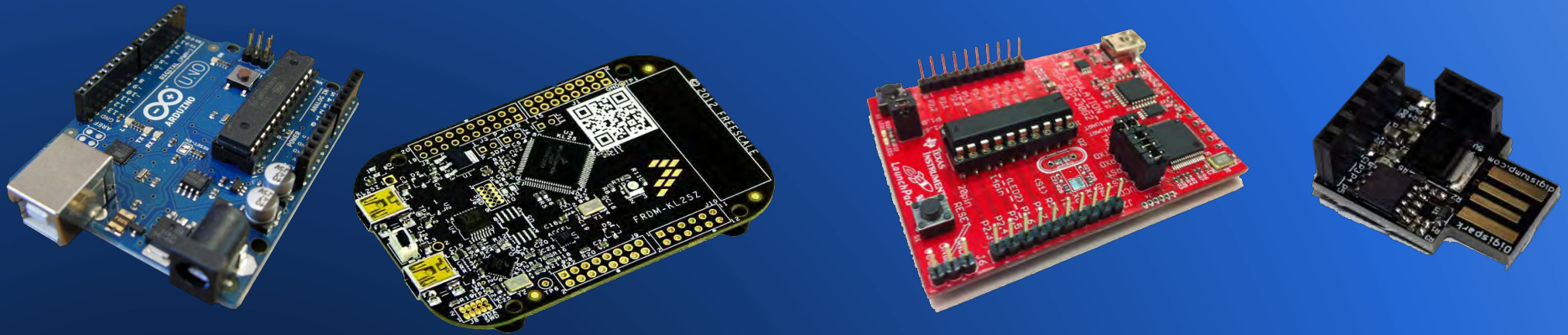


Micro Controllers for Model Railroading



Terry Terrance

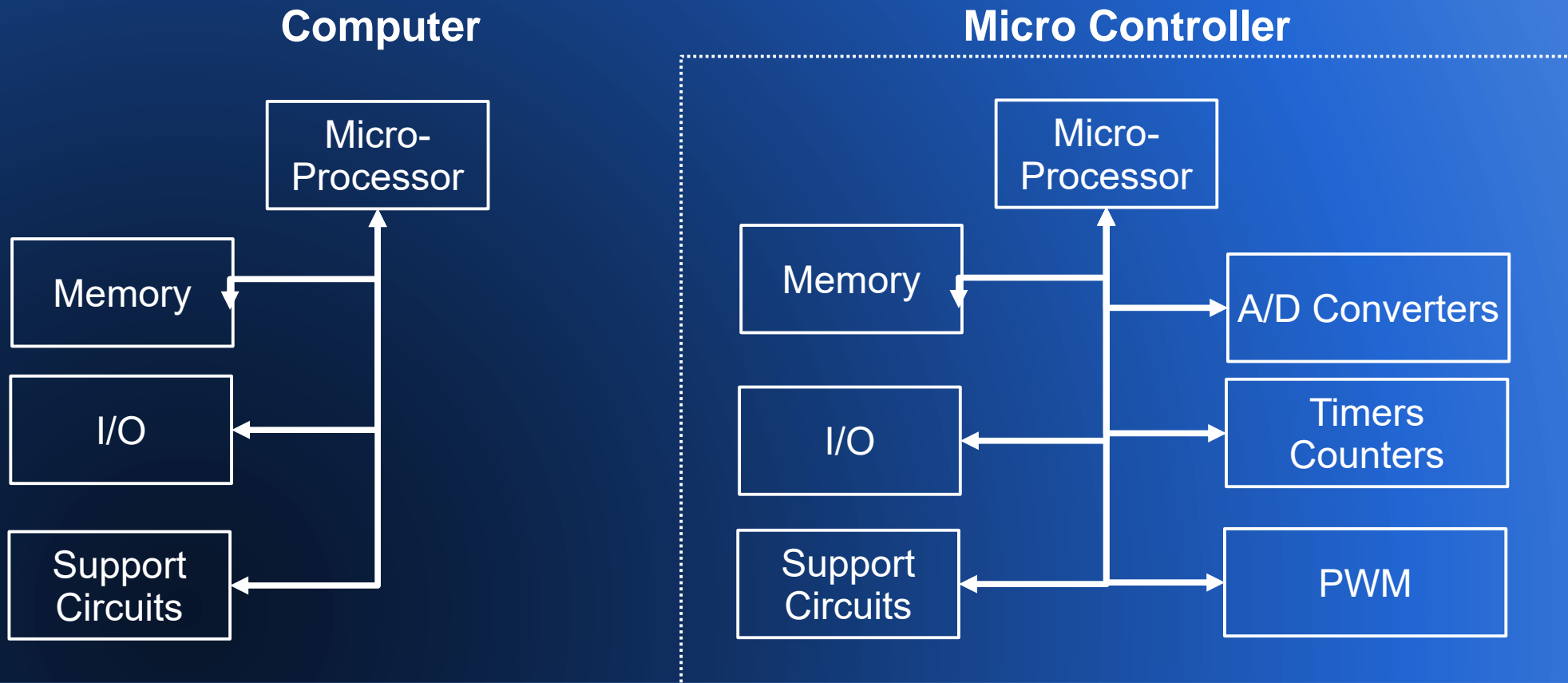
2018 MER Convention

Manifest

- What is a Micro Controller?
- OK, What can it do?
- Why would I want one?
- Which One Do I Want?
- How do I make something with a Micro Controller?
- Resources

So What The Dickens is a Micro Controller Anyway?

- A micro controller is a microprocessor plus peripherals integrated into a single chip allowing them to sense the outside world and with outputs that have enough current to drive small external loads. And doesn't use and operating system.



But That's Not The Whole Story

- The micro controller proper is a single chip
- To be useful, more is needed
- The last few years there's been an explosion of engineering /experimenter boards that make using micro controllers easy.
- These boards have a power supply and programming circuits
- And, depending on the model, LEDs, switches, touch pads, displays, etc.
- These boards can be built into model railroad projects
- In this presentation, *micro controller* will refer to one of these boards

OK, So What Can It Do?

- Micro controllers are in many of the things Model Railroaders use today; like throttles, DCC and sound systems, etc.
- Other potential uses for micro controllers are:
 - Alternate Flasher
 - Traffic Light Sequencer
 - Flare/Fusee simulator
 - Chase Lights
 - Candle/Gas Lamp/Ash Pit
 - Arc Welder Simulator
 - Emergency Vehicle Flasher
