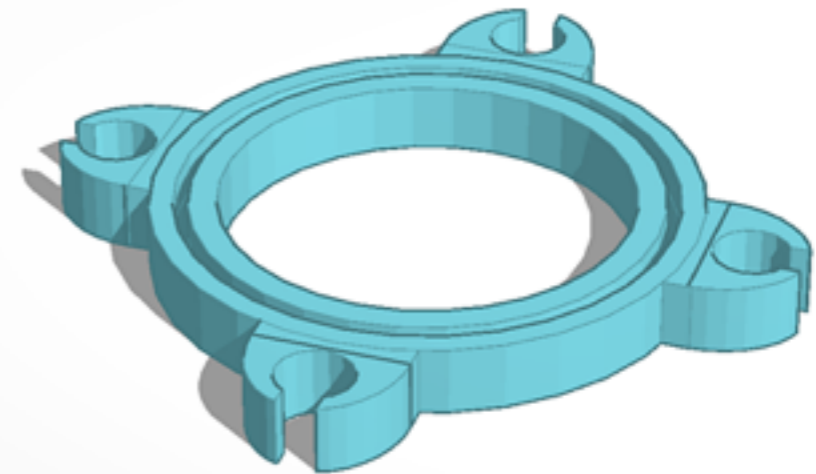
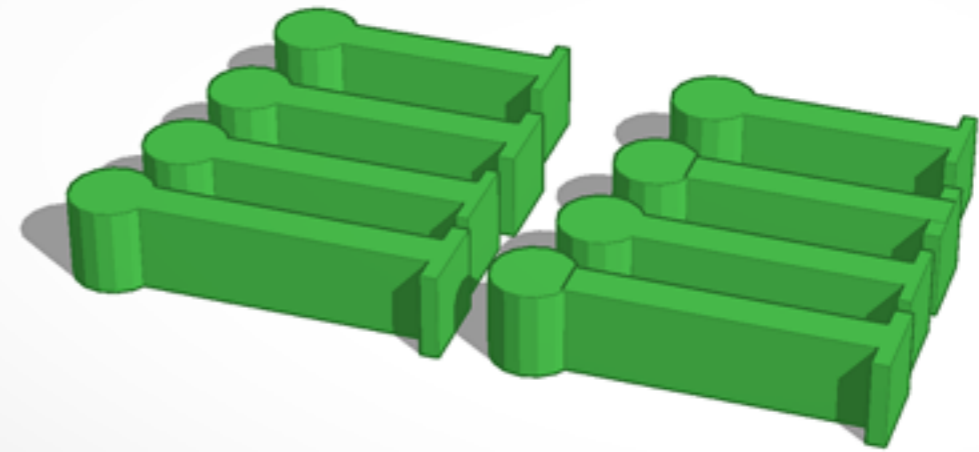




