Week 2

ECE2883 HPC

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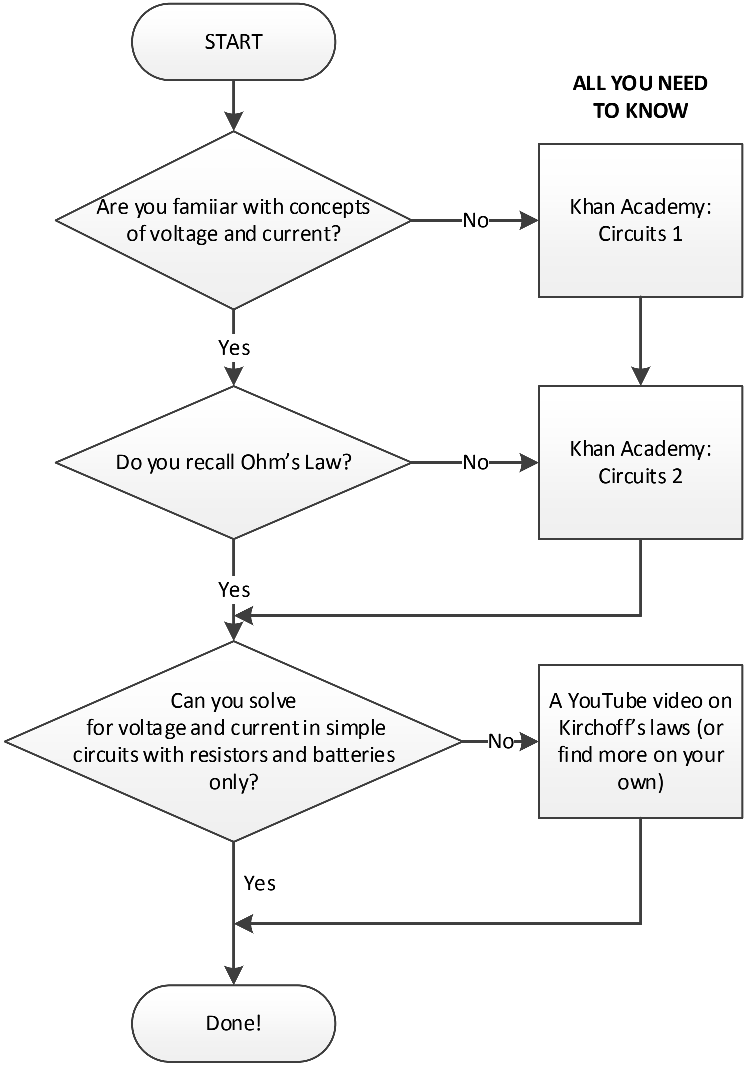
This and that

- Thoughts about the reading homework?
  - Did anyone try Harris & Harris?
- Last week’s lab
- Tour the online material briefly
- Questions?
- Football game next week

Lab activities

- Last week
  - Learn about workstation
- Next week
  - SME: Create circuits in FPGA
  - Non-SME: Connect devices to function generator, oscilloscope
- Almost half of you (SMEs) are going to get what you need to start thinking about generating digital signals for projects
- The rest of you and going to be able to start thinking about using those signals
- Everyone can start to think about the combination of the two parts

Physics



- Are we comfortable?
- We will use Ohm's Law surprisingly little
- And solve circuits even less
- Today will include one of the few times

Boolean Algebra

- Positive Logic:
  - Being “near 0V” ≡ logic ‘0’ or “false”
  - Being “near 5V” ≡ logic ‘1’ or “true”
- This is why digital designers often just poke around circuits and look at voltages
- And the connection to logic allows us to use circuits to express Boolean Algebra
- We saw some examples in lab of inputting 0s and 1s (switches) and seeing outputs (LEDs)

