SUMMER CAMP

Pushing Electrons

Cheap tools for artists who want to make their work sense, move, shine and sing

by camp counselors
Alberto Gaitán and Tom Lee

transformer gallery

washington dc

28 Feb 2009

http://www.transformergallery.org

Physical Computing

- "a creative framework for understanding human beings' relationship to the digital world"

- "In practical use, the term most often describes handmade art, design or DIY hobby projects that use sensors and microcontrollers to translate analog input to a software system, and/or control electro-mechanical devices such as motors, servos, lighting or other hardware."

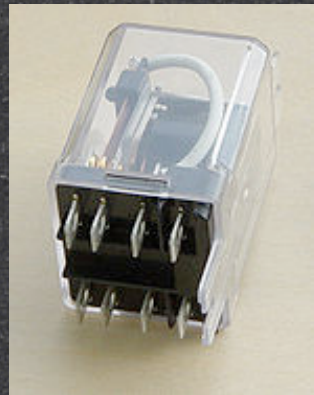http://en.wikipedia.org/wiki/Physical_computing

Electronics

don't poke your eye out

Safety

- Low voltage vs High voltage projects

    - 3V - 12V (DC); up to 1A but often in mA ranges

    - possible to control high voltage/current (AC)
      devices with low voltage/current (DC) devices
      via AC relays

http://en.wikipedia.org/wiki/Relay

Environment

- RoHS – Restriction of Hazardous Substances Directive

- Look for the RoHS logos (may be slightly more expensive than dirty components)


http://www.rohs.gov.uk
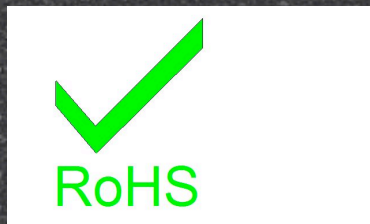
Circuits

- Electricity wants to go to ground

  - it looks for path of least resistance – even if that's through YOU!

- For your project, you want to make it jump through hoops on its way there

Hydraulic Analogy

You can (sorta) think of electric circuits like plumbing

- Voltage (volts: V): hydraulic pressure - also called potential difference; a difference in pressure between two points

- Current (amperes: A) — flow rate: the quantity of water flowing past a point over given time — usually what kills you

- Resistance (ohms: Ω): pipe diameter

http://en.wikipedia.org/wiki/Hydraulic_analogy
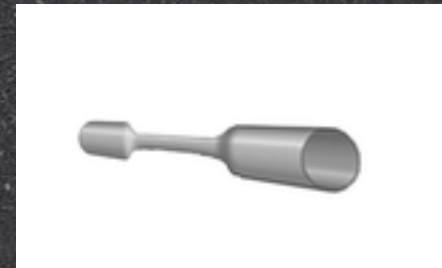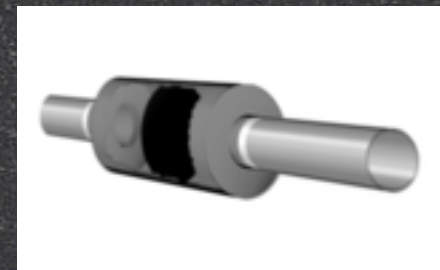
Hydraulic Analogy

- Diodes: valves
  - triggered flow
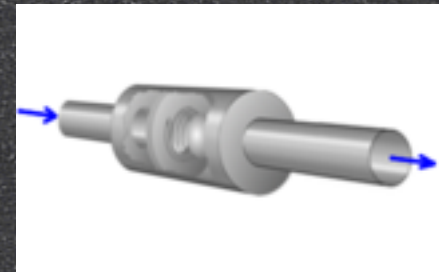
- Capacitors: tanks
  - store potential energy

http://en.wikipedia.org/wiki/Hydraulic_analogy

But electricity is light, not water

- this all happens instantaneously; electricity does not naturally wait

- and it does not think procedurally like we do, but...

...microcontrollers do!