cell holder installed

Cell holder

center vapor cell in a
magnetic shield





Need: fiber polarizer

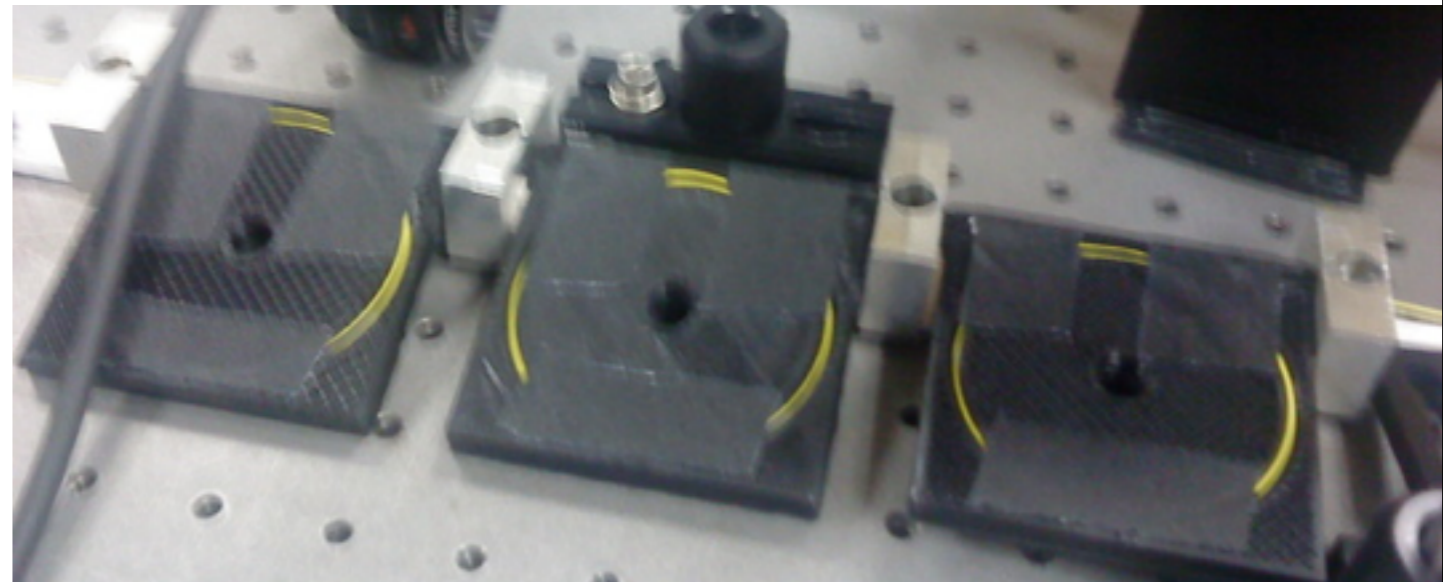
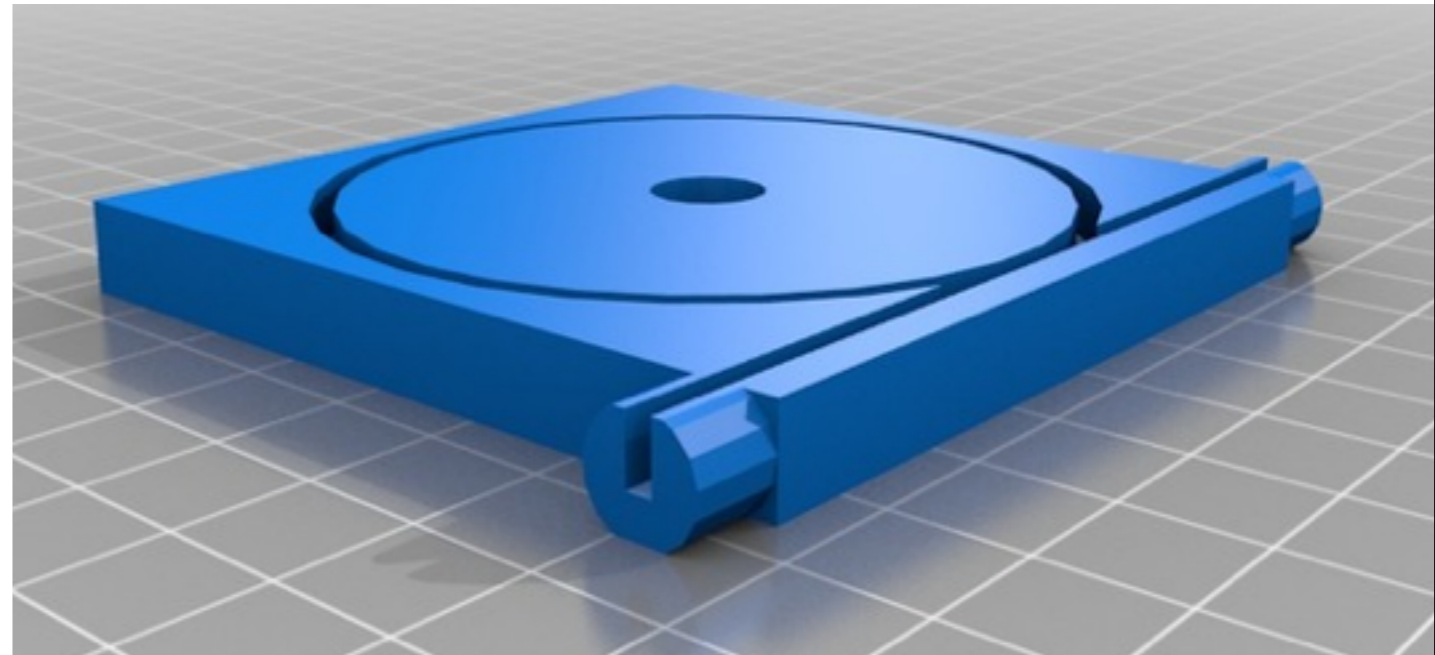
each paddle is a wave plate ($\lambda/4$, $\lambda/2$, $\lambda/4$)

