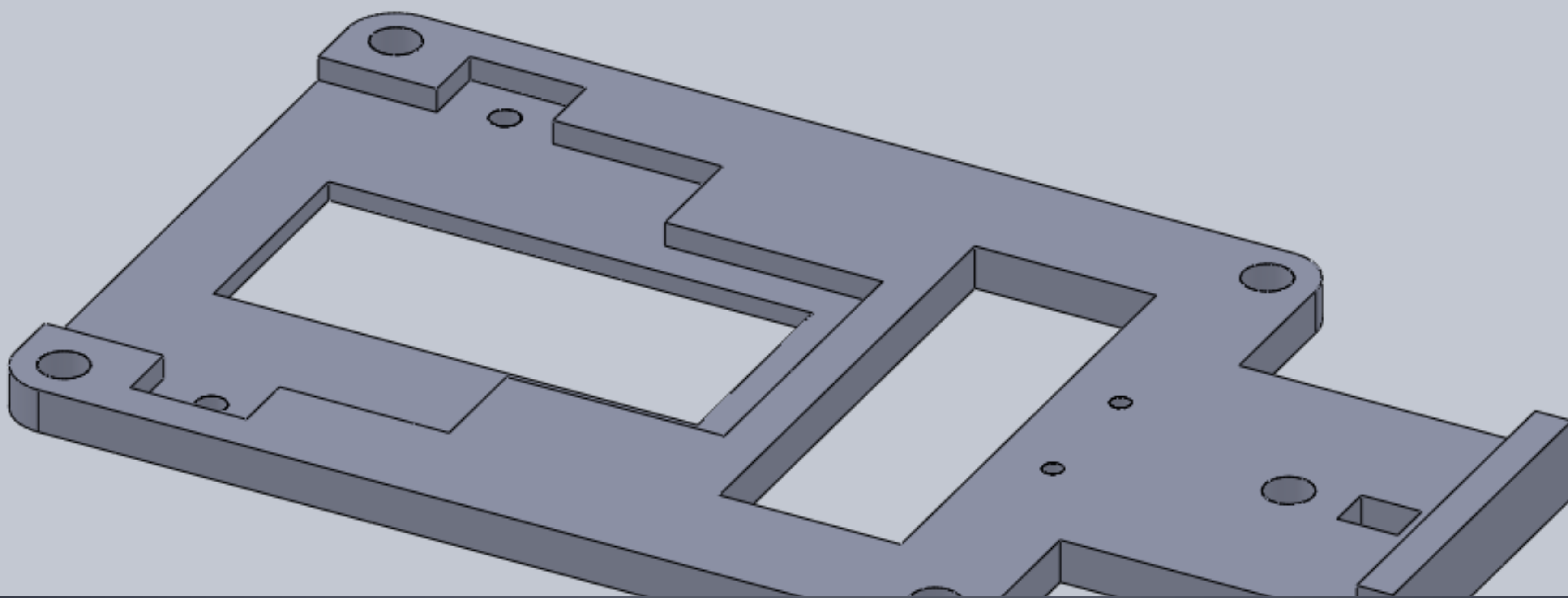
E11 Lecture 5: Design Representation



Two questions

- Did you take/pass the machine shop safety test?
- Is everyone's Muddiuno working?

Outline

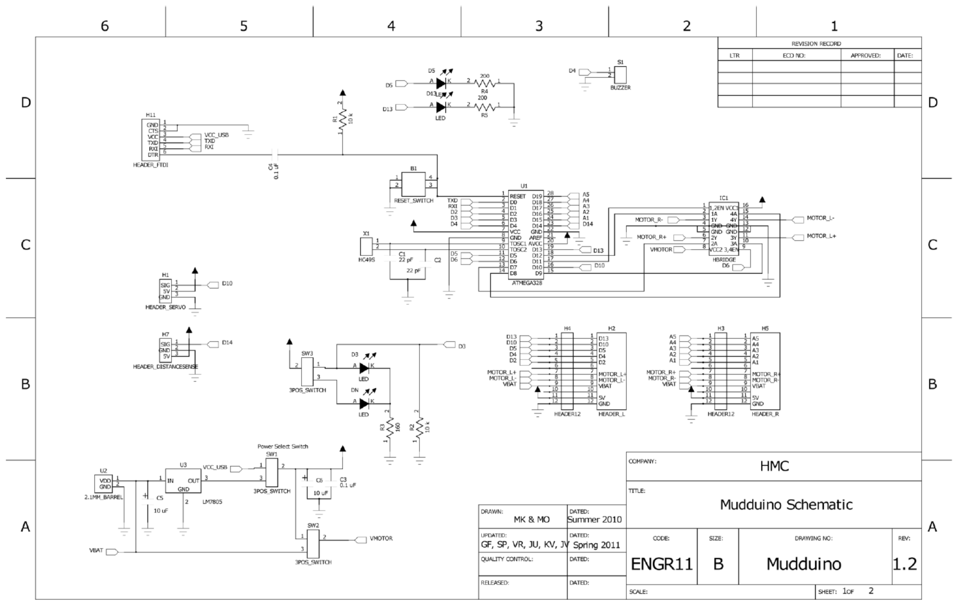
- Electronic Design Representation
- Mechanical Design Representation
- Design Examples

Outline

- Electronic Design Representation
  - Schematic Elements
  - Mudduino Schematic
- Mechanical Design Representation
- HMC Design Example

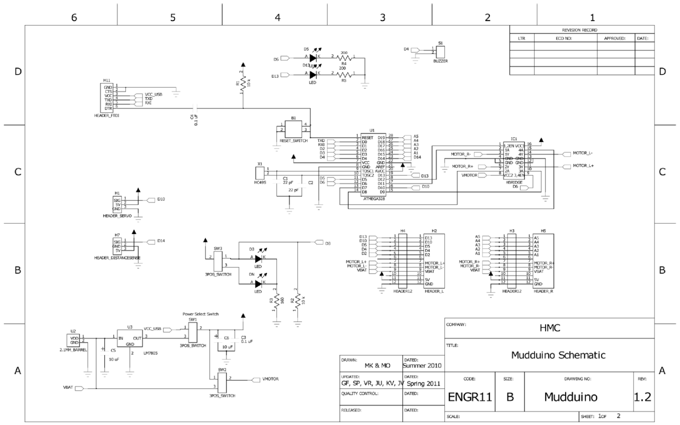
Electronic Design Representation

- Schematic describes the connection of electronic components

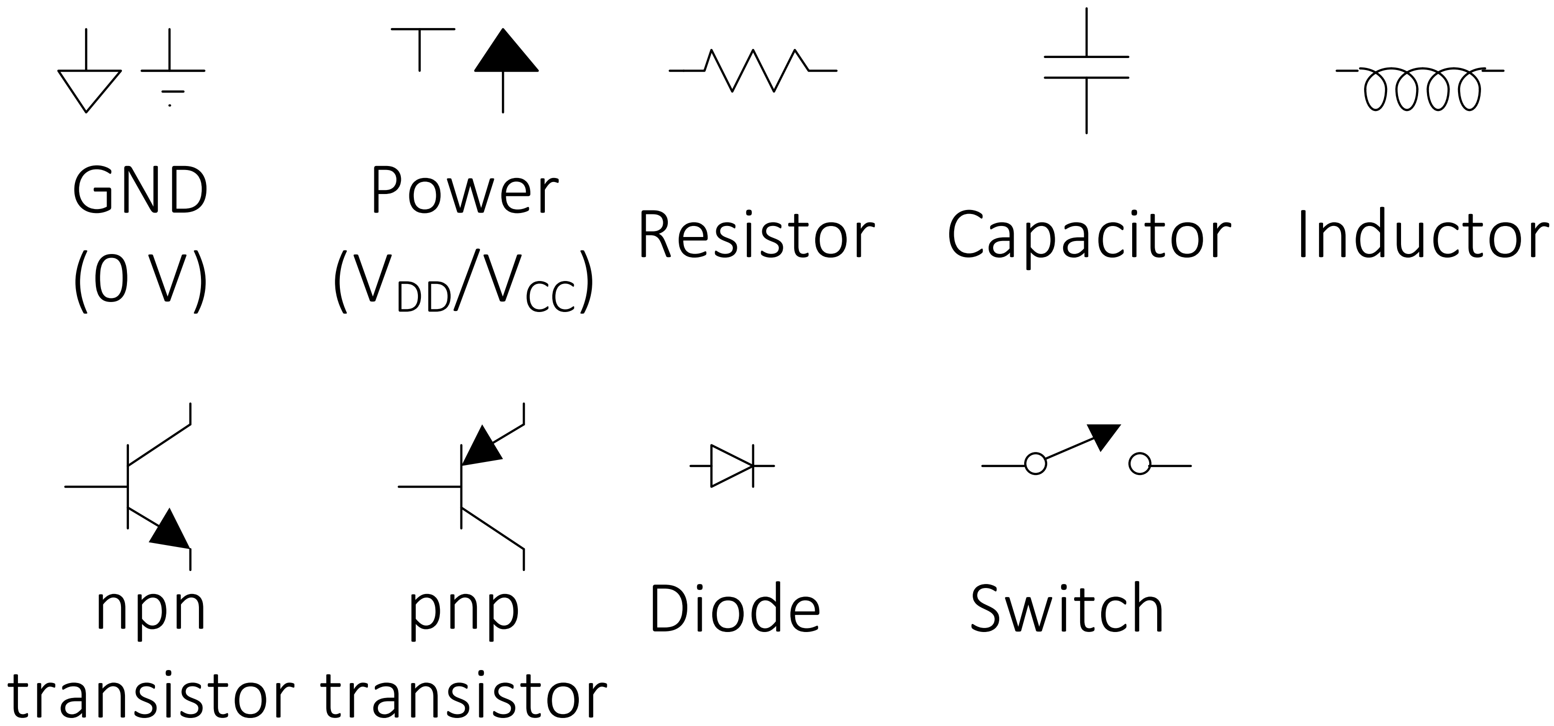


Electronic Design Representation

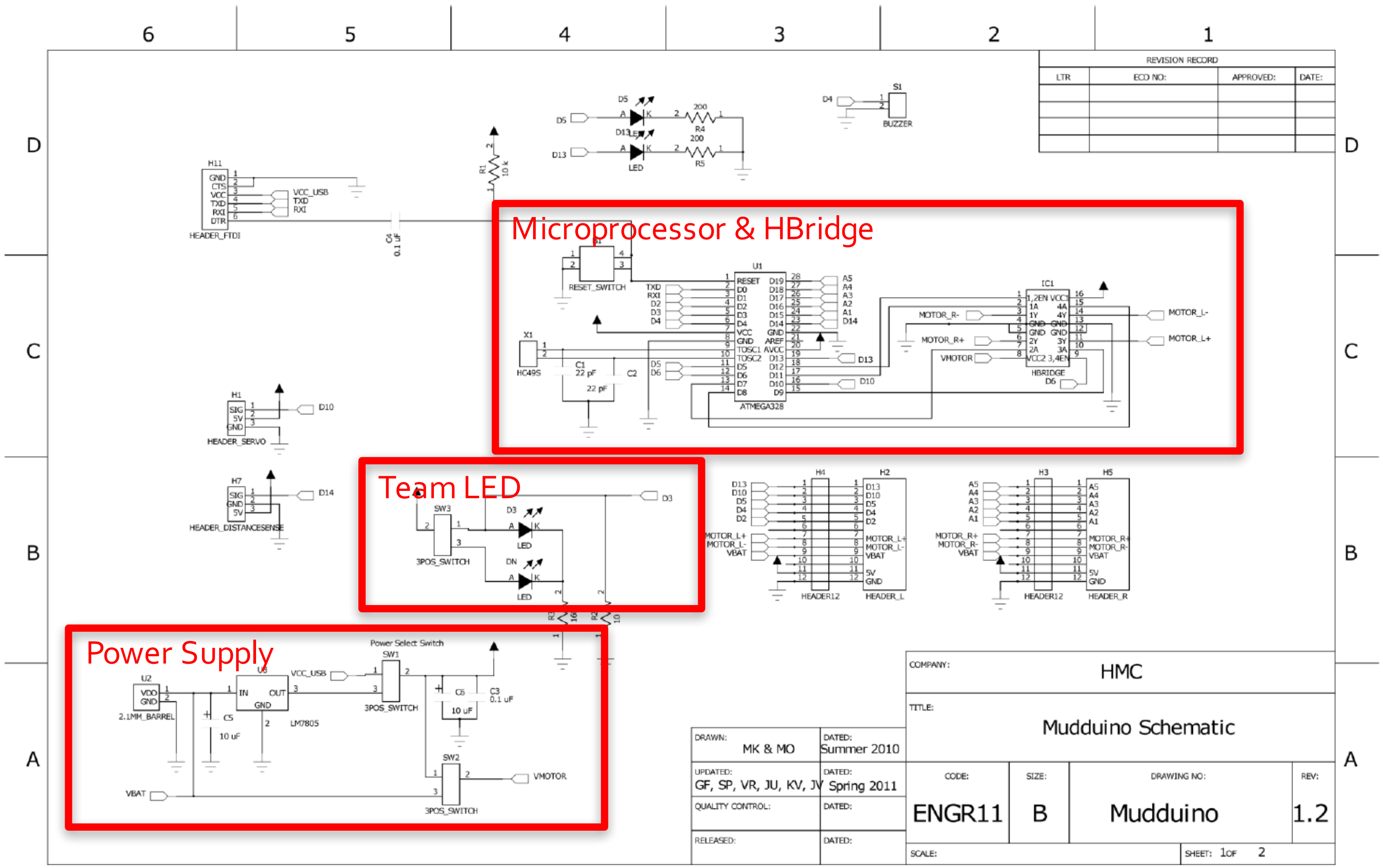
- Good schematic practices
  - Make the drawing easy to read
  - Use standard symbols
  - Group together related elements
  - Avoid bending lines without a reason
  - Use pins to connect by name where appropriate



Schematic Symbols



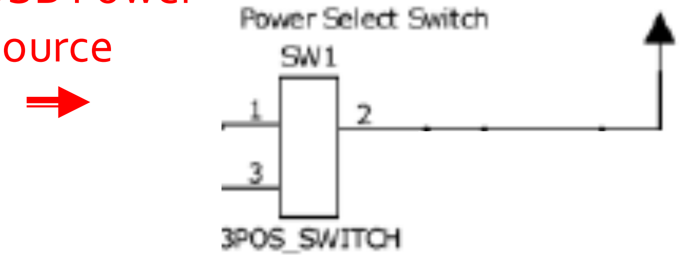
Mudduino Schematic



Power Supply

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

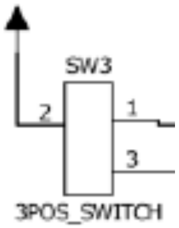
USB Power Source



E

