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# Computer Engineering

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*Henry Clay, May 11, 2016*

University of Kentucky
Electrical & Computer Engineering

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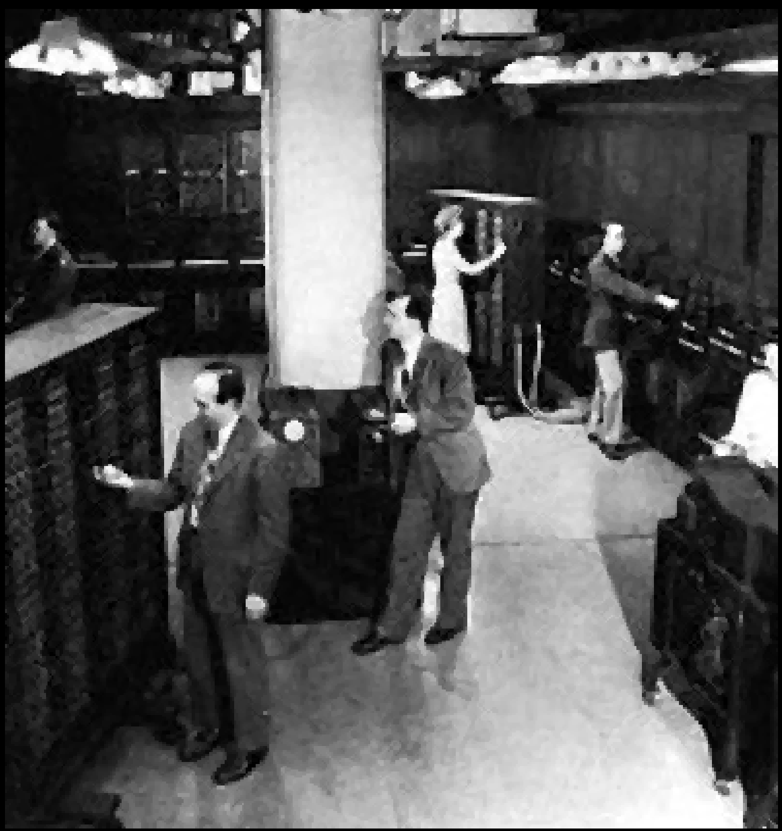
# Computer Engineering

- Electrical Engineers make hardware?
- Computer Scientists make software?
- Computer Engineers make it all work:
  - System software; compilers & OS
  - Hardware architecture, logic, & VLSI
  - Understand, design, and implement computing systems to meet goals (performance and/or new abilities)

# Computer Engineering Core Topics Include…

- Programming & software engineering
- Basic circuits & digital logic
- Computer architecture
- Compilers
- Operating Systems
- Embedded systems

