Programming the real World

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Why Do We Love Programming?

- Challenge of problem solving
- Creating something that didn't exist before
- Seeing something work
- Show off our abilities
- ...but everybody loves those feelings!

Everybody Wants To Create

Artists...

Everybody Wants To Create

Athletes...

Everybody Wants To Create

Young and old...

Everybody Wants To Create

Politicians...

(no, really!)

Everybody Wants To Create

Engineers...

Everybody Wants To Create

Fashion designers...

Software is Different

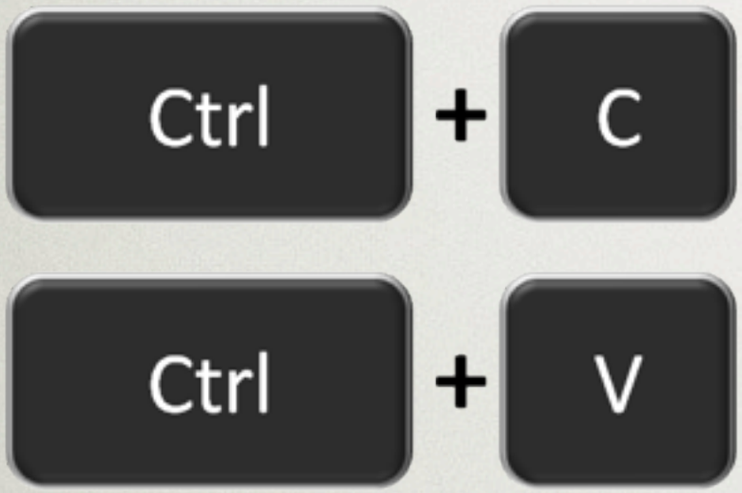
Software is Different

- Something about creating with software is qualitatively different

- How many pottery billionaires have you heard of lately?

- How many other young businesses have hundreds of millions of users?

Why Is Software Different?



vs

Software is design-only,
with no marginal cost to reproduce

Why Is Software Different?

first_script.html - Notepad

File Edit Format View Help

```
<!DOCTYPE HTML>
<HTML>
        <HEAD>
                <TITLE>A First Script</TITLE>
        </HEAD>

        <BODY>
                <SCRIPT LANGUAGE = "Javascript">
                        alert("Hello World")
                </SCRIPT>

        </BODY>
</HTML>
```

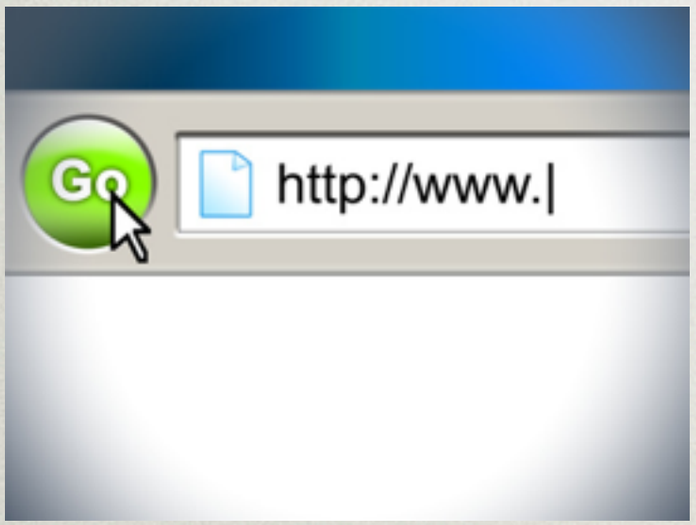
VS

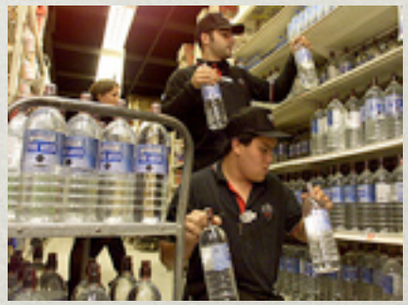
Software has a lower barrier to participation.

What is the “Hello World” for surgery?

Why Is Software Different?

vs





Distribution is easier and cheaper

Why Is Software Different?

Tools and libraries let us abstract away non-core tasks

Why Is Software Different?

mozilla
FOUNDATION

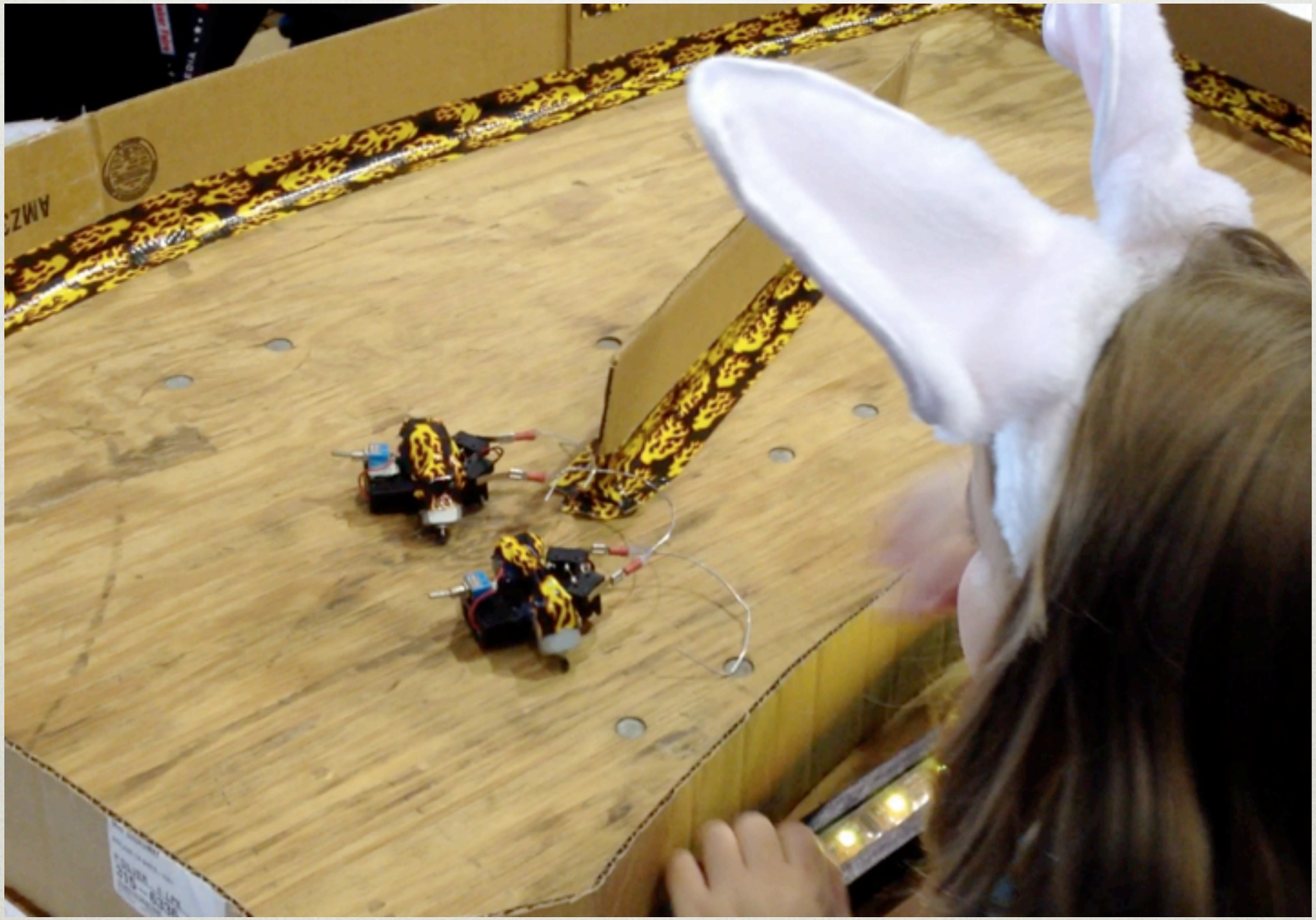
Communities and contribution tools
allow us to build on the best work of others

