

E11 Lecture 5: Design Representation

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Fall 2014

Outline

- Mechanical Design Representation
 - Orthographic Projections
 - Isometric Projections
 - Computer-Aided Design (CAD)
 - Computer-Aided Manufacturing (CAM)
 - Autonomous Vehicle Chassis
- Electronic Design Representation
 - Schematic Elements
 - Mudduino Schematic

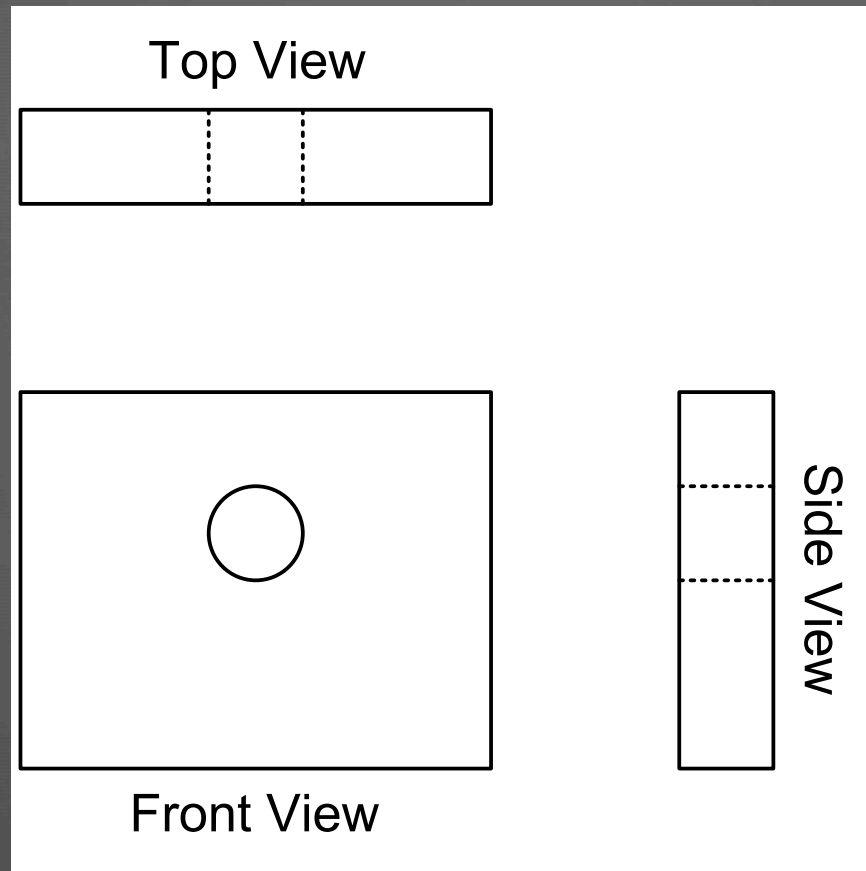
Design Representation

- How to represent a 3-dimensional object on a 2-dimensional page?
- Projections
 - Orthographic
 - Isometric

Orthographic Projection

- Front, top, and side views
- *orthos* “straight” + *graphic* “drawing”
- Used by Greek and Roman astronomers and engineers

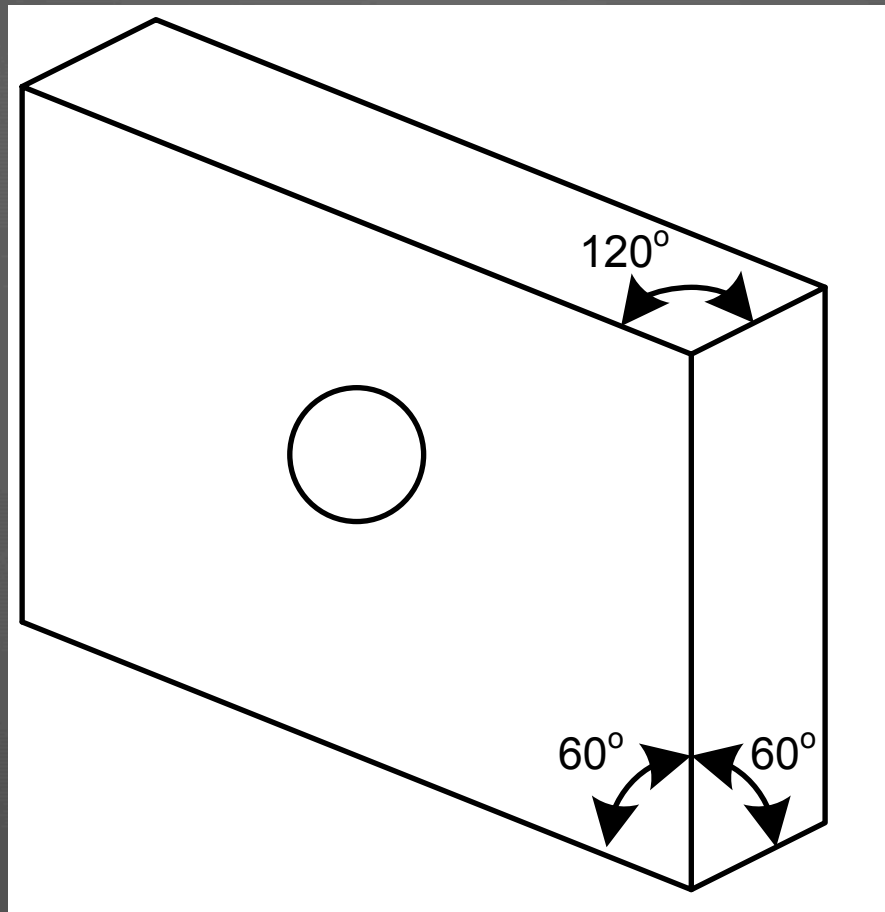
Orthographic Projection



Isometric Projection

- Shows three faces all at once
- Preserves distances accurately along each axis
- Angles between each axis are 120 degrees
- *iso* = "equal" + *metric* = "measure"

Isometric Projection



Example: I-beam



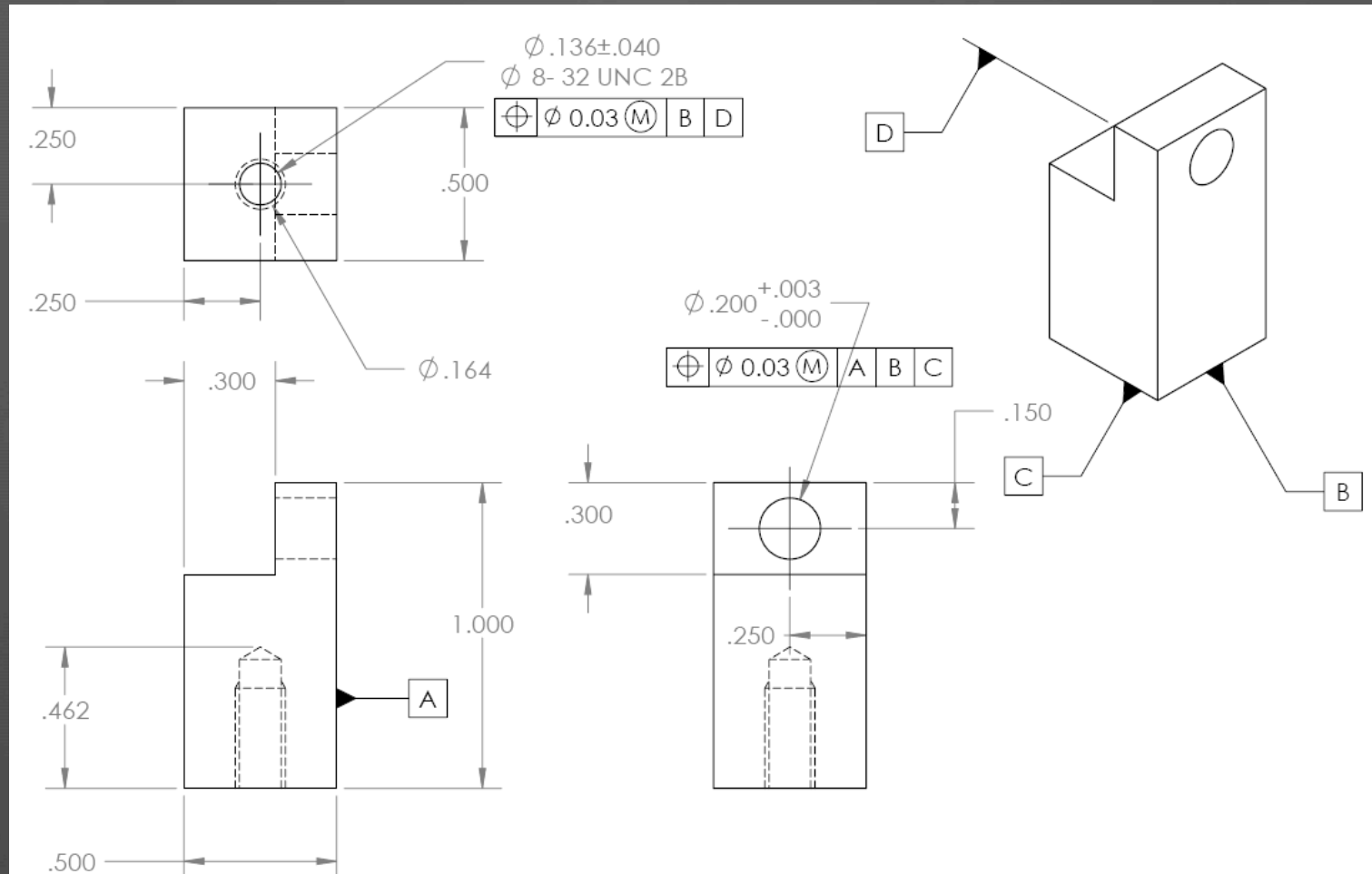
Datum Features

- Datum features are used to align the part
 - Make measurements from a consistent edge
- Feature labeled “A” is the *primary datum*
 - Align the part to this edge whenever possible
 - Keep it flat against a vice during machining
- Features “B” and “C” are *secondary* and *tertiary* datum

Dimensioning

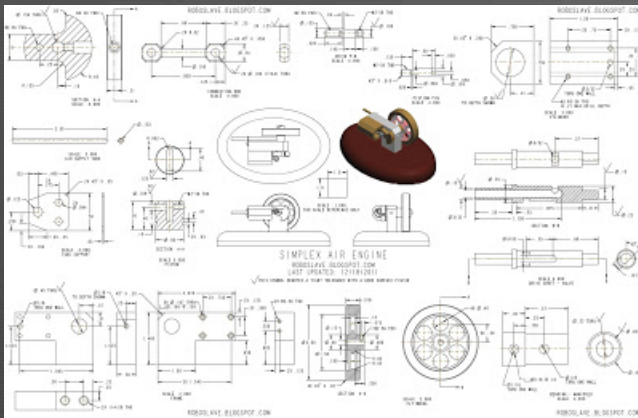
- Dimensions are measured from the datum features
 - Only a minimum necessary set are shown
 - If a dimension isn't labeled, it is implied by symmetry
- Often you will need to make calculations
 - Mark up the drawing to make your life easier in the shop
- Holes are specified by their diameter (\varnothing)
- Some dimensions have tolerances shown

Example: Sensor Tower

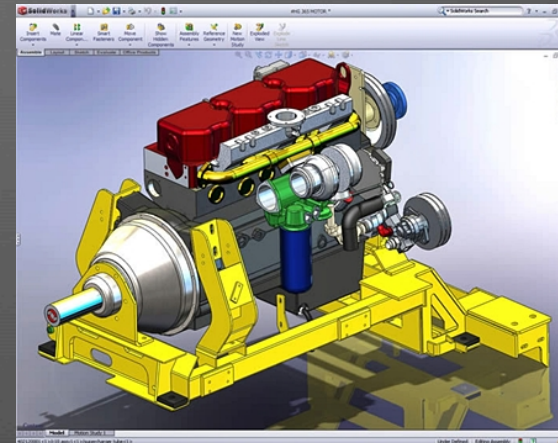


Computer-Aided Design

- CAD software has replaced the drafting table
- HMC primarily uses SolidWorks
 - World's leading CAD tool
 - Relatively easy to use
 - Easy integration with simulation and manufacturing



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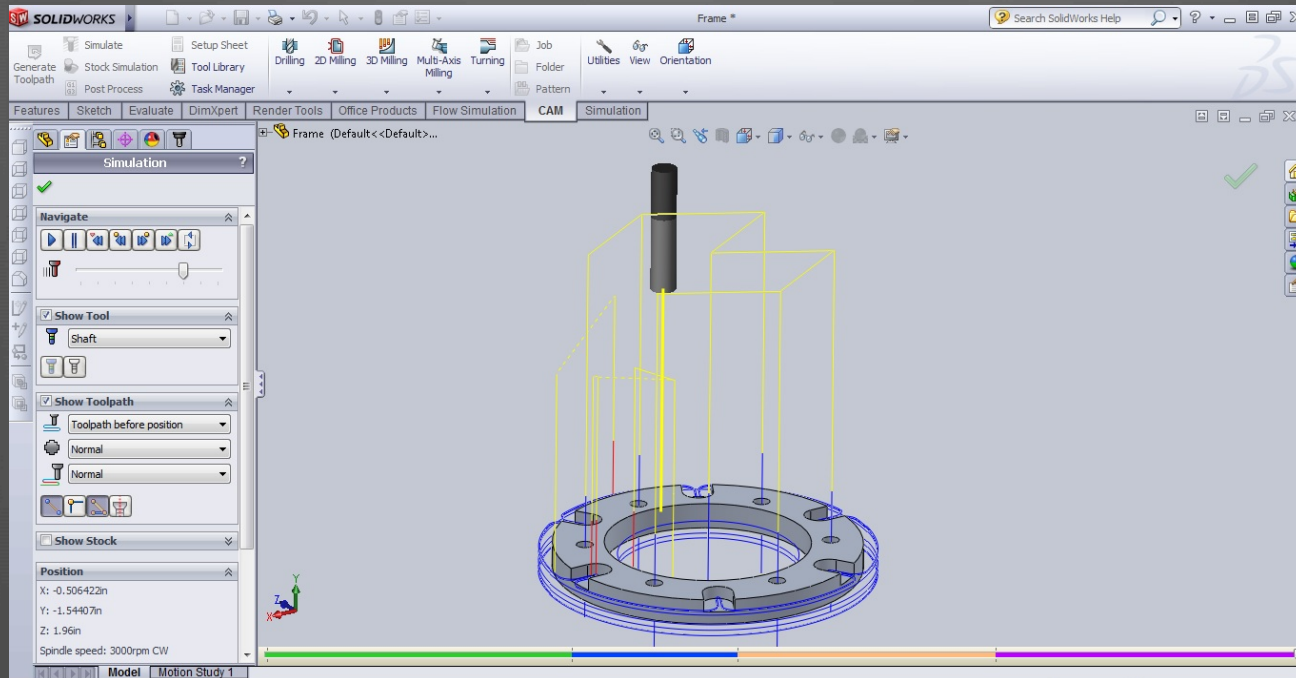
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SolidWorks Concepts

- Sketches
 - 2D shapes such as lines, circles, text
 - Must be fully dimensioned
- Features
 - 3D objects built by extruding or cutting sketches

Computer-Aided Manufacturing

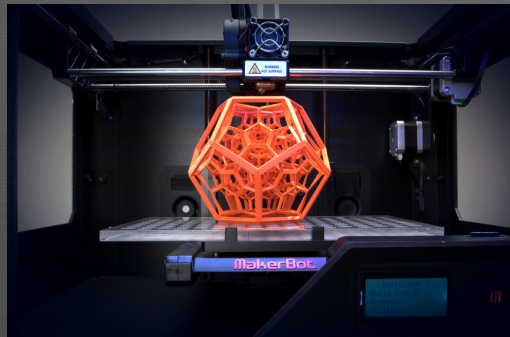
- Automate manufacturing from CAD drawings
 - 3D printing
 - Computer numerical control (CNC) machining



3D Printing

- Additive manufacturing process
- Create 3D object from successive layers of materials
- Primarily use powders or polymers
- Good for models and visualization
- Limited material strength

<http://3dprint.com/wp-content/uploads/2014/04/money-feat.jpg>



<http://everything3dprinting.com/wp-content/uploads/2013/12/3D-Printed-Dinosaur.jpg>



Dimension ST1200 3D Printer

- Prints with ABS plastic
- Soluble support material
- 10 or 13 mil layers
- 10 x 10 x 12" maximum volume
- \$30k machine cost
- \$10/in³ materials cost



3dimensionprint.co.uk

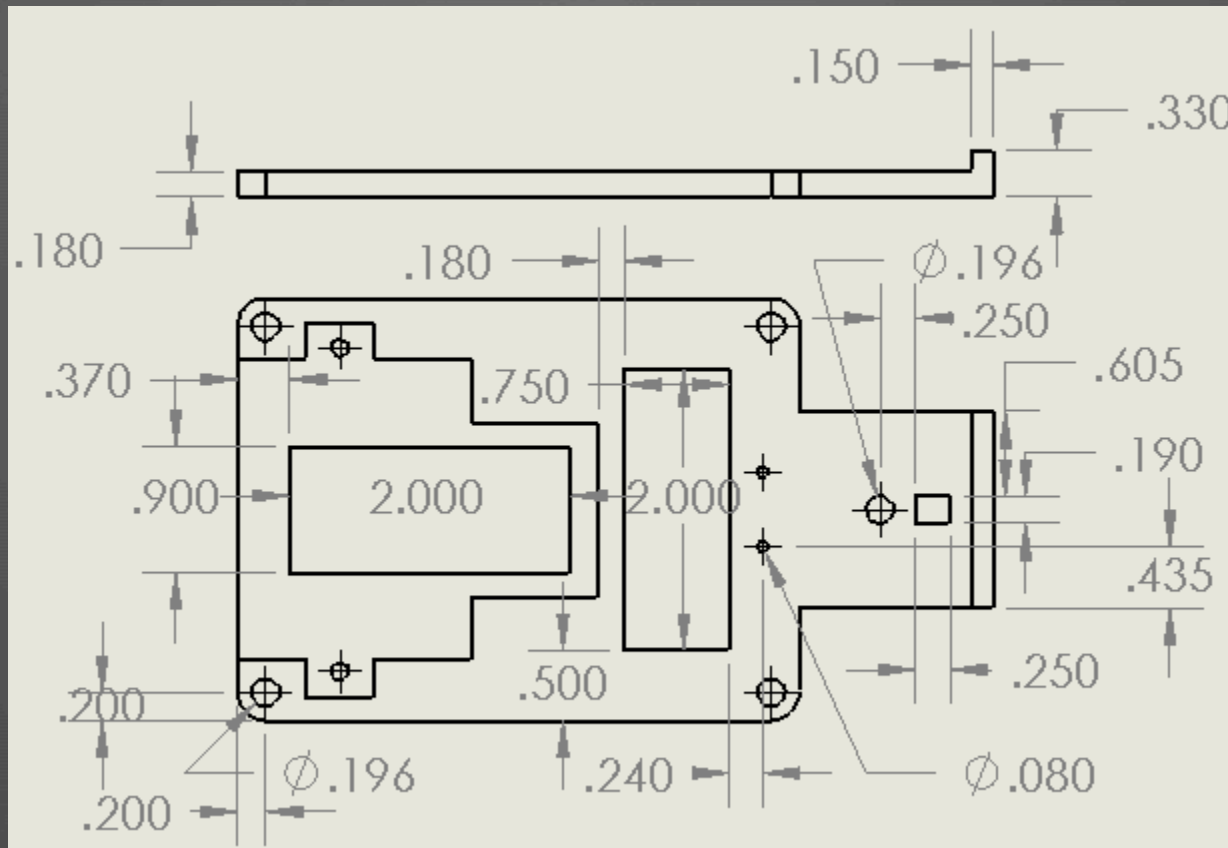
CNC Machining

- Subtractive manufacturing process
- Computer-controlled tool removes material from a piece of stock
- Examples:
 - CNC Mill and Lathe
 - Laser Cutter
 - ShopBot

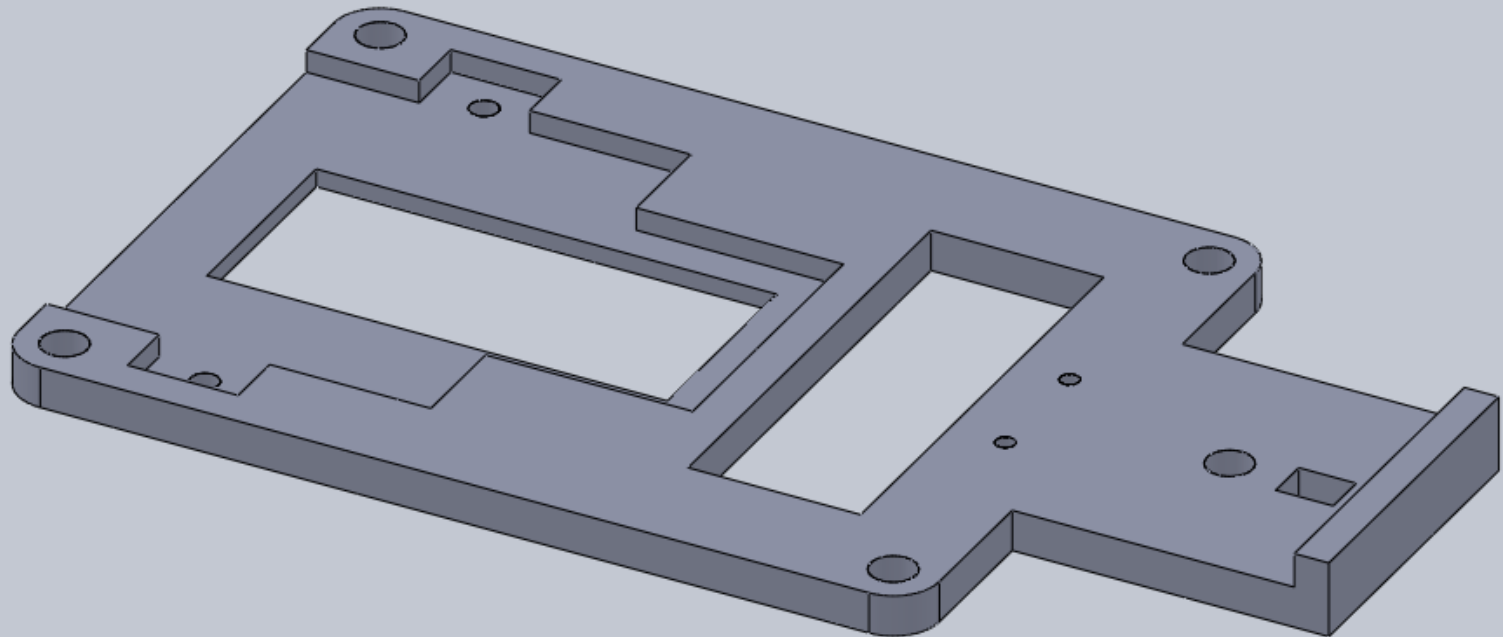


Autonomous Vehicle Chassis

- Lab 2: Draw in SolidWorks and 3D print chassis



Chassis Isometric View



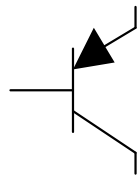
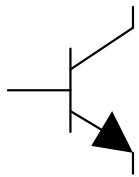
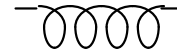
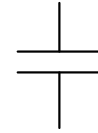
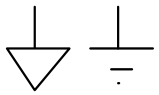
3D Printer Access

- Save your SolidWorks drawing in Stereolithography (.STL) format
- Email .STL file to Willie_Drake@hmc.edu with subject "E11 3D print request for <username>"
- Class covers materials costs for Lab 2 + one additional chassis, up to 2.5 in³
- You may use the printer for personal projects on a space-available basis at a cost of \$10/in³ payable to Engineering

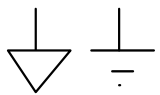
Electronic Design Representation

- Schematic describes the connection of electronic components
- Good schematic practices
 - Make the drawing easy to read
 - Use standard symbols
 - Group together related elements
 - Avoid bending lines without a reason
 - Use pins to connect by name where appropriate
- Bill of materials (BOM) specifies purchasing information

Schematic Symbols



Schematic Symbols



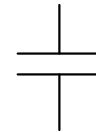
GND
(0 V)



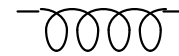
Power
(V_{DD}/V_{CC})



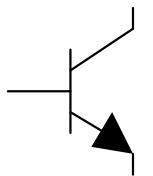
Resistor



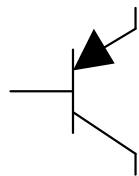
Capacitor



Inductor



npn



pnp

transistor transistor

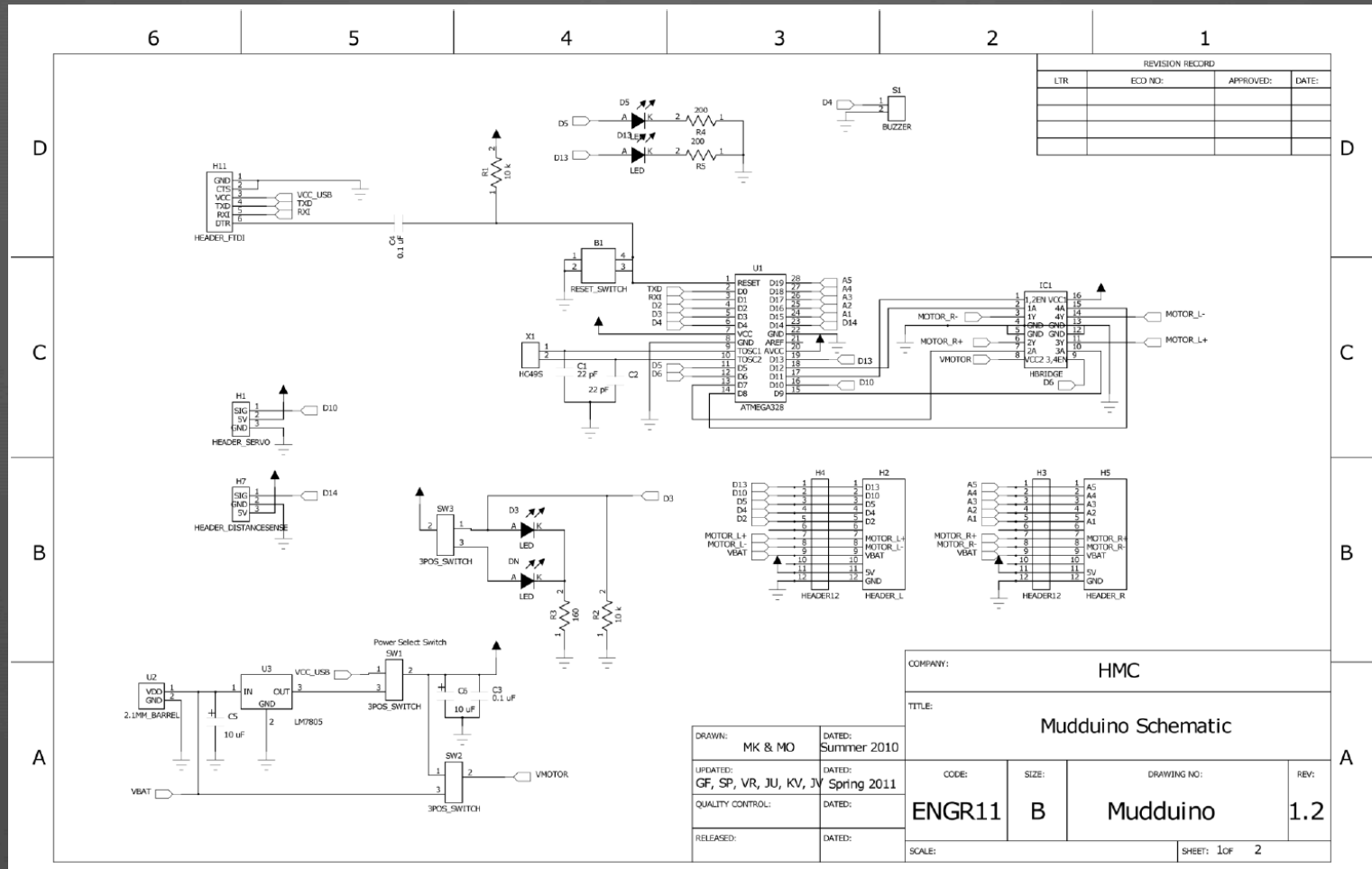


Diode



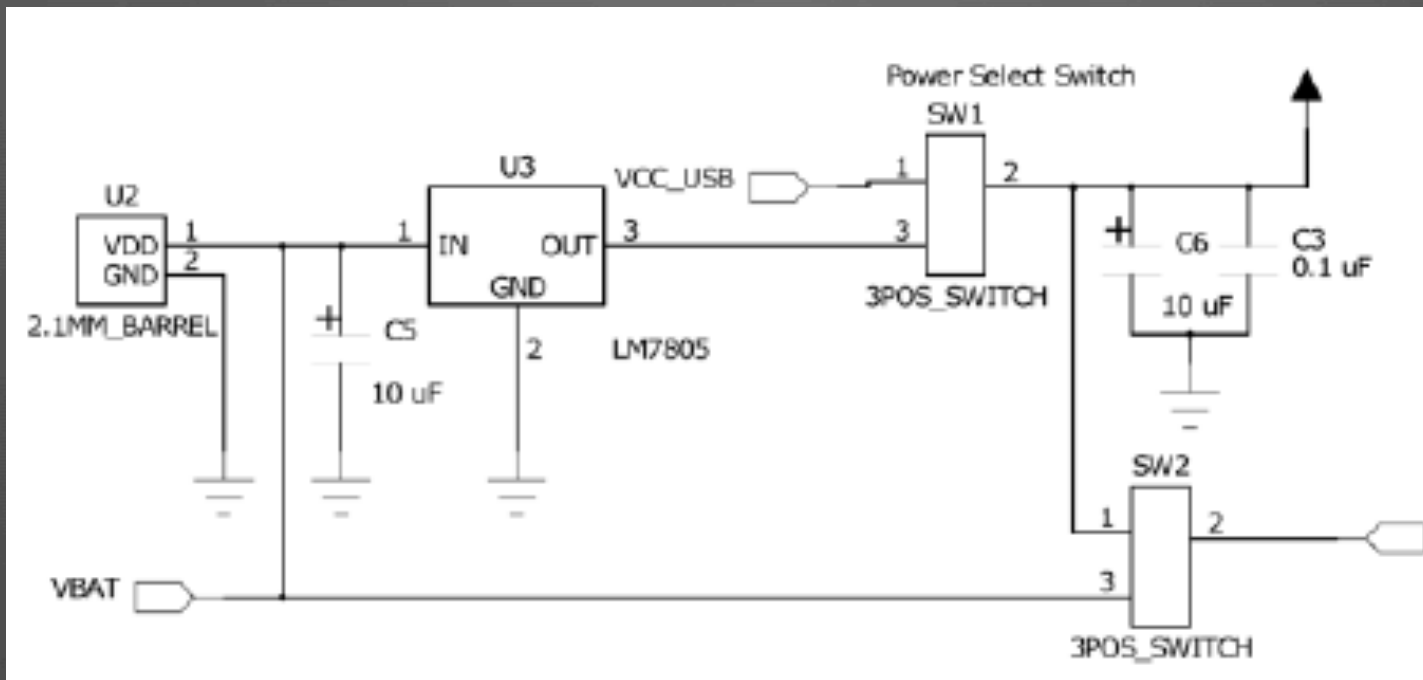
Switch

Mudduino Schematic



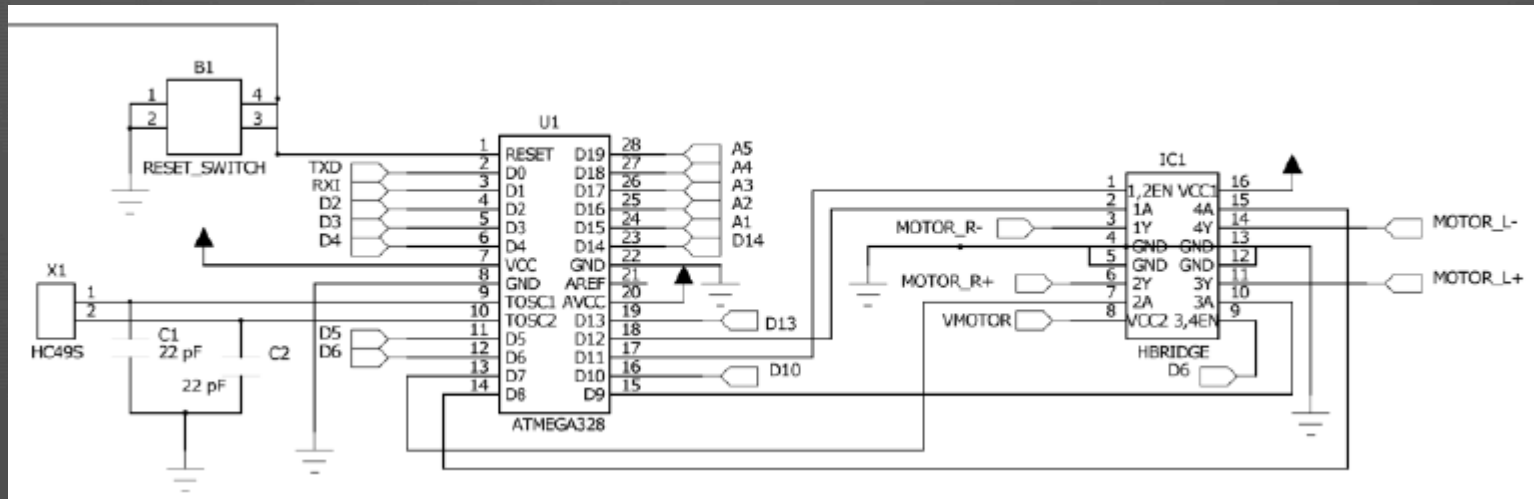
Power Supply

- Battery & USB sources
- Power and Motor switches + Bypass capacitors



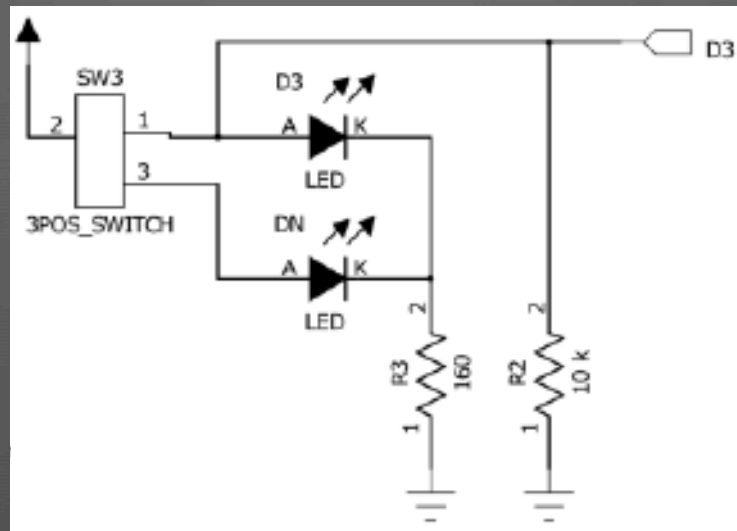
Microprocessor & H-Bridge

- ATMEGA 328 Microprocessor
- H-Bridge Motor Driver
- Oscillator & reset switch



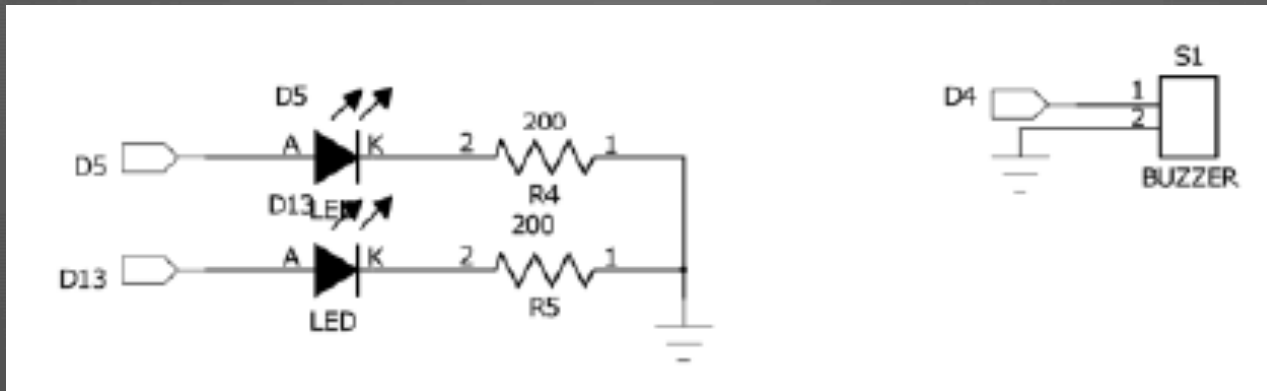
Team LED

- Switch to select team
- Two LEDs to indicate team
- D3 reports team to processor



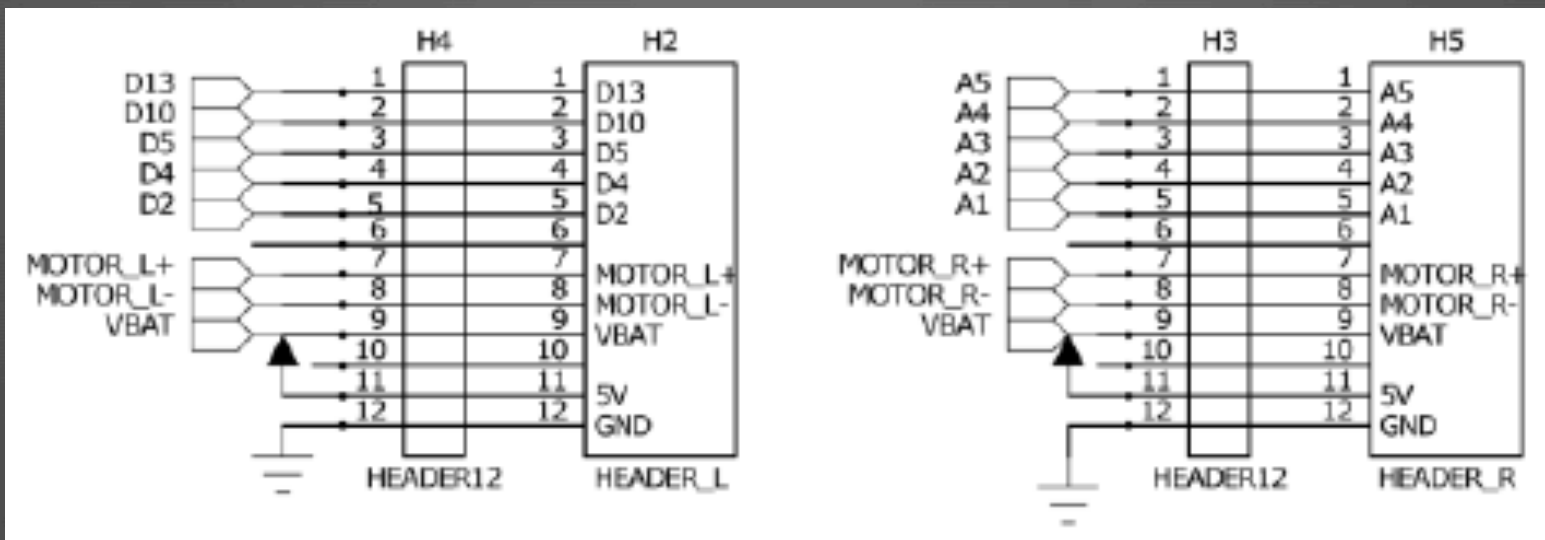
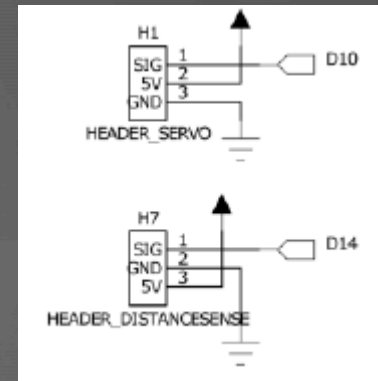
LEDs and Buzzer

- D5 and D13 drive LEDs
- D4 drives buzzer



Header Pins

- Left and right:
 - Analog/Digital I/O, Motors, V_{bat} , 5V, GND
- Servo and distance sensor (D10 / D14)



FTDI Connector

- Serial transmit and receive data (TXD, RXI)
- 5V and GND, limited to 500 mA
- Reset pulse after programming