thorlabs: FPC560 \$211.20

Fiber polarizer

3-paddle design

2 person-hours +
4 printer-hours +
\$4.50 of ABS plastic



custom wavelengths

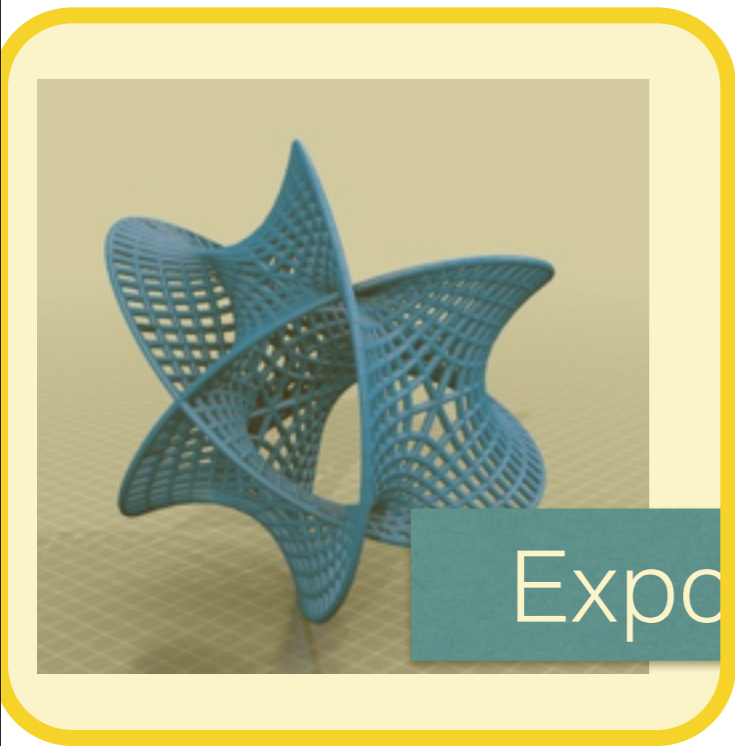
Other examples

- Push-on fiber holder
- Optical table adapters (1/4-20 @ 1" centers)
- AOM mounting bracket
- Quickpost:

Workflow

Design...

and print



Export

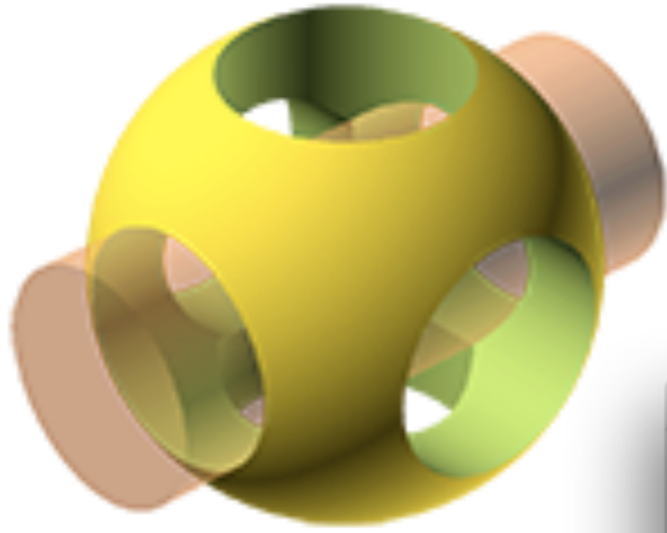
STL

Slicer

G-code

"Print"





