ARTBOTICS
Attracting Students to STEM
Artbotics is...

- An interdisciplinary program, which started as a collaboration between the University of Massachusetts Lowell and the Revolving Museum, starting in the Summer of 2006.

- Learning art, computer science, and robotics by creating interactive, kinetic sculpture.

- The Artbotics curriculum has been adapted for many timeframes and age levels.
Artbototics at a Glance

http://www.youtube.com/watch?v=IJZeNlDsef0
Artbotics Curriculum

- Two-dimensional art
- Lights and LEDs
- DC motors
- Sensors (distance, touch, sound, etc.)
- Three-dimensional art
- Mechanisms (cranks, cams, gears, etc.)
- Servo motors
- Variables and Functions
- Final projects
College Courses

- Taught at UMass Lowell
- Science Gen Ed. for Art students
- Arts and Humanities Gen Ed. for CS students
- Class twice per week with one lab
- 4 credit course
PLAY – Spring 2011 Exhibition

http://www.youtube.com/watch?v=HJwwMZwxTNY
After School Classes

- Took place at the Revolving Museum in Lowell, MA
- High school students from Lowell High School
- 10-12 weeks long, meet twice a week
Other Side by Spring 2011 class
Primal Spirit by Fall 2009 class
Workshops and Camps

- 1-day or 2-day workshops for educators and high school students
- Week-long middle school summer camps
Replications

- Artbotics has been adapted to many curricula outside of our core program.
- Weston Middle School, Lexington High School, MassBay Community College, Holyoke Community College
- Beyond Massachusetts: Adler Planetarium in Chicago, IL; Del Mar High School in San Jose, CA
- And many more!
Artbotics Technology

- All previous programs have used the Super Cricket microcontroller

- We are currently expanding the Artbotics curriculum to be used with Lego Mindstorms

- Many classrooms already have Lego Mindstorms kits
Questions?
Artbotics Curriculum

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ARTBOTICS

Programming with Lego Mindstorms NXT

Driving and Drawing
Lego Mindstorms NXT Brick

Rechargeable microcontroller for use with Lego motors, lights, and sensors

- Motor/light ports
- USB Port
- Display screen
- Side mounting slots
- ON / Select button
- Left / right menu buttons
- OFF / Back button
- Sensor ports
Lego Mindstorms NXT

Blocks based programming environment

**Blocks:**
- Move
- Record/Play
- Sound
- Display
- Wait
- Loop
- Switch

Palette selector: **Common**, Complete, Custom

Sequence beam

Download Control

Configuration Panel
Lego Drawing Car

- Left motor in port C
- Right motor in port B
- Pen holder
**Sequence Beam**

Sequence of command blocks that are executed from left to right

Multiple sequence beams may be linked together to run in parallel
Downloading and Running

Programs may be downloaded and run, or just downloaded and then later run manually.

Make sure the USB cable is plugged in to the NXT Brick whenever downloading!

When just downloading, make sure your program is saved with a memorable filename.

You can find your program using the NXT Brick’s menu under “My Files”
Drawing with NXT Car

http://www.youtube.com/watch?v=8wl1eFG31bo
Drawing with NXT Car

http://www.youtube.com/watch?v=SNn3eeZji04
ARTBOTICS

Exploring Mechanisms

Cranks, Gears, and Cams
Mechanisms

- Convert rotary movement from a single motor into:
  - Smooth waving motions – **Crank**
  - Multiple rotary movements at different speeds – **Gears**
  - Linear motion – **Cams**
Crank

- Rotary movement to smooth waving motions

http://www.youtube.com/watch?v=hkb8JgMgVKc
Crank

- Rotary movement to smooth waving motions
**Crank**

- **Connector** and end bar can vary in size
- **Connector** to end bar joint placement can vary
- End bar to ground bar joint placement can vary
Crank

- **Connector** to end bar joint placement can vary

- Joint is 8 pegs from the bottom

[http://www.youtube.com/watch?v=hkb8JgMgVKc](http://www.youtube.com/watch?v=hkb8JgMgVKc)
Crank

- **Connector** to end bar joint placement can vary

- Joint is 5 pegs from the bottom

http://www.youtube.com/watch?v=LOLtf_jcdFl
Crank

- End bar to ground bar joint placement can vary

- Joint is 5 pegs from the left

http://www.youtube.com/watch?v=ob2qLidY1hQ
Gears

- Multiple rotary movements with different speeds (gears)
Gear Sizes

Large
40 teeth

Medium
24 teeth

Small
8 teeth
Gear Ratios

- The speed changes because of the number of teeth on a set of interacting gears, known as the gear ratio.
- A gear with more teeth will move slower than a gear with less teeth.
- A gear with less teeth will move faster than a gear with more teeth.
- The number of teeth and size of the gear change how long it takes to complete one full revolution.
Gear Ratios

