EMBEDDED SYSTEMS AND KINETIC ART:

DRAWING MACHINES

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Department of Art and Art History

Logistics

- Class meets T-Th 3:40-5:00pm
- We'll start meeting in Art 169
  - At some point we may also meet in MEB 3133 (Merrill Engineering Building) on the north side of campus
- Web page is www.eng.utah.edu/~cs5789

Kinetic Art

- Kinetic art contains moving parts
  - Depends on motion, sound, or light for its effect
- Kinetic aspect often controlled by microcontrollers
  - Using motors, actuators, transducers, sensors
- The artwork can react to its environment
  - Distinct from "computer art"
  - The computer is usually behind the scenes

Embedded Systems

- Computer systems that are embedded into a complete device
  - Often small or special purpose computers/ microprocessors
  - Designed to perform one or a few dedicated functions
  - Often reactive to environmental sensors
  - Often designed to directly control output devices

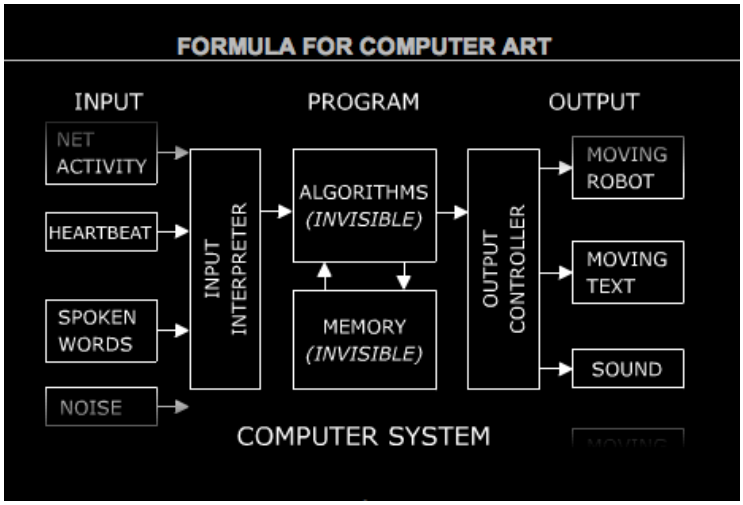
Drawing Machines

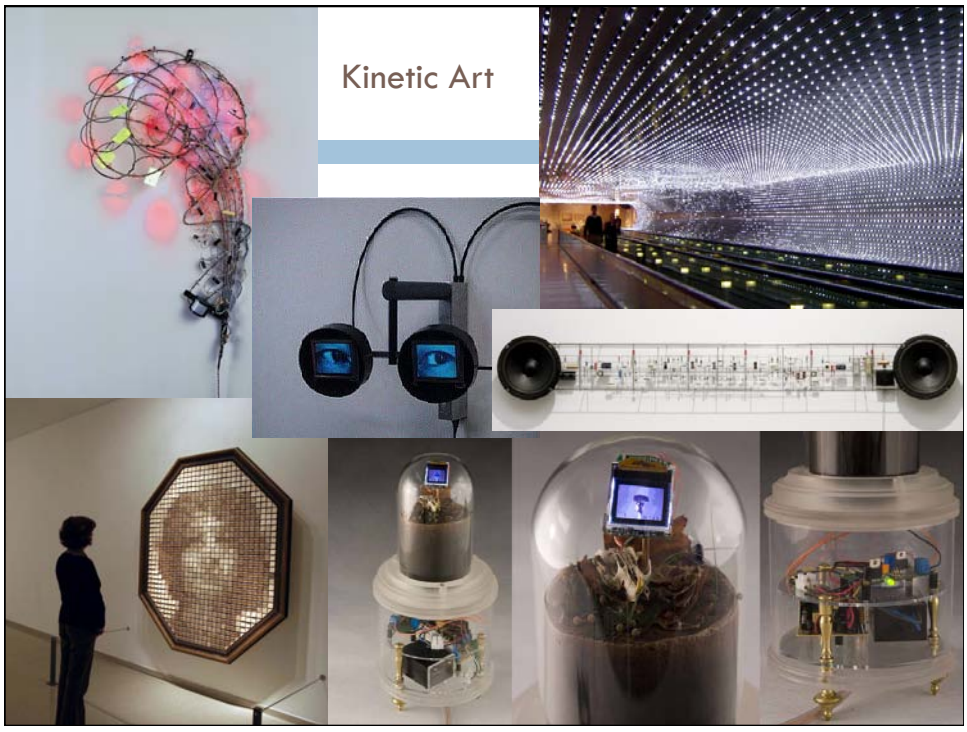
- Kinetic art that makes drawings
  - Drawing is mark-making
  - Mark-making can be interpreted in many ways…
  - We'll explore lots of options

Embedded Systems and Kinetic Art

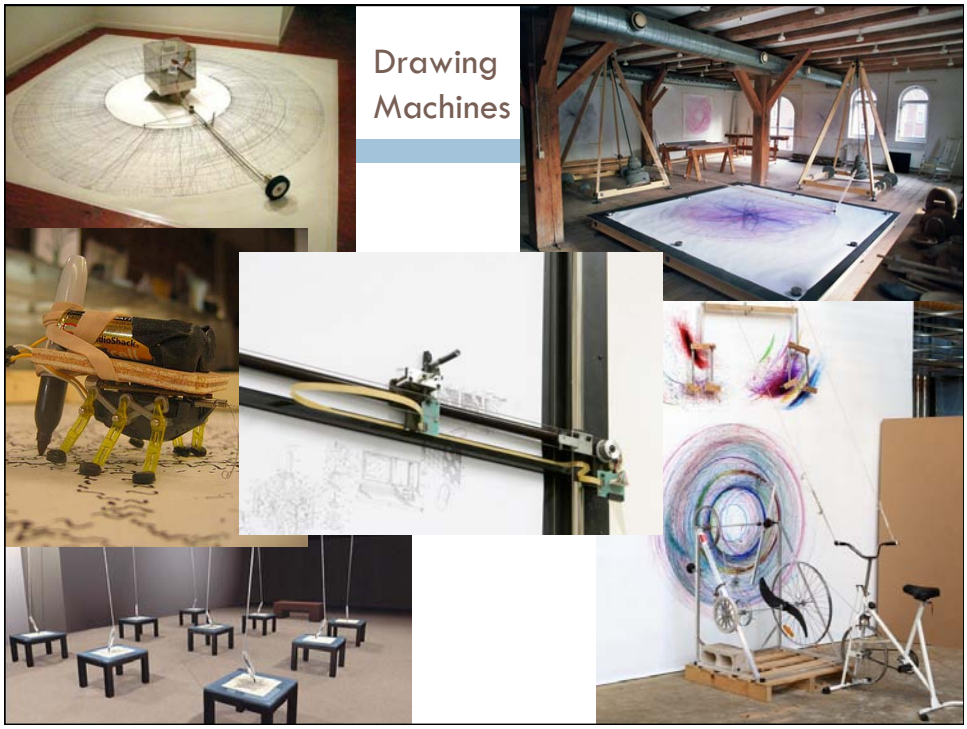
- Cross-college collaborative course
  - Brings Art students and Computer Science and Engineering (CSE) students together
  - Design and build embedded-system-controlled kinetic art
    - Drawing Machines are the focus this spring
  - Goal is that both groups of students benefit
- Fundamental nature of ***Design***
  - Engineering design vs. creative design?