OpenSCAD

- Programmatic design
 - code → compile
- Ideal for:
 - specified geometry
 - algorithmic design
 - patterns

```
OpenSCAD - example001.scad

|
module example001()
{
  function r_from_dia(d) = d / 2;

  module rotcy(rot, r, h) {
    rotate(90, rot)
    cylinder(r = r, h = h, center = true);
  }

  difference() {
    sphere(r = r_from_dia(size));
    rotcy([0, 0, 0], cy_r, cy_h);
    rotcy([1, 0, 0], cy_r, cy_h);
    rotcy([0, 1, 0], cy_r, cy_h);
  }

  size = 50;
  hole = 25;

  cy_r = r_from_dia(hole);
  cy_h = r_from_dia(size * 2.5);
}

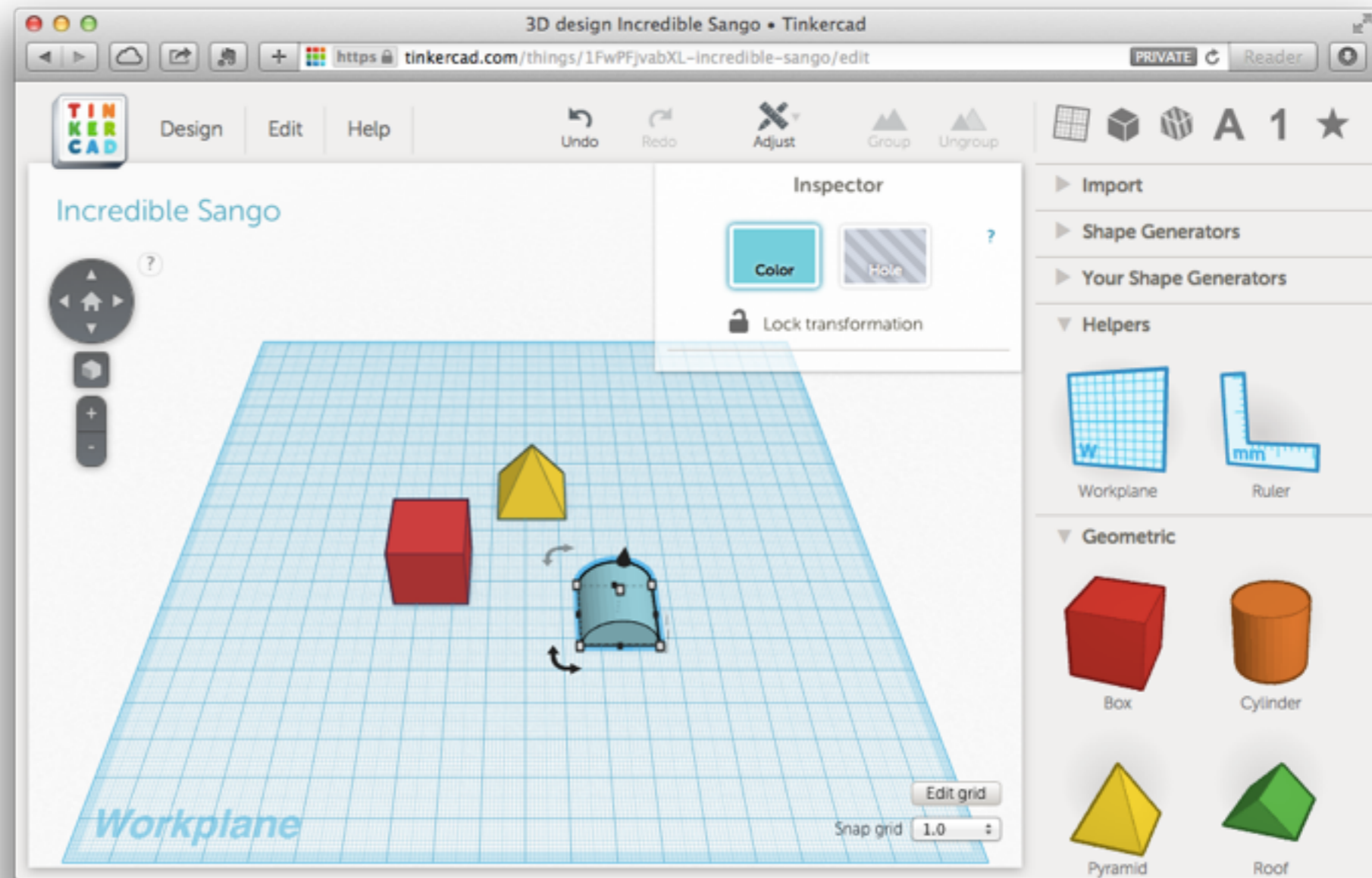
example001();
```

Module cache size: 0 modules
Compiling design (CSG Tree generation)...
Compiling design (CSG Products generation)...
PolySets in cache: 14
PolySet cache size in bytes: 924880
CGAL Polyhedrons in cache: 11
CGAL cache size in bytes: 4901816
Compiling design (CSG Products normalization)...
Normalized CSG tree has 4 elements
CSG generation finished.
Total rendering time: 0 hours, 0 minutes, 0 seconds

Viewport: translate = [0.00 0.00 0.00], rotate = [55.00 0.00 25.00], distance = 500.00

Tinkercad

- Fluid 3D design
 - click & drag
- Ideal for:
 - rapid prototyping
 - fast revisions
 - sharing