- they're like little computers
  - can run a program
  - only know about a few things:
    - the time
    - how to do math
    - how to remember things (but not too many)

We like Arduino!

http://arduino.cc/en/Main/Buy
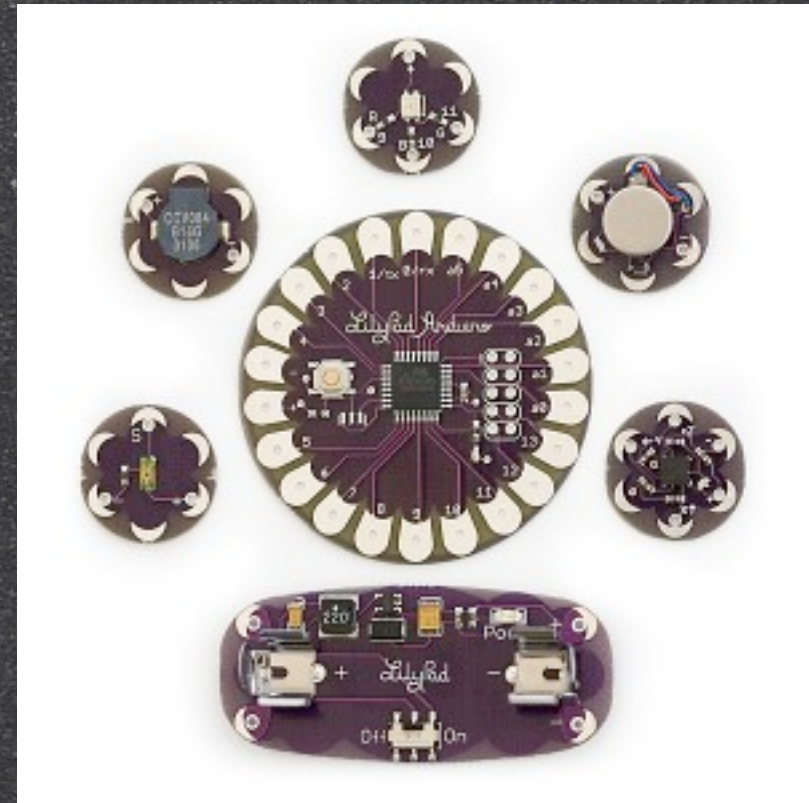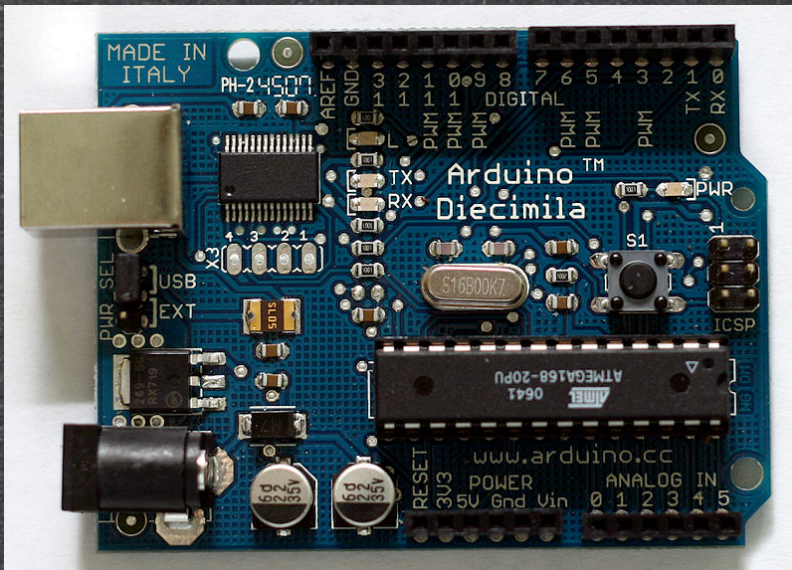
LilyPad is a wearable e-textile technology developed by Leah Buechley and cooperatively designed by Leah and SparkFun.
http://web.media.mit.edu/~leah/
http://www.sparkfun.com/

Arduino

- microcontroller (µC) = ATMEL ATmega168

- Arduino is a platform, not just a µC

  - platform = the combination of a particular **computer** and a particular **operating system**

Arduino

The Arduino Diecimila & Duemilanove

- Operating voltage: 5V

- input voltage: 7V - 12V
  DC current per pin: 40mA
  DC current @ 3.3V pin: 50mA

- no. of digital i/o pins: 14
  (6 provide PWM)