Jim Campbell's Algorithm





Drawing Machines



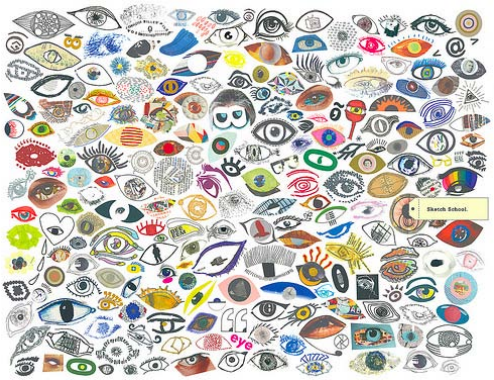
How Will the Class Work?

- Good question! It's an ongoing experiment from both sides...
  - Start with some background study
    - Hands-on simple drawing machines to warm up
  - Some hands-on labs with the microcontroller
    - Build a toolkit of input sensors, output transducers and computer code to interface with them
  - Teams will eventually design a project (or two?) together
  - Class critiques, refinement, final build
  - Exhibit of the results in Spring

How Will the Class Work?

- Also: everybody should keep a sketchbook
  - At least a page a day
    - Not every page needs to be a masterpiece…
  - Design ideas, inspiration, thoughts, etc.
  - Look at Carol Sogard's "Sketch School" for inspiration

http://www.flickr.com/photos/carolsogard/sets/72157627069987019/



How Will the Class Work?

- Also occasional readings
  - One-page responses, and class discussions
  - Readings will be posted to the class web page
  - First reading: "Art in the Age of Mechanical Reproduction"
    - 1936 essay by German cultural critic Walter Benjamin

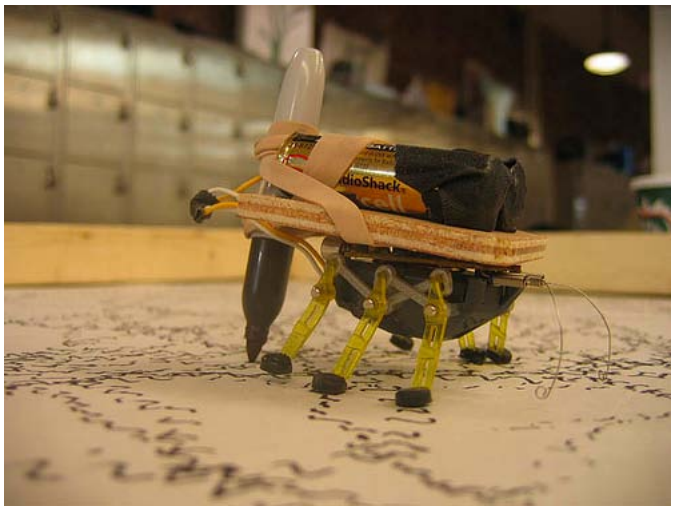
Drawing Machine Survey

- Not comprehensive!
- Kinetic art as drawing machines
  - Ranges from very simple to very complex
  - Mark-making takes on many meanings

Very Simple Drawing Machines

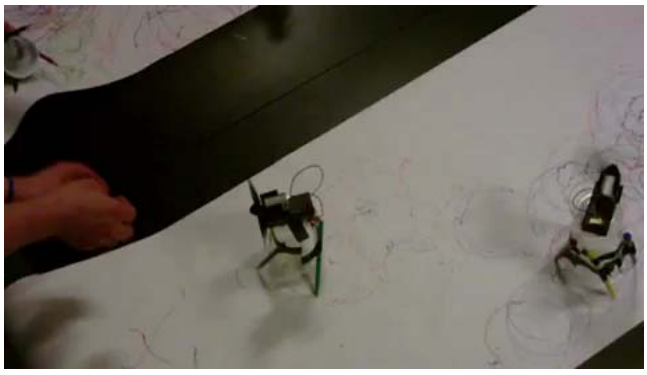
http://www.youtube.com/watch?v=oQMcRvkkoO0