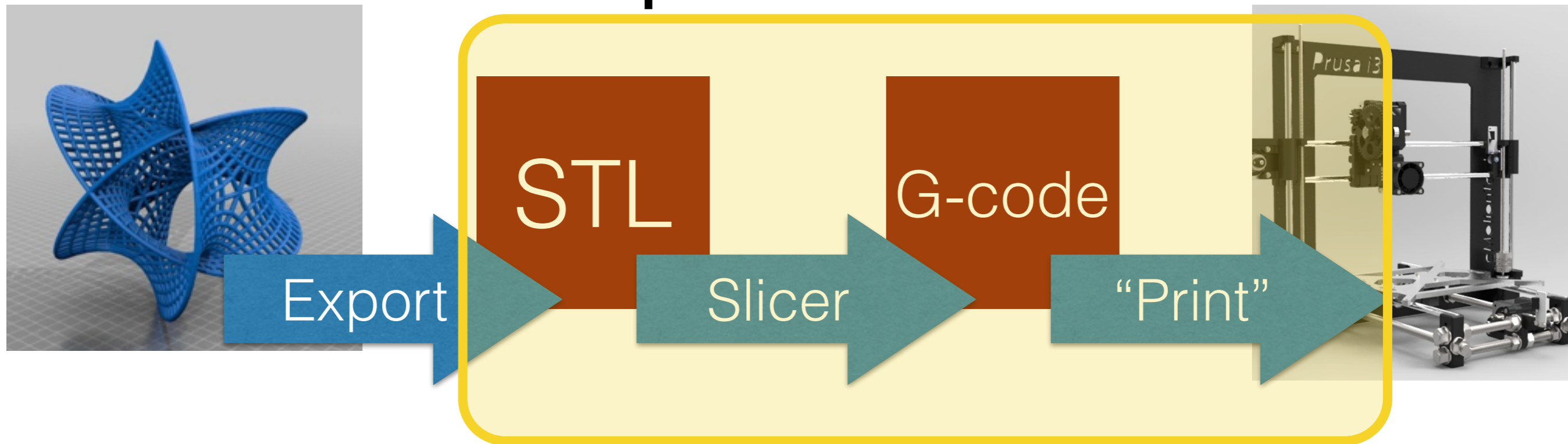


Demo

Design...