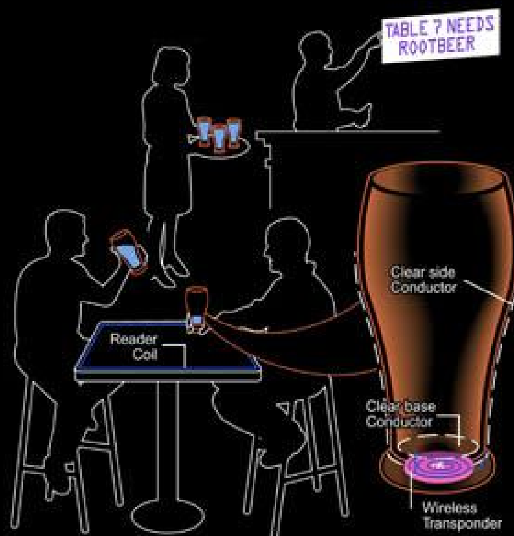
# Early Computers



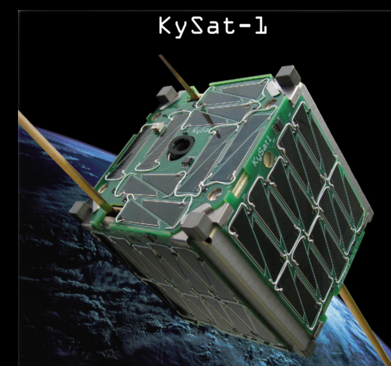
# Personal Computers

# Supercomputers

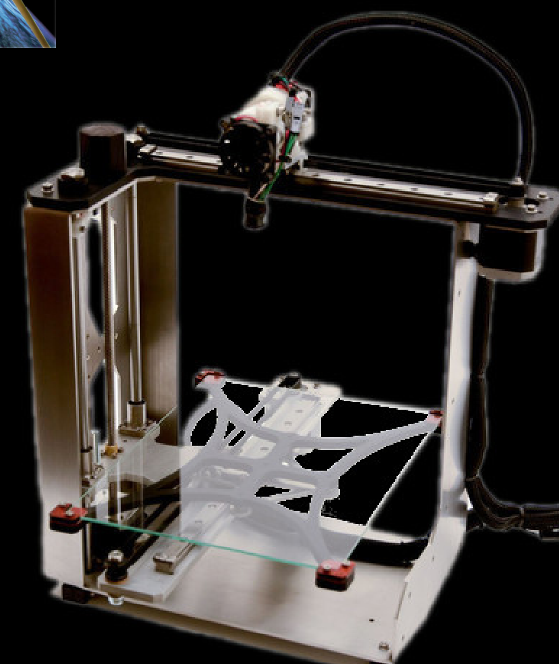
# Embedded Computers











# It's All About Being Smart

- Building and using powerful computers as tools amplifies human intelligence
- Embedding computers in things makes them able to act intelligently

# Supercomputers

Computers that can solve big problems and can ***scale*** to solve bigger problems.

- Mostly about parallel processing
- Need not be huge, expensive, etc.
- We make them able to do new things
- We make them cheap:
  Clusters, SWAR, GPUs...

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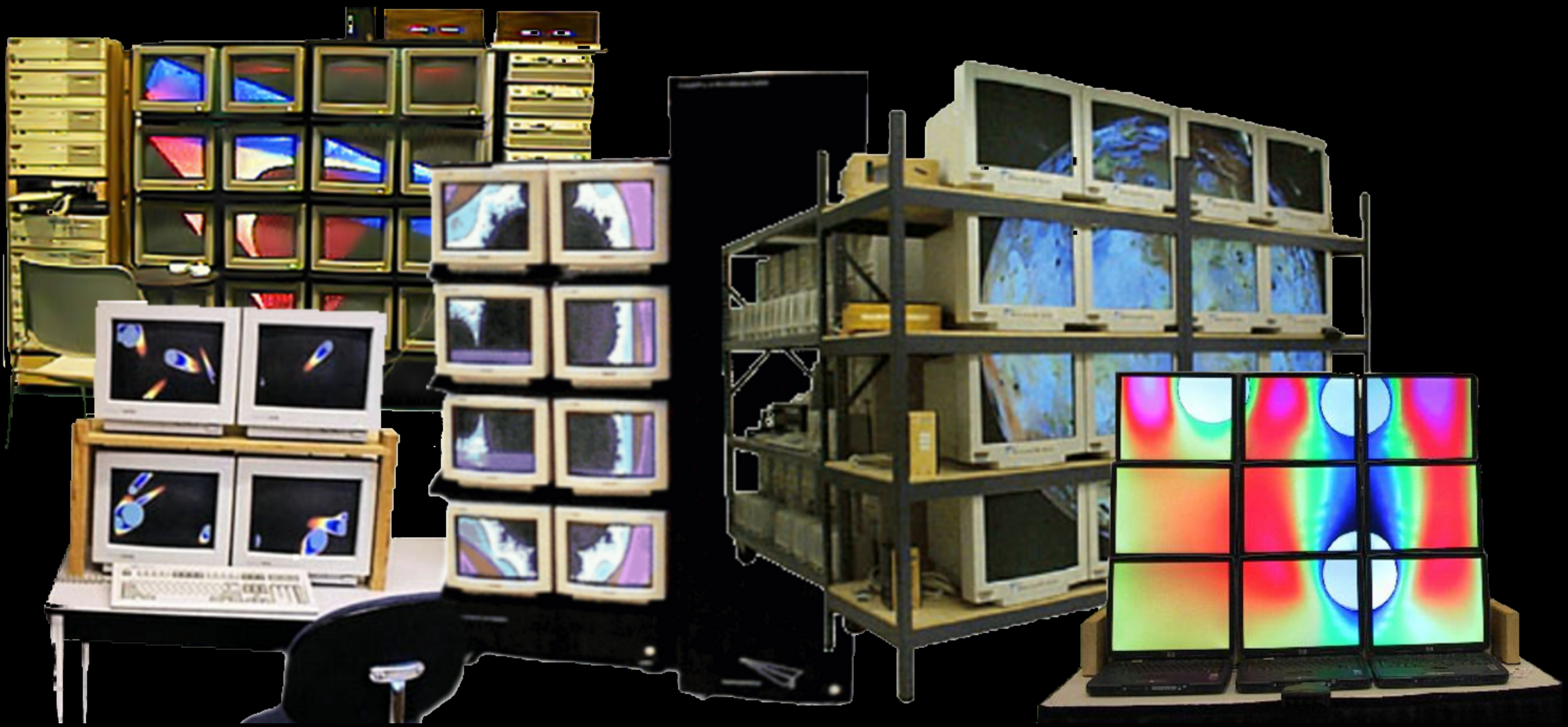
# A New Supercomputer Thing: Video Walls