Very Simple Drawing Machines



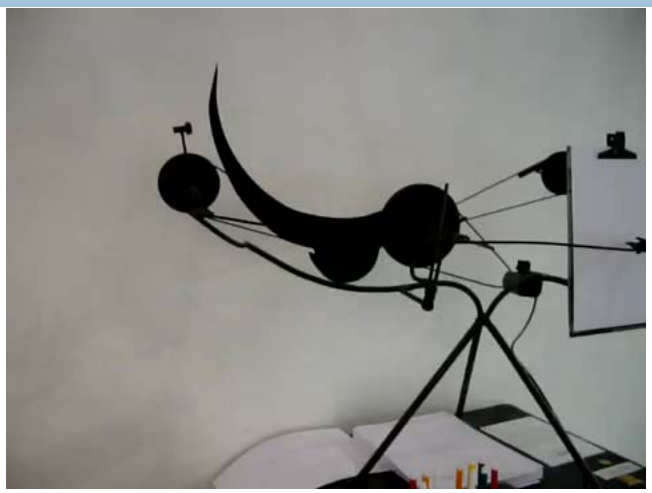
http://blubee.com/theblog/?p=53

Very Simple Drawing Machines



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

Mechanical Drawing Machines



Jean Tinguely
Metamatic
1959

http://www.youtube.com/watch?v=GOo5uq2fH6g

Mechanical Drawing Machines

http://www.happy-pixels.com/2011/07/08/drawing-machine/

Mechanical Drawing Machines

http://www.youtube.com/watch?v=5yumD0ezoVE

Mechanical Drawing Machines

Tim Knowles

http://www.bitforms.com/tim-knowles-gallery.html

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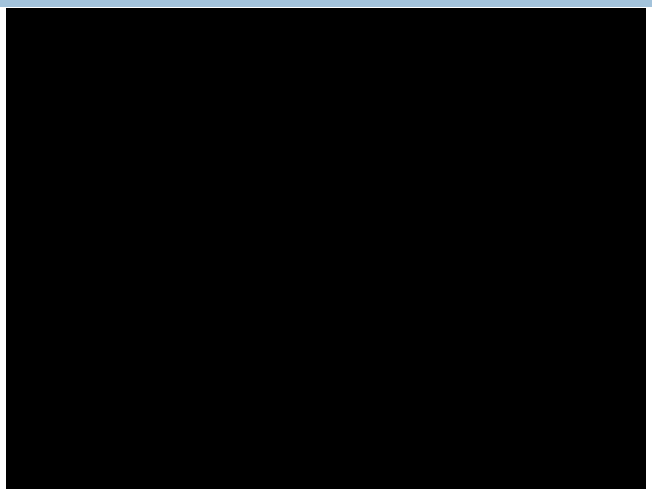
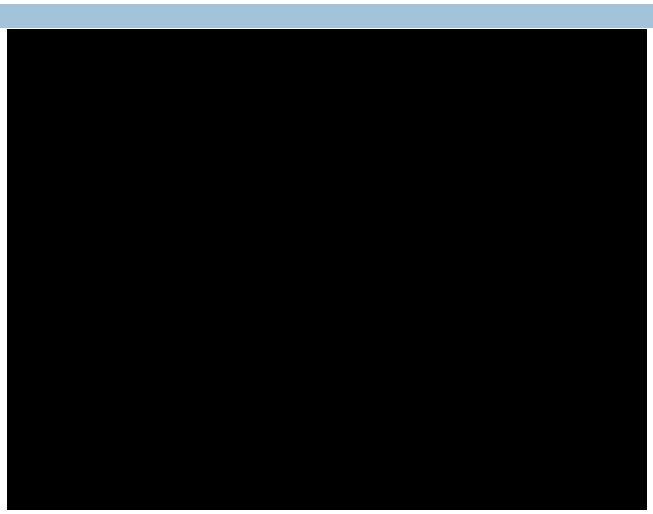


http://www.youtube.com/watch?v=dPZ-Mpbn37U

Mechanical Drawing Machines



http://www.youtube.com/watch?v=4O8tDgYh7LY

Mechanical Drawing Machines

http://www.fi.edu/learn/sci-tech/automaton/automaton.php?cts=instrumentation

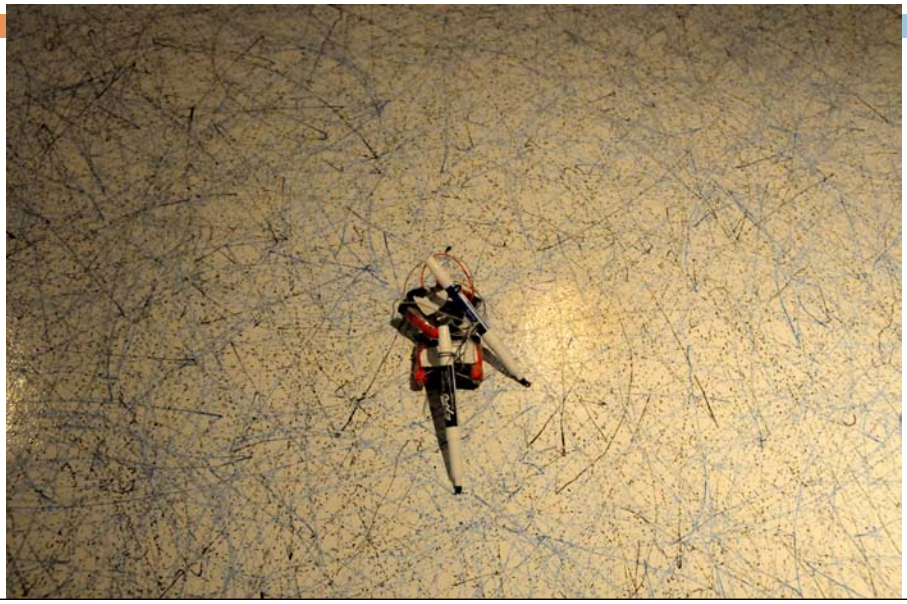
Mechanical Drawing Machines

http://www.youtube.com/watch?v=pokSViy6Eck

Mechanical Drawing Machines

http://www.youtube.com/watch?v=Qem8FVdQ5gA

Computer Controlled Machines



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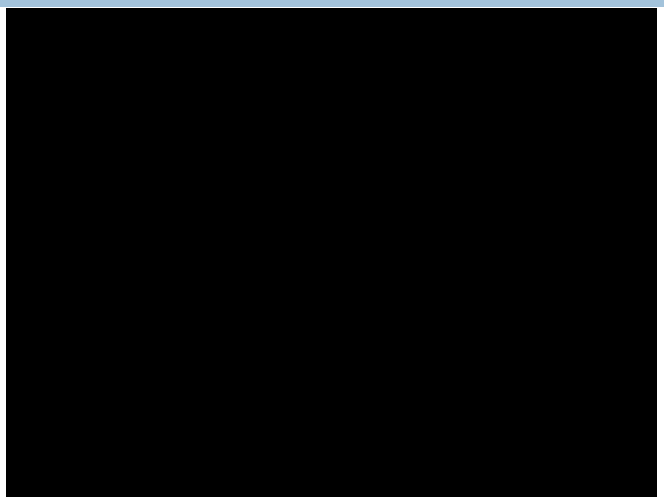

http://www.dwbowen.com/

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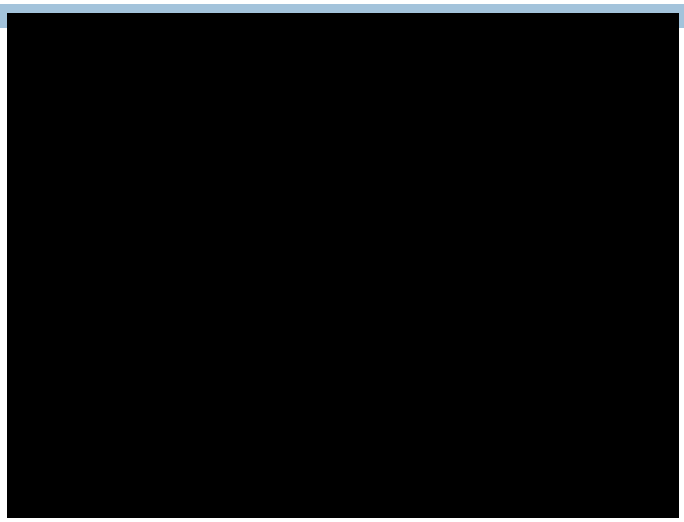