- no. of analog input pins: 6

- clock speed: 16MHz

- usable flash memory: 14KB

- EEPROM: 512 bytes
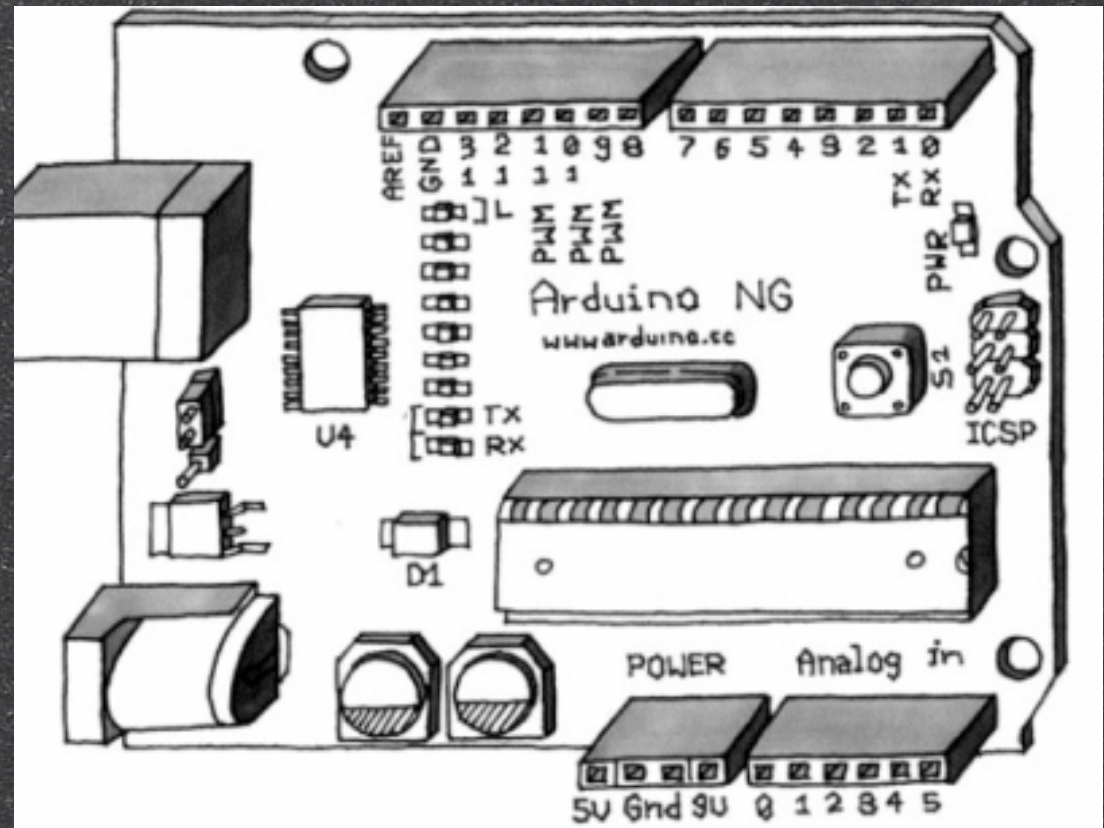
Arduino NG board - illustration by Elisa Canducci
for Massimo Banzi's "Getting Started With Arduino"
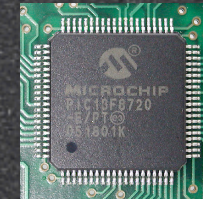
Other microcontrollers