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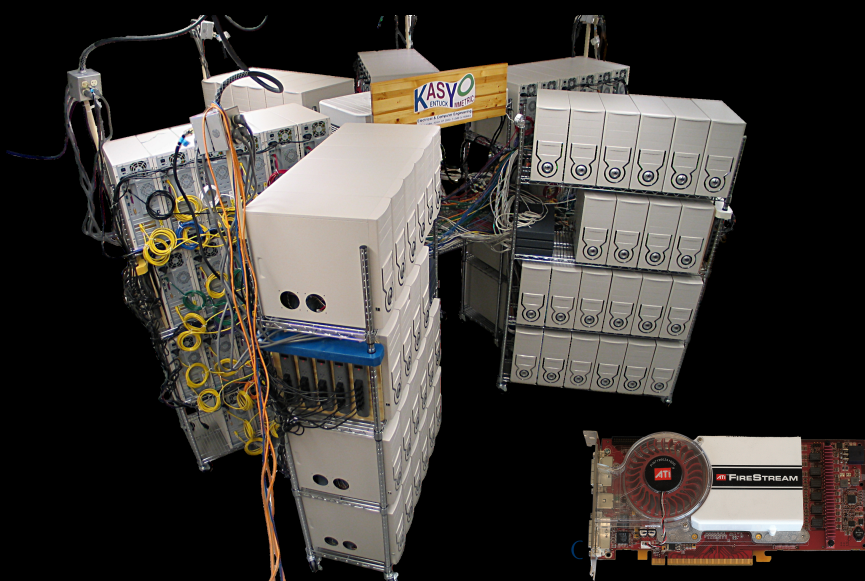
# Cheap Supercomputers


# How Cheap?

A GFLOPS is
1,000,000,000 add or multiply per second

1992 MasPar MP1 $1,000,000 / GFLOPS

# How Cheap?

A GFLOPS is
1,000,000,000 add or multiply per second

| | | |
|---|---|---|
| 1992 | MasPar MP1 | $1,000,000 / GFLOPS |
| 2000 | KLAT2 | $650 / GFLOPS |
| 2003 | KASY0 | $84 / GFLOPS |
| 2010 | NAK | $0.65 / GFLOPS |

Best now under $0.15 / GFLOPS...

# Computational Photography

Cameras create a model of a scene;
use computation to enhance camera abilities
and / or to process the data captured.