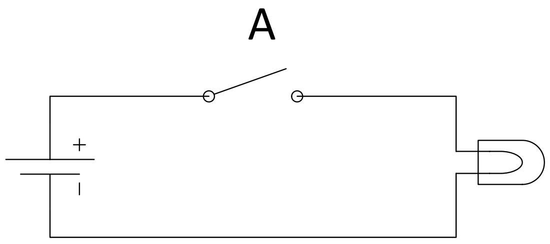
Review: Boolean algebra

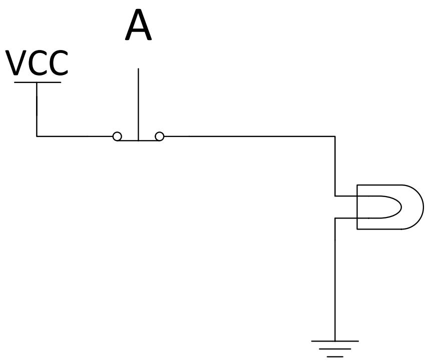
AND	In order to get a good grade in ECE 2030, a student should come to class **AND** take good notes **AND** work study problems.
OR	Today's computers run Microsoft Windows 7 **OR** Mac OS X **OR** Linux.
NOT	Campus food is **NOT** a good value.

- We've seen how everyday concepts can be described with logic

Simple logic from reading

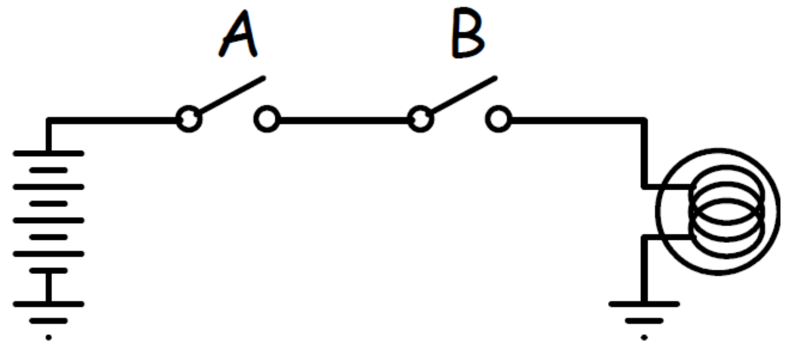
- Circuit at top is similar to Wills & Wills, p. SW-2
  - If A is the state of the switch (true = pushed/closed), and L is the state of the light (true = lit)
  - Then L = A
- Circuit at bottom shows more typical power/ground notation and a "normally closed" pushbutton switch
  - If A is the state of the switch (true = pushed/open), and L is the same as before
  - Then L = NOT A



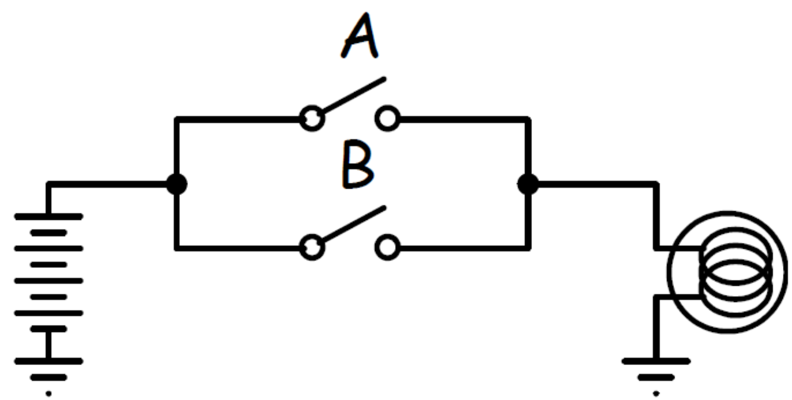


AND, OR from Wills & Wills

- Top: L= A AND B
  = A · B
  = AB



- Bottom: L= A OR B
  = A + B



- Most digital circuits are not made with manual switches, but they can be…

Logic in your house

- Logic can be implemented with switches
  - It does not have to be TTL voltages
- Light switches on either end of a hall
  - We need to have total control at BOTH ends
  - It is not sufficient to have to turn BOTH on to get the light on
  - Or both off to get the light off