 - Programmable Light Sequencer
 - Blacksmiths Forge
 - Animation controller
 - Back 'n Forth Shuttle Controller
 - Campfire/Ash Pit/Building on Fire effect
 - Mars Light/Gyalite/Rotating Beacon
 - Simple Strobe
 - Lightning
 - IR Train Detectors
 - Current Train Detector
 - Defect Detector Simulator
 - Scale Simulator
 - Scale Speedometer
 - Relay Controller
 - Turn Table Controller
 - Fast Clock
 - Turnout Control
 - Yard Ladder Controller
 - Bridge Animation (swing or lift)
 - Signal System Logic
 - Semaphore Animator
 - Surround Sound
 - DCC Stationary Decoders
 - DCC Turnout decoders
 - DCC Throttle

Why Would I Want One?

- Cost
- Custom Functions
- Diminishing Manufacturing Base
- The Cool Factor

Cost Comparison

Crossing Flasher

- Circuitron DF-1 Detector and Flasher \$ 44.95

And it's unidirectional !!!

- Micro controller \$9.99
- IR LEDs \$2
- Photodiodes \$2
- Software Free
- Total About \$14

Arc Welder Simulator

- Circuitron AW-2
\$26.95

- Micro controller \$9.99
- White LEDs \$0.50
- Software Free
- Total About \$10.50

Custom Functions

- Unusual signaling systems
 - e.g. B&O CPL signals with all six markers
- Yard routing
- Interlocking
- Complex animation sequences
- Cityscapes

Diminishing Manufacturing Base

- Fewer MRR manufacturers are available as “cottage industry” operators retire.
- Micro controllers fit into the paradigm of a new, high tech, do-it-yourself, on-demand manufacturing movement which includes laser cutting and 3D printing.