- Detection / manipulation of image properties
- Intelligent computer control of capture
- New camera / sensor / processing models

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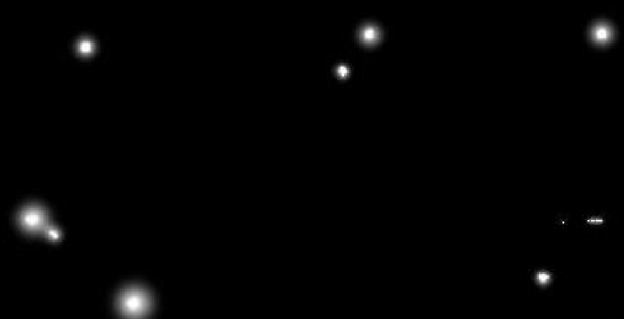
# Fixing Fuji  “White Orbs”



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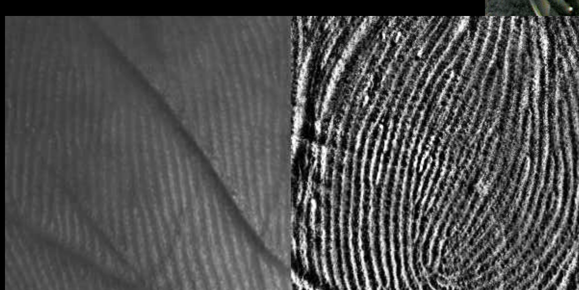
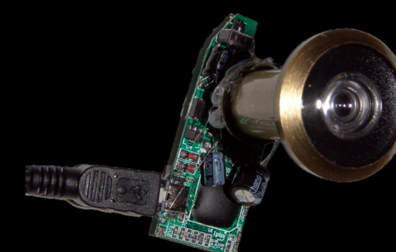
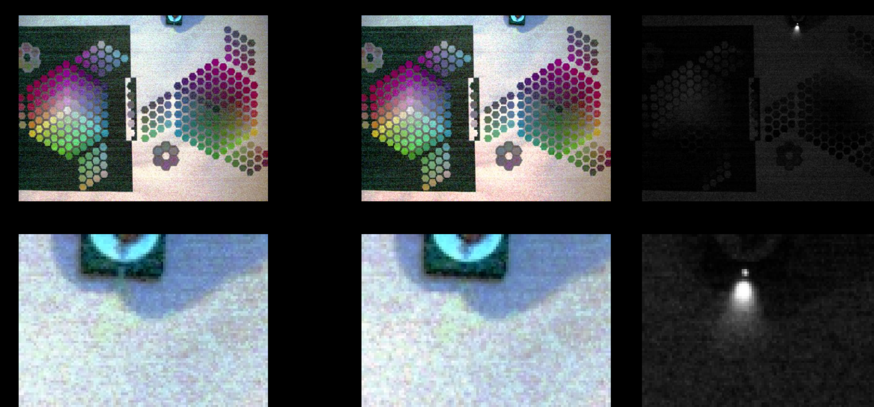


Normal processing | RGB extraction | IR extraction



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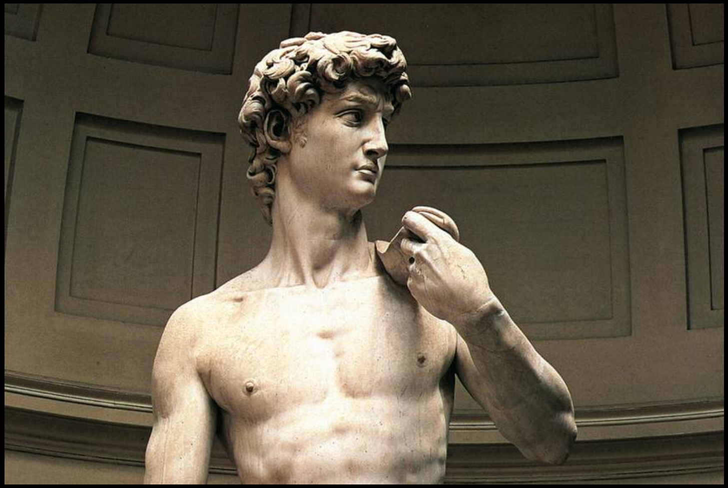
# Making Technologies

3D printing and other "rapid prototyping," such as laser cutters, CNC mills, etc.