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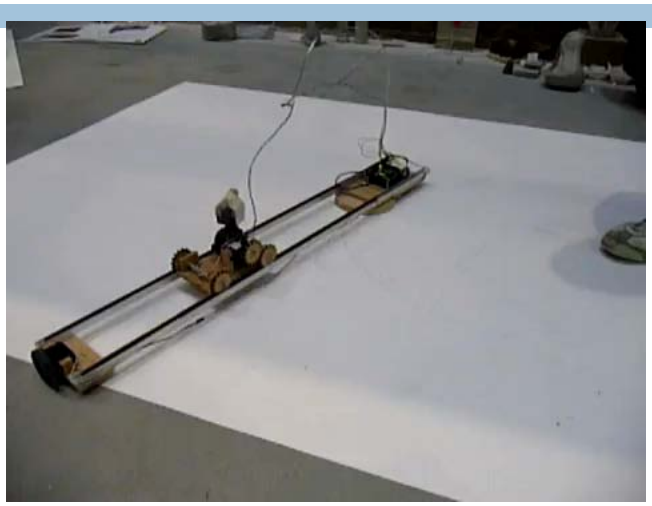

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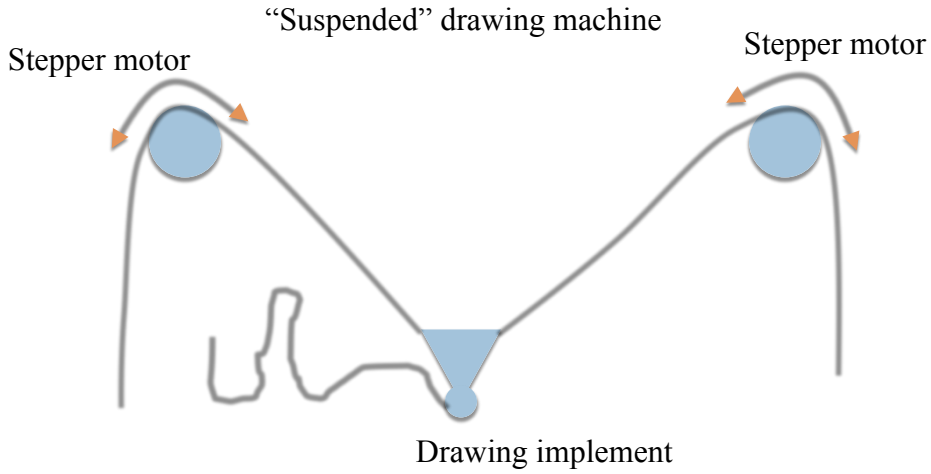

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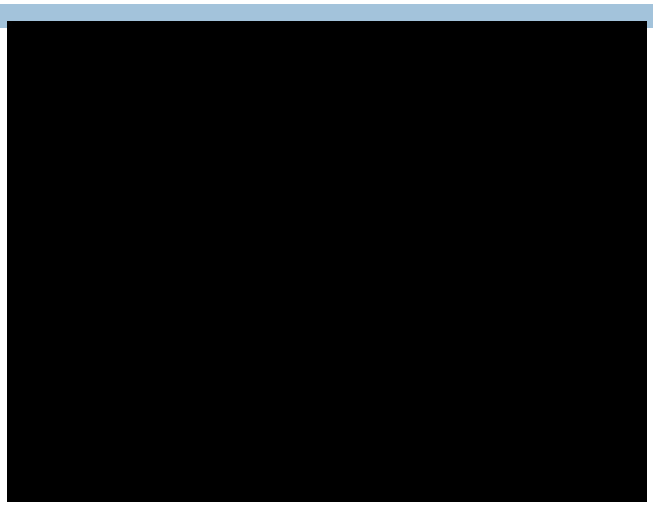

http://www.youtube.com/watch?v=i5rxxGuWUo8

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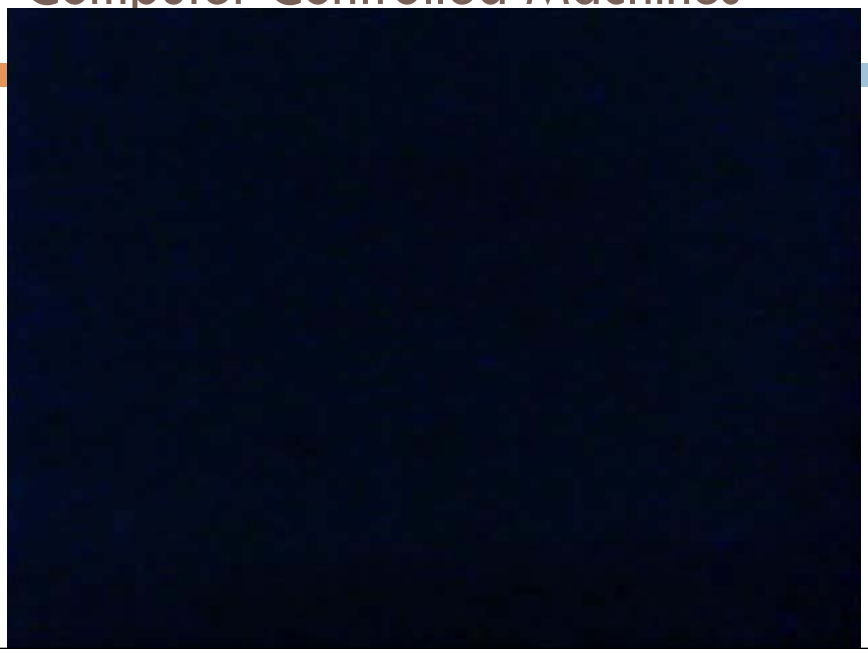