Definitions

- Two switches, A and B
  - Define “true” or ‘1’ as “switch up”
- One light, Z
  - Define “light on” as Z= “true” or ‘1’

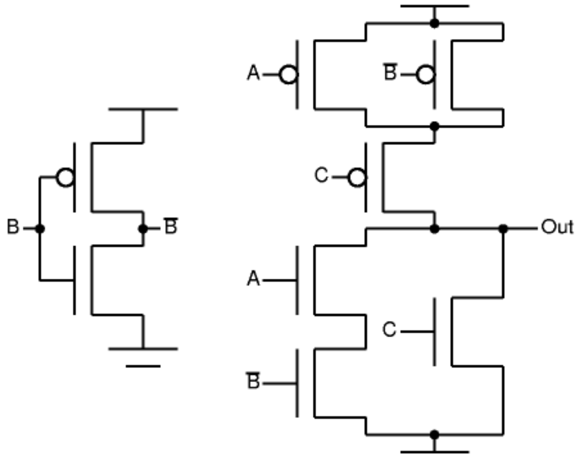
- Problem:
  - Write an equation where having either, but not both, switches “up” results in the light being on.
  - Use only AND, OR, and NOT

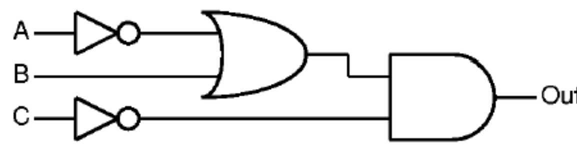
Our solution

A	B	Z
0 (down)	0 (down)	0 (off)
0 (down)	1 (up)	1 (on)
1 (up)	0 (down)	1 (on)
1 (up)	1 (up)	0 (off)

- There are two ways the light can be turned on:
  - A up and B down: A and (not B)
  - A down and B up: (not A) and B
- Since EITHER works, we simply "OR" them
  - Z = [A and (not B)] or [(not A) and B]
  - Or $Z = A\,\bar{B} + \bar{A}B$

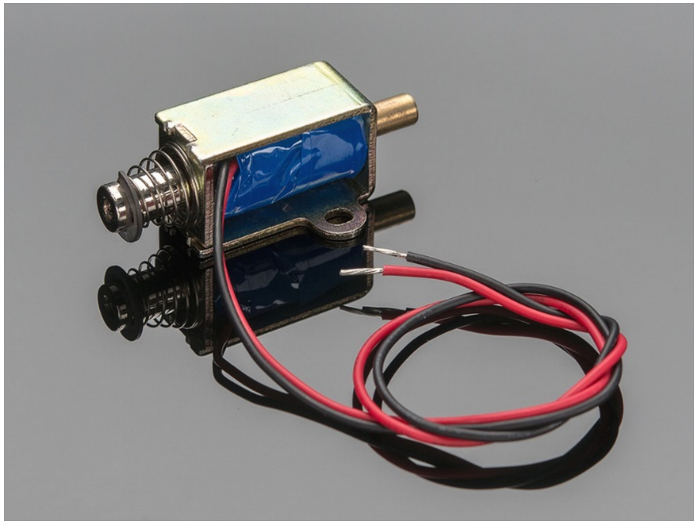
Transistors and Gate diagrams





- Later in the reading assignment, logic was drawn as transistors and gates
- Transistors: not important (skipped in reading)
- Gates: important – will be used in this class
  - Here, $Out = (\bar{A} + B\ )\bar{C}$