- A large gear against a medium gear
  40:24, or reduced to 5:3

- A medium gear against a small gear
  24:8, or reduced to 3:1

- A large gear against a small gear
  40:8, or reduced to 5:1
Gears

The yellow star is spinning 5 times slower than the orange star (motor power is set to 35)

http://www.youtube.com/watch?v=eUmTzvhMYic
Gears

The yellow star is spinning 5 times faster than the orange star (motor power is set to 35)

http://www.youtube.com/watch?v=2uYdqjY7-CI
Cams

- Rotary movement to linear motion

http://www.youtube.com/watch?v=ew3um8M_Fhg
Cams

- Rotary movement to linear motion
A cam is a curved piece that rotates and moves its accompanying follower.
A cam is a curved piece that rotates and moves its accompanying follower.
Cams

- Multiple cams can be attached to a single bar out of the motor
There are two types of Lego pieces that can be used to make cams, or you can make your own out of foamcore and electrical tape.
Cams

http://www.youtube.com/watch?v=-jZfFfGIQ90

Circular cam
Cams

http://www.youtube.com/watch?v=bH0mkK0xBzo

Snail cam
ARTBOTICS

Programming with Lego Mindstorms NXT

Reacting to Sensors
**Touch Sensor**
True/False Boolean value

**Sound Sensor**
0-100 value (silent-sound)

**Ultrasonic Sensor (Distance)**
0-100 value (far-close)

Plug into ports 1, 2, 3, 4 on the NXT Brick
Touch Sensor

Boolean value: true or false, on or off

https://www.youtube.com/watch?v=_qPa0fz1oT0
Sound Sensor

0-100 value for volume

https://www.youtube.com/watch?v=IP6MD4YoKRk
Distance Sensor

0-100 value for distance from sensor

https://www.youtube.com/watch?v=-4yF7257P7E
Blocks used with Sensors

Wait blocks
The program pauses until the sensor is interacted with, and then continues executing the program

Switch block
The program executes either the top beam or bottom beam commands based on the sensor’s input
ARTBOTICS

Building an Interactive Kinetic Sculpture
Interactive, Kinetic Sculptures

- Combine all components with art materials to create an interactive, kinetic sculpture

- All projects must use at least:
  - 1 motor
  - 1 sensor
  - You are encouraged to utilize mechanisms!

- Each team will be given a 12” x 12” piece of foamcore to mount all components

- 2.5D (not quite 2D, not quite 3D) or 3D projects
Example Projects

http://www.youtube.com/watch?v=w4650htXE00
Example Projects

http://www.youtube.com/watch?v=6ew87BEmPaA
Example Projects

http://www.youtube.com/watch?v=_CAXAY6FYSc
Interactive, Kinetic Sculptures

- Do not use glue on any Lego pieces!

- Sticky Tabs work great on Lego pieces; easy to apply, easy to remove, and maintain their stickiness

- To mount motors to the foamcore board see the design in the file Artbotics Motor on Foamcore.lxf
ARTBOTICS

Best Practices and Lessons Learned
**Timeframe**

- Pick and choose what exercises to use; all are available on the [artbotics.org/lego](http://artbotics.org/lego)
- Each can be expanded on if time allows
- Short exercises that introduce the basics, but allow for customization
- Semester-long classes, after school programs, single day sessions, workshops
Depending on time frame, using a theme introduces a constraint that pushes creativity and unifies the projects students create.

- Have students work in pairs.

- There are text-based Lego programming languages:
  - Robot C: not free, firmware update needed
  - LeJOS: free, no firmware update (Java-ish)
  - NXC: free, no firmware update needed
Lego Hardware and Software

- Lego Mindstorms NXT Kit ~$300
- Lego Mindstorms NXT Software ~$80
- Can be purchased in sets of 2, 4, 6, 8, 10, or 12
- Lego Mindstorms EV3 Kit ~$340
- Lego Mindstorms EV3 Software ~$100
- Lego Mindstorms EV3 Home Software = FREE!
Craft Materials

- Building materials can be purchased at any crafts store or online
- ~$100 or less, depending on class size
- Hot glue and sticky tabs are best to allow for easy removal and less damage to Lego pieces
- UMass Lowell can make pen holders for any workshop attendees who are interested
Visit us online for more info!

artbotics.org

legoeducation.us

robotics.cs.uml.edu