- Looks like Mechanical Engineering, but:
  - Materials (e.g., PLA for 3D printing)
  - Computer control for smart, generic, tools
  - Computer Aided Design / Manufacturing (CAD / CAM)
- Many issues yet to be resolved, such as design for manufacturability

# Subtractive Building



"Every block of stone has a statue inside it and it is the task of the sculptor to discover it."
– *Michelangelo*

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# Additive Building

"The whole is greater than the sum of its parts."
– *Aristotle*

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# How To Make Stuff

- People used to make things by hand... but humans make and use tools
- Most tools are special purpose; they only make a particular type of thing
- Using computer control we can build smart, generic, tools – even tools that can build themselves (RepRap: Replicating Rapid prototyper)

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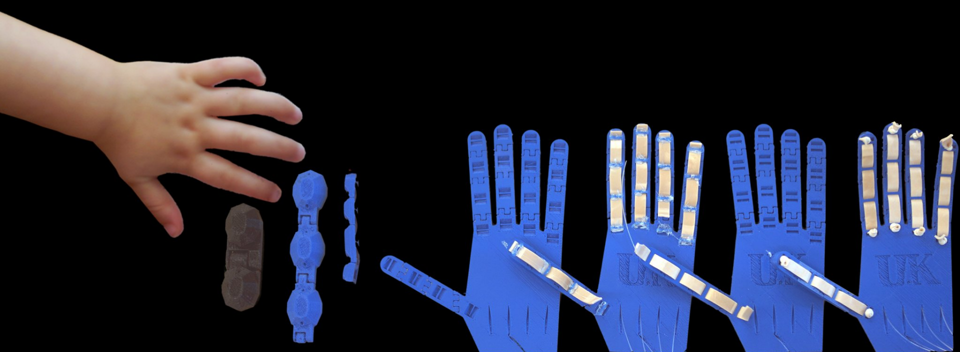