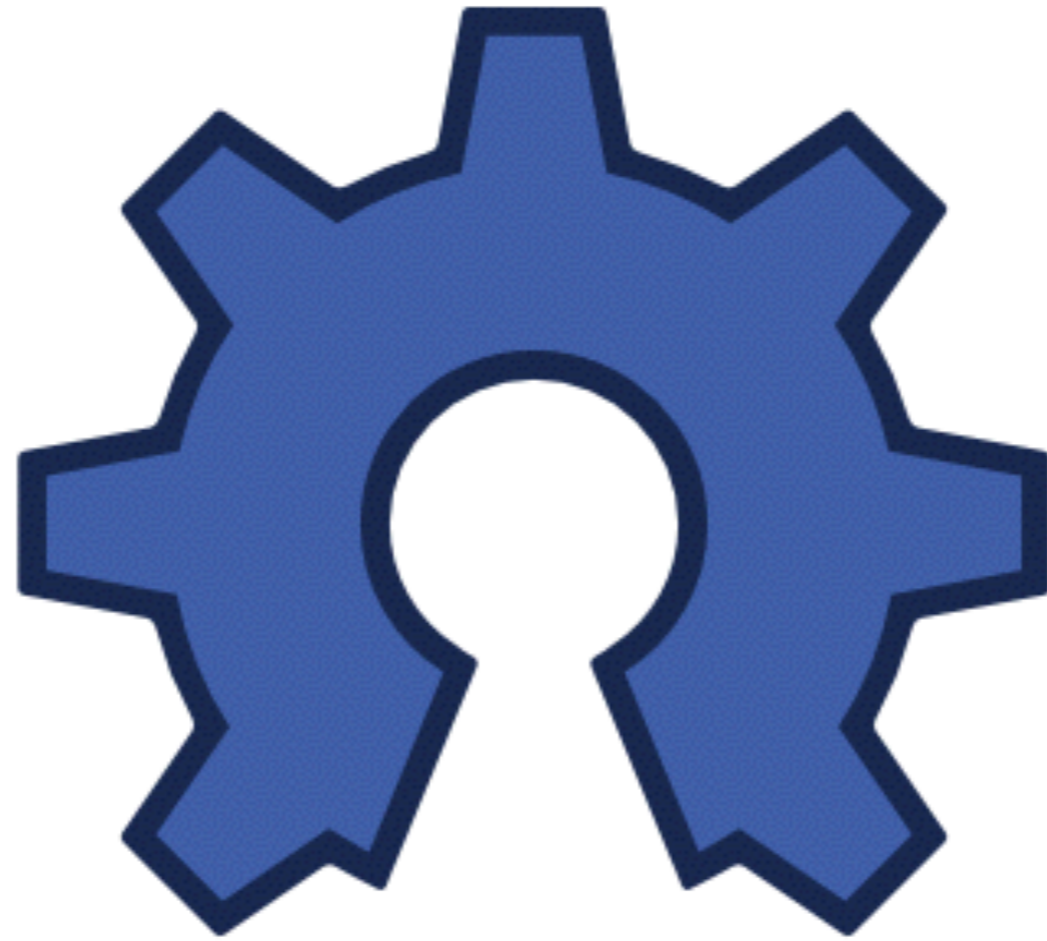
and print

Repetier-Host



Demo

Lessons learned



open hardware

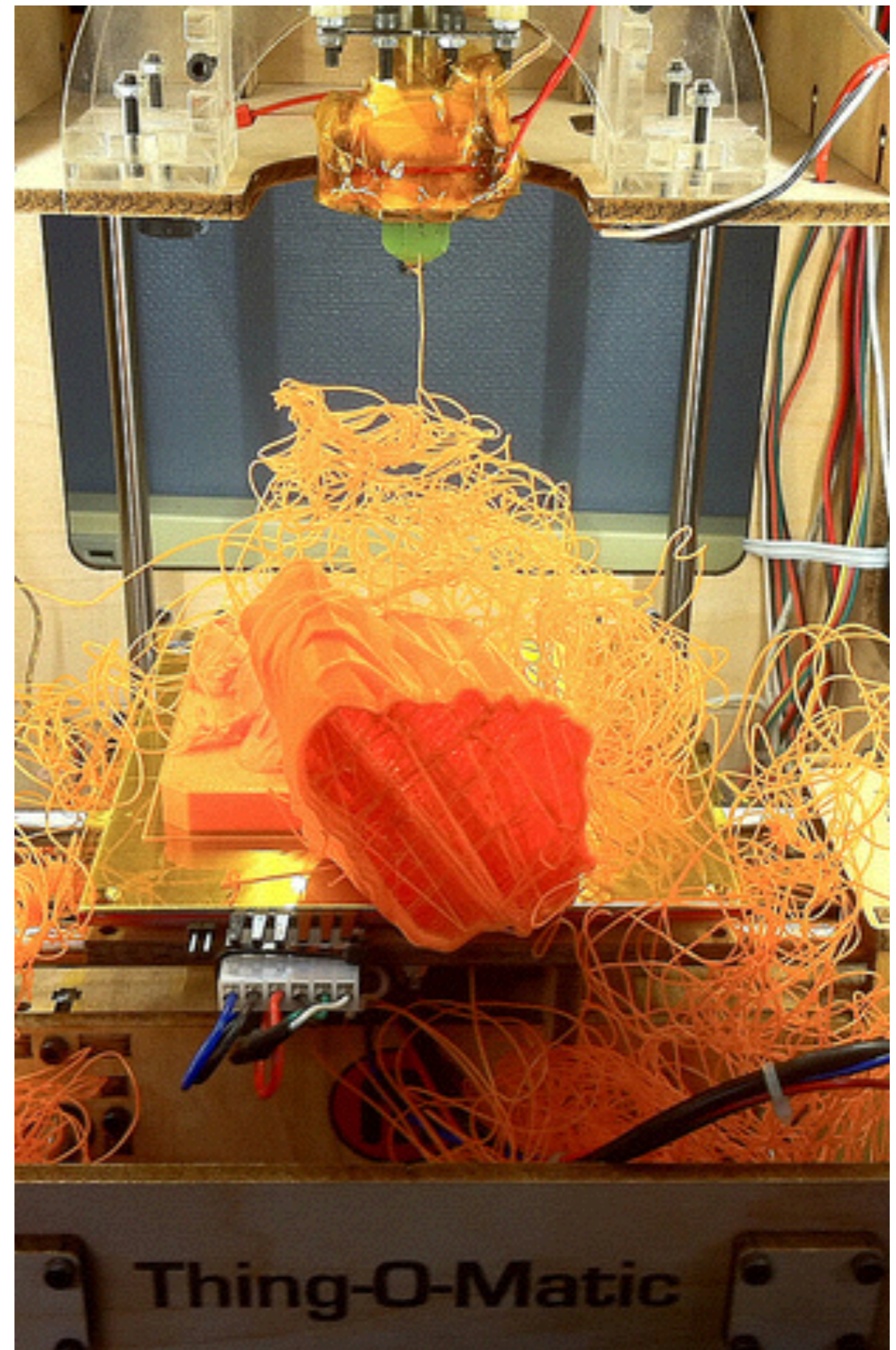
We bought our kit in January 2012, by September 2012
Makerbot shifted to closed source development and
effectively orphaned their prior products.

