THE UNIVERSITY OF UTAH

SaltGrass PRINTMAKERS

High Tech Art

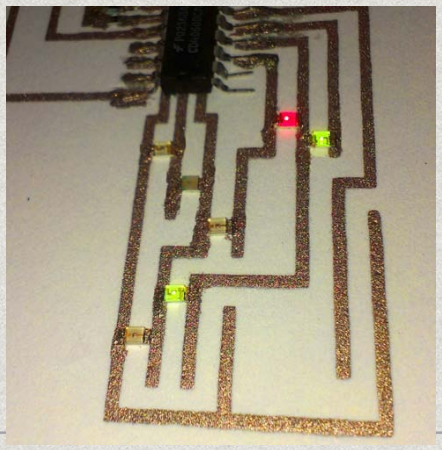
21st Century Drawing and Printmaking

Erik Brunvand

Saltgrass Printmakers
& University of Utah

High-Tech Drawing and Printmaking?

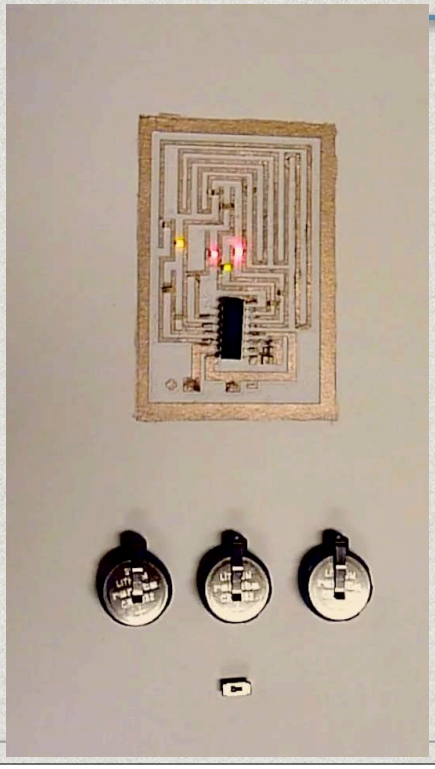
- I'm going to talk about two things:
  - Automated Drawing Machines (Kinetic Sculpture)
  - Electrified Printmaking

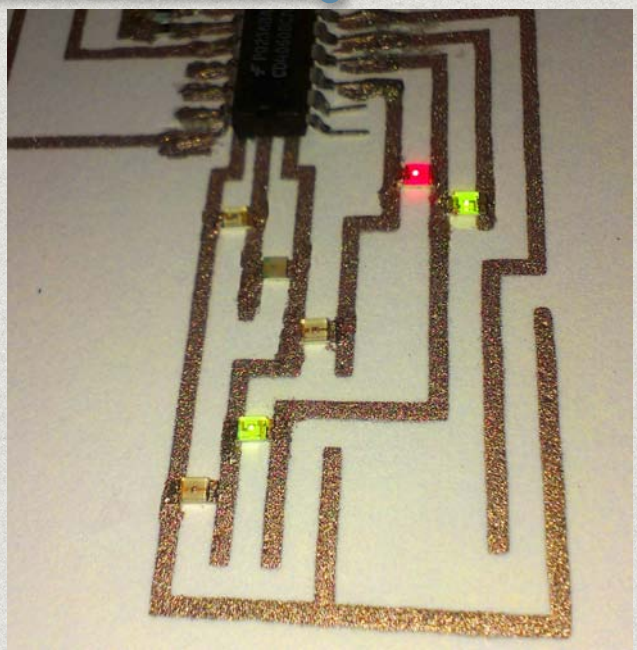


Electrified Printmaking

- Printing involves transfer of ink to a substrate
  - Visual properties depend on the physical properties of the ink
- What about physical properties of the printed images?
  - What if the ink were conductive?
  - What are the possibilities of an active electronic print?
  - Extend the vocabulary of print towards digital media?

Printed “Wires”

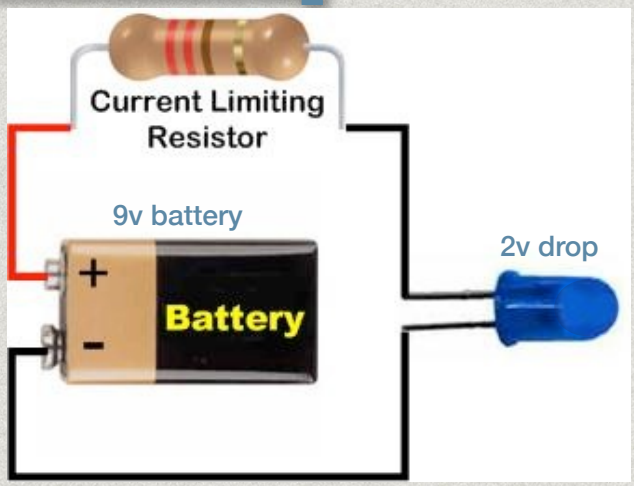




Erik Brunvand, 2013

LED Circuit

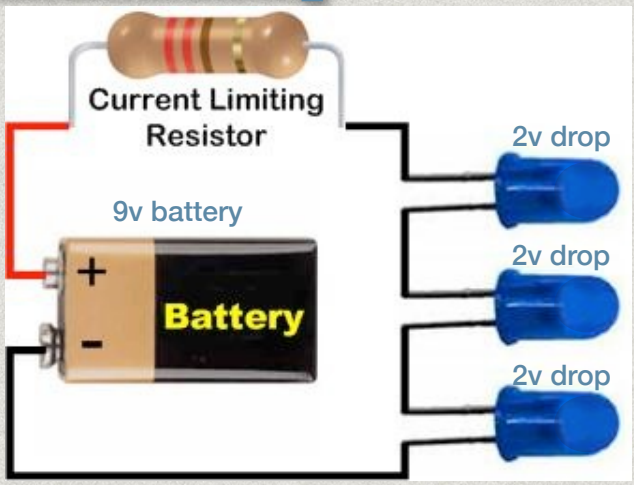
Resistor sized to drop 7v at 0.020A



- Current flowing through an LED makes it light
  - typical limit: 20mA
  - typical LED ***voltage drop***: 1.2v-3v
- R = V/I
  R = $(V_{bat} - V_{led})/I$
  R = (9v - 2v)/0.020A
  R = 350Ω

LED Circuit

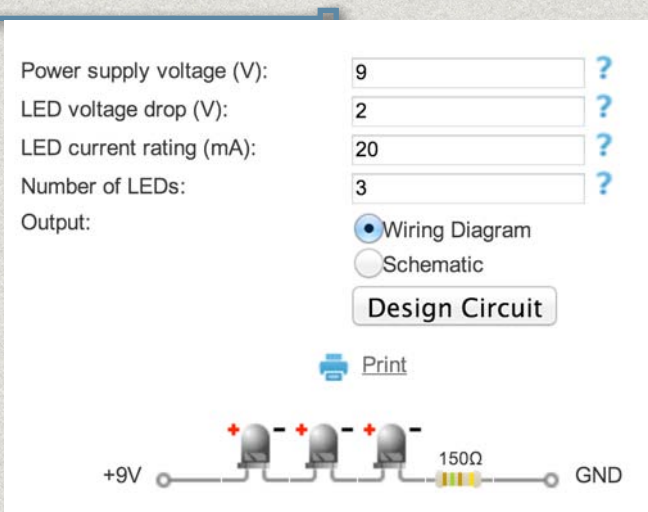
Resistor sized to drop 3v at 0.020A



- Current flowing through an LED makes it light
  - typical limit: 20mA
  - typical LED ***voltage drop***: 1.2v-3v
- R = V/I
  R = $(V_{bat} - V_{led})/I$
  R = (9v - (2 + 2 + 2)v)/0.020A
  R = 150Ω

LED Circuit

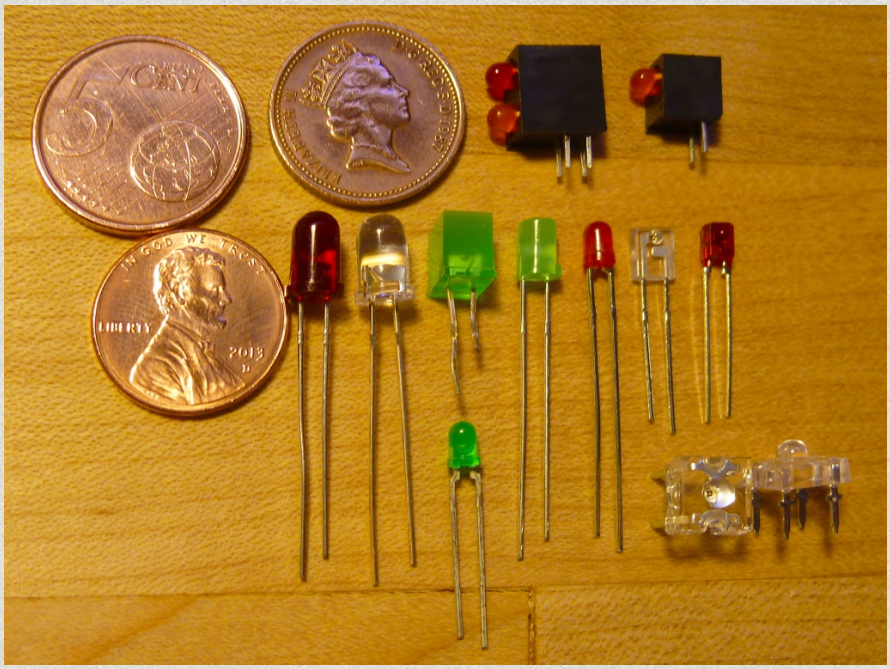
- ledCalculator.net...