http://vimeo.com/24647023

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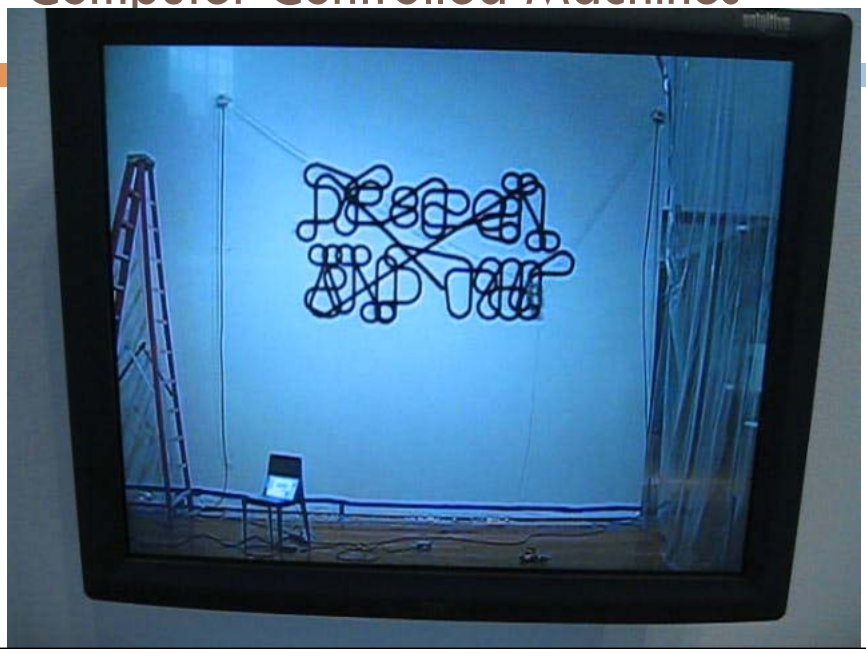
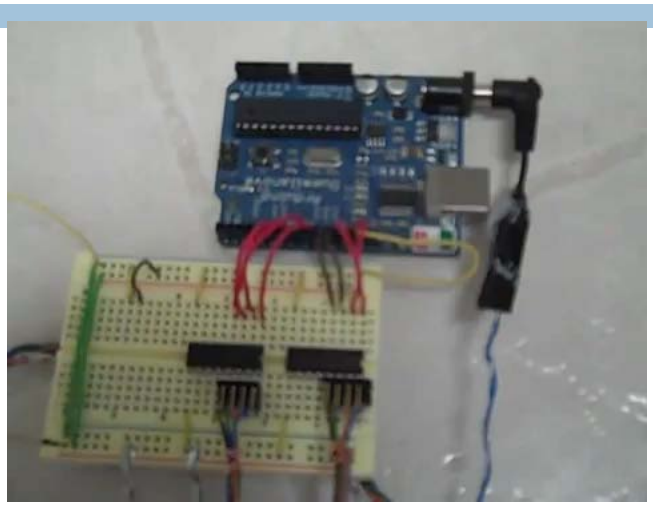


Computer Controlled Machines

"SADbot" suspended drawing machine – Dustyn Roberts

http://www.youtube.com/watch?v=mDNl4pxh_dk

Computer Controlled Machines



http://www.youtube.com/watch?v=z8V1eTA5R6E

Computer Controlled Machines

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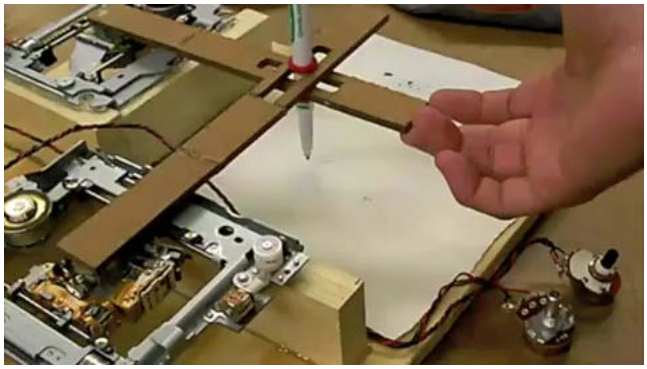

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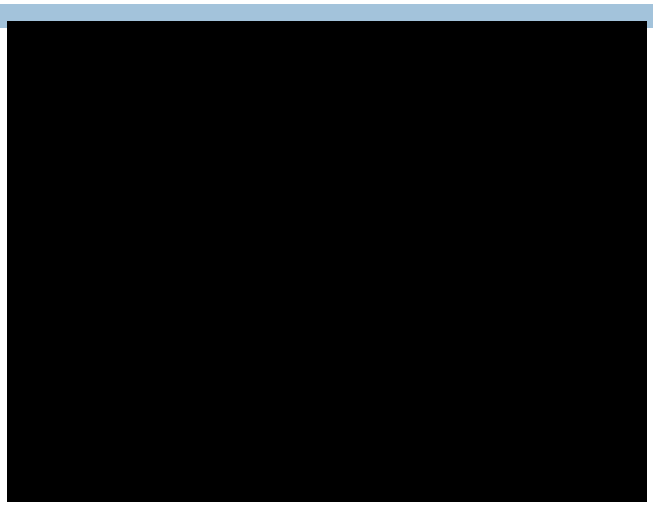
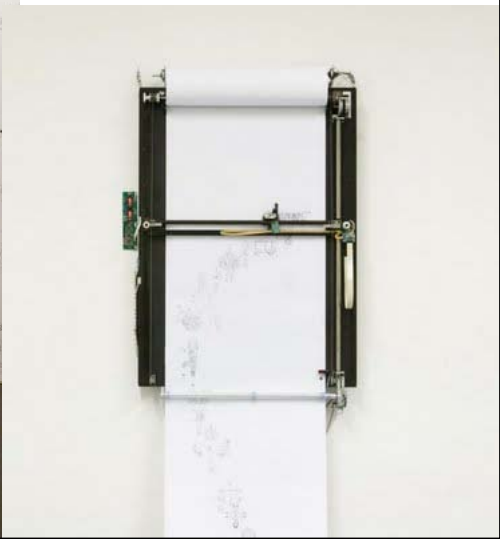


http://www.youtube.com/watch?v=uI5L42-ZY00

Computer Controlled Machines

http://storyteller.allesblinkt.com/



Computer Controlled Machines

http://www.youtube.com/watch?v=T0EAvqCdP2s

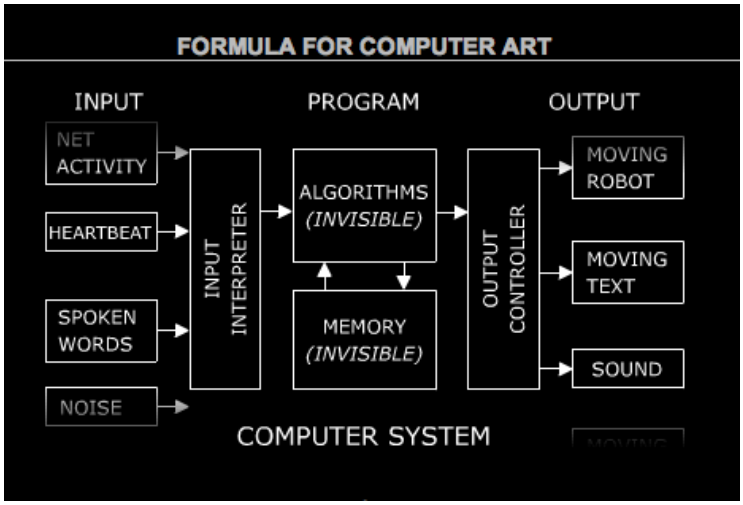
Whew!