It's Not Just For Software Anymore

The Maker Movement

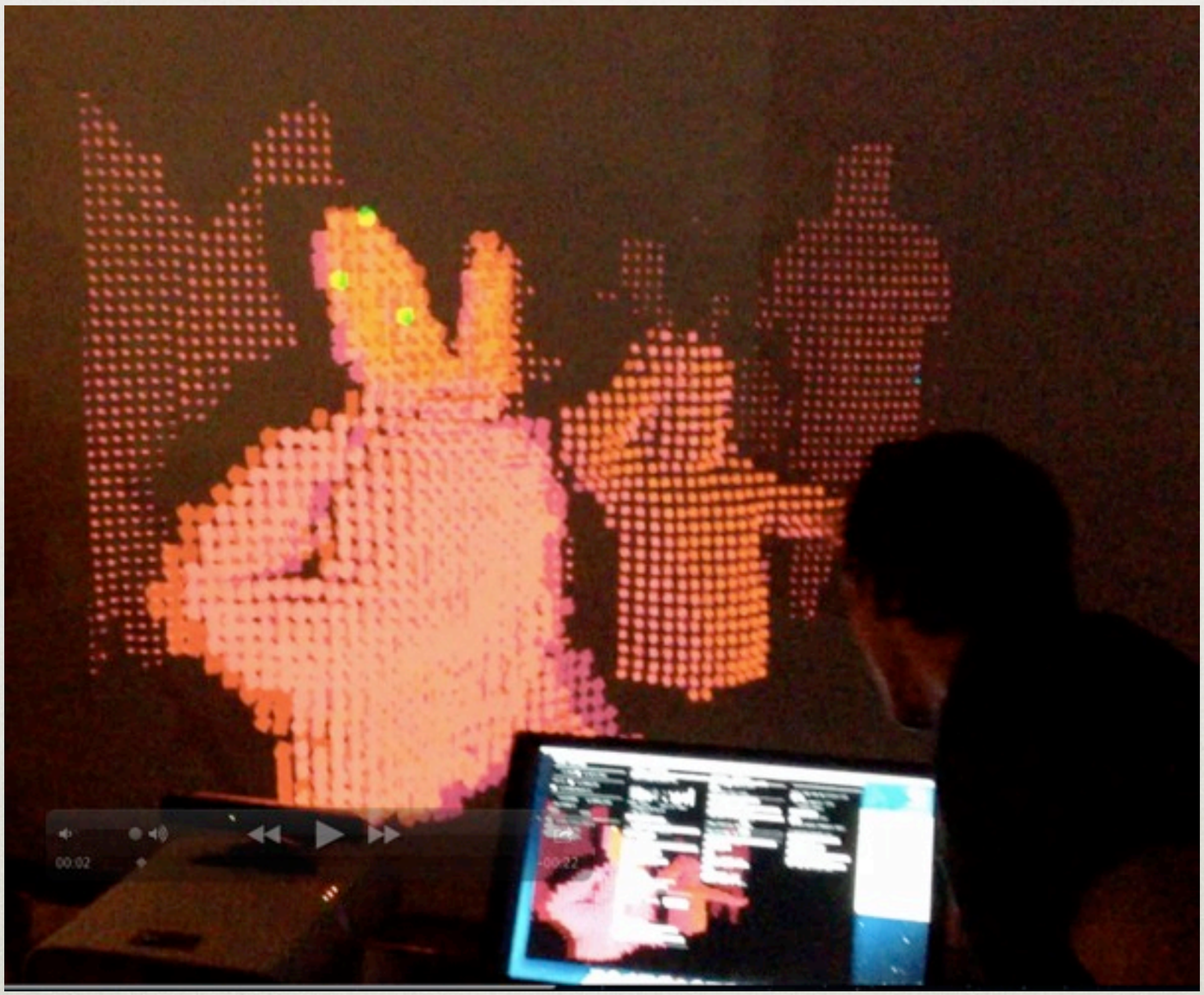
- Costs for hardware of all sorts are falling
- Resources for learning electronics and hardware are better than ever and improving
- The internet makes showing off your creations easier than ever
- Maker Faire - the biggest show and tell on Earth - http://makerfaire.com/