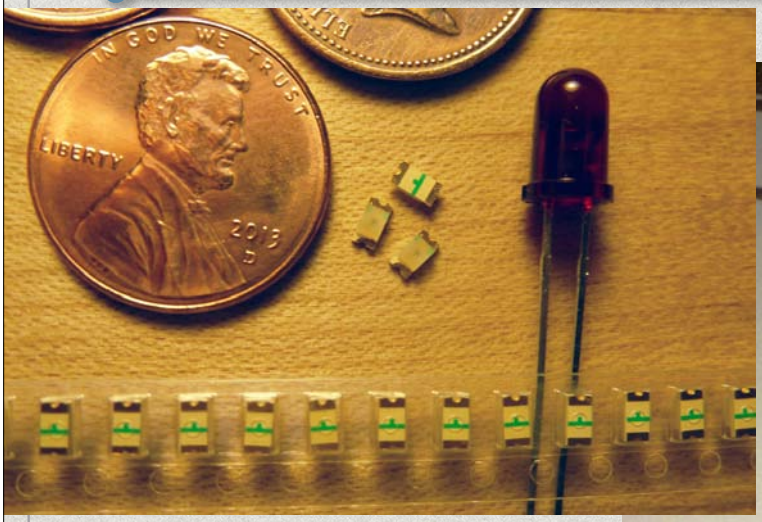
Required resistance can be in a separate resistor, or in the wires themselves!

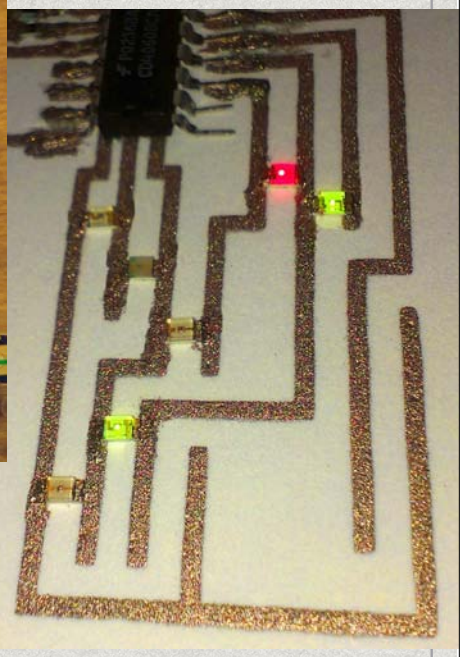
As we'll see, some printable wires have noticeable resistance...

LEDs



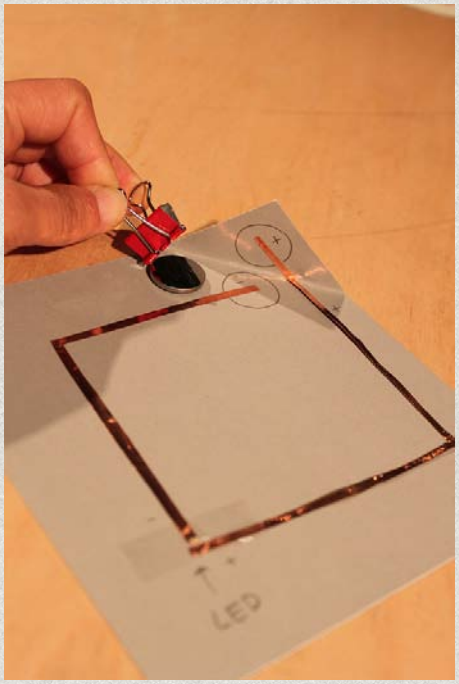
LEDs

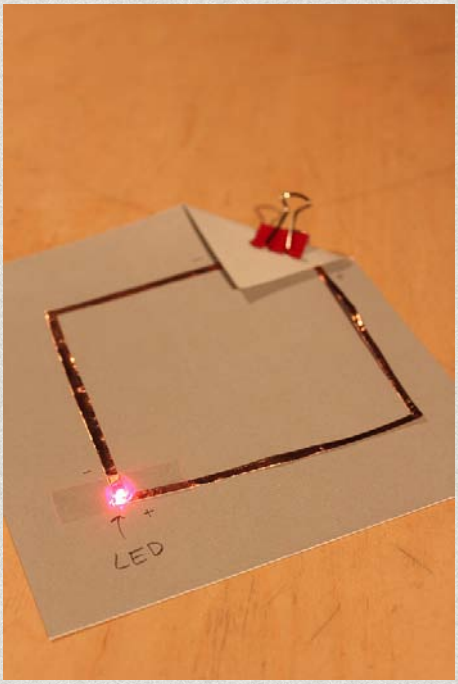




"1206" size surface-mount LED
3.2mm x 1.6mm

Paper LED Circuit





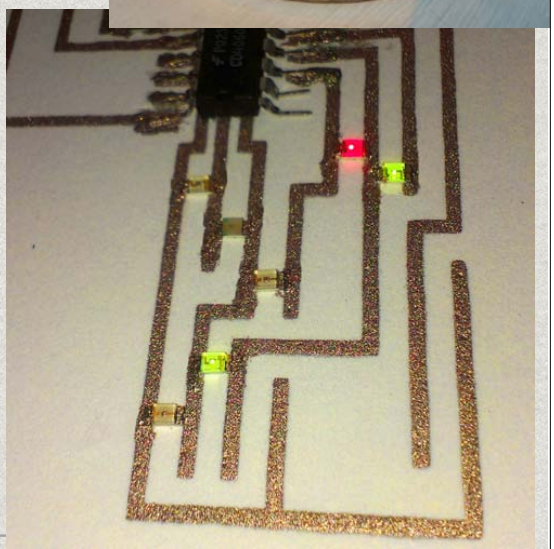
Tinkering Studio
Exploratorium, San Francisco, CA

Conductive Paint Testing

- "Metallic" paints don't work!
- Adding metal flakes to screenprint ink doesn't work
- Adding graphite to screenprint ink ***does*** work
  - Resistance is fairly high though...

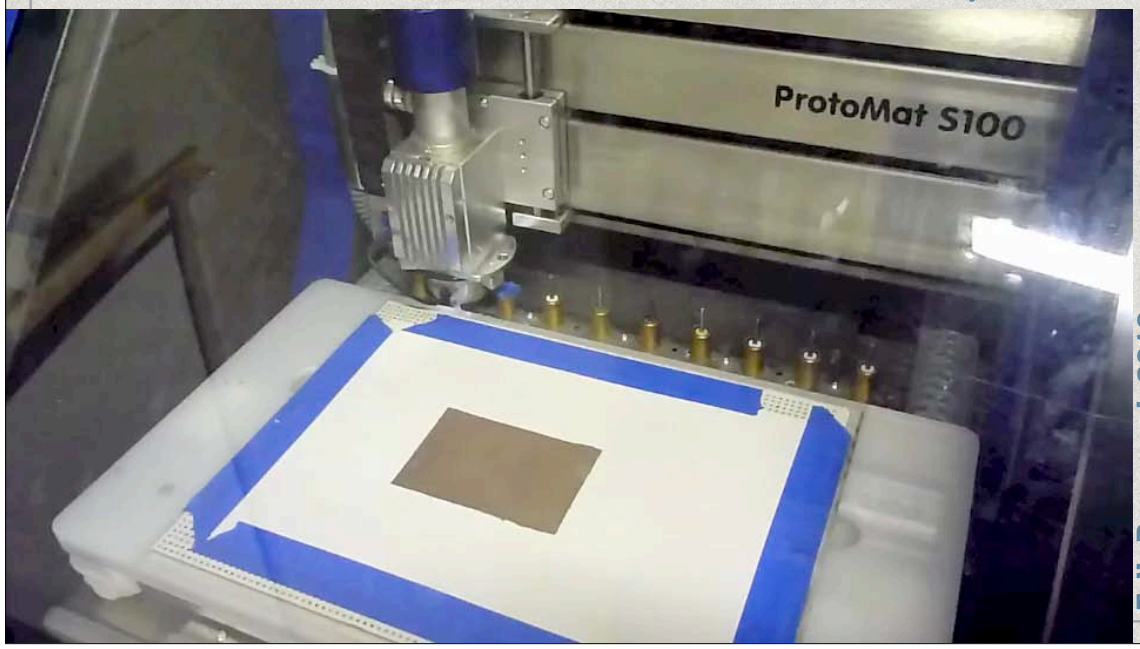
Copper-Based Paint

- CuPro Cote from LessEMF.com
- Copper-based conductive paint
  - Water-based paint - easy-ish cleanup (dries fast)
  - Low resistance: < 1Ω/sq
  - A little loose straight out of the can
  - Can be thickened a little with a little bit of screenprint medium



CNC Routing

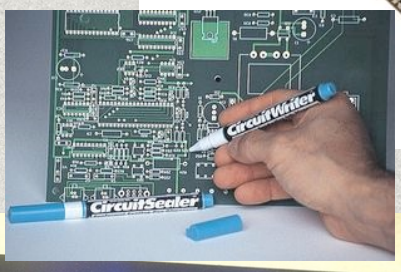
- Start with paint applied to the paper
- Use a circuit-board CNC router to remove the surface layer

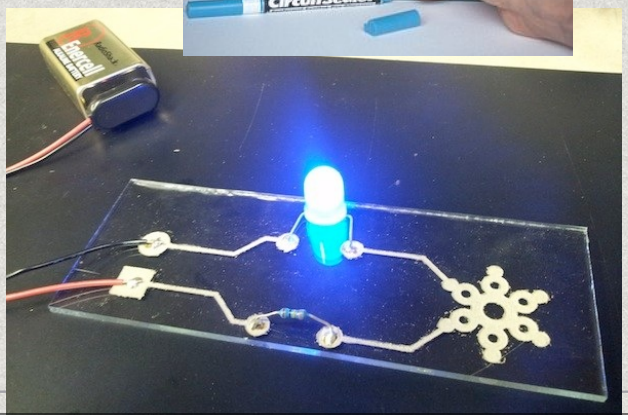


Erik Brunvand, 2013

Silver Ink Pen

- CircuitWriter by Caig Labs
  - Extremely low resistance: 0.017Ω/sq
  - Designed for repairing circuit traces
  - Silver color
  - Expensive!