- A lot of variation in kinetic art drawing machines
- That's just a sampling…
  - Random drawing machines
    - powered by motors, wind, mail carriers, etc.
  - Mechanical drawing machines
    - hand-cranked, motor driven, wind-up, etc.
  - Reactive drawing machines
    - use environmental sensors of some sort
  - Computer controlled drawing machines
    - range from random to precise
- Pen/ink, paint, light, sand, etch-a-sketch, etc…

First Assignment

- Look around on the web and find something interesting related to kinetic art and drawing machines
  - Think about other definitions of "draw"
  - Think about pure drawing ideas that might inspire mechanical drawing
  - Think about non-mark-making kinetic art pieces that might inspire something that makes marks
  - Think about some engineering artifact that might inspire an art piece
  - Think about other interaction modes
  - Think about other presentations and contexts
- Come on Thursday ready to (quickly) share it

Jim Campbell's Algorithm



Output Transducers

- Motion
  - Motors - DC, Stepper
  - Servos
- Light
  - LED, bulbs, etc.
- Sound
  - Generated, recorded, physical, etc.

Input Sensors

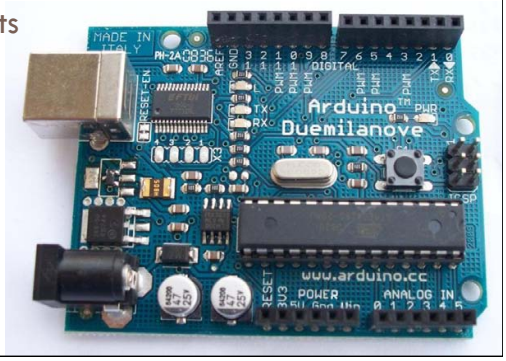
- Switches
- Resistive sensors
  - Get analog values based on sensing input
  - light, temperature, knobs, flex, etc
- Proximity/motion sensing
  - PIR, distance, etc.

Electronic Glue

- Power supplies
- Transistors
  - used as electronic switches for medium power devices
- Relays
  - used as electronic switches for high power devices
- resistors, capacitors, wires, etc.

Computer Control

- Microprocessor
  - receive inputs
  - do some computation
    - You'll have to write some programs…
  - send signals to the outputs

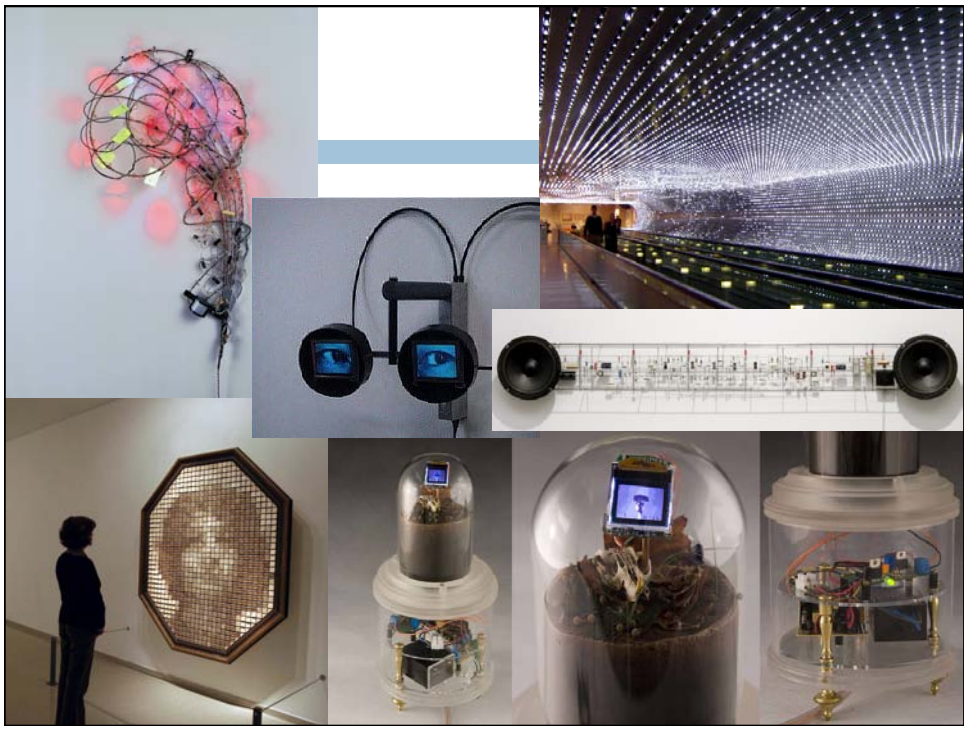


Other Resources

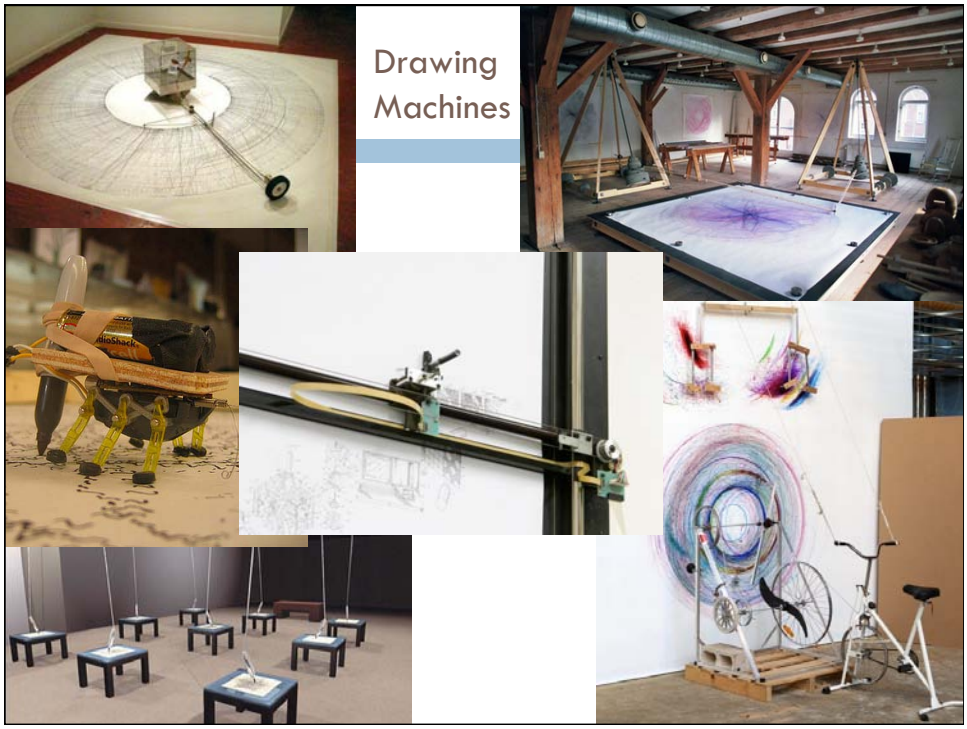
- Wood and metal shop in Art department
- Metal shop in the Engineering building
  - We'll schedule orientations…
- Laser cutter in the Art department
  - VERY cool machine – can cut many things like plastic, paper, and plywood
- Water jet cutter in Engineering
  - VERY cool machine that can cut almost anything
  - Requires training – costs $10 for training class
  - Costs $47/hour (but most jobs take only minutes)