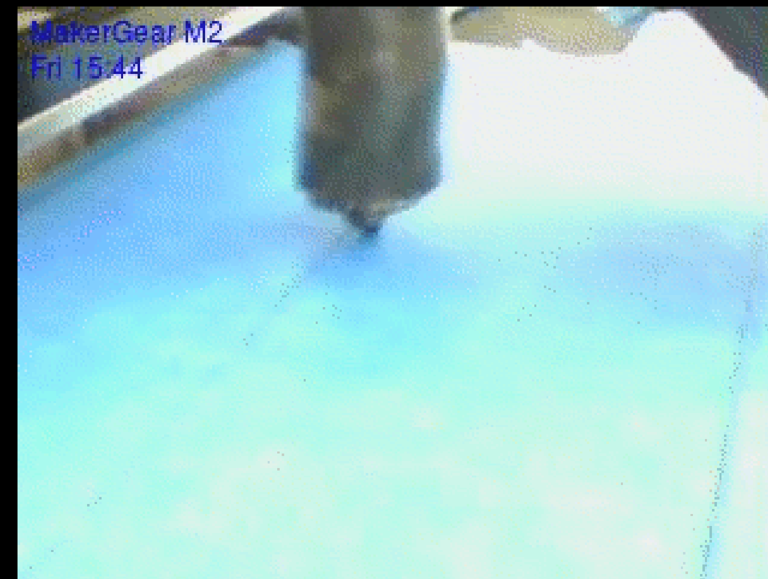


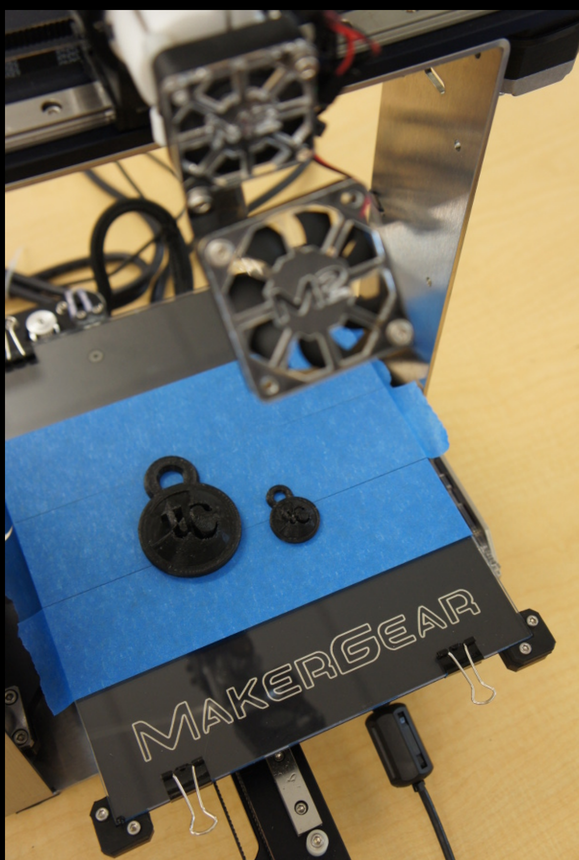



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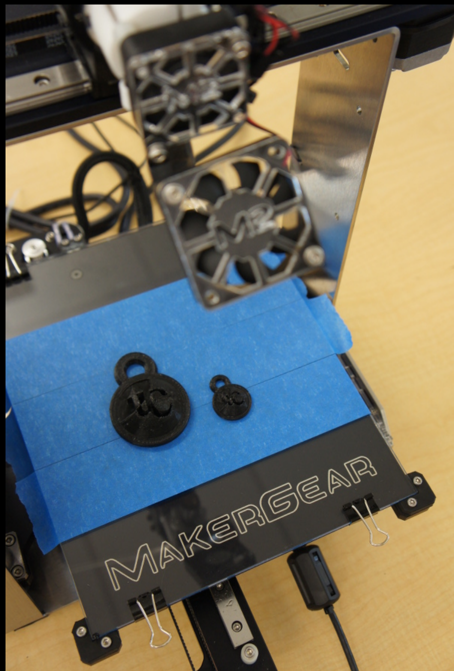
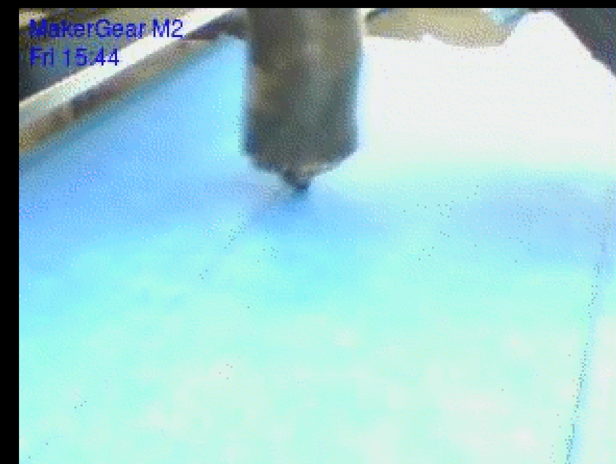
# 3D Printing




- $1700 MakerGear M2, $400 Wanhao I3
- We extrude 1.75mm diameter PLA filament to make 0.25mm tall “threads”
- PLA extrudes around 180° – 210°C
- No clamping; extrusion bonds to hot bed