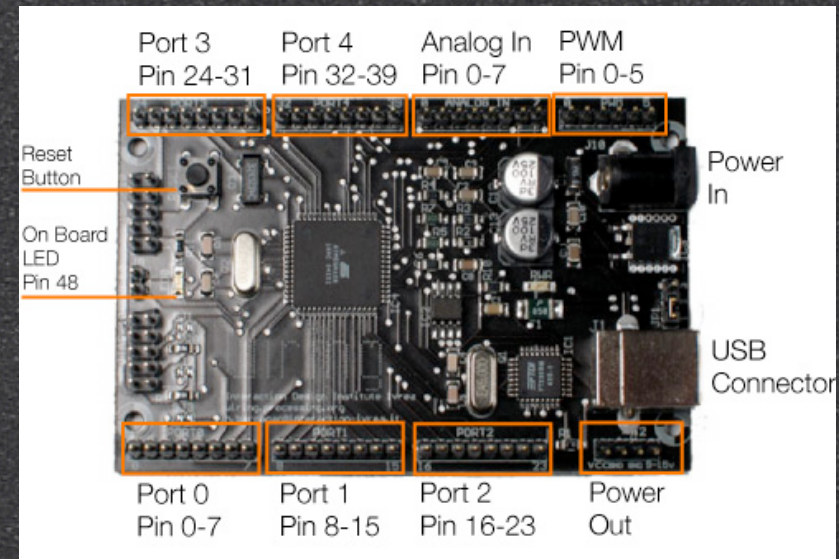- PIC

- Bare bones AVR

- ATMEL ATmega128

  - used in the Wiring I/O board & programming environment (an earlier platform that Arduino is based on)

the PIC18F8720 microcontroller

http://www.wiring.org.co/

Why we like Arduino

- fast, cross-platform environment written in C/C++

  - Windows, OS X, Linux

- open source - lots of developers sharing wares

- cheap!

- growing community and lots of online resources

Basic project

- input => processing => output
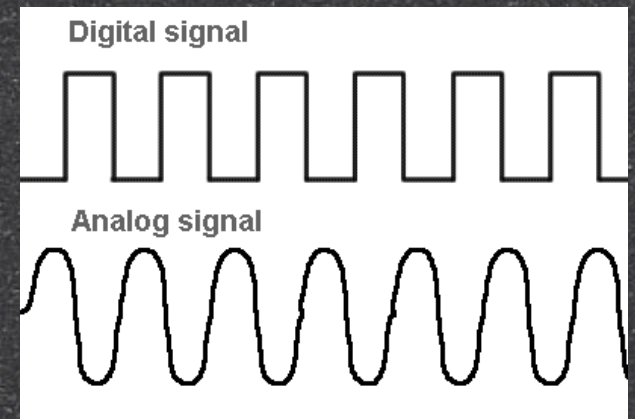
input=>

- digital

    - on/off signals

        - push buttons, toggle switches

- analog

    - continuous signals

        - are output by most sensors and expressed as voltage values (e.g., 0V to 3V; 0V to 5V)
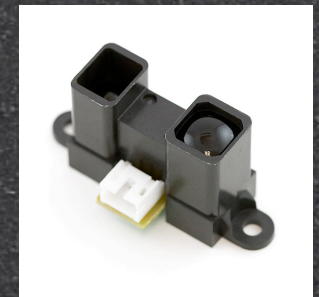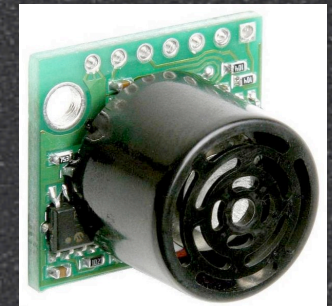

Digital signal

Analog signal

http://www.inlethd.com

Sensors

- infrared

  - passive - motion detectors

  - binocular - proximity detectors

- ultrasonic

  - proximity detection with more range

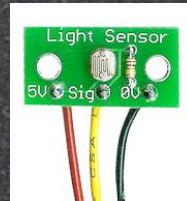http://www.makingthings.com/

http://www.sparkfun.com/

http://www.maxbotix.com/

Sensors

- photo

- stress

- touch

  - piezo

  - capacitive

http://www.makingthings.com/

http://www.sparkfun.com/

Human Interface

- push buttons

- knobs / rotary encoders

- keyboards & keypads

- mouse

- specialized

  - Wii

  http://www.windmeadow.com/node/42

Network interface

- XPort - entire web server and ethernet interface on a chip

http://www.lantronix.com

=>processing=>

- this is where you tell your project how to think about inputs

- IDE: Integrated Development Environment

  - Processing(.org) http://processing.org
    (written in Java - a bit slow)

  - Arduino http://arduino.cc/en/Reference/Comparison
    (written in C/C++ - faster)

  - pd - (pure data) http://puredata.info

Processing(.org)