Printer support

establish a list of expert users

culture of helping each other

communicate about what
breaks (yes, it will break)



Next steps...

Outreach

- 2014–2015 faculty development grant
- Prusa i3 (build from kit)
- Share with 7-8th graders during Fall semester
- iPad apps for design



“I could make that!”

Thank you:

- Jeff Mintz
 - *Physics minor* — assembly and testing
- Noah Holte,
 - *Physics major* — cell holder, fiber paddles,
- Hunter Dassonville
 - *Physics major* — cell heater structure
- *NSF, Research Corp, Murdock Charitable Trust, Pacific U.*



Outtakes



A LETTERS JOURNAL EXPLORING
THE FRONTIERS OF PHYSICS

November 2013

EPL, 104 (2013) 48001

www.epljournal.org

doi: 10.1209/0295-5075/104/48001

Sculplexity: Sculptures of Complexity using 3D printing

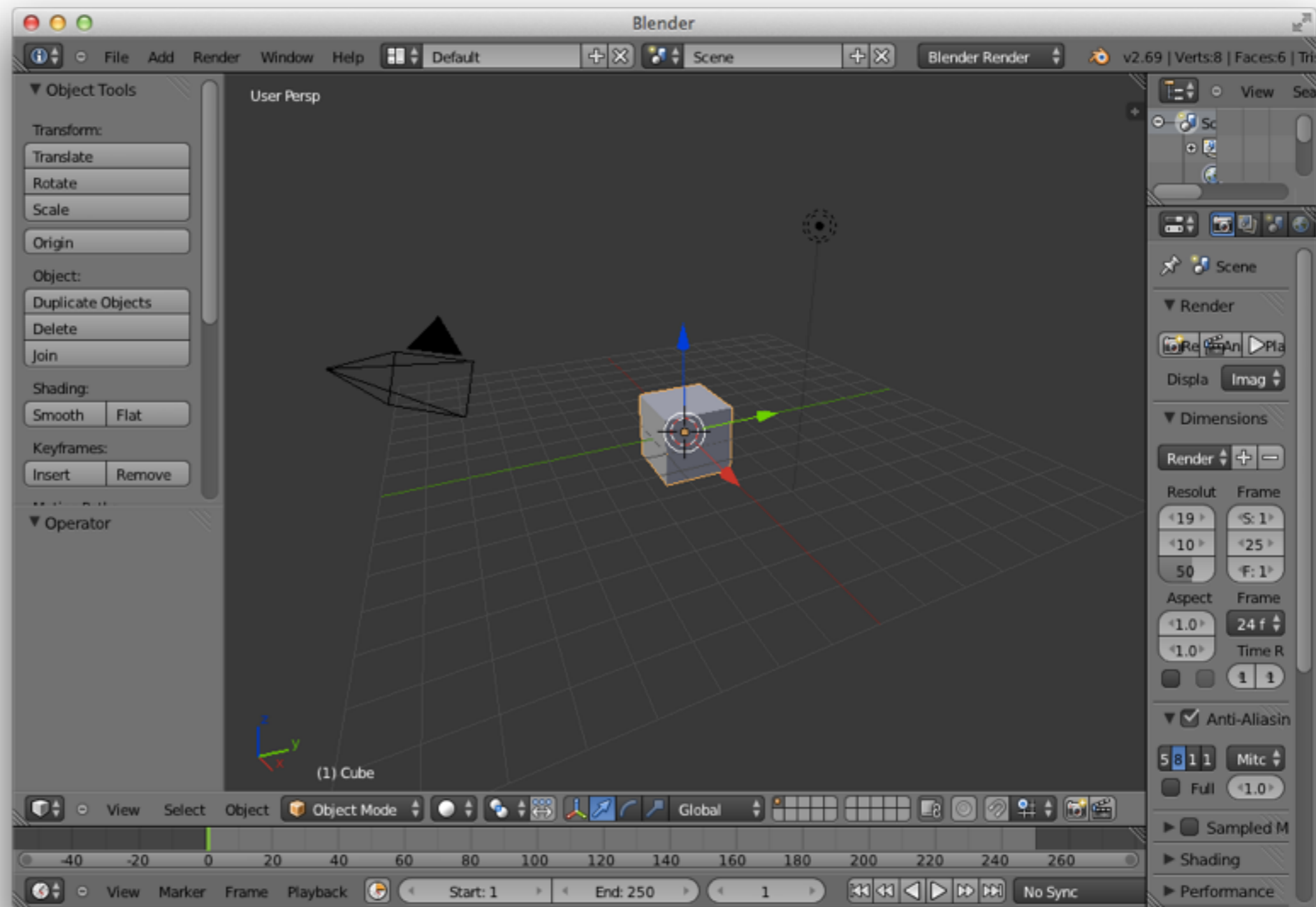
D. S. REISS, J. J. PRICE and T. S. EVANS