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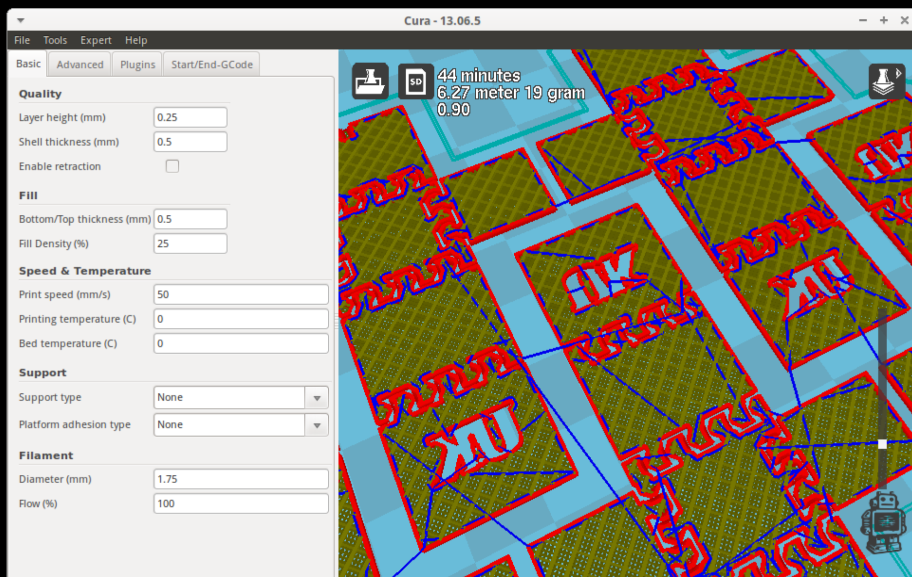
# Print-Assembled Hinges




```
G1 X90.062 Y143.899 E2.97592
G1 X89.502 Y143.229 E3.05532
G1 X88.872 Y142.279 E3.15897
G1 X88.262 Y141.249 E3.26782
G1 X87.812 Y140.339 E3.36013
G1 X82.282 Y126.599 E4.70690
G1 X81.972 Y125.579 E4.80383
G1 X81.432 Y123.169 E5.02841
G1 X81.332 Y122.429 E5.09631
G1 X81.242 Y119.949 E5.32196
G1 X81.252 Y119.199 E5.39016
```

- Can't have unsupported structures...
  45-degree overhangs are ok
- 3D model > STL > slicing > gcode

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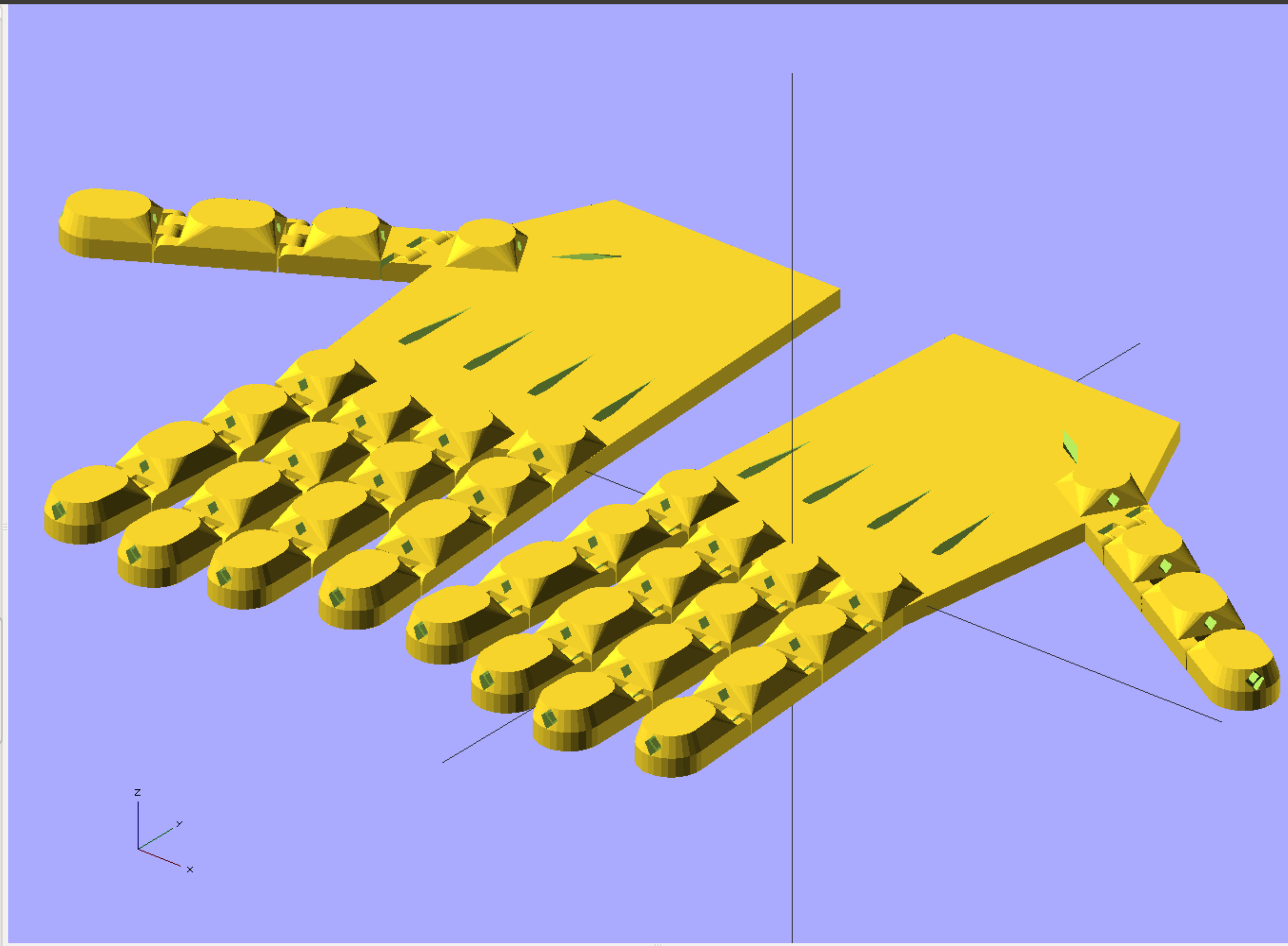
OpenSCAD - hand20130925.scad