The Cool Factor

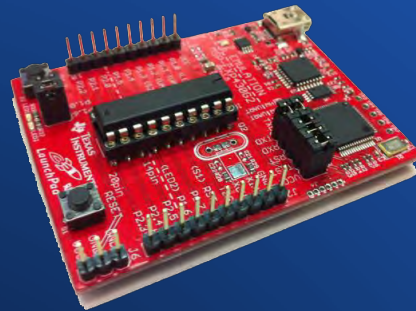
- Programming a “blank slate” like a micro controller is, in effect, a form of scratch building.
- Create things that no manufacturer has yet conceived.
- Impress friends and visitors that you really are tech savvy.
- May be a way to attract young people to the hobby?

Overview of Micro Controllers

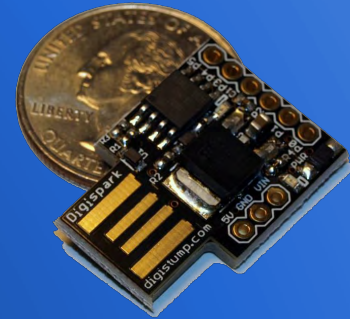
- What follows is a quick, non-exhaustive overview of suitable micro controller products
- The selection criteria for being included are as follows:
 - Low cost: less than \$20; preferably less than \$10
 - Capable of being programmed with just your PC
 - Free programming software
 - No need for an operating system (Linux, Android)
- The following examples cover the spectrum of features available at this price

Some Microcontroller Experimenter Boards

TI *'LaunchPad'*



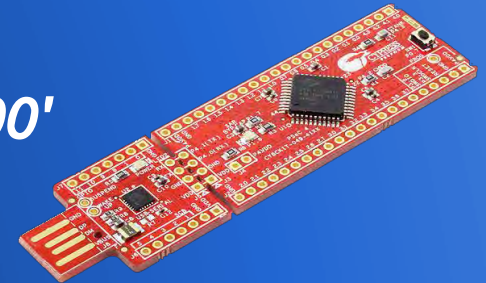
digistump
'Digispark'



Freescale Semi
'Freedom'



Cypress Semi
'CY8CKIT-049-4200'



ST Microelectronics
'Discovery'



What About the Raspberry Pi?

Particularly the Raspberry Pi Zero

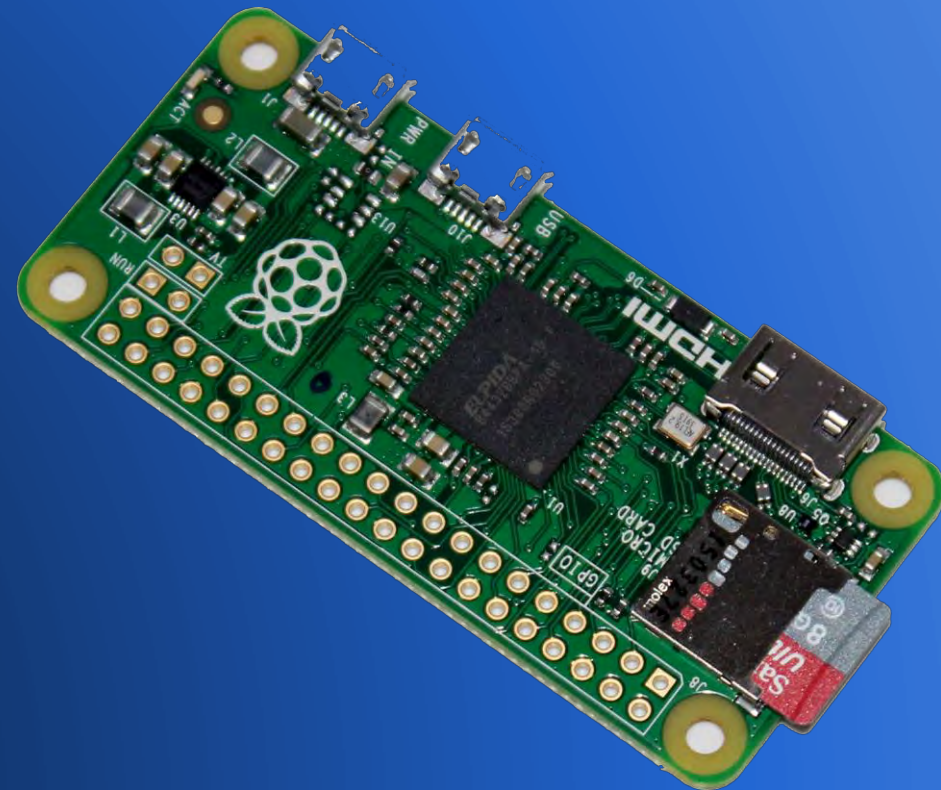
The Raspberry Pi is a complete computer on a card starting at \$25