Maker Faire



Robot bugs that skitter,
made with $10 of electronics

Maker Faire



Real-time visualization of dancing

https://github.com/benMcChesney/ofxOpenVJ

Maker Faire

250 Fish and Lobsters Singing Beethoven's 9th

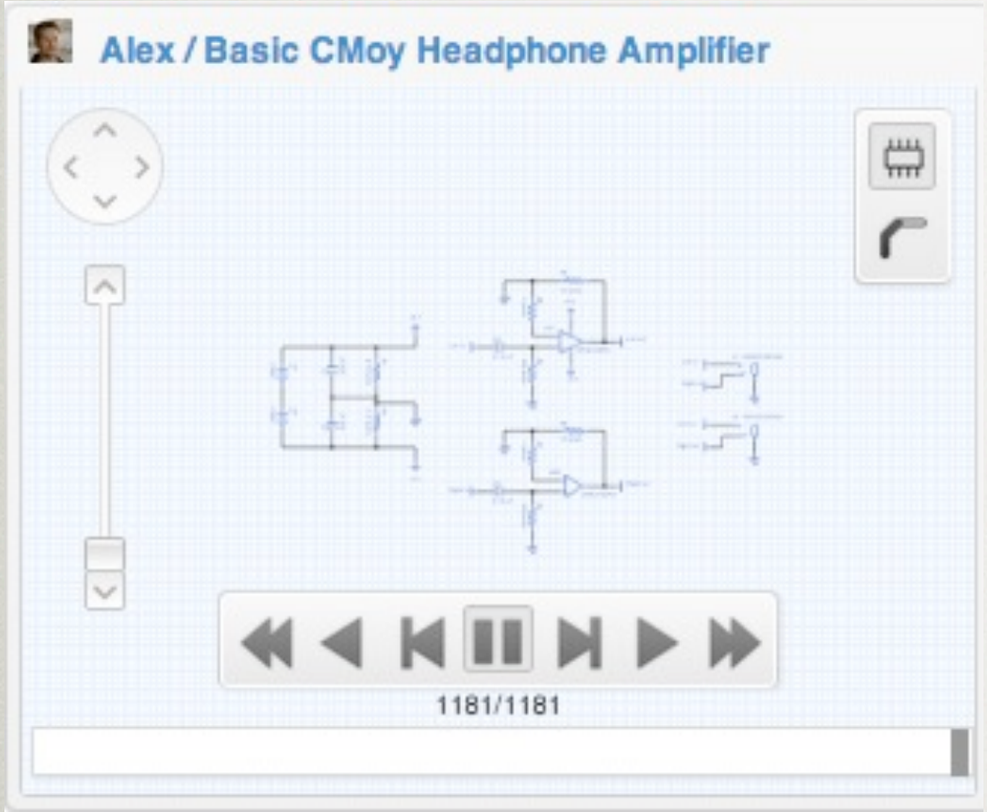
http://www.sashimitabernaclechoir.org/

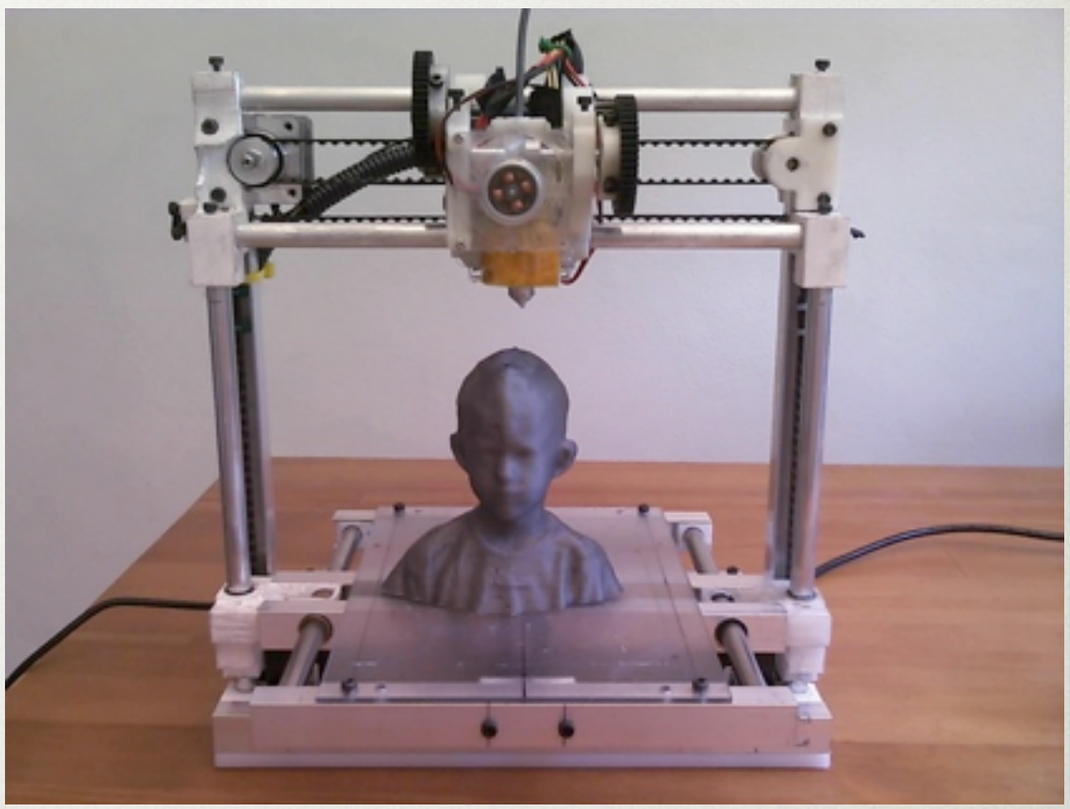
Maker Faire

Coming Soon to a City Near You!