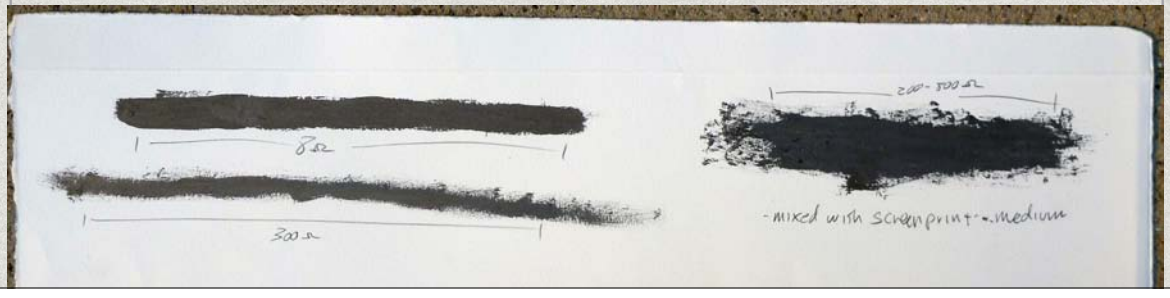


Conductive Ink-Jet Ink

- Microsoft Research, Cambridge
- $100/100ml silver-based ink

Nickel-based paint

- MG Chemicals Super Shield
  - Nickel based coating
  - Low resistance: 0.6Ω/sq
  - Designed to be a shielding coating for electronics
  - Medium grey color
  - ***NOT water soluble! Pretty stinky stuff... Gums up screens instantly... Better used for painting than for printing...***

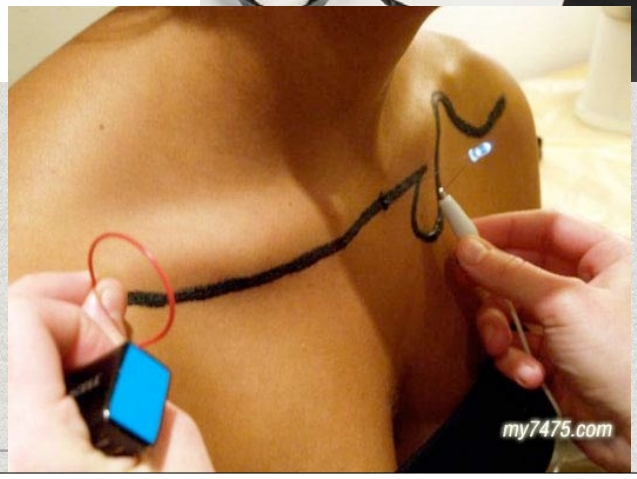


Carbon-based paint

- Bare Conductive
  - Moderate resistance: 50Ω/sq
  - Water soluble
  - Designed for painting and for printing
  - Comes in jars or pens

Carbon-based paint

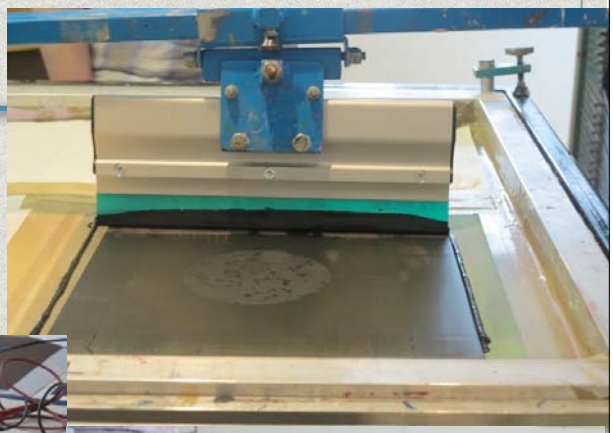
- Bare Conductive
  - Moderate resistance: 50Ω/sq
  - Water soluble
  - Designed for painting and for printing
  - Comes in jars or pens
  - Safe to paint on skin!

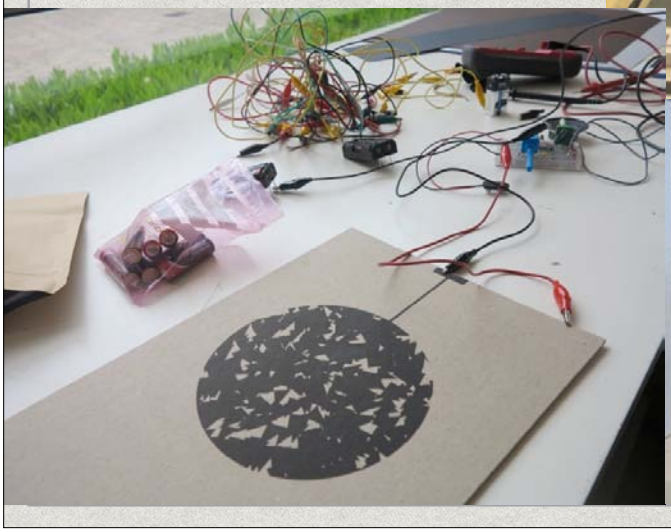


Luma Studios

(London)

Screenprinting with Bare Conductive carbon-based ink



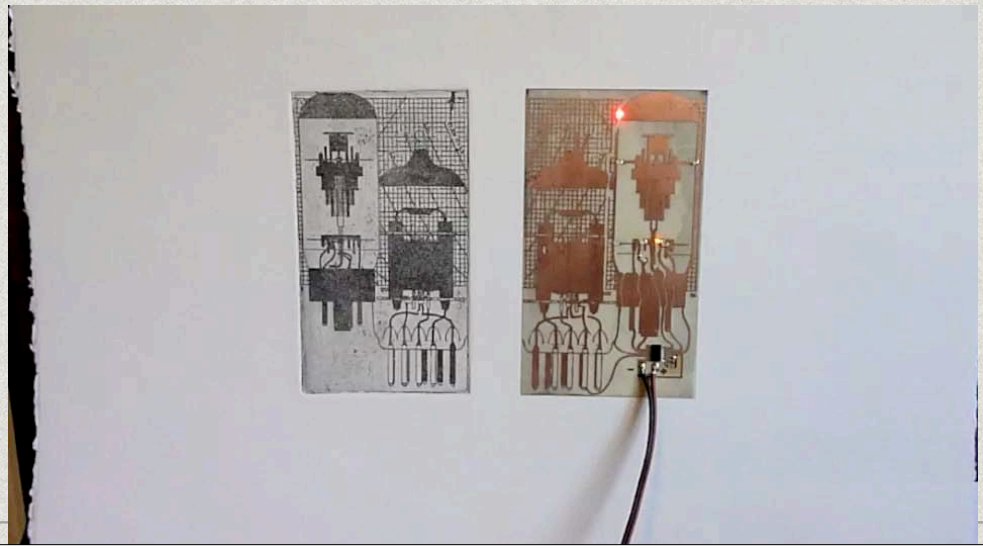


Commercial conductive inks

- e.g. Vorbeck Materials
  - $100/500g sample
  - Not water-based...

Etched Copper

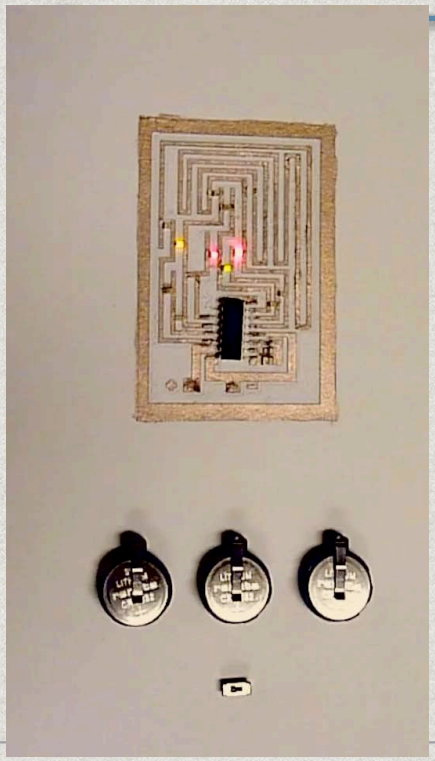
- Copper-plated fiberglass
  - Used for electronic circuits
  - Etched in Ferric Chloride, just like copper etching plates