However, the Raspberry Pi Zero is \$5! →

Sorta needs a keyboard and display to program

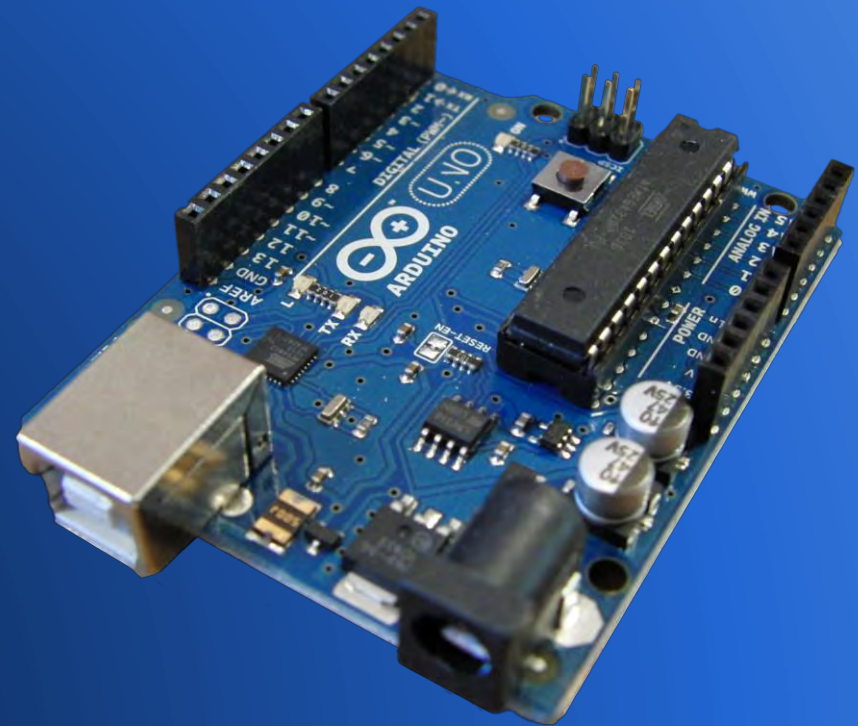
Requires an OS (Linux)

As the Pi Zero becomes more available & popular, may have to bend the rules.



Arduino

- The “Arduino” has become the most popular experimenter's micro controller board
- Designed by hobbyists and “open source”
- Now a family of boards
- Very popular with hundreds of add-ons and thousands of code examples on the Internet



So How Do I Make Something With A Micro Controller?

- Pick a project
- Pick a Micro Controller
- Add external components
- Program
- Power your Micro Controller
- Admire your handiwork

Pick a Project

- If you are tech-savvy you can dream up your own project using:
 - LEDs and lamps
 - Relays
 - Motors and Servos
- The less tech savvy can find micro controller projects on the Internet.

Which Micro Controller?

- Short answer:
 - Use the one that the project is designed for, or the code is written for. (Hint: use the Arduino).
- Complex answer:
 - Need a lot of them? (e.g. signals) Use the cheapest one that will work.
 - Choose based on special features – PWM, lots of I/O, display, touch interface, CANbus, etc.