http://makerfaire.com/map/

The Maker Movement



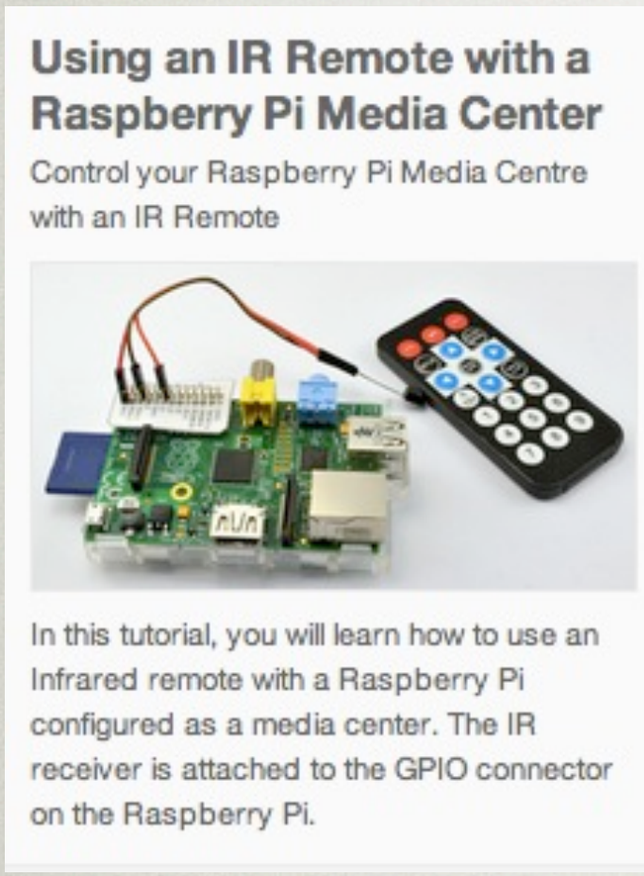


New tools for design and experimentation

Left: http://upverter.com for designing circuits

Right: 3D printer for prototyping complex shapes

The Maker Movement



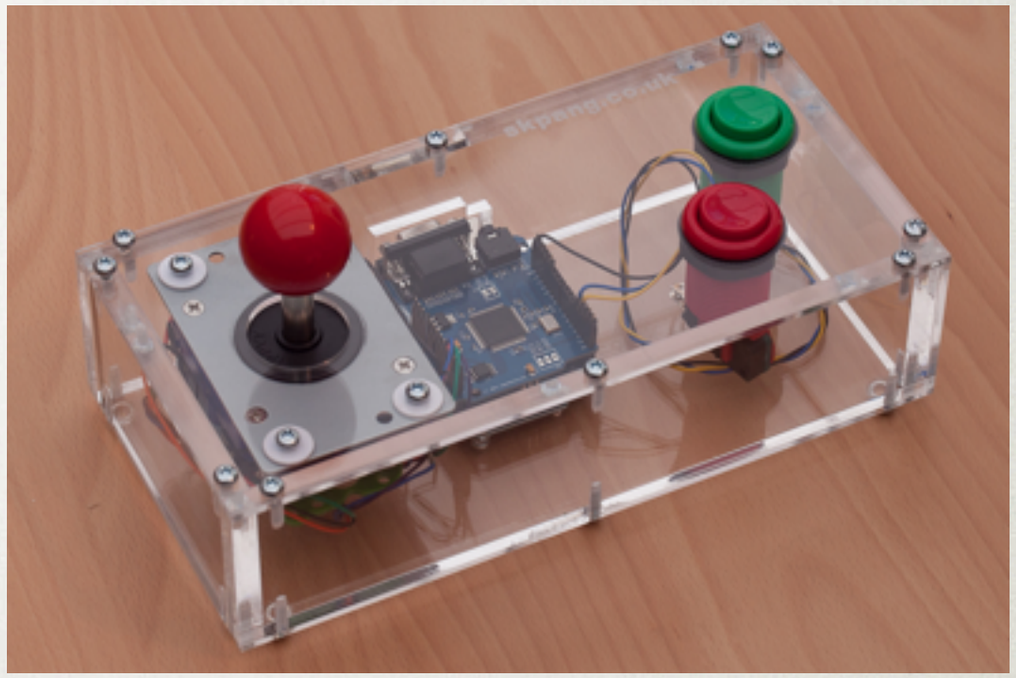
Tools and resources for learning

L: Adafruit tutorials http://learn.adafruit.com/

C: LightUp augmented reality http://www.lightup.io/

R: littleBits kits http://littlebits.com/

The Maker Movement



DIY Projects

Left: Roominate DIY Dollhouse Kits

http://www.roominatetoy.com/

Right: Retro Gaming with Raspberry Pi

http://learn.adafruit.com/retro-gaming-with-raspberry-pi

Software Enables Intelligent Interaction With *Abstract* Things

Hardware Enables Intelligent Interaction With *Physical* Things

Hardware Becoming Software

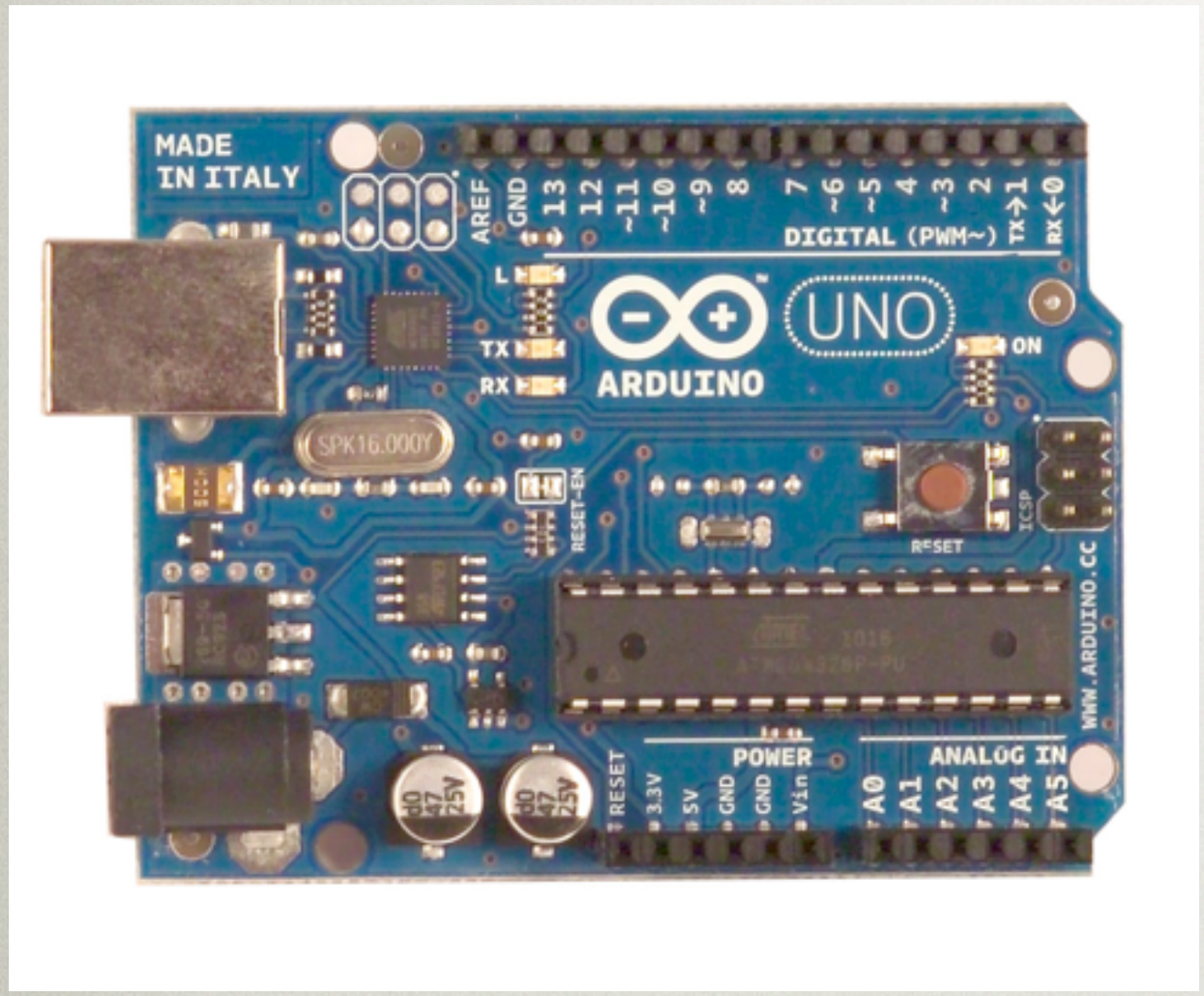
"Hackers love to build hardware, and customers love to buy it. So if the ease of shipping hardware even approached the ease of shipping software, we'd see a lot more hardware startups."

http://www.paulgraham.com/hw.html

Hardware Becoming Software

- Shrinking marginal cost - cheaper hardware
- Broad participation - Maker movement
- Distribution - Kickstarter, Shopify
- Abstract non-core tasks - kits, more components
- Community and collaboration

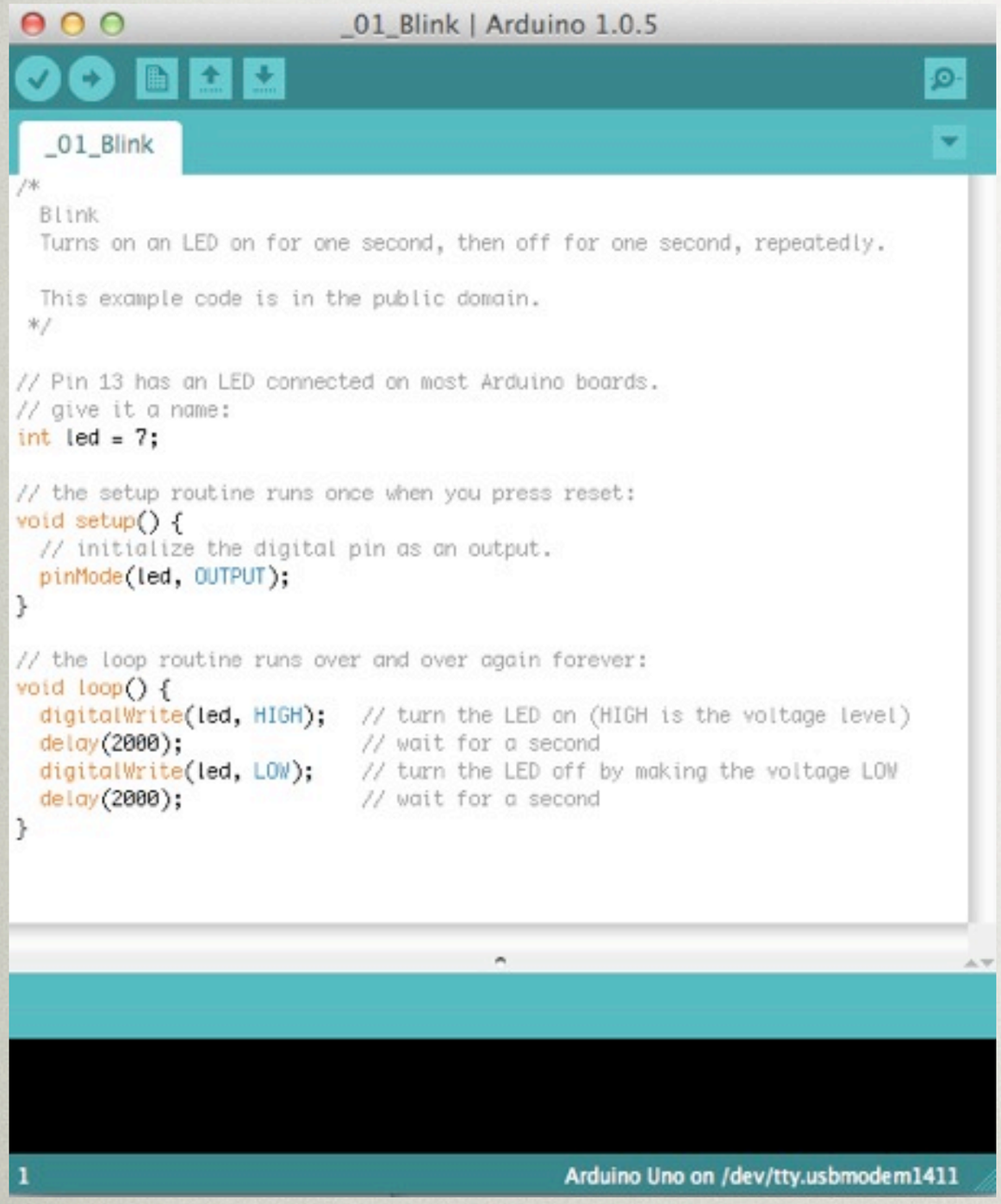
Arduino



Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. It's intended for artists, designers, hobbyists, and anyone interested in creating interactive objects or environments.

