SPARKFUN ELECTRONICS NATIONAL TOUR 2013

K

111111

The National Education Tour is coming to a stop near you? This tour has one goal - to share SparkFun's passion for electronics with students and teachers across the country. DIY electronics educators will to stop in 50 states on 50 dates, teaching lifelong skills such as programming, soldering, and building circuits along the way. Whether you've never played around with DIY electronics or you are a seasonad pro, we will give you he tools, knowledge, and skills you need to explore the wonderful world of how electronics fits with STEAM education.

— For more information about SparkFun and the tour, visit learn.sparkfun.com/tour. —





Introduction to Arduino

With ArduBlock & LilyPad Dev



Brian Huang Education Engineer brian.huang@sparkfun.com

Pre-Class Survey



http://bit.ly/14Xk3Ek

Resources

This PPT \rightarrow

ArduBlock Download & Installation → http://www.ardublock.com/





General Rules

- Raise your hand if you have a question. Be respectful.
- When I raise my hand...
- Share your findings with the people near you.
- Poke around, experiment, and have fun... Imagine, create, and play!!!

Objectives

Provide a thorough introduction to the Arduino programming environment.

Develop a use of simple functions to interact with the LEDs, light sensor, push button, and buzzer on the Protosnap Pro Mini.



Arduino LilyPad Protosnap Dev



What is it?

What can it do?

Who cares?

What is it?

Heart of it – ATMega328 (a \$4 microcontroller)

Open Source

High tolerance for ESD and "bad" electronics practices...

Provides easy way to interact with a computer physically – a.k.a. *physical computing*

What can it do?



- Great for prototyping ideas
- Great to teach Intro to Programming Arduino (no assembly required!)
- Lots and lots of options!
- Large pads can be sewable

Who cares?

Hackers / Makers Engineers **Artists Musicians** Kids! **Teachers!!** You!!!

Physical Computing



Components, Silk Screen & Pins

What is all this???



Actual Pin-outs

TQFP Top View



ArduBlock

Introduction to Programming Scratch-like interface Clear transition to text-based coding







Block Organization Control



Block Organization Pins



Block Organization Numbers/Constants



Block Organization Operators



Block Organization Operators













Block Organization Utilities



Block Organization Utilities I²C







Understanding Input vs. Output

Referenced from the perspective of the microcontroller (electrical board).

Inputs is a signal / information going into the board.

Output is any signal exiting the board.





Almost all systems that use physical computing will have some form of output

What are some examples of Outputs?

Startup Arduino IDE



Double-click on either the Arduino Icon or wherever you installed (saved) the Arduino program.



Plug it in



Lesson #0 – Configuring Arduino

 Setup Board (LilyPad Arduino w/ ATmega328)
Setup COM Port PC – Highest COM # Mac – /dev/tty.usbserial-A####xXx

Settings: Tools \rightarrow Board

©	sketch_aug01a Ar	rduino 1.0.5	ATtin
File Edit Sketch To	ols Help		ATtin
sketch_aug01;	Auto Format Archive Sketch Fix Encoding & Reload	Ctrl+T	ATtin ATtin ATtin ATtin
	Serial Monitor	Ctrl+Shift+M	ATtin
	ArduBlock		ATtin
	Board	÷	ATtin
	Serial Port	Þ	Altin
	Programmer Burn Bootloader	•	ATtin
			Ardu
			Ardu
			Ardu
-			Ardu
<i>د</i>			Ardu
			Ardu
1	L	ilyPad Arduino i	Ardu
			Ardu
			LIIYPa

y45 (internal 1 MHz clock) y45 (internal 8 MHz clock) y45 (external 20 MHz clock) y85 (internal 1 MHz clock) y85 (internal 8 MHz clock) y85 (external 20 MHz clock) y44 (internal 1 MHz clock) y44 (internal 8 MHz clock) y44 (external 20 MHz clock) y84 (internal 1 MHz clock) y84 (internal 8 MHz clock) y84 (external 20 MHz clock) ino Uno ino Duemilanove w/ ATmega328 ino Diecimila or Duemilanove w/ ATmega168 ino Nano w/ ATmega328 ino Nano w/ ATmega168 ino Mega 2560 or Mega ADK ino Mega (ATmega1280) ino Leonardo ino Esplora ino Micro ino Mini w/ ATmega328 ino Mini w/ ATmega168 ino Ethernet ino Fio ino BT w/ ATmega328 ino BT w/ ATmega168 ad Arduino USB LilyPad Arduino w/ ATmega328 LilyPad Arduino w/ ATmega168