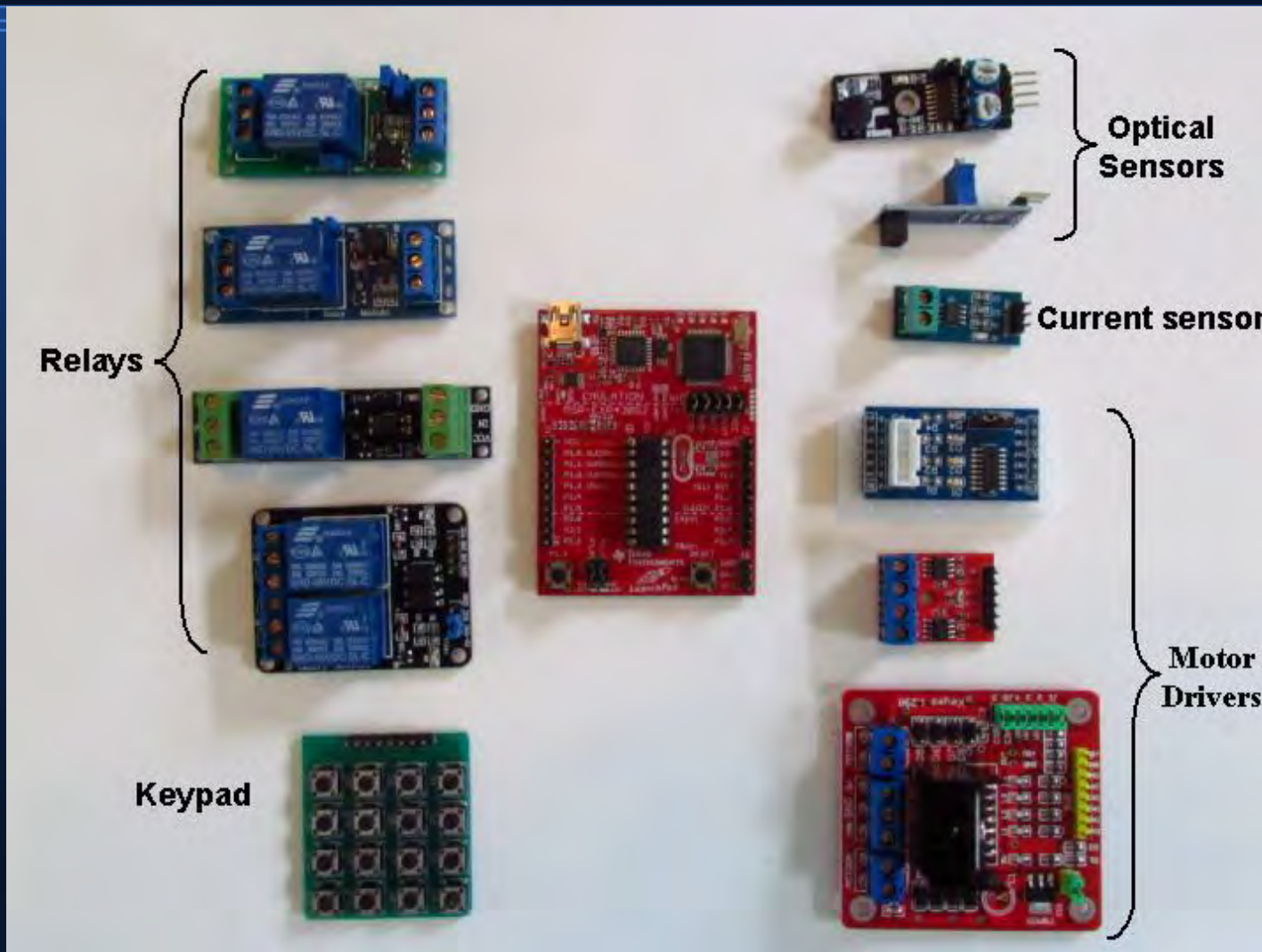
Obtaining Micro Controllers

- From Major Electronics Distributors:
 - Mouser Electronics: www.mouser.com
 - Newark Electronics/Element 14: www.newark.com
 - Digikey: www.digikey.com
- Hobbyist Sources:
 - Seeed Studios: <https://www.seeedstudio.com>
 - Adafruit: <https://www.adafruit.com>
- Micro Center Computer Stores: www.microcenter.com

Adding External Components

- Microcontroller pins can drive LEDs (and similar small lamps) directly.
 - Use a 270-300 ohm series resistor for LEDs
- Servos can be driven directly as well
- Use a plug-in auxiliary board (called a “shield” for Arduino)
- For other functions, use modules designed for the robotics community.
 - 3 or 4 wire interconnect

Typical Modules



Programming Your Micro Controller

- Most micro controllers are programmed in the “C” or “C++” programming language.
 - All of the micro controllers cited here provide a free software environment.
 - Installs on your PC, then the PC can program the micro controller
- Arduino programs are called '*sketches*' and is programmed in 'C++' that's not ANSI standard 'C++'
 - Non standard but helpful extensions to the language
- Ask a buddy (or your kid) to program it for you.