- http://www.arduino.cc/

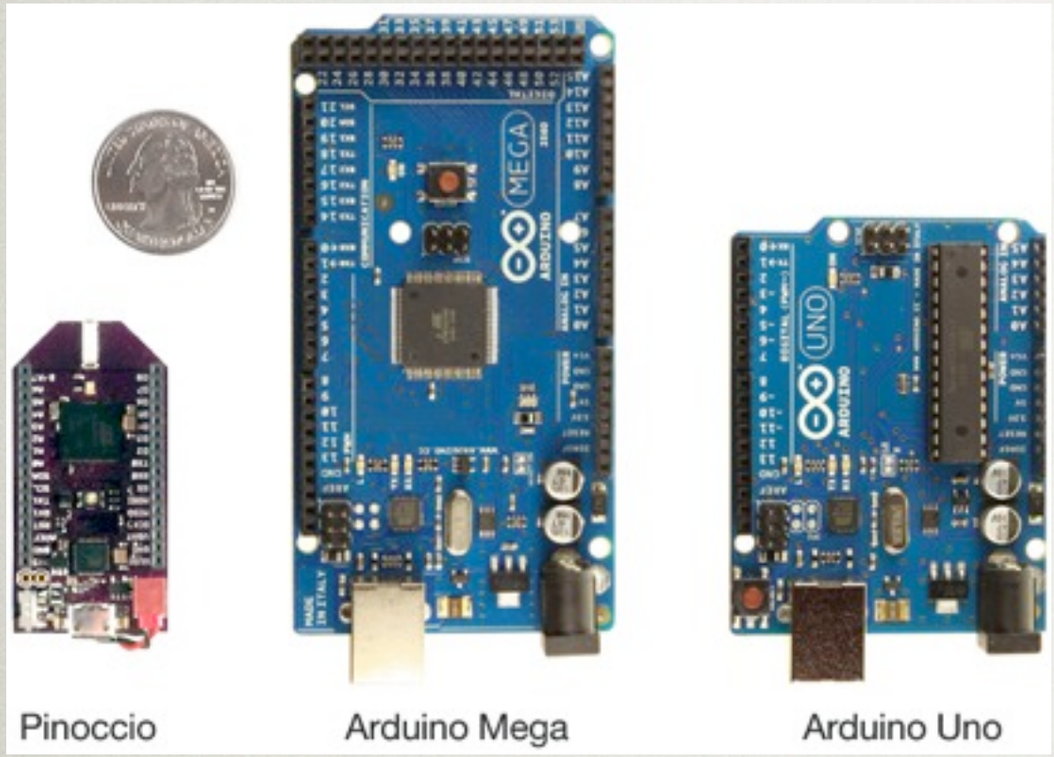
Arduino

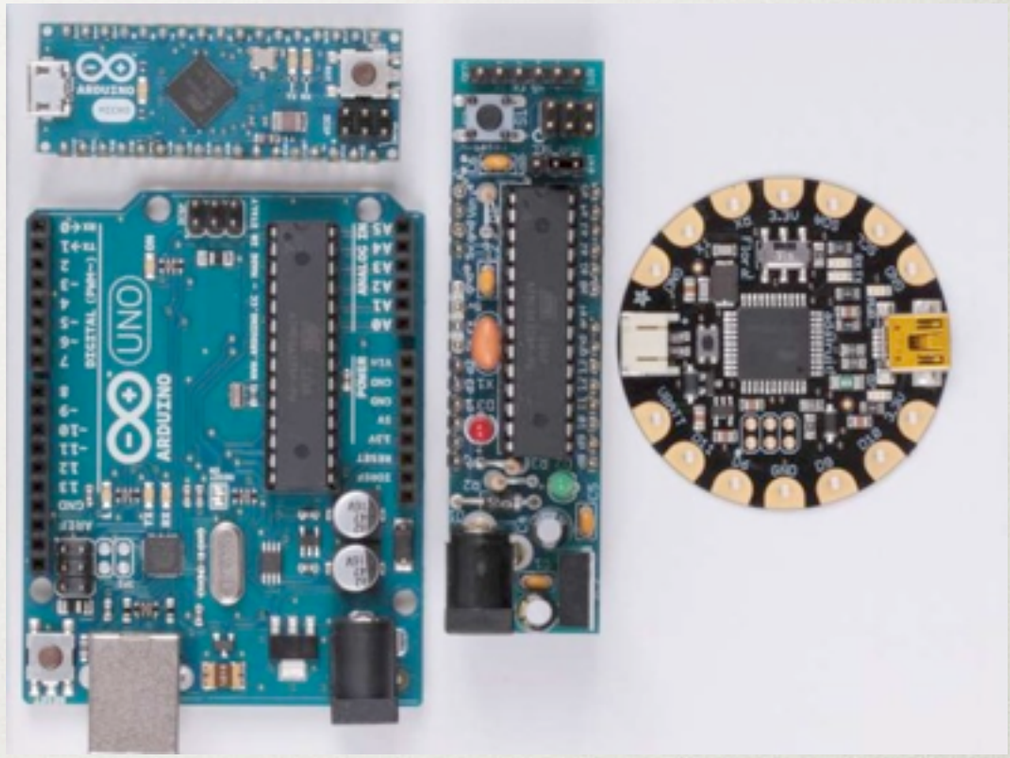


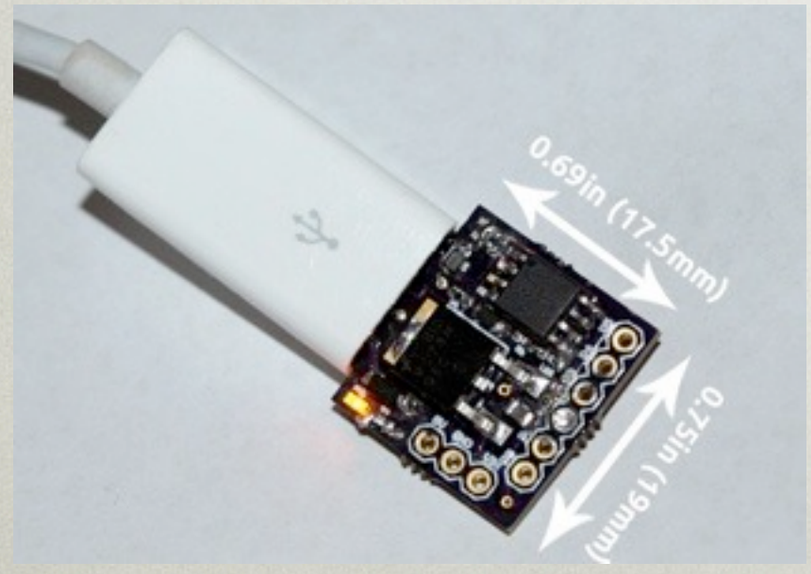
Arduino IDE

- Free, multiplatform
- Includes examples with documentation
- Compiles code and loads as firmware to any Arduino-compatible bord

Arduino







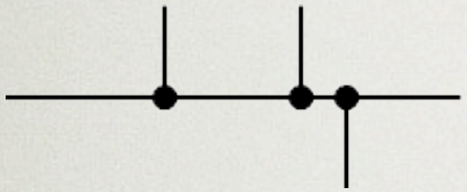
A family of compatible boards
with different options for:
extensibility, features,
size, power, cost,

Electronics Crash Course

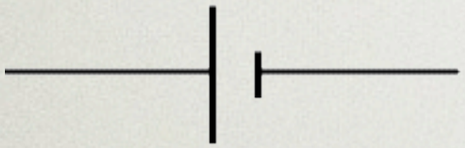
Electronics Crash Course

- Electrons flow from negative to positive (current)
- If there's no path, the flow stops (circuit)
- You can put stuff in the circuit to use, alter, or react to the current
- Each component is like a function with inputs and outputs, and they chain together

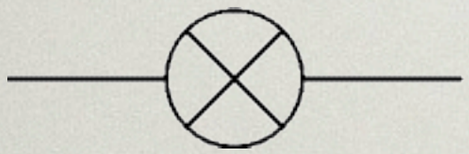
Electronics Crash Course



- Wire - connect 2 components, function argument



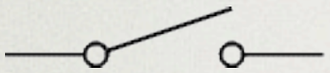
- Battery - provides current, run the program