File Edit Design View Help

```
module fingtip(wide=10, long=11, thick=6) {
    // make a finger segment
    assign(inset=1) // inset of top of finger
    assign(bandwide=6+2*tol) // width of rubber band
    difference() {
        hull() {
            // bottom of segment
            translate([0, long/4, 0])
            cube([wide, long/2, thick/2], center=true);
            translate([0, (long-wide)+wide/2, 0])
            cylinder(r=wide/2, h=thick/2, center=true);

            // top of segment
            translate([0, wide/2, thick/2])
            cylinder(r1=wide/2, r2=wide/2-inset, h=thick/2, center=true);
            translate([0, (long-wide)+wide/2, thick/2])
            cylinder(r1=wide/2, r2=wide/2-inset, h=thick/2, center=true);
        }

        // hole for muscle wire
        translate([0, long, thick/4+sqrt(2)])
        rotate([90, 0, 0])
        cylinder(r=1, h=long*2, center=true, $fn=4);

        // spot to tuck end of muscle wire
        translate([0, long, thick/4+sqrt(2)])
        rotate([90, 0, 0])
        sphere(r=2, $fn=4);

        // loop for rubber band
        translate([0, long-thick/2-(bandwide/2*sqrt(2))/2, -thick/4])
        difference() {
            rotate([0, 90, 0])
            sphere(r=bandwide/2*sqrt(2), $fn=4);
            translate([0, 0, -sqrt(2)*bandstrap])
            rotate([0, 90, 0])
            sphere(r=bandwide/2*sqrt(2)+0.001, $fn=4);
        }
    }
}

module finger(wide=10, long=11, thick=6, nofing=0) {
    assign(firstlong=1*long)
    assign(twolong=1.25*long)
    assign(tiplong=1.25*long)
    union() {
        if (nofing == 0)
        translate([0, wide+thick/4+tol, 0])
        union() {
            translate([0, firstlong+thick/2+2*tol, 0])
            union() {
                translate([0, twolong+thick/2+2*tol, 0])
                union() {
                    hingelen(wide, thick/2);
                    translate([0, thick/4+tol, 0])
                    fingtip(wide, tiplong, thick);
                }
                hingelen(wide, thick/2);
                translate([0, thick/4+tol, 0])
                fingseg(wide, twolong, thick);
            }

            hingelen(wide, thick/2);
            translate([0, thick/4+tol, 0])
            fingseg(wide, firstlong, thick);
        }

        difference() {
            // hand base
            fingseg(wide, wide, thick);
            translate([0, -wide, 0])
            cube([2*wide, 2*wide, 2*thick], center=true);
        }
    }
}

module thumb(wide=10, long=11, thick=6) {
```

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Edges: 49532
Halffacets: 39020
Facets: 19510
Volumes: 39
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# Questions?

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