Arduino Alternate Flasher '*Sketch*'

This code example (found in a quick internet search) will alternately flash 2 LEDs connected to pins 12 & 13 of the Arduino.

You can find this code and hookup instructions here:

<http://robotmill.com/2011/02/13/arduino-blink-2-leds-emergency-flasher-style/>

```
void setup(){
  pinMode(13, OUTPUT);
  pinMode(12, OUTPUT);
}

void loop(){
  digitalWrite(13, HIGH);
  digitalWrite(12, LOW);
  delay(500);
  digitalWrite(13,LOW);
  digitalWrite(12,HIGH);
  delay(500);
}
```

Powering the Micro Controller

- The easiest way to power your micro controllers is via it's USB port
 - USB Powered hub
 - USB extension cables (Male A to Female A; available from the dollar store)
- Batteries
- Most can also be powered from 5V (or 3.3V), filtered, regulated DC

13 Port USB Powered Hub



Admire Your Handiwork

https://www.youtube.com/watch?v=EFp6oE26__k

Resources

- Resources supporting Arduinos are all over the Internet – simply search
 - Don't overlook YouTube
- Newark Electronics has a Experimenters/Engineering community called Element 14 with forums and blogs supporting numerous micro controllers
 - Free to join
 - The forums can be geeky and elitist

Resources

Hackerspace/Makerspace

- Your local hackerspace (also referred to as a hacklab, makerspace, or hackspace) are open community labs incorporating elements of machine shops, workshops and/or studios where hackers can come together to share resources and knowledge to build and make things.
- Most hacklabs have lots of people well-versed in micro controllers – especially the Arduinos.
- Sources for micro controller-compatible modules
 - www.dx.com
 - www.goodluckbuy.com
 - E-bay. Search for the what you want + Arduino

Resources

- Model Railcast Show #182

- <http://static.squarespace.com/static/5089f0e6e4b08eae9f20c36/t/515257b0e4b0574a80b6c475/1364350896279/mrc0182.mp3>

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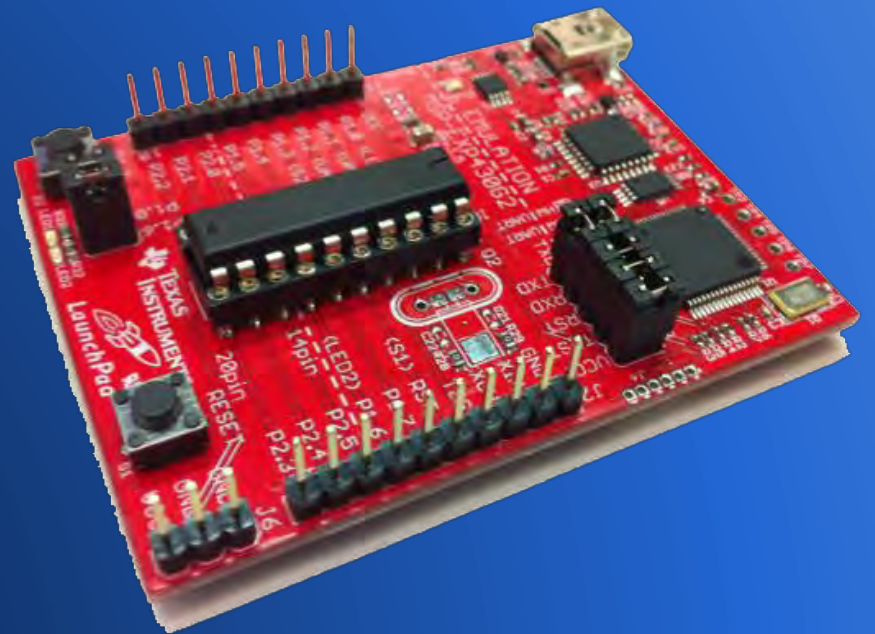
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Thank You!