- Made for artists

  - headed by Casey Reas & Ben Fry

- IDE created in Java

  - interactive

    - allows step-wise refinement and easy prototyping & experimentation
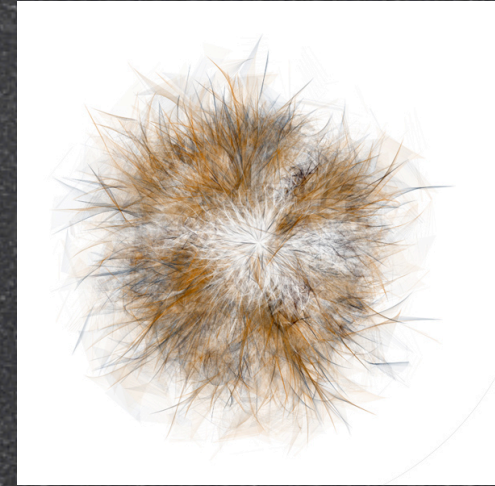
Process 6 (Puff 3) 2005
by Casey Reas
http://reas.com

pure data (pd)

http://puredata.info
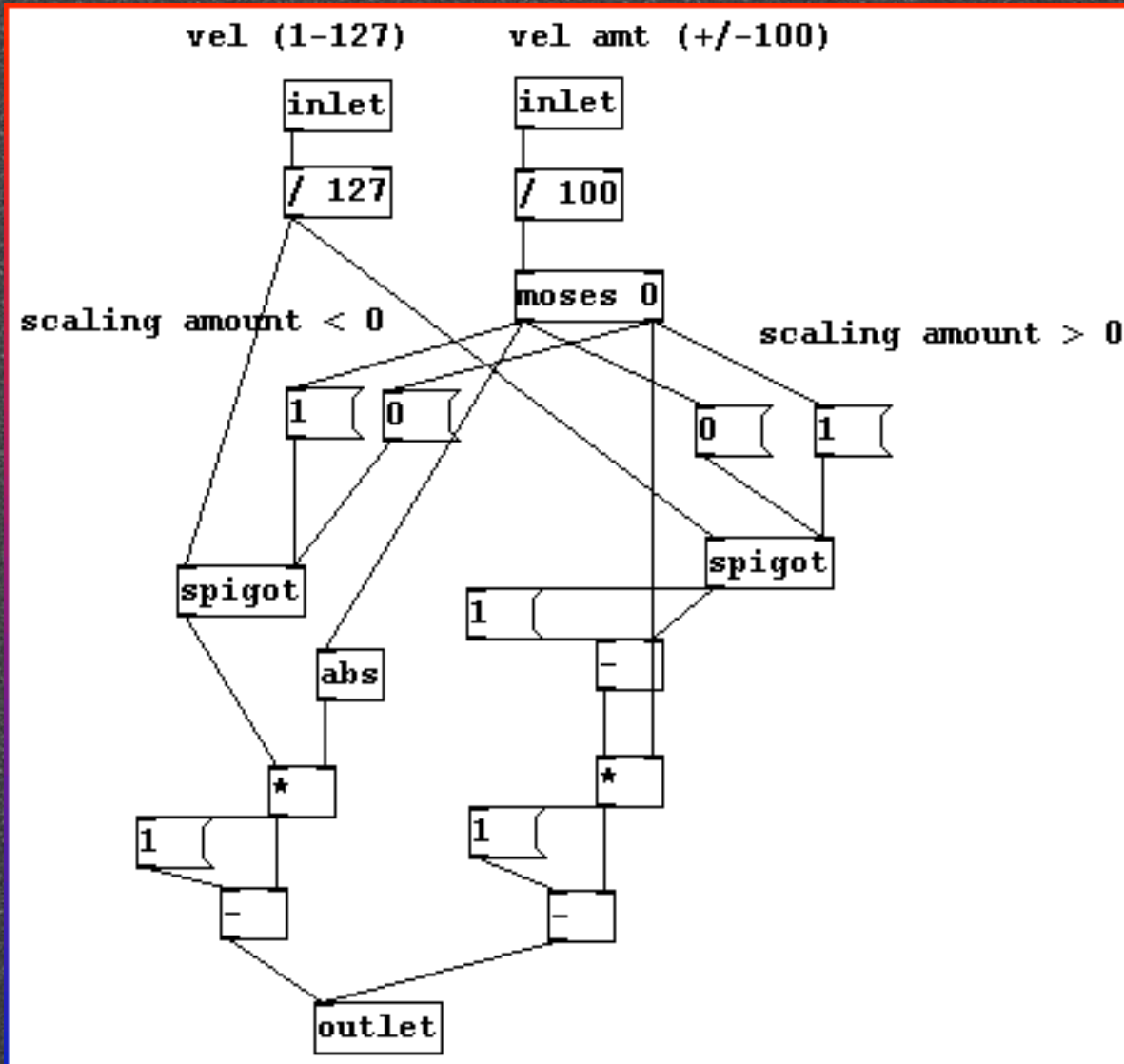