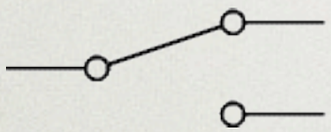
- LED - side effect, output

http://electronicsclub.info/circuitsymbols.htm

Electronics Crash Course



- On-off Switch - boolean variable

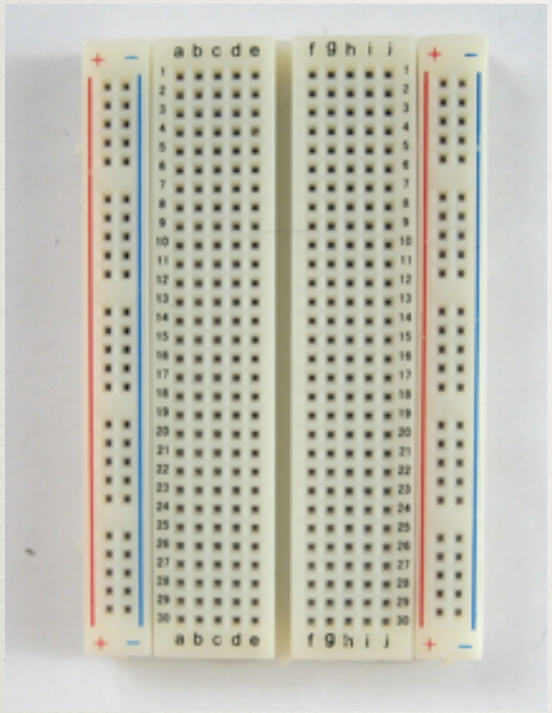


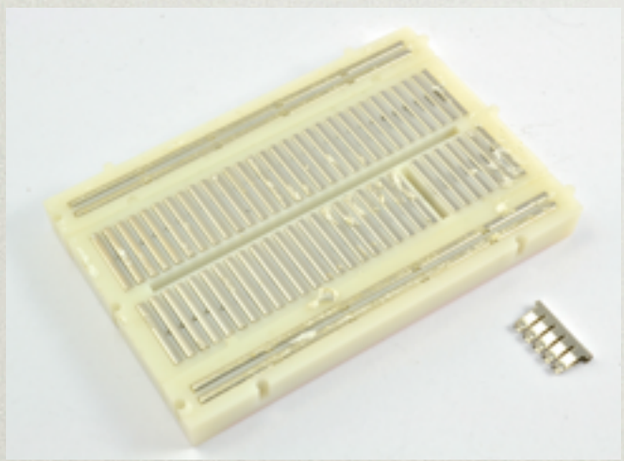
- 2-Way Switch - if statement

- Resistor - input checking

http://electronicsclub.info/circuitsymbols.htm

Electronics Crash Course



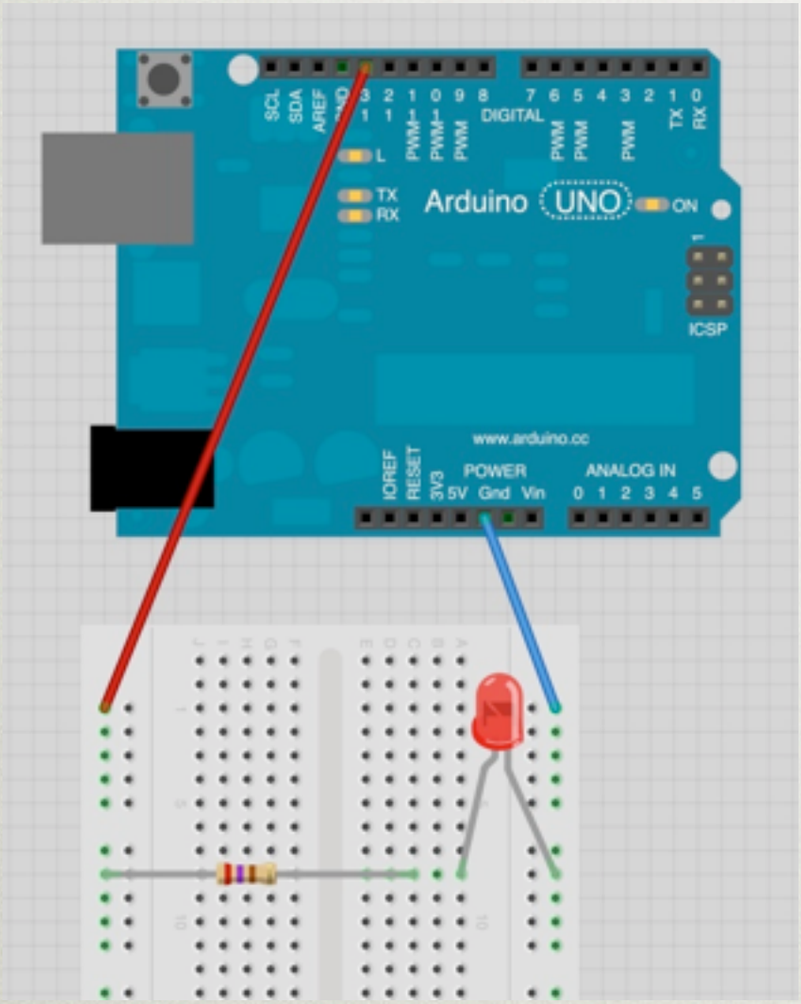


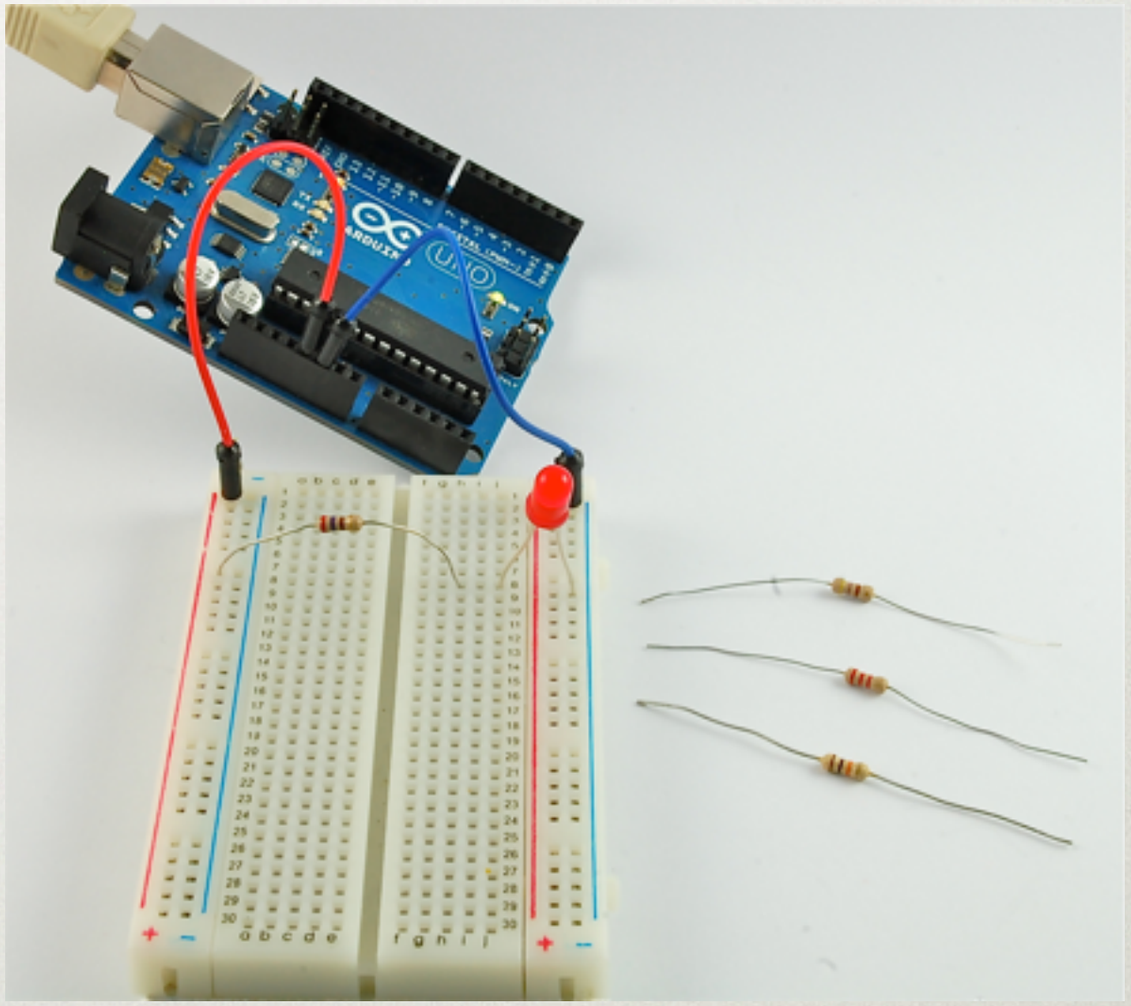
- Breadboard for prototyping
- Conductive strips underneath holes make easy connections
- Like a REPL or console

http://electronicsclub.info/circuitsymbols.htm

Electronics Crash Course

Wiring an Arduino circuit: schematic and pic





http://learn.adafruit.com/category/learn-arduino

Electronics Crash Course

- Arduino code has 2 requires functions
- void setup() - run once when the board is powered up
- void loop() - runs repeatedly until the board is powered down
- Other functions allowed for clarity

Electronics Crash Course

```
/*
  Blink
  Turns on an LED on for one second, then off for one second, repeatedly.

  This example code is in the public domain.
 */

// Pin 13 has an LED connected on most Arduino boards.
// give it a name:
int led = 13;

// the setup routine runs once when you press reset:
void setup() {
  // initialize the digital pin as an output.
  pinMode(led, OUTPUT);
}

// the loop routine runs over and over again forever:
void loop() {
  digitalWrite(led, HIGH);   // turn the LED on (HIGH is the voltage level)
  delay(2000);               // wait for a second
  digitalWrite(led, LOW);    // turn the LED off by making the voltage LOW
  delay(2000);               // wait for a second
}
```

What About Javascript?