Settings: Tools \rightarrow Serial Port

\odot	sketch_aug01a /	Arduino 1.0.5	- 5	×
File Edit Sketch	Tools Help			
sketch_aug01:	Auto Format Archive Sketch Fix Encoding & Reload	Ctrl+T		©. ▼
	Serial Monitor	Ctrl+Shift+M		^
	ArduBlock			
	Board Social Dant	<u>+</u>	- COM21	
	Senai Port	•	♥ COM21	
	Programmer Burn Bootloader	+		
				~
<				>
1		LilyPad Arduino v	√ATmega328 on	COM21

Other Board Types



Load ArduBlock

sketch_aug01a Arduino 1.0.5 − □ ×				
File Edit Sketch	Tools Help			
sketch_aug01:	Auto FormatCtrl+TArchive SketchFix Encoding & ReloadSerial MonitorCtrl+Shift+1			
	ArduBlock			
	Board Serial Port	b		
	Programmer Burn Bootloader	•		
		~		
<		>		
1	LilyPad Arduin	no w/ ATmega328 on COM21		

Lesson #0 - Test Upload



Check for Status Messages



Success.
Let's get to hacking...

Lesson #1 – Blinking an LED "Hello World" of Physical Computing

Psuedo-code – how should this work?



Let's get to hacking...

Lesson #1 – Blinking an LED "Hello World" of Physical Computing





LED Pins



How are Analog Pins really identified?

Digital Pins are numbered 0 to 13. Analog Input Pins are A0 to A5.

A0 = 14 A1 = 15 A2 = 16 A3 = 17 A4 = 18A5 = 19

Alright? Let's blink!



* The Power of Thinking Without Thinking

Malcolm Gladwell

Challenge 1a – Blink multiple LEDs Plan out a pattern – can you make it?

Challenge 1b – Blink to mimic a heartbeat

Challenge 1c – Multiple LEDS – Knight Rider style

Save your Project



- Save <u>early</u>, Save <u>often</u>!
 - Enumerate your iterations – (e.g. blink_10.adp, blink_11.adp, blink_12.adp...)

Concept: Analog vs. Digital

Microcontrollers are digital devices – ON or OFF.

An Analog signal is anything that can be a full range of values. What are some examples? Think of like a ramp or a hill.



Concept: Analog vs. Digital

To create an analog signal, the microcontroller uses a technique called PWM.

Pins 3, 5, 6, 9, 10, 11 are capable of producing an Analog Output





Color Mixing with 3 LEDs analogWrite()



Challenge 2a:

- 1) How do you turn on the RED LED?
- 2) Experiment with different values what do you observe happens?
- 3) How do you turn on the GREEN or the BLUE LED?

Color Mixing with 3 LEDs Tri-color LED



The RGB LED is a <u>Common-</u> <u>Anode</u> (means the positive side of the LED is all tied to V_{cc}).

The signal line is connected to the <u>bottom</u> of each LED.

Don't worry - it's just a different method of completing a circuit!





Color Mixing with 3 LEDs analogWrite()

Challenge 2b:

Experiment with different values of Red, Green, and Blue to create a couple different colors.

Write down the values you used. Check these values with <u>www.colorpicker.com</u>

Challenge 2c:

Create a unique lighting display that integrates a blink, fade, or a switching of colors. Be prepared to have a name for your art piece and show this to the rest of the class.

Save your Project #2



Concept: If(), If() – else... conditional logic If this is TRUE...