Made for artists

by Miller Puckette
http://en.wikipedia.org/wiki/Miller_Puckette

http://digitalmedia.oreilly.com/2005/04/27/pd.html

Arduino IDE

http://arduino.cc/en/Reference/HomePage

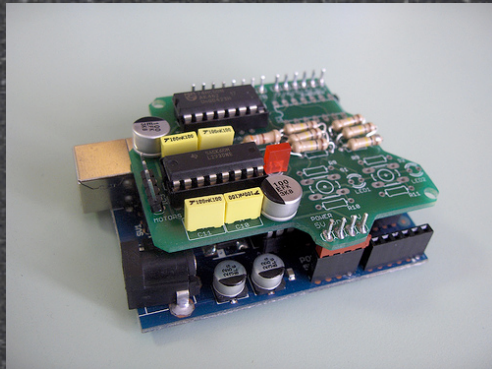- Written in C/C++

- Based on Wiring
  (http://wiring.org.co)
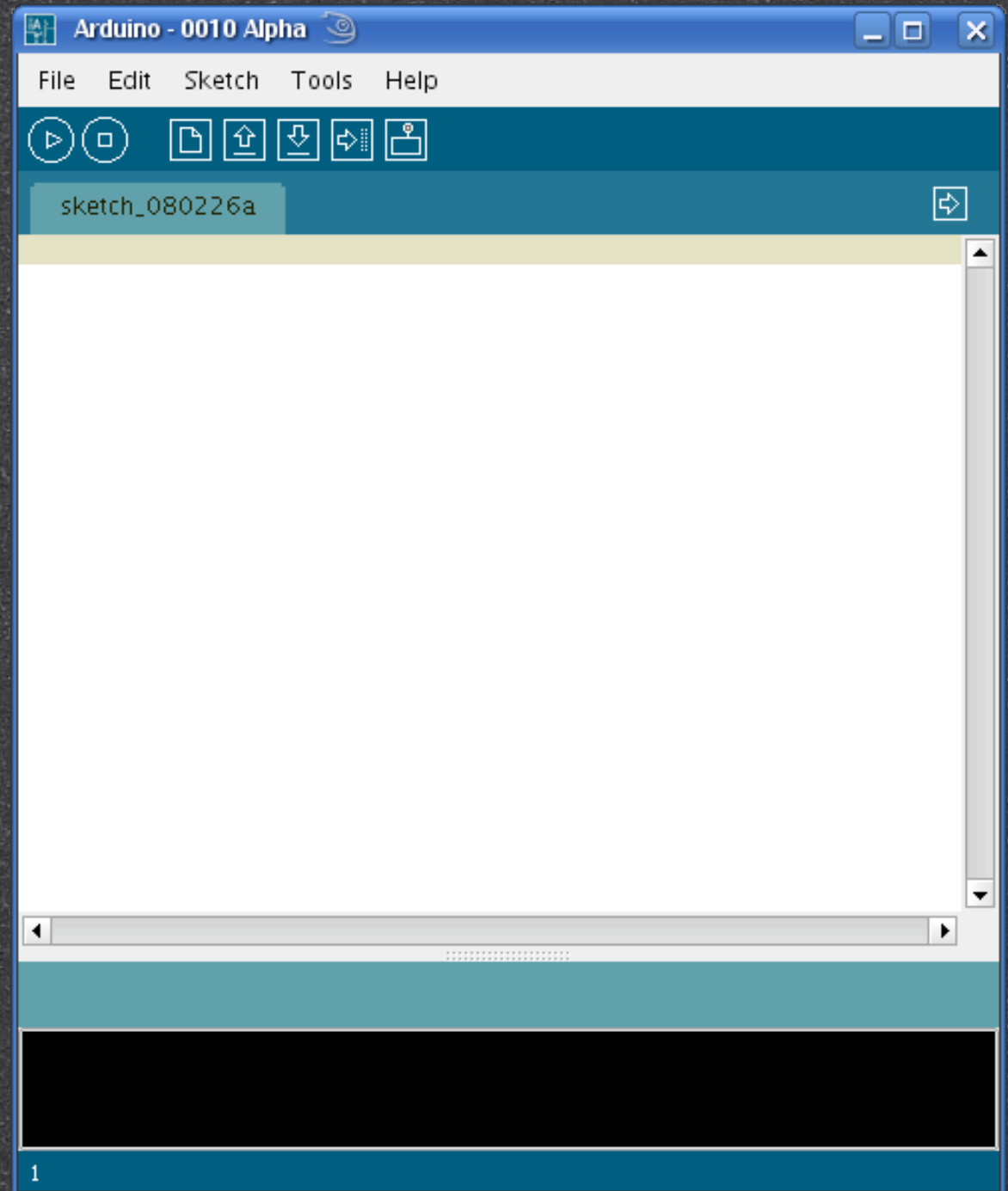
Arduino IDE