Department of Physics, Imperial College London - London, SW7 2AZ, UK

received 6 September 2013; accepted in final form 12 November 2013
published online 9 December 2013

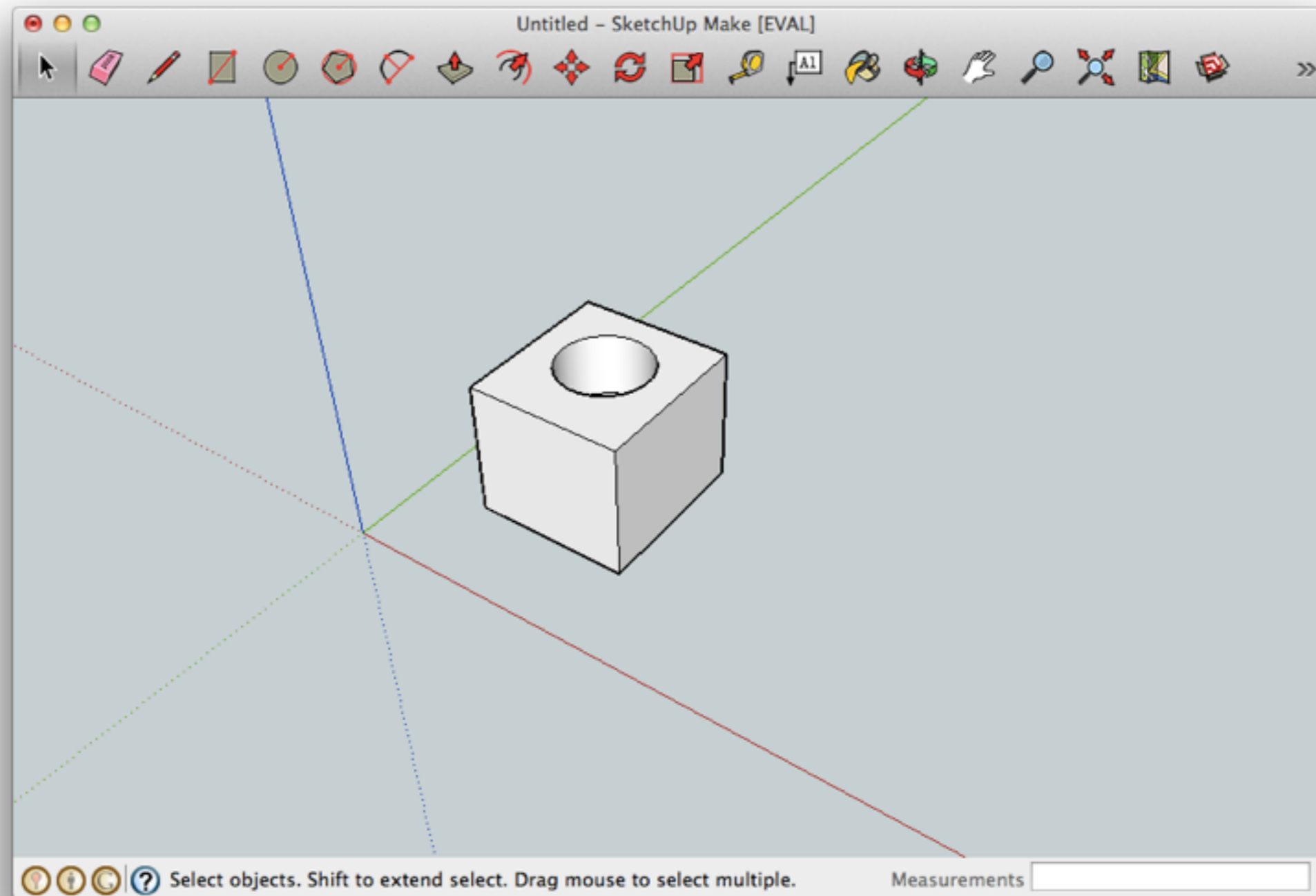
Blender

- Advanced 3D design
- 3D raytracing
- Ideal for:
 - existing users



Sketchup Make

- click & drag
- large 3D library
- free*



* Pro version is also available at an EDU discount