Thank You!

Texas Instrument's LaunchPad

- When introduced, the LaunchPad was the lowest priced
- The LaunchPads are an extensive family of boards
 - MSP430
- Several add-on boards
- Model railroad projects for the LaunchPad are available at the LaunchPad4MRR blog



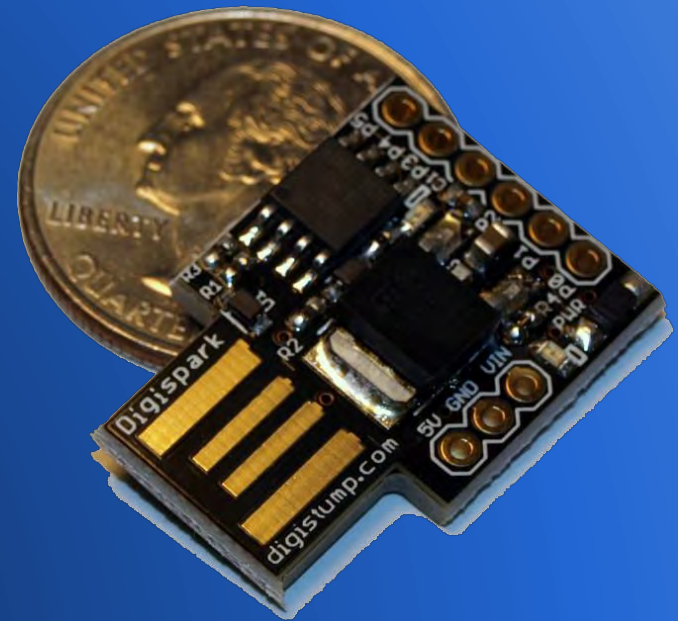
ST Microelectroninc's Discovery

- Low priced with a powerful processor
- Also a family of boards
- Lots of I/O. Touch pad & displays on some models make sophisticated interfaces possible



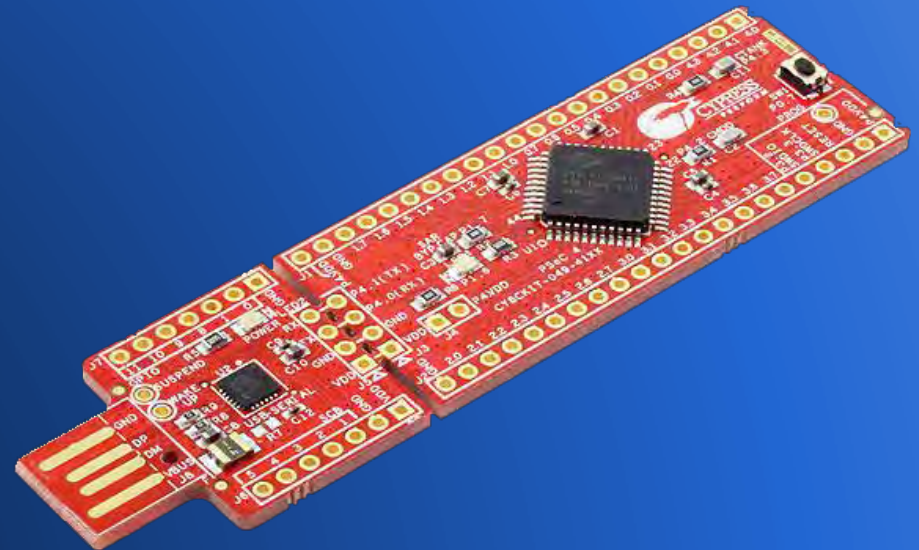
digiStump's Digispark

- Tiny board for simple tasks in small spaces
- Crowd Funded
- Surprising number of add-on boards
- Built-in PWM & motor-driver add-on makes a DCC decoder possible



Cypress Semi's CY8CKIT-049-4200

- Current lowest priced - \$4!
- Powerful processor
- LED, switch and 39 I/O lines!



Freescal Semi's Freedom

- Low priced with a powerful processor
- Also a family of boards
- Some are compatible with Arduino add-ons
- Touch pad on-board, USB for communication