- is doing a lot of things for us

- easy to create "sketches"

- upload to Arduino board via USB
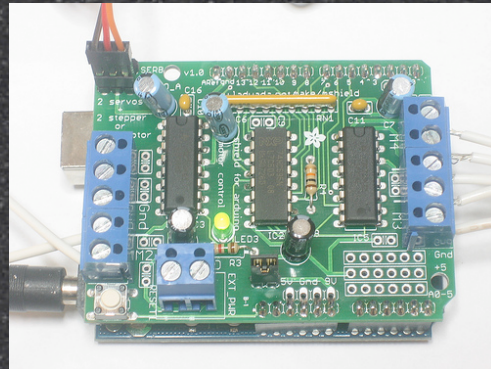
- once on the Arduino board, power it up and it runs your program ad nauseum

Shields

- custom daughter-boards providing extended features to an Arduino

- examples: controlling motors, connecting devices or other Arduinos wirelessly, or accessing TCP/IP (ethernet / internet)
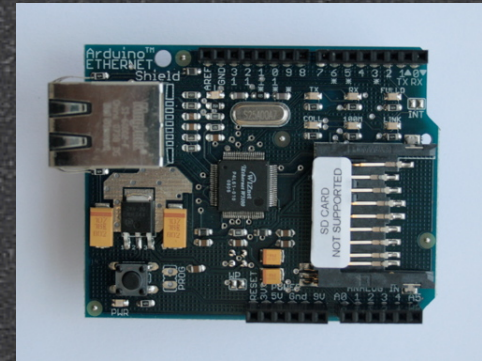

a couple of motor shields

http://www.arduino.cc

http://www.ladyada.net

ethernet shield

http://arduino.cc/en/Main/ArduinoEthernetShield

=>output

- Digital & Analog signals

  - analog output is faked in the Arduino by generating rapid on-off digital signals: pulse width modulation (PWM)

- Visual

  - LEDs   http://www.buy-leds-online.com

  - pixels via Processing
    or pd or...

PWM
http://en.wikipedia.org/wiki/Pulse-width_modulation

- Audio (via shields)

  - MIDI
    - http://www.thebasementscientist.com/2008/10/07/the-midi-shield-is-here/