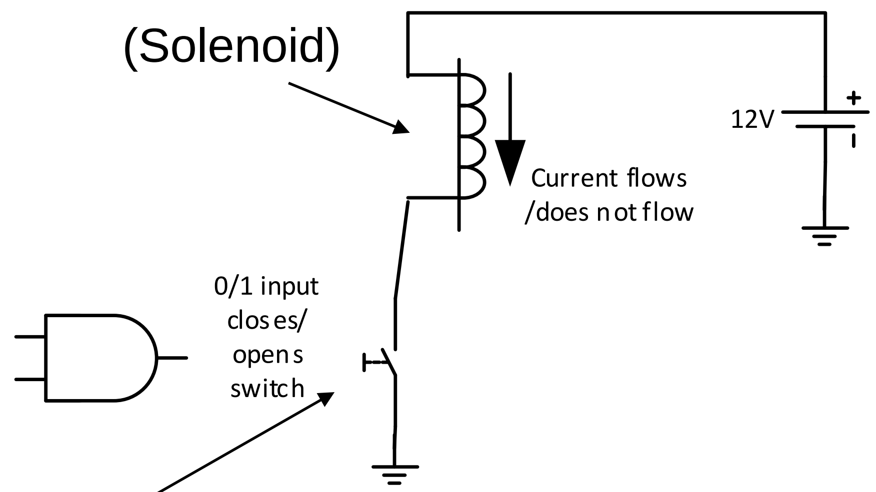
Where this is headed (one example)



- A solenoid has two positions
- One corresponds to “energized” and the other is “not energized”
- It can thus be treated as a digital device (like the red and green LEDs in lab)

Issues with voltage and current

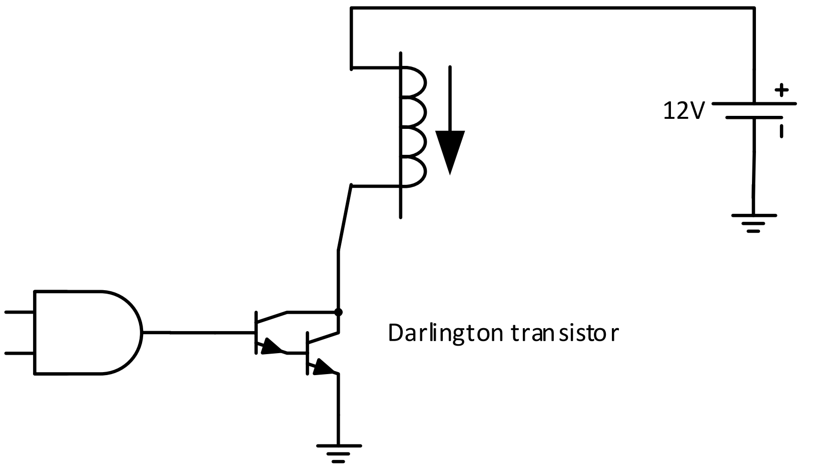
- Not all interesting digital devices work with ~0 to ~5 volts
  - Some of ours will be ~0 to ~12V
- And some of them require more current than a typical logic chip can provide
- Need a device that accepts a 0 or 1 from a gate and will open or close a switch



- We will use something called a "Darlington Transistor"

Digital control with Darlington

- Here, the logic gate can directly control the solenoid
  - 0 : no current
  - 1 : solenoid energized
- The Darlington transistor (or Darlington pair) acts like a digitally controlled switch
- The solenoid could also be a motor or other high-current device
- The 12V voltage could be higher or lower, as needed