A Simple Example



Try this bit of code.

What do you think will happen? Test it and write down your observations.







Challenge 3a:

Re-arrange the blocks or add new ones to:

- Turn ON an LED when the button is pressed.
- Otherwise blink continuously...



digital Inputs Buttons / Slide Switches

Challenge 3b:

Now, using the button / switch – to start a disco/light changing pattern

Challenge 3c:

Now, using the button / switch – to turn on and off the VIBE motor.

Serial Monitor



Serial print command

Any message

"glue"

Data

Example



Open up Serial Monitor

	sketch_aug01a	Arduino 1.0.5	- 🗆 🗙				
File Edit Sketch Tool	s Help						
			Serial Monitor 🕫				
sketch_aug01a							
		\$	C	OM27		- 🗆	×
						Ser	nd
		Button	state:1				^
		Button	state:1				
		Button	state:1				
		Button	state:1				
		Button	state:1				
<		Button	state:1				
		Button	state:1				
Arduino V	ersion:	Button	stat				~
Arduino V	ersion:	<					>
		 Autoscroll 			No line ending 🛛 🤟	9600 baud	¥
1			Arduino Uno on COM27				

Reading the Light Sensor?





Challenge

Use the light sensor input to affect the blink rate of the LEDs.

Use the light sensor input to affect the speed of a "knight-rider" or cylon display.

Use the light sensor to _____

Save your Project #3 Sensors

Making Music Setting up the Speaker



Making Music Let's Play a song...

Twinkle-Twinkle:

CC GG AA G FF EE DD C GG Happy Birthday: G G A G C B G G A G D C G G G E C C B A Hot Cross Buns:

B A G <> B A G <> G G G G <> A A A A B A G

Mary Had A Little Lamb:

B A G A BB B <> AA A <> BB B <>

B A G A BBBB AAA BAG.

Musical Notes / Frequencies

Note	Frequency (Hz)			
C ₄	261			
$C^{\#}_4/D^{b}_4$	277			
D ₄	293			
$D^{\#}_4/E^{b}_4$	311			
E ₄	329			
F ₄	349			
$F^{\#}_4/G^{b}_4$	369			
G ₄	392			
$G^{\#}_4/A^{b}_4$	415			
A ₄	440			
$A^{\#}_4/B^{b}_4$	466			
B ₄	493			

Note	Frequency (Hz)			
C ₅	523			
$C_{5}^{\#}/D_{5}^{b}$	554			
D ₅	587			
D [#] ₅ /E ^b ₅	622			
E ₅	659			
F ₅	698			
$F_5^{\#}/G_5^{b}$	739			
G ₅	783			
$G_{5}^{\#}/A_{5}^{b}$	830			
A ₅	880			
$A_{5}^{\#}/B_{5}^{b}$	932			
B ₅	987			

Save your Project #4 Tone

Getting started with Arduino







Additional Resources

http://www.sparkfun.com

http://learn.sparkfun.com

http://www.arduino.cc

http://www.bildr.org

SparkFun Tutorials and Projects

- GardenBot:

www.sparkfun.com/news/598

- High Altitude Balloon:

www.sparkfun.com/tutorials/180

- GPS Clock:

www.sparkfun.com/tutorials/47

- Earthquake Data Logger:

www.sparkfun.com/tutorials/235

Thousands of Amazing ideas...

The Cat Defender...

http://www.plasma2002.com/blenderdefende <u>r/</u> List of projects at Sparkfun:

http://goo.gl/2M3AM

Questions?



Before leaving, please fill out a quick survey so that I can get your e-mail and a little info about your familiarity with Arduino / Sparkfun.

Thanks!



http://bit.ly/ZAmDMk



www.sparkfun.com 6175 Longbow Drive, Suite 200 Boulder, Colorado 80301


Buttons / Slide Switches Digital Input, Pull-up Resistors, and digitalRead()





Buttons / Slide Switches Digital Input, Pull-up Resistors, and digitalRead()