  - audio playback

  - synthesis

=>output

- Control

  - motors / actuators

    - DC (hobby) motors

    - servo motors - limited angle of rotation

    - gear motors - higher torque

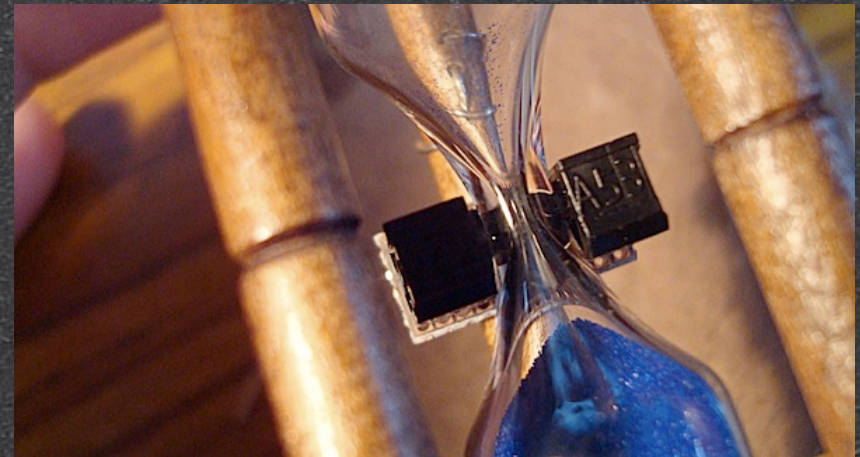   - stepper motors - high torque, slow
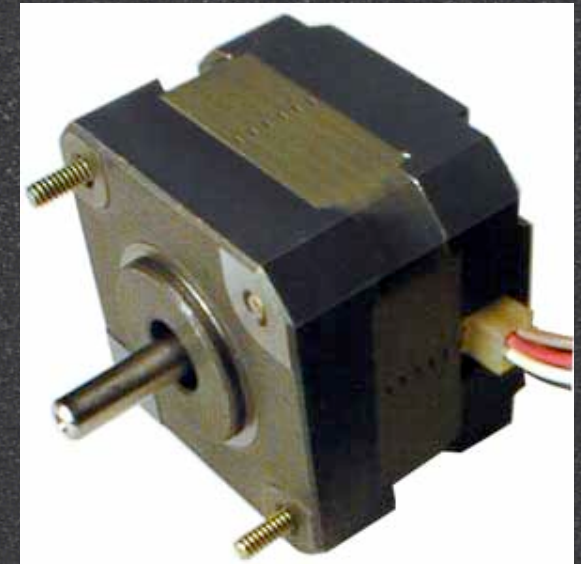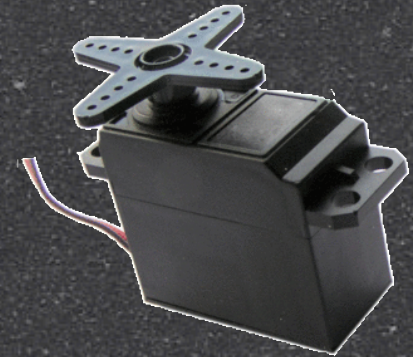
Illustrative Projects

The Beat Dress

- http://www.we-make-money-not-art.com/archives/2007/09/remember-my-pos.php

opto-interrupt hourglass trigger

- http://blog.makezine.com/archive/2009/02/arduino_sandglass_timer.html?CMP=OTC-0D6B48984890

Links

Some communities

- DorkbotDC (http://dorkbot.org/dorkbotdc)
- HacDC (http://hacdc.org)
- Make Magazine (http://www.makezine.com)
- Instructables (http://www.instructables.com)
- Making Things (http://www.makingthings.com)
- IRC - irc.freenode.net
    - #arduino
    - #dataflow (pd's irc channel)
    - #processing

Links

- ## Some suppliers

  - Sparkfun (http://www.sparkfun.com)
  - Maker Shed (http://www.makershed.com)
  - DigiKey (http://www.digikey.com)
  - Solarbotics (http://www.solarbotics.com)
  - Small Parts (http://www.smallparts.com)
  - eBay (http://www.ebay.com)
  - McMaster-Carr (http://www.mcmaster.com)

Links

Some blogs

- We Make Money Not Art (http://www.we-make-money-not-art.com)

- Rhizome (http://www.rhizome.org)

- Eyebeam (http://eyebeam.org/reblog)

Reading

Basic Electronics

- "Getting Started in Electronics" by Forrest M. Mims III

- "Practical Electronics for Inventors" by Paul Scherz

Reading
Arduino & Processing

- "Getting Started with Arduino" by Massimo Banzi (Make Books)

- "Making Things Talk: Practical Methods for Connecting Physical Objects" by Tom Igoe (Make Books)

- "Processing: A Programming Handbook for Visual Designers and Artists" by Casey Reas, Ben Fry and John Maeda

SUMMER CAMP

Now go make something.

transformer gallery
washington dc
February 2009

http://www.transformergallery.org