Complete Art Piece

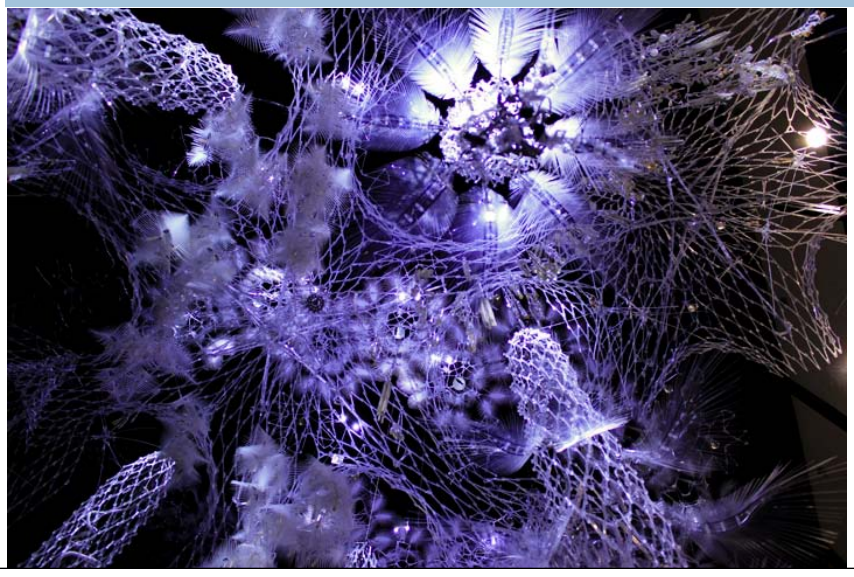
- Kinetic concept in a well-conceived and constructed artifact
- For this semester, think about making marks
  - Traditional 3d materials
  - Wood, metal, plastic, wiring, and other structural materials
  - Unattended functioning (i.e. in gallery)
  - Consider maintenance and support issues too…



Drawing Machines



Hylozoic Veil at The Leonardo



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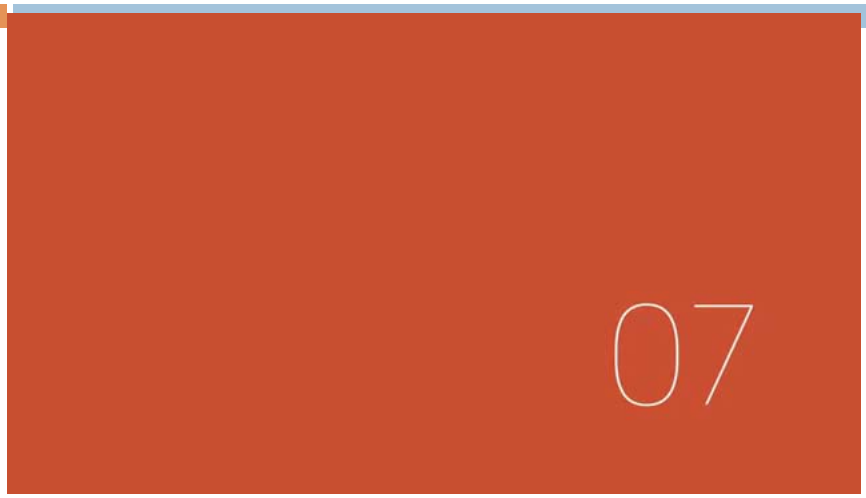


http://www.youtube.com/watch?v=0cdOFIkoZso

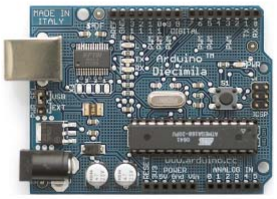
Microcontroller

- The "brains" that coordinates the kinetics
  - Small computers
  - Typically with special support for sensors and actuators
    - Analog-digital converters on inputs
    - pulse-width modulation on outputs
- We'll use one called Arduino

What is Arduino?

The word "Arduino" can mean 3 things

A physical piece of hardware



A programming environment

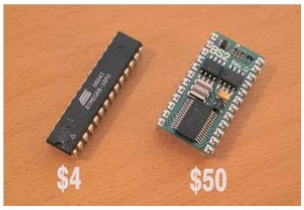
A community & philosophy

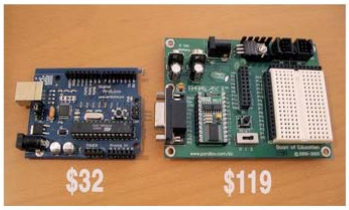
Arduino Community

- Open source physical computing platform
  - "open source" hardware
  - open source software environment
  - physical computing means sensing and controlling the physical world
- Community
  - Examples wiki (the "playground")
  - Forums with helpful people

Arduino Hardware

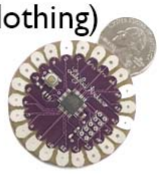
- Similar to Basic Stamp (if you know of it)
  - but cheaper, faster, & open
- Uses AVR ATmega$_{328p}$ microcontroller chip
  - chip was designed to be used with C language



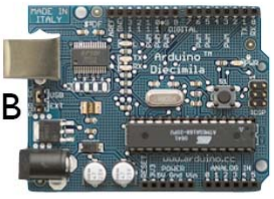


Arduino Hardware Variety

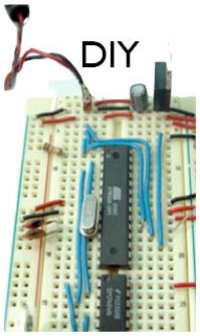
LilyPad
(for clothing)