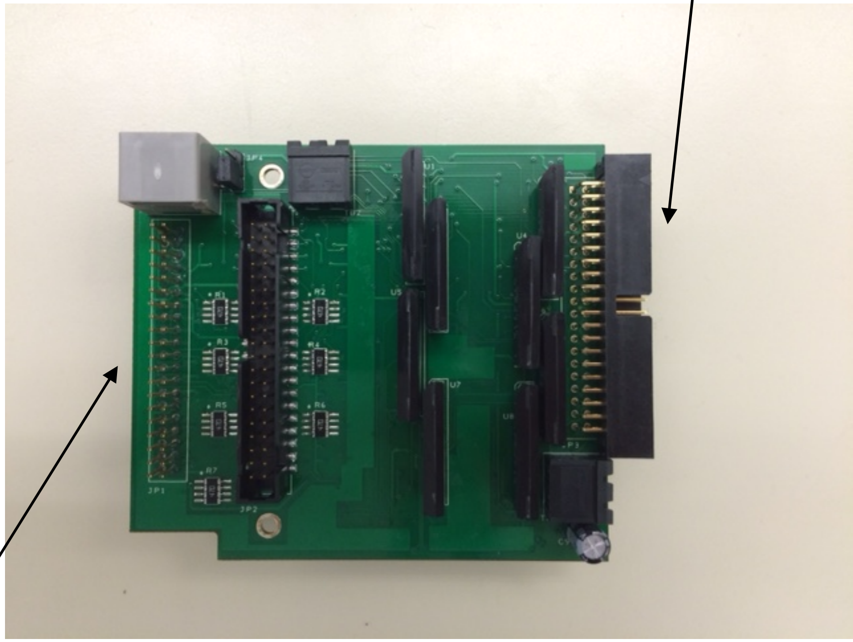


- (Non-SMEs: The SMEs haven't had this yet, either!)

Custom daughterboard #1

- "Current driver"
- Plugs into DE2-115
- Has 32 Darlingtons
  - Allows 32 outputs from DE-2 to control high-current devices
- Some other signals come in and are passed through

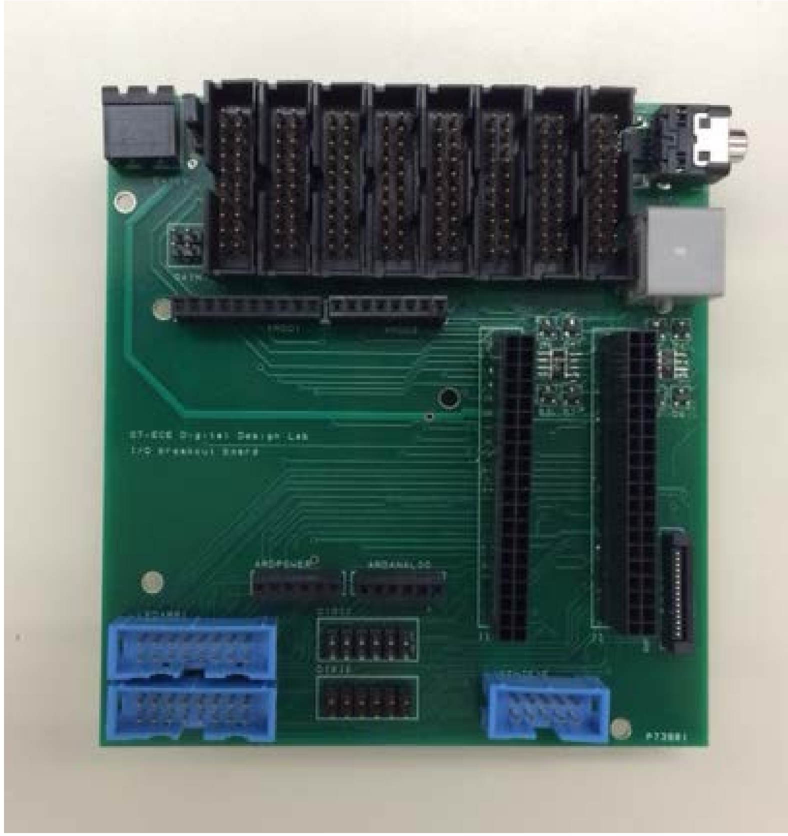
32 high-current outputs are here



32 TTL-level signals come in here

Custom daughterboard #2

- Stacks on top of daughterboard #1
- Has very little circuitry on it
- Mainly provides lots of convenient connectors