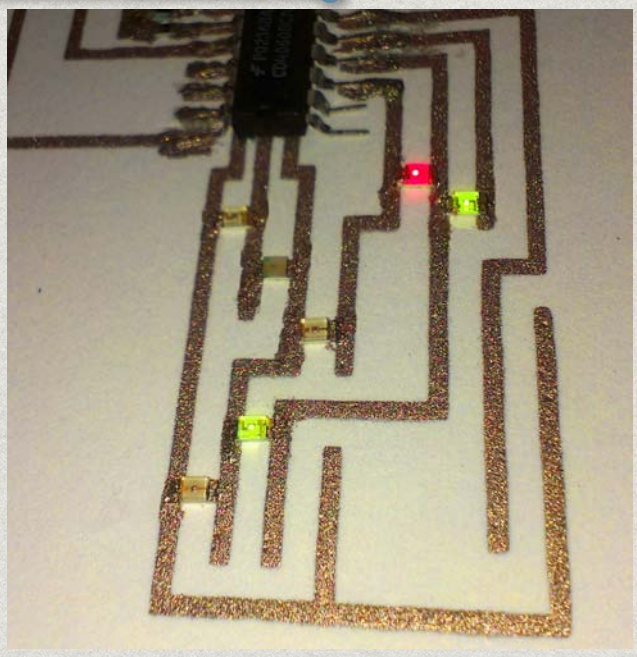


Erik Brunvand, 2013

Gallery

Erik Brunvand

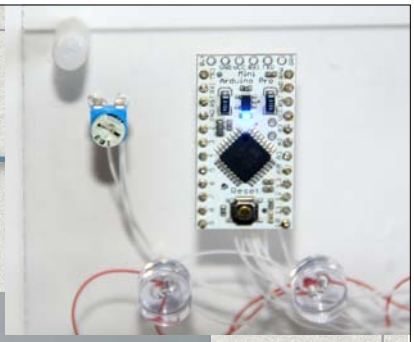


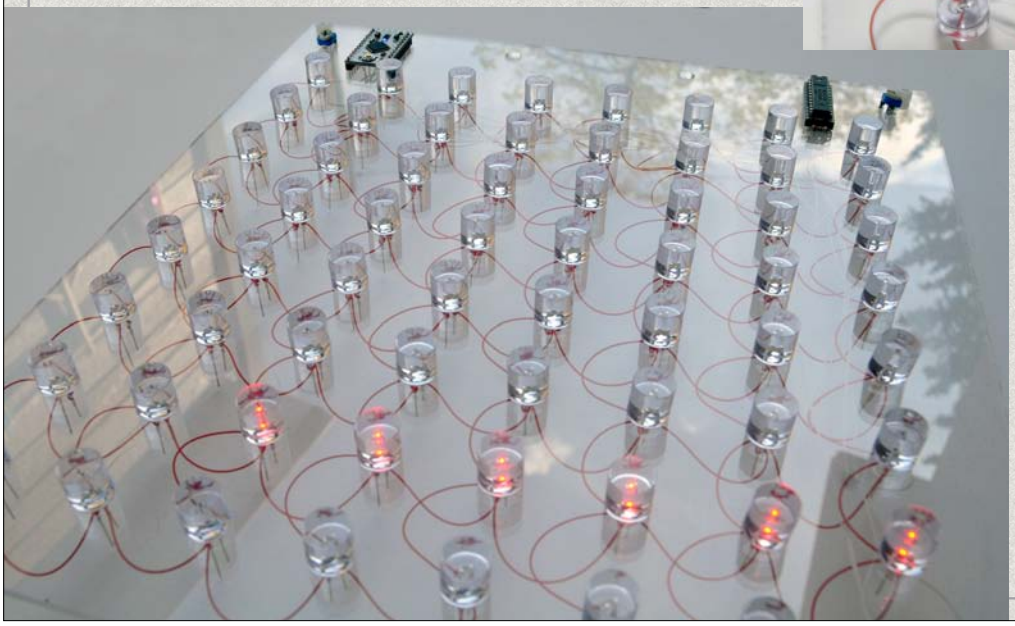


Erik Brunvand, 2013

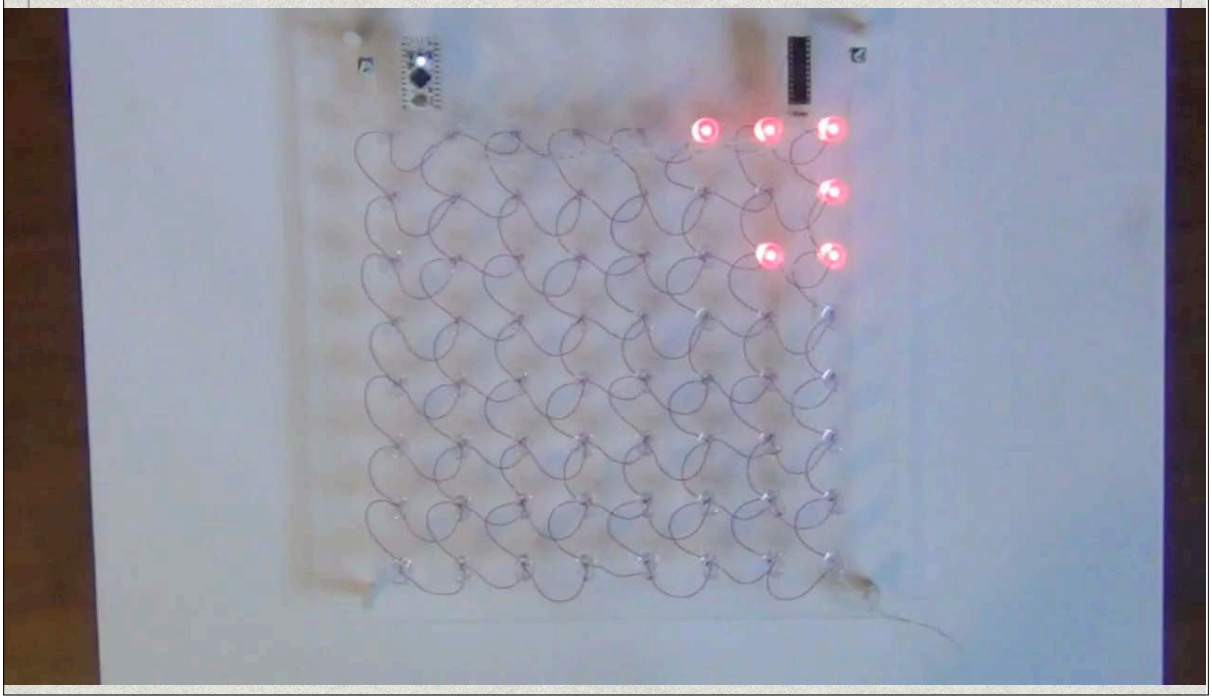
Erik Brunvand

Erik Brunvand

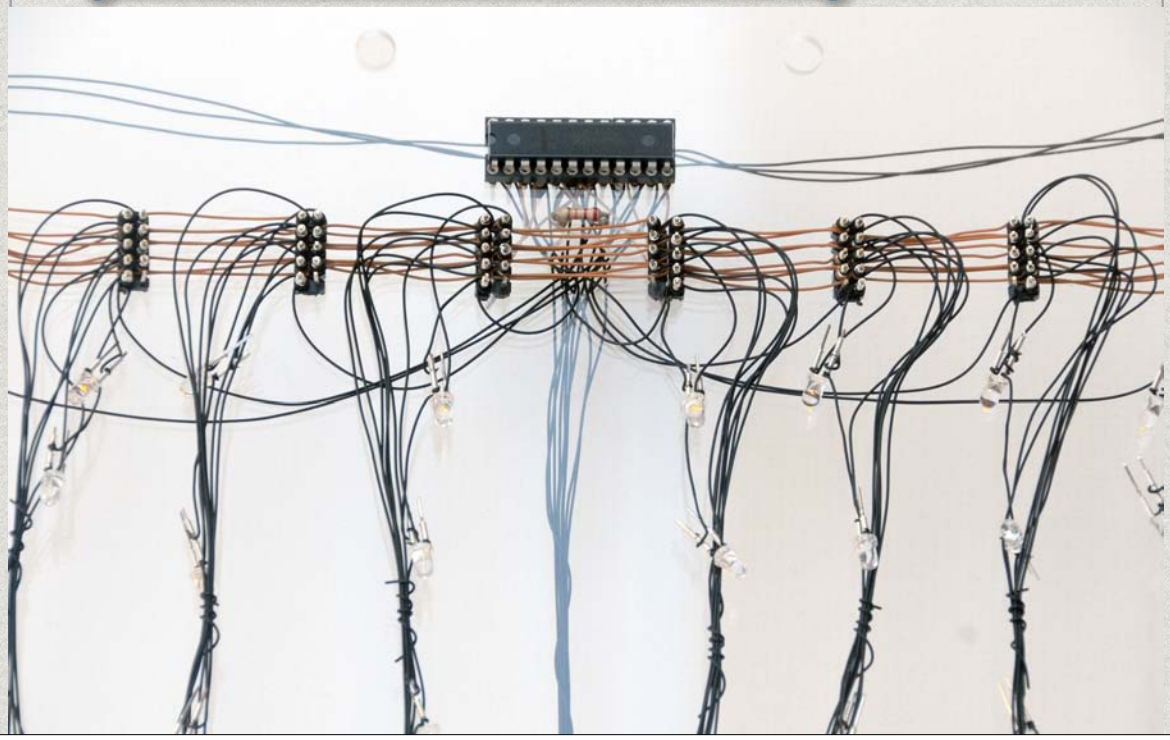




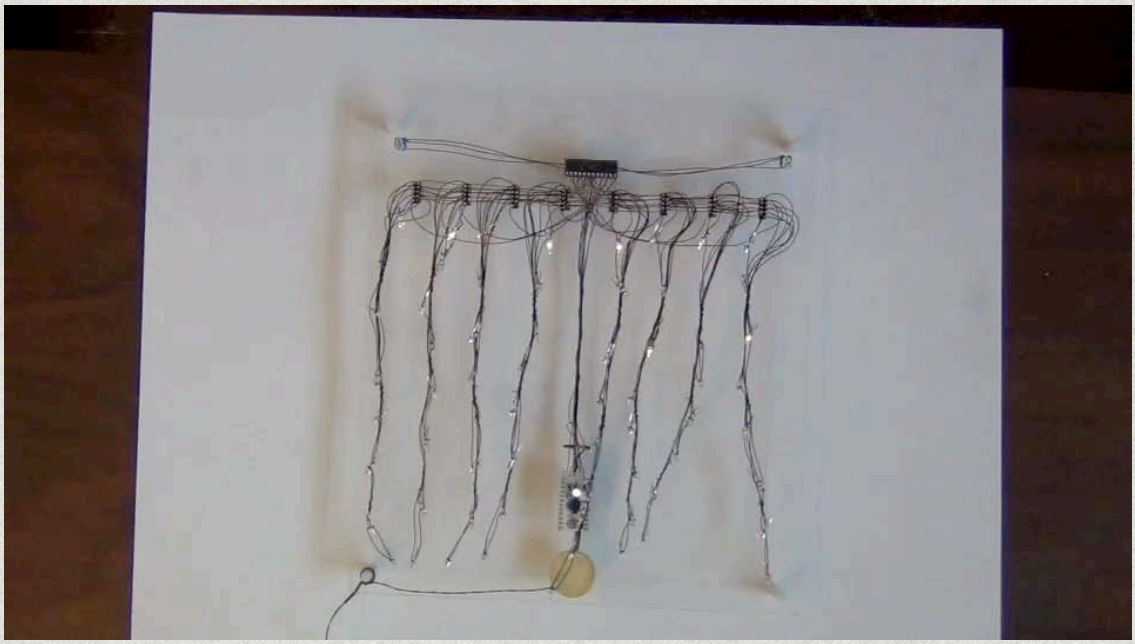
Erik Brunvand



Erik Brunvand



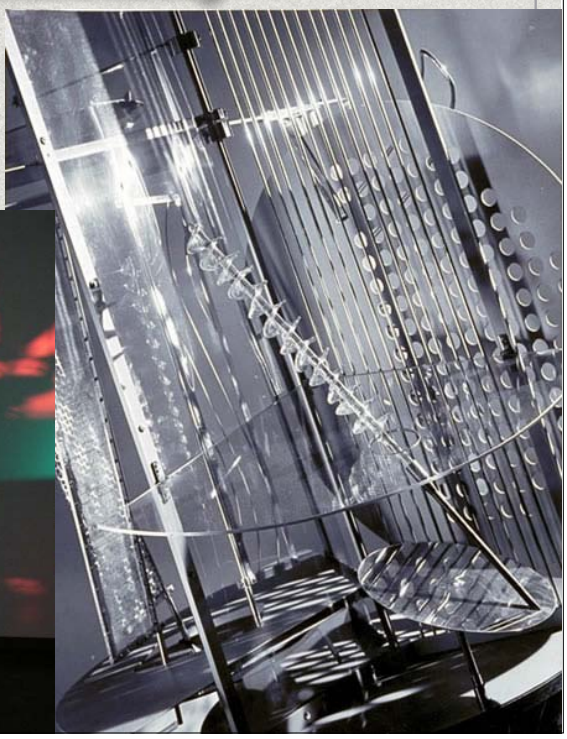
Erik Brunvand

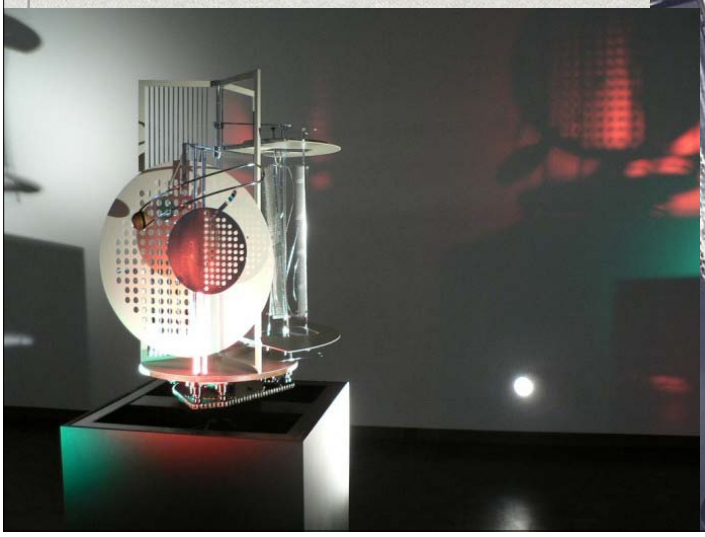


Erik Brunvand

László Moholy-Nagy

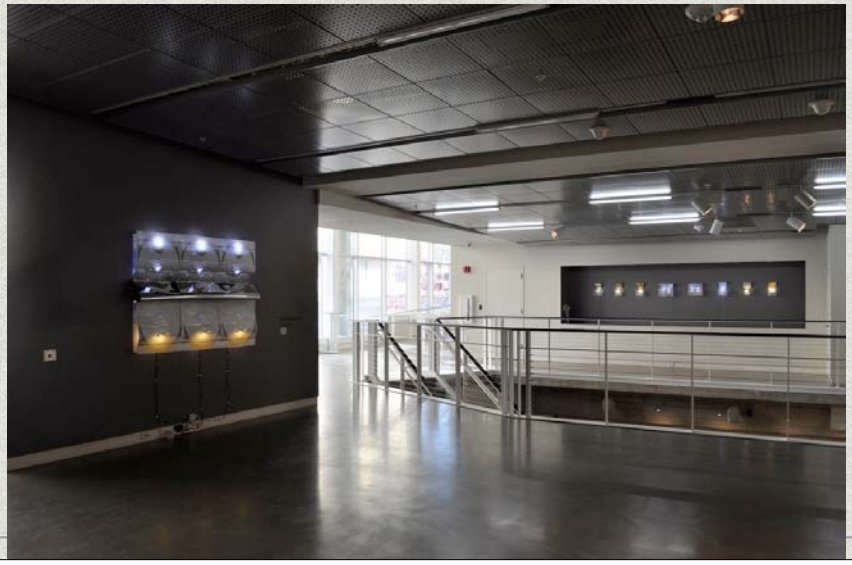
Light-Space Modulator (1922-30)





Erik Waterkotte

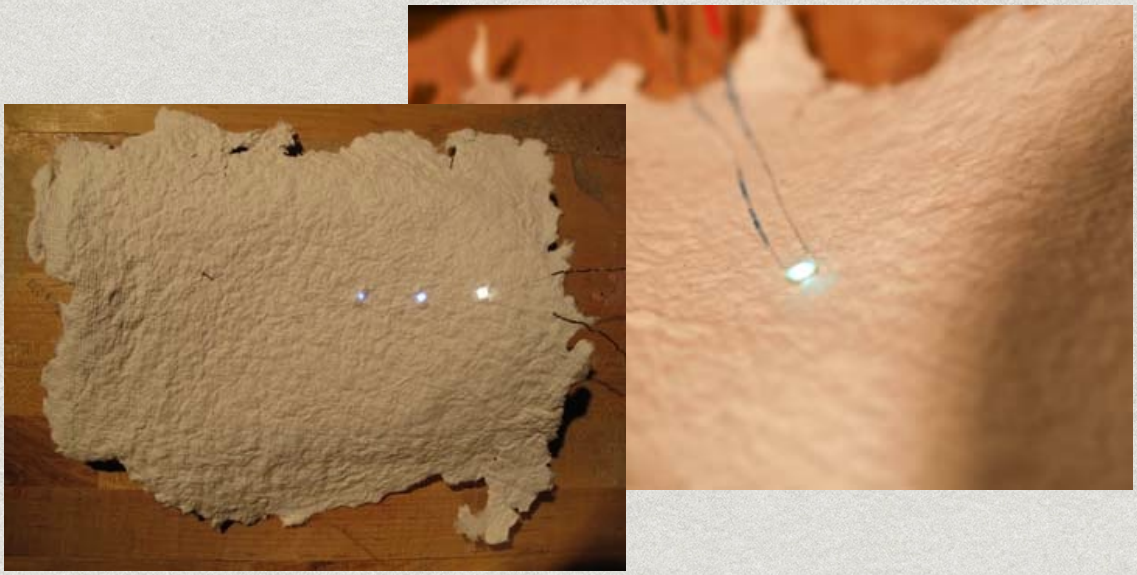
- Chimera and Inverse Incandescence
  - Exhibited at Utopia/Dystopia at the Urban Institute of the Contemporary Arts, Grand Rapids, MI, 2013