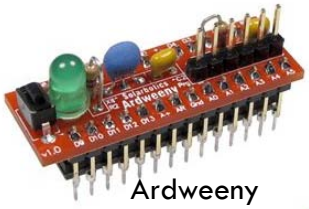


USB



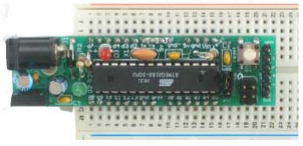
DIY





Ardweeny

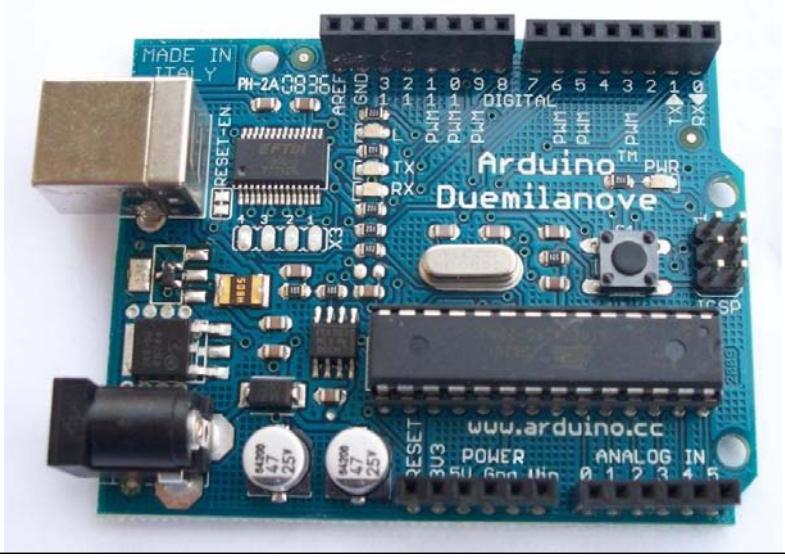
Boarduino Kit



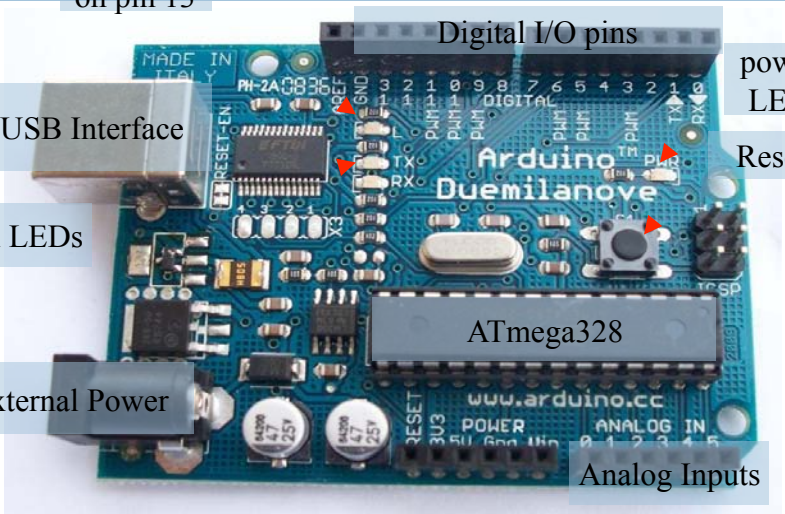
"Stamp"-sized

many different variations to suite your needs

Arduino



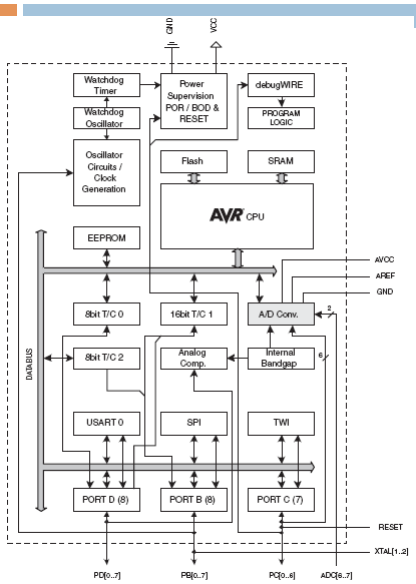
Arduino



Arduino

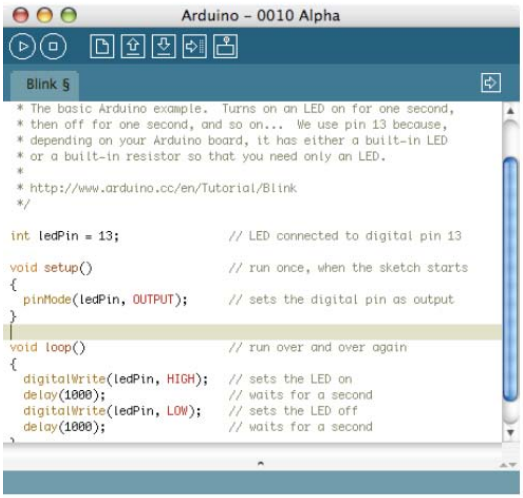
- Based on the AVR ATmega328p chip
  - 8 bit microcontroller (RISC architecture)
  - 32k flash for programs
  - 2k RAM, 2k EEPROM, 32 registers
  - 14 digital outputs (PWM on 6)
  - 6 analog inputs
  - Built-in boot loader
  - Powered by USB
    or by external power

ATmega328P



8-bit RISC CPU – 16MHz
32 registers
32k Flash, 2k SRAM, 1k EEPROM
3 8-bit I/O ports
6 ADC inputs
2 8-bit timers
1 16-bit timer
USART
SPI/TWI serial interfaces

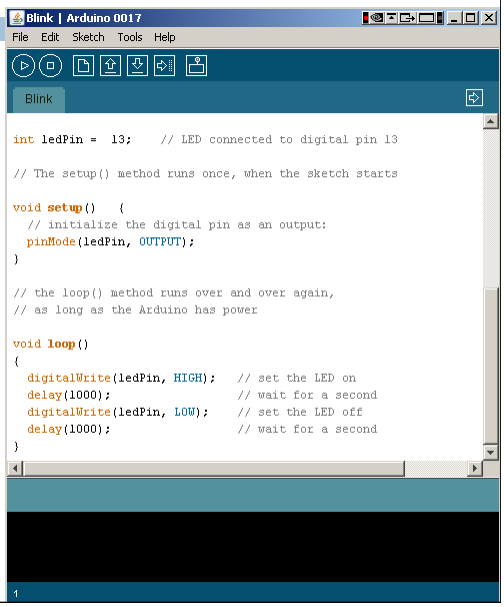
Arduino Software



- Like a text editor
- View/write/edit sketches
- But then you program them into hardware

Programming Arduino

- Open-source programming environment
- Arduino language is based on C
  - Actually, it *is* C/C++
  - Hiding under the hood is gcc-avr
  - But, the Ardiuino environment has lots of nice features to make programming less scary...



More Arduino Info?

- www.arduino.cc/
  - Main Arduino project web site
- www.arduino.cc/playground/Main/HomePage
  - "playground" wiki with lots of users and examples
- www.freeduino.org/
  - "The world famous index of Arduino and Freeduino knowledge"
- www.eng.utah.edu/~cs5789
  - our class web site

Resources for this class

- We have some supplies for the class
  - Arduino boards
  - sensors of various different types
  - motors and servos
  - LEDs and LED controllers
- You should expect to have to buy a few more parts on your own to complete your project though...

Questions?