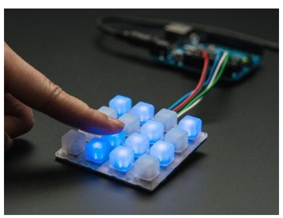


Parts list

× 70

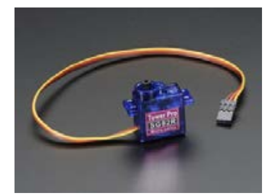
× 40

× 70



× 20

× 10

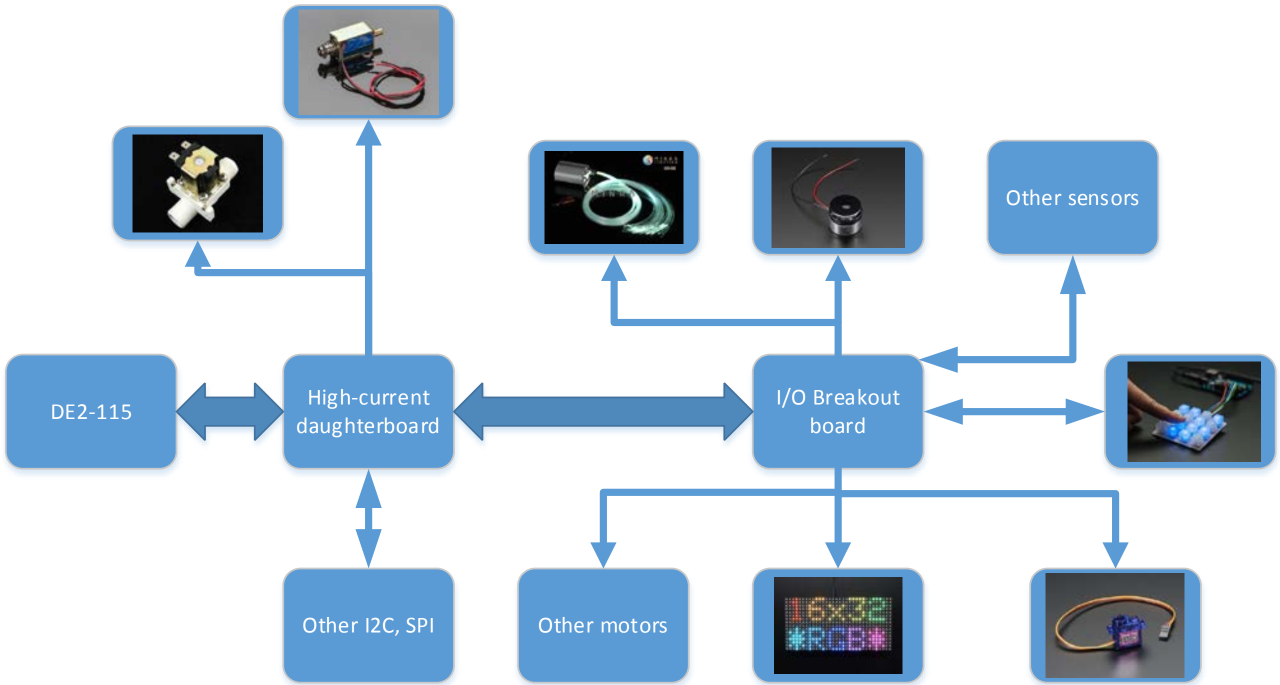


× 32

× 1

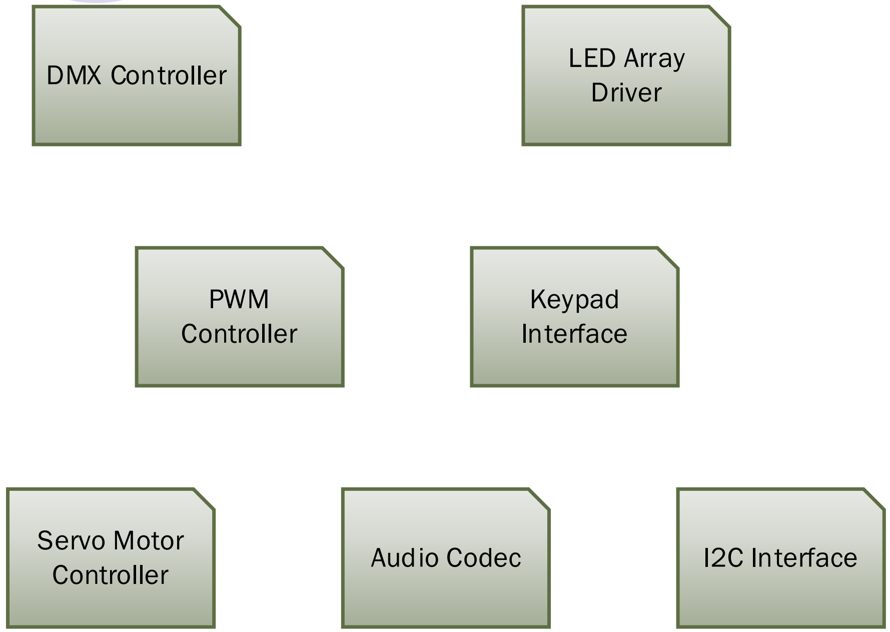
Plus misc. DC motors, input devices (pressure, joystick, inertial, etc.)

A big picture of a 2883 project



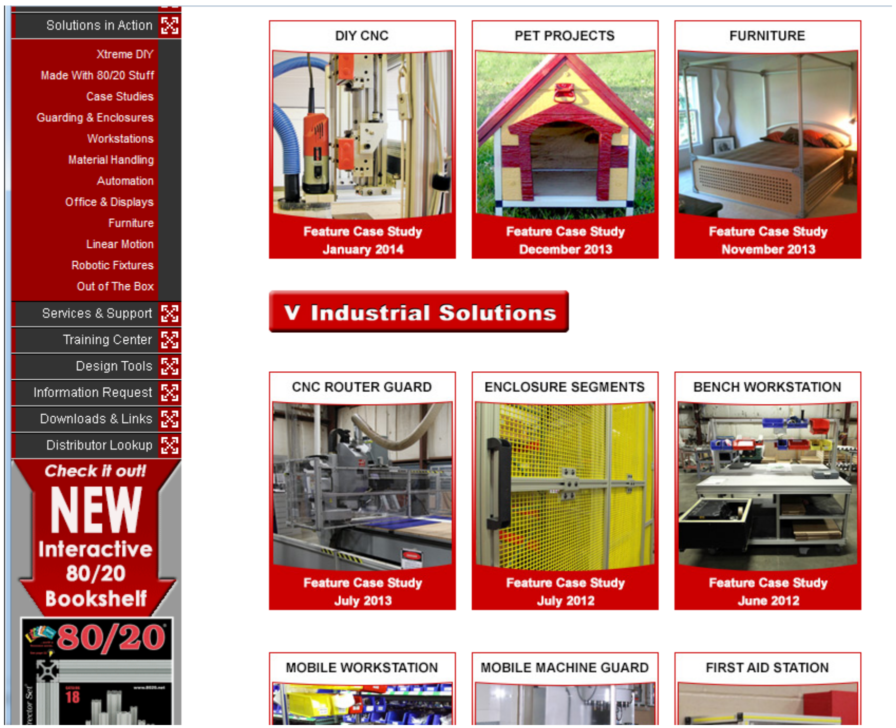
- Quantities will vary
- Need to identify sources and funding for anything else that is needed

Inside the FPGA



- Some will be given to you, working or nearly so
- Others you will develop according to your needs

Structural elements



- Some 80/20 hardware is available
- Other needs up for discussion

http://8020.net/T-Slot-2.asp