Javascript For Makers

- Javascript rose to new popularity coincident with the Maker movement
- Maker projects use the web
- Projects made by non-developers, tinkerers, engineers - smart people new to software
- Hardware is event-based, so JS is a good fit
- Javascript is a kind language for beginners - single numeric type, familiar syntax, type conversions

Javascript For Makers

Libraries

- node-serialport - https://github.com/voodootikigod/node-serialport

- Firmata - common firmware protocol for controlling microcontroller boards http://firmata.org/

Javascript For Makers

Libraries - JohnnyFive

```
button = new five.Button(8);

// "down" the button is pressed
button.on("down", function() {
    console.log("down");
});

// "hold" the button is pressed for specified time.
//         defaults to 500ms (1/2 second)
button.on("hold", function() {
  console.log("hold");
});

// "up" the button is released
button.on("up", function() {
  console.log("up");
});
```

Firmata library with component behavior events

https://github.com/rwldrn/johnny-five

Javascript For Makers

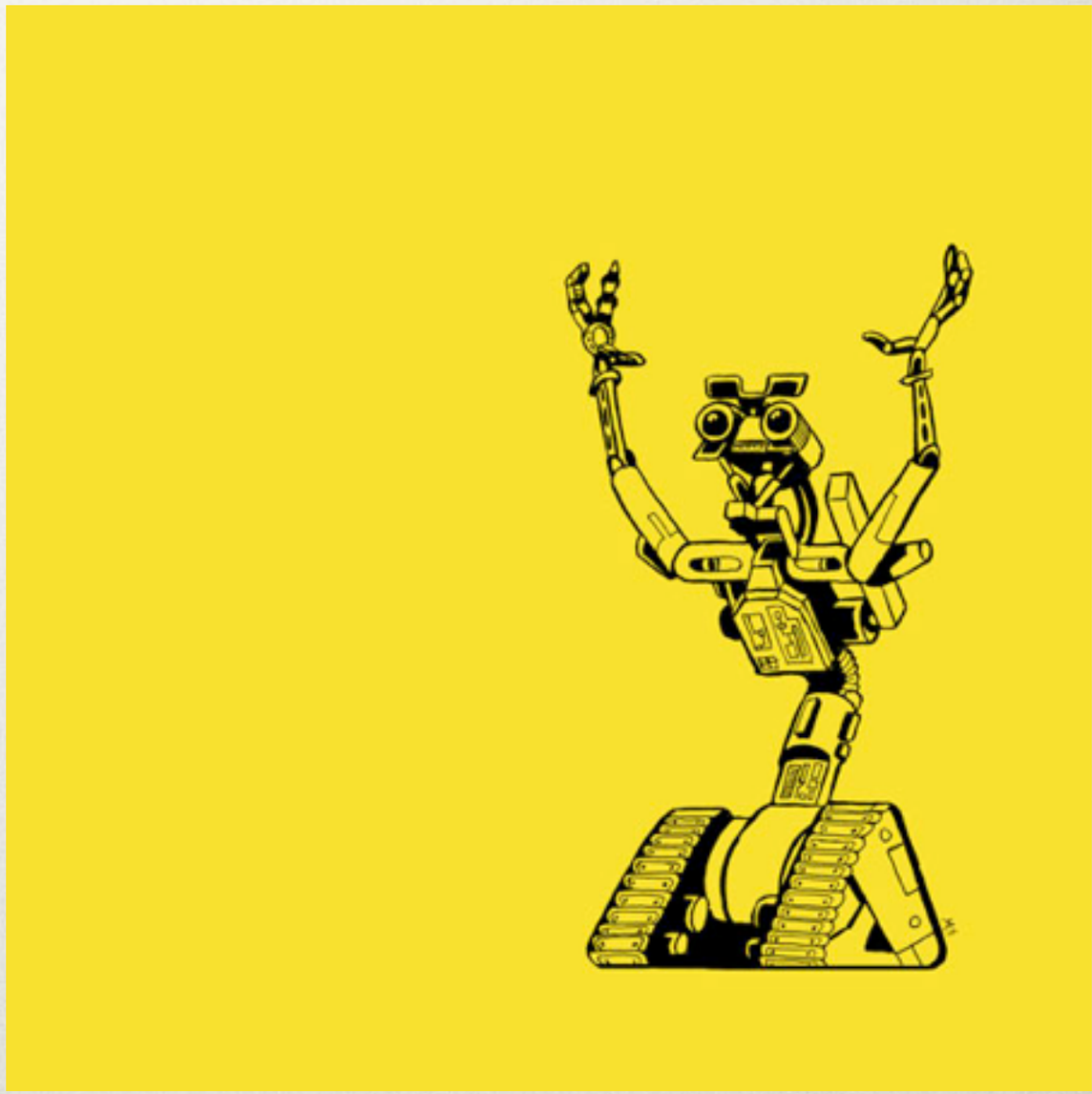
Enabling Libraries - JohnnyFive

http://www.youtube.com/watch?v=gFiL4xVINdw

Javascript For Makers

NodeBots
Hack Hardware With JS

NodeBots: a full day event where JS developers team up and use soldering guns and parts nearby to create amazing robotic devices.



http://nodebots.io/

Javascript For Makers

THE NODE COPTER

```
var arDrone = require('ar-drone');
var client = arDrone.createClient();

client.takeoff();

client
  .after(5000, function() {
    this.clockwise(0.5);
  })
  .after(3000, function() {
    this.animate('flipLeft', 15);
  })
  .after(1000, function() {
    this.stop();
    this.land();
  });
```

http://nodecopter.com/

http://www.youtube.com/watch?v=ymlbNEL5TQQ

Javascript For Makers

Miniature Hardware

Raspberry Pi

Beagle Bone Black

Small, inexpensive general purpose computers with ARM chips, USB and HDMI ports, run Linux and any software

Javascript For Makers

Where to Buy?

http://www.adafruit.com/

http://sparkfun.com/

http://www.hobbytronics.co.uk/

$$! €€! (?)

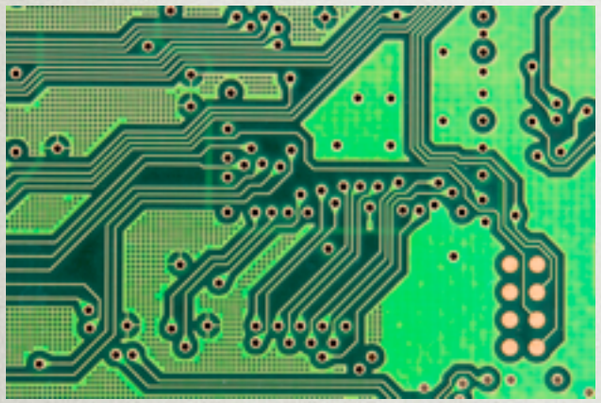
- Not expensive to start: ~$30 for Arduino, ~$45 for Raspberry Pi or BeagleBone
- Kits for < $100
- Whole pile of electronic parts and computers for < $200

$$! €€! (?)

- Prototyping parts are reusable; you only incur more costs when you:
  - break stuff (it happens)
  - want new features (motors, sensors, etc)
  - want to build more because you designed something useful

Advanced Electronic Design

- Custom circuit design - Eagle, CAD, http://upverter.com



- Designs printed on a PCB (printed circuit board)

- Components assembled into finished hardware

Advanced Electronic Design

- Designed circuits can be assembled by lots of manufacturers

- Upverter has manufacture integrated into their workflow

- DIY tools are developing, improving

I Don't Know Electronics, What Can I Do?

What Can I Do?

- Find a hardware project you're interested in
  - Maker Faire, Kickstarter, Meetups, etc
- Add to software, improve software practices
  - Source control, abstraction, testing, etc
- Miscellaneous contributions - documentation, etc

What Can I Do?