Erik Waterkotte

Erik Waterkotte

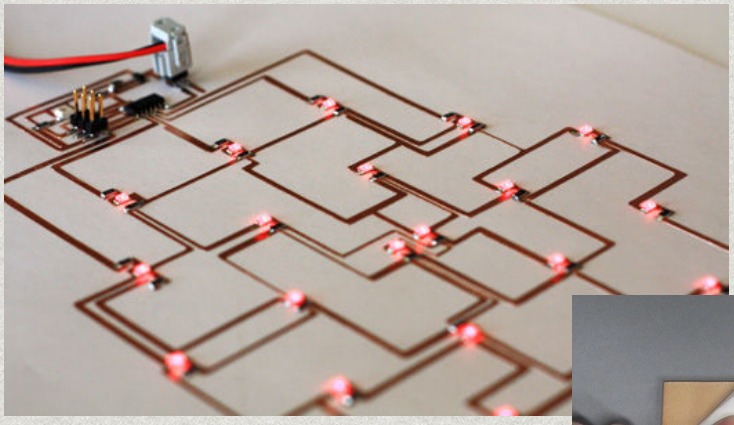
Caroline Brown

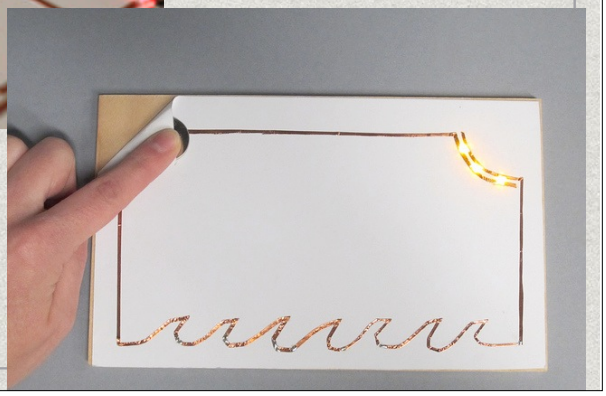


Student at ITP program at NYU

Tinkering Studio

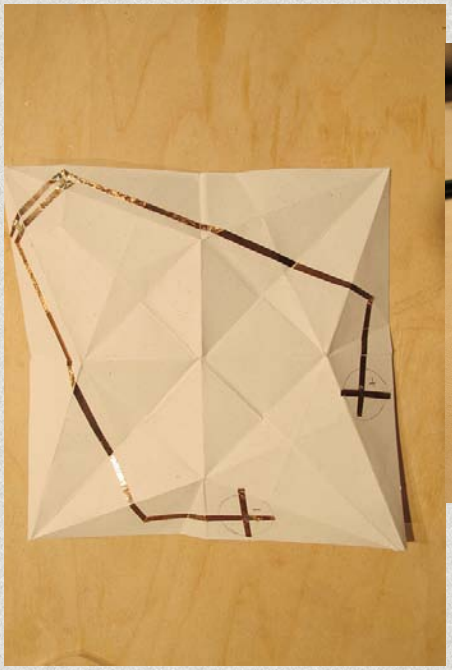
Exploratorium, San Francisco, CA

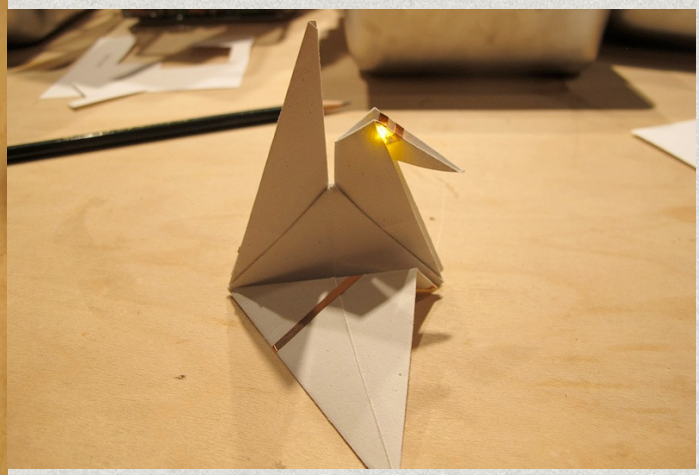




Tinkering Studio

Exploratorium, San Francisco, CA





Michael Shorter - DJCAD

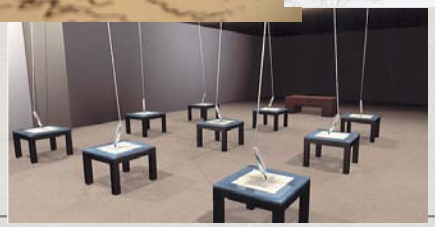
- Printed electronics
  - Makes a "Theramin-like" musical instrument

Conclusions (part I)

- Fascinating possibilities!
- Don't be intimidated!
  - Ink/Paint is a little expensive, but not terrible
  - Electronics can be very simple and effective
  - Electronic components (LEDs, resistors) are cheap
- Add some bling to your prints!

Erik Brunvand, elb@cs.utah.edu, www.cs.utah.edu/~elb

Drawing Machines

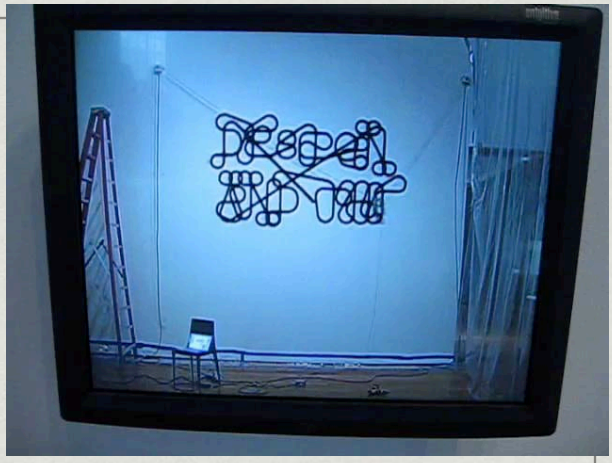


Automated Drawing

- Drawings made with mechanisms
  - Repeatable?
  - Controllable?
  - Editionable?
- Based on data?
  - Or made to be as random as possible?

Mike Lyon, Kansas City, MO
http://mlyon.com/

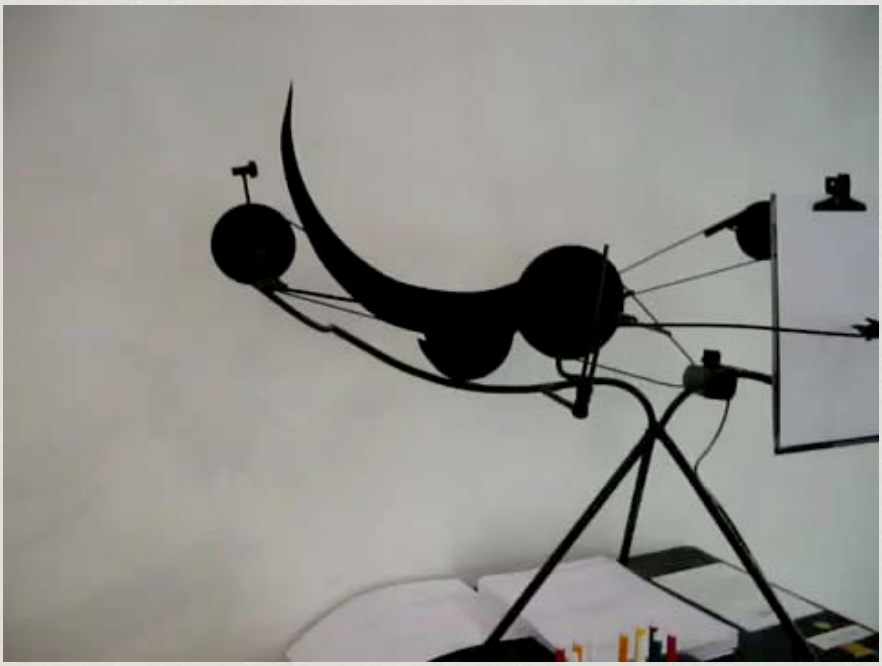
This Talk



Uli Franke, Jürg Lehni: Hektor, 2002

- Start with some images
  - to whet your appetite
- Think about an automated drawing taxonomy
  - Time Line: historical, computer age, and contemporary
  - Not intended to be comprehensive
- End with some examples of specific curricula

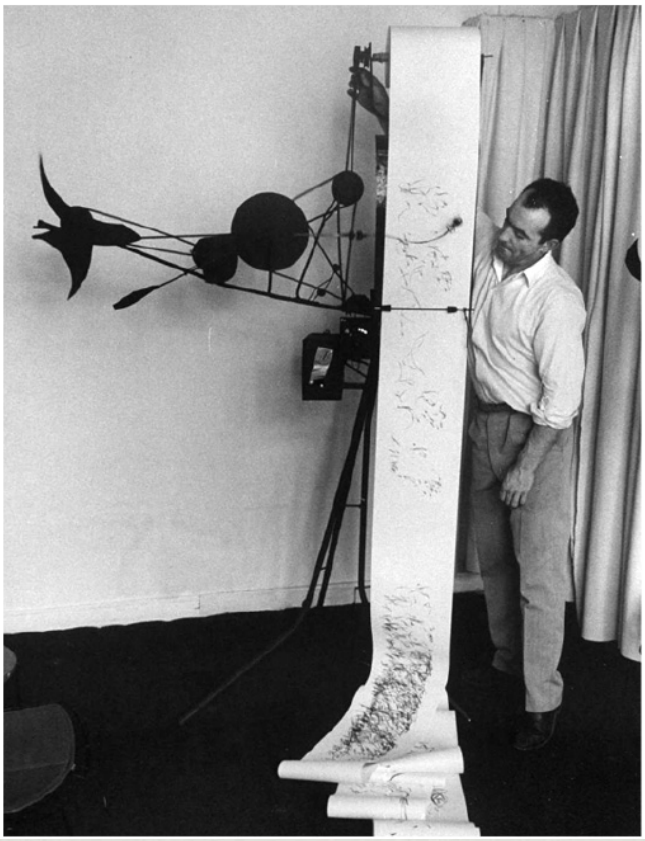
Jean Tinguely - Switzerland, 1959



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

Jean Tinguely

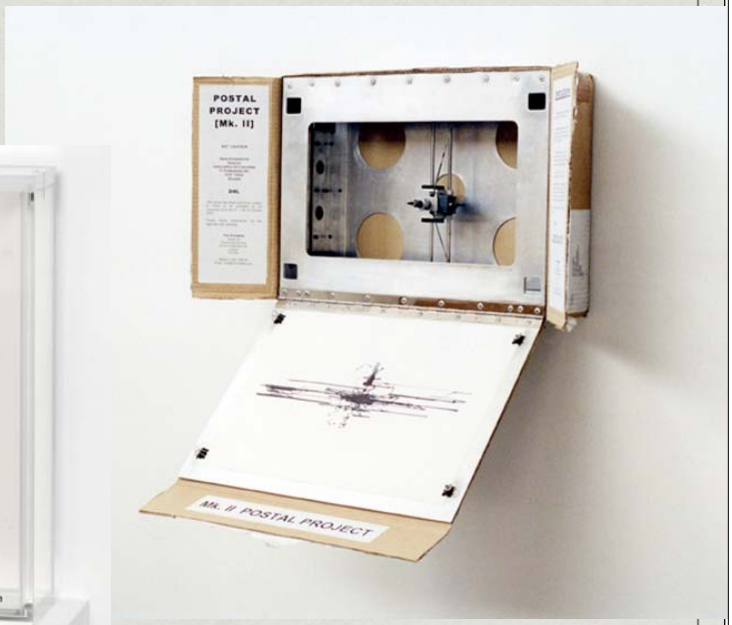
Metamatics



Eske Rex - Denmark (2011)

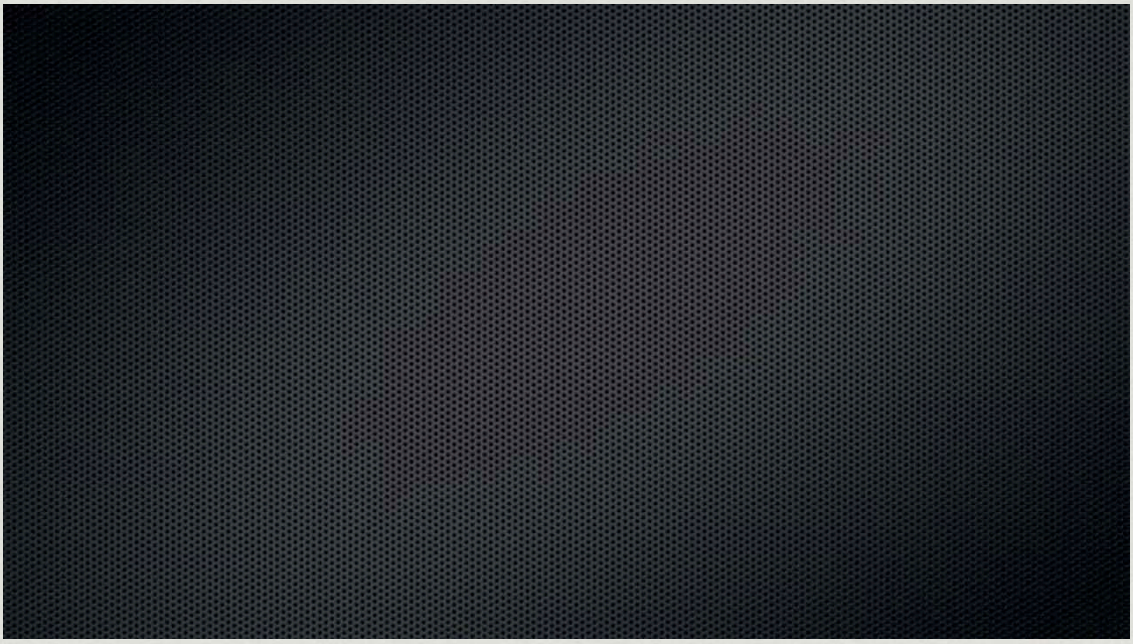
http://www.youtube.com/watch?v=5yumD0ezoVE

Tim Knowles - England, 2006



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

Erik Brunvand - USA, 2013



A Drawing Machines Taxonomy

Control / Image	Analog (mechanical)	Digital (electronic)
Random	Random marks with direct control of the drawing tool	Computer control, often using environmental input
Deterministic	Mechanical drive of the drawing tool	Computer programmed control

A Drawing Machines Taxonomy

Control / Image	Analog (mechanical)	Digital (electronic)
Random	Tim Knowles Eske Rex	Student from Trinity Valley School
Deterministic	Erik Brunvand	Mike Lyons

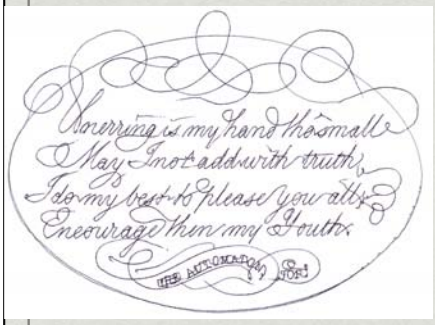
A Time Line

- Historical: 18th and 19th centuries (automata)
- Early Modern: 1950's (Metamatics)
- Computer Age: 1960's – 1970's (printers/plotters)
- Contemporary: 1990's to Now (lots of artists!)

Maillardet's Automaton, 1810

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

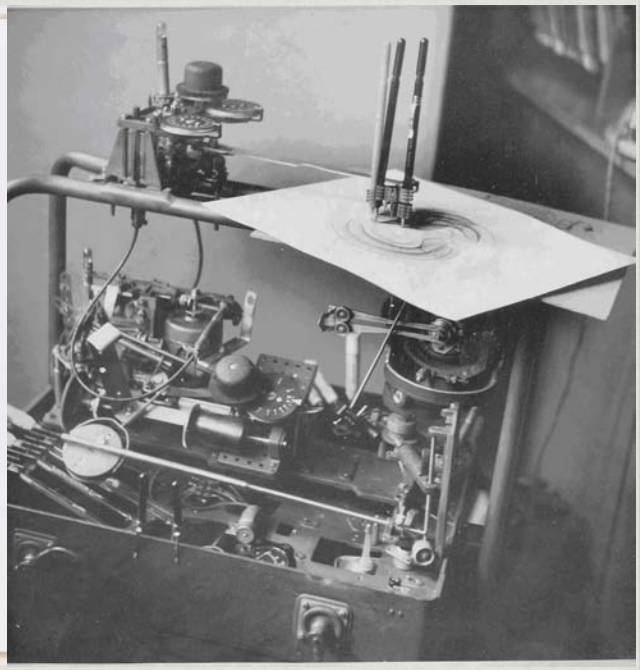
Maillardet's Automaton, 1810



Jaquet-Droz Automata

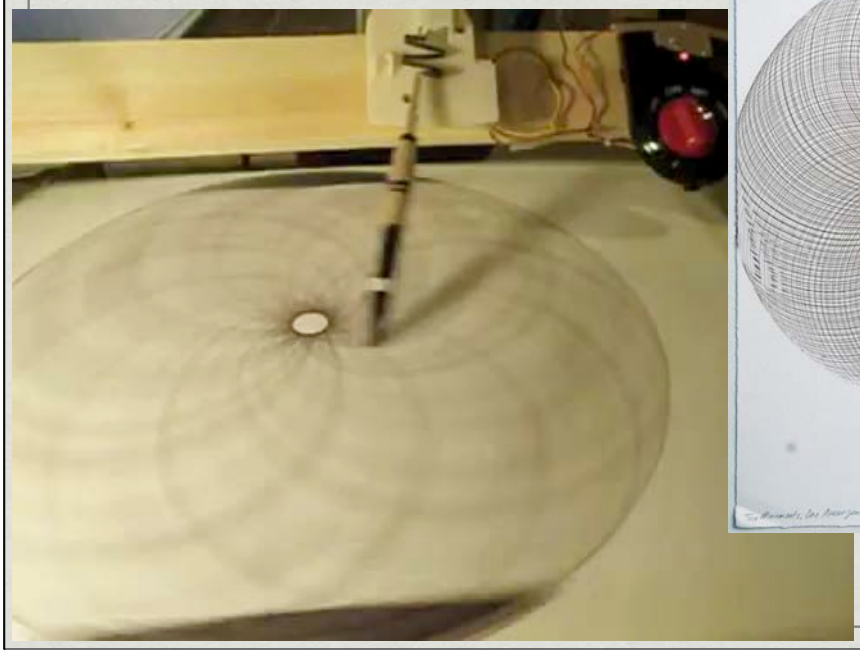
1768-1774
The Draughtsman

Desmond Paul Henry: 1962



http://www.desmondhenry.com/index.html

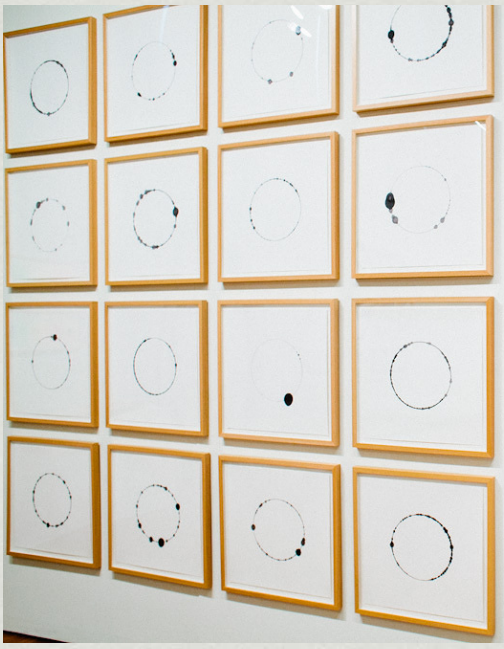
Leslie A. Grossman, 2012



Leslie A. Grossman, 2012

leslieagrossman.com/

Leslie A. Grossman, 2012



leslieagrossman.com/

Cameron Robbins, Australia

cameronrobbins.com/artwork/

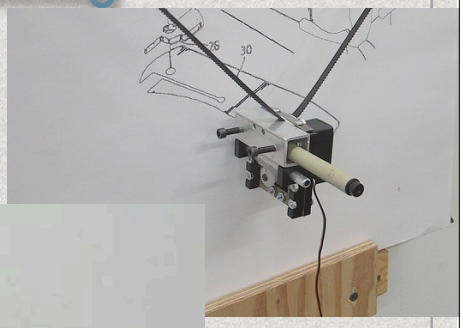
David Bowen, U Minn, 2003

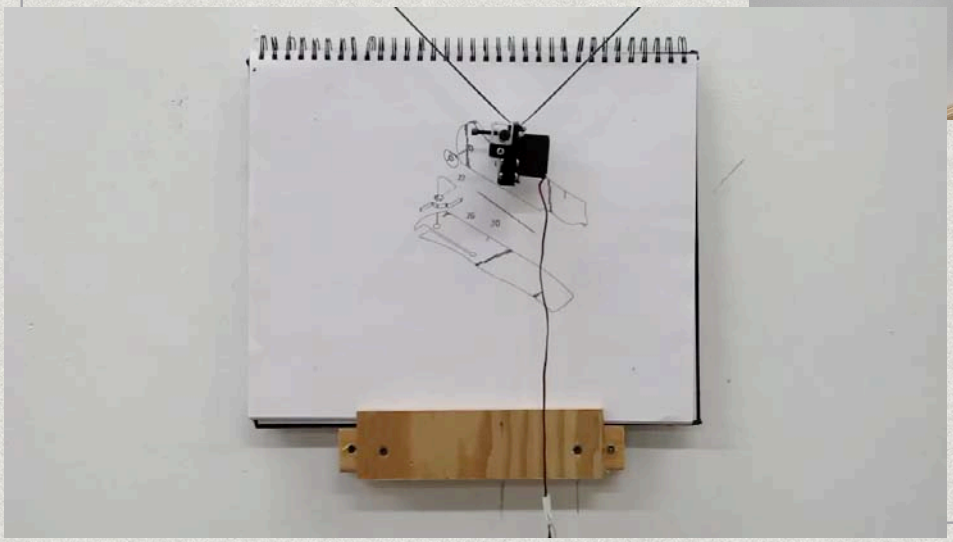
http://www.dwbowen.com/sonarmovie.html

Patrick Tresset: Paul the Drawing Robot

http://doc.gold.ac.uk/~ma701pt/patricktresset/

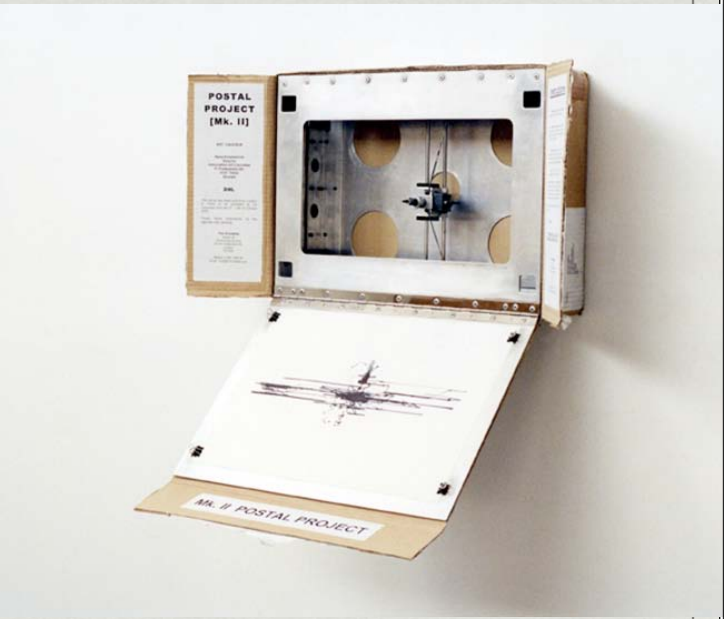
Robert Twomey, 2013





Example High School Curriculum

- Based on the *Postal Project* by Tim Knowles
  - Katie Campbell
    Alta High School
    Salt Lake City, UT



Example High School Curriculum

- Objectives:
  - Each student is given a postal box
  - Each student chooses a drawing medium
  - Each student puts drawing paper as well as their drawing medium inside the postal box
  - Each student seals the postal box
  - Each student is required to carry the postal box for a period of one day, from sun up to sun down, without opening the box

Katie Campbell, Alta High School, Salt Lake City, UT

Example High School Curriculum

Katie Campbell, Alta High School, Salt Lake City, UT

Example High School Curriculum

Katie Campbell, Alta High School, Salt Lake City, UT

Example High School Curriculum

Katie Campbell, Alta High School, Salt Lake City, UT

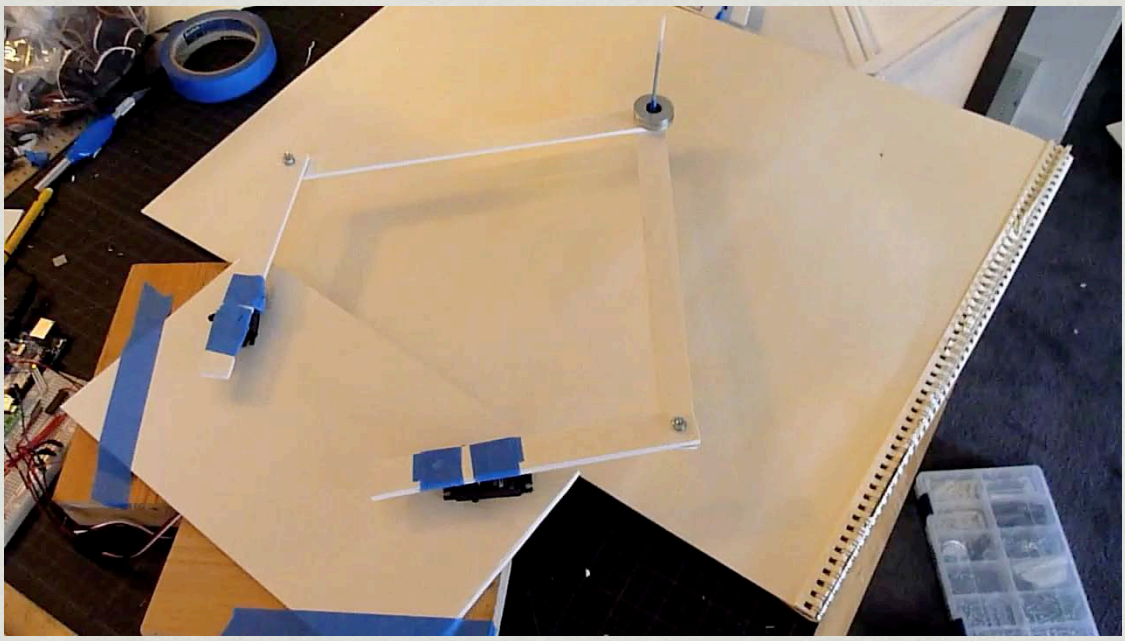
Example High School Curriculum

Katie Campbell, Alta High School, Salt Lake City, UT

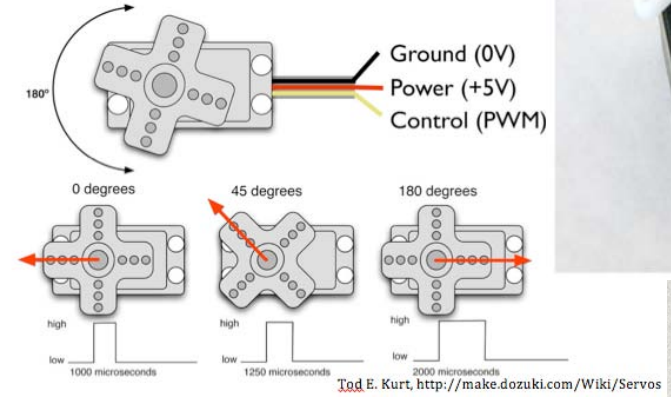
Workshop Project

- A couple specific drawing machines that are easily prototyped
  - Computer control with Arduino
  - Introduces computing in an arts context
  - Introduces art in a computing context
  - Great for interdisciplinary groups
- Details…
  http://www.cs.utah.edu/~elb

The Dancing Arms Drawing Machine



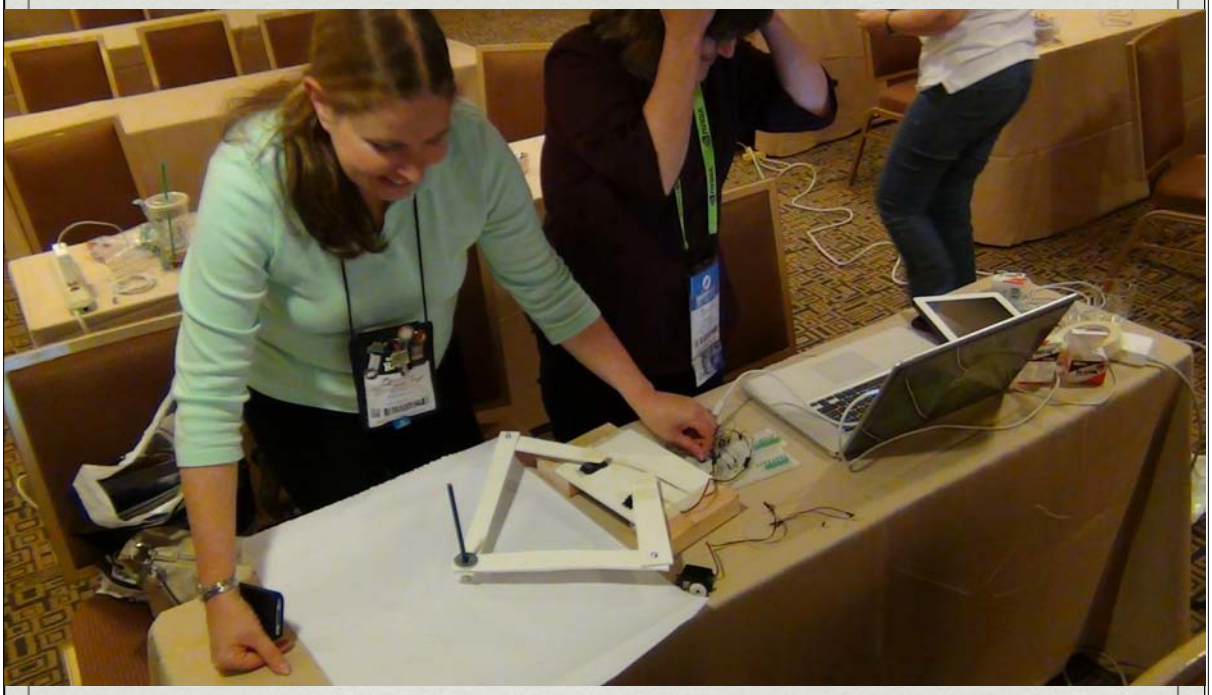
Hobby Servos



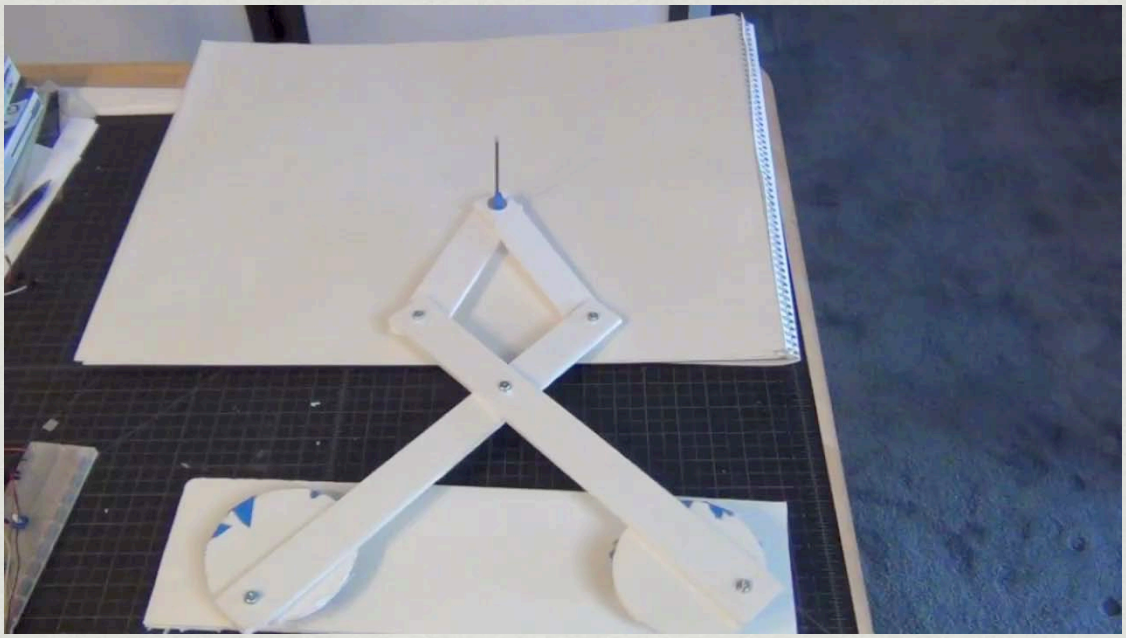
Tod E. Kurt, http://make.dozuki.com/Wiki/Servos

Tod E. Kurt, http://make.dozuki.com/Wiki/Servo

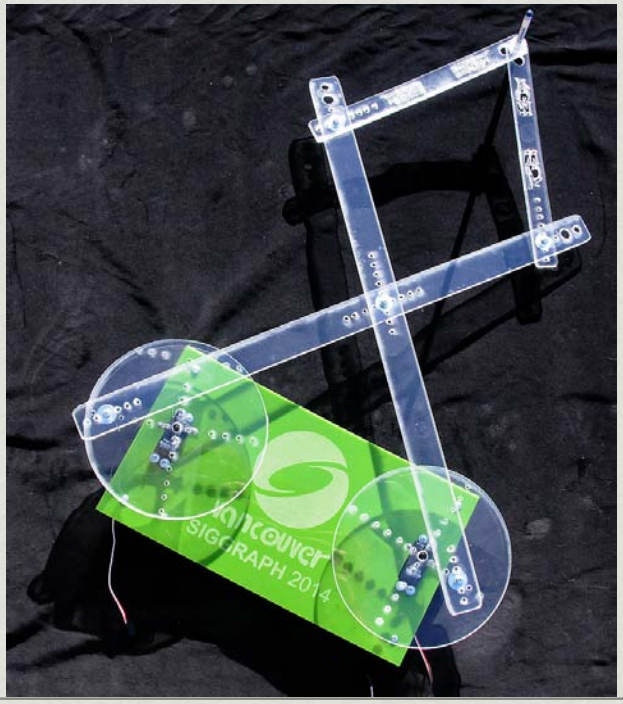
From an Educator Workshop



The Harmonograph



The Harmonograph



Conclusions

- Drawing Machines are an intriguing way to combine art and engineering
  - Long and interesting history
  - Fascinating kinetic sculptures
  - Potential for collaboration
    - *Art students are introduced to engineering*
    - *Engineering students are introduced to art*

Contact / Handouts

- Erik Brunvand - ebrunvand@hotmail.com

- Handouts/slides - http://www.cs.utah.edu/~elb

THE UNIVERSITY OF UTAH

Saltgrass PRINTMAKERS