- Build demo apps on hardware APIs
- Example: moj.io
  - Plugs into car diagnostic port
  - Sends geocoded logs over cellular network
  - Expose API for building car data apps

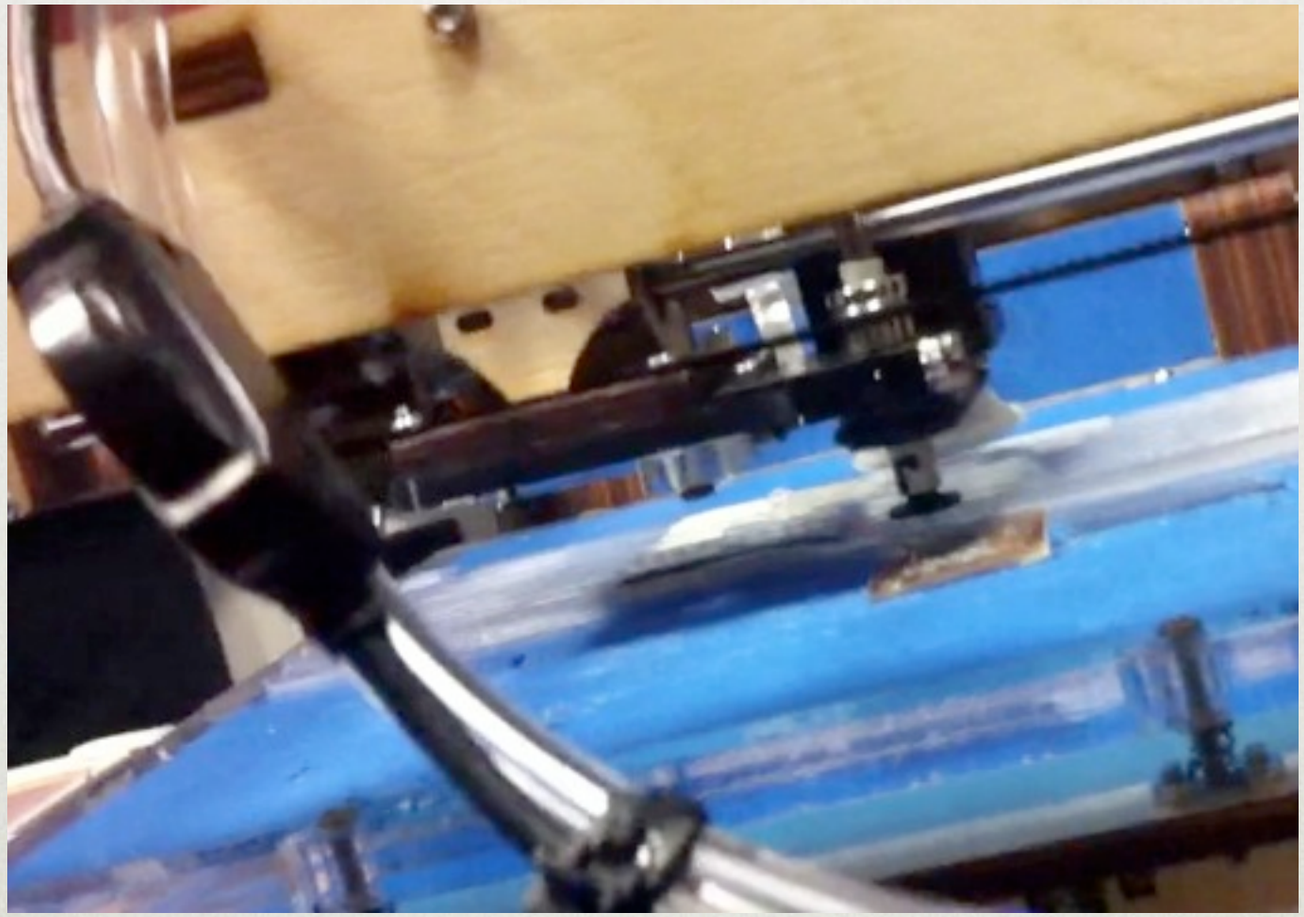
How I Got Into Hardware

How I Got Into Hardware

- No background except for 1 college class 15 yrs ago
- Went to YC Hardware hackathon in Feb ’13
- Got little done because I had so many basic questions
- Liked the project and team so I continued working on a prototype for Maker Faire
- I wrote software for a hardware project, so I contributed and learned a lot without slowing down the project

Tempo Automation

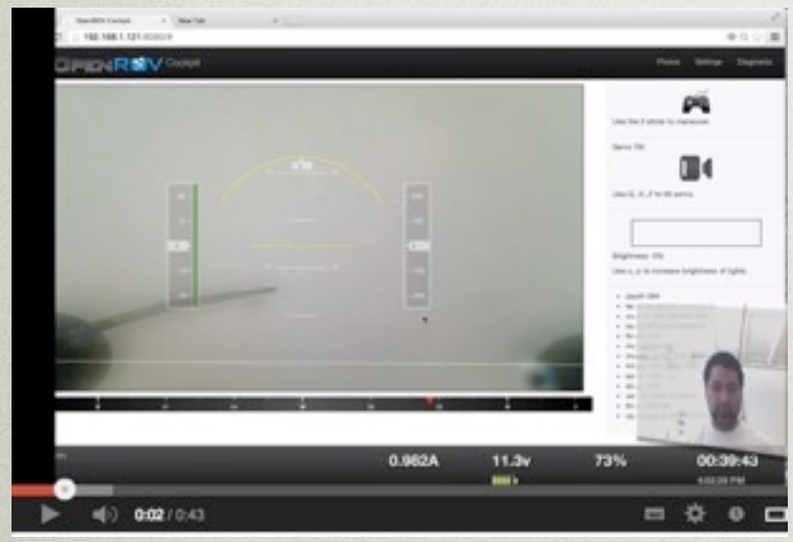
Here's the demo - it assembles circuit boards



http://www.youtube.com/watch?v=-jsQF-xFdJM

https://www.facebook.com/video/embed?video_id=4184537549975

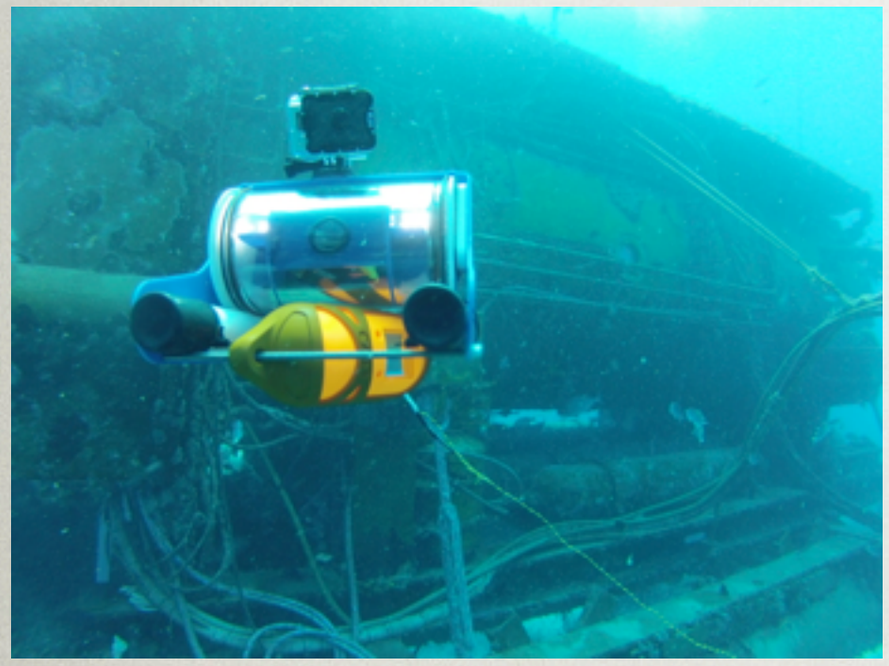
OpenROV



- Started by guys looking for "return on adventure"
- Sold > 100 kits on Kickstarter
- Open, worldwide community

http://www.youtube.com/watch?v=GVp0zeH0H3Q

OpenROV



- Node.js server serves cockpit web page, translates input into motor commands through Arduino

- I didn’t buy a kit, so I can’t write or test software for it

- I take and post notes from monthly dev calls, helps community

Concluding Thoughts

- What would you make if you weren't stuck inside the computer or the internet?

- What objects do you interact with daily that you could make smarter?

- What would you do if you could program the real world?

You are only limited by *your imagination.*

What will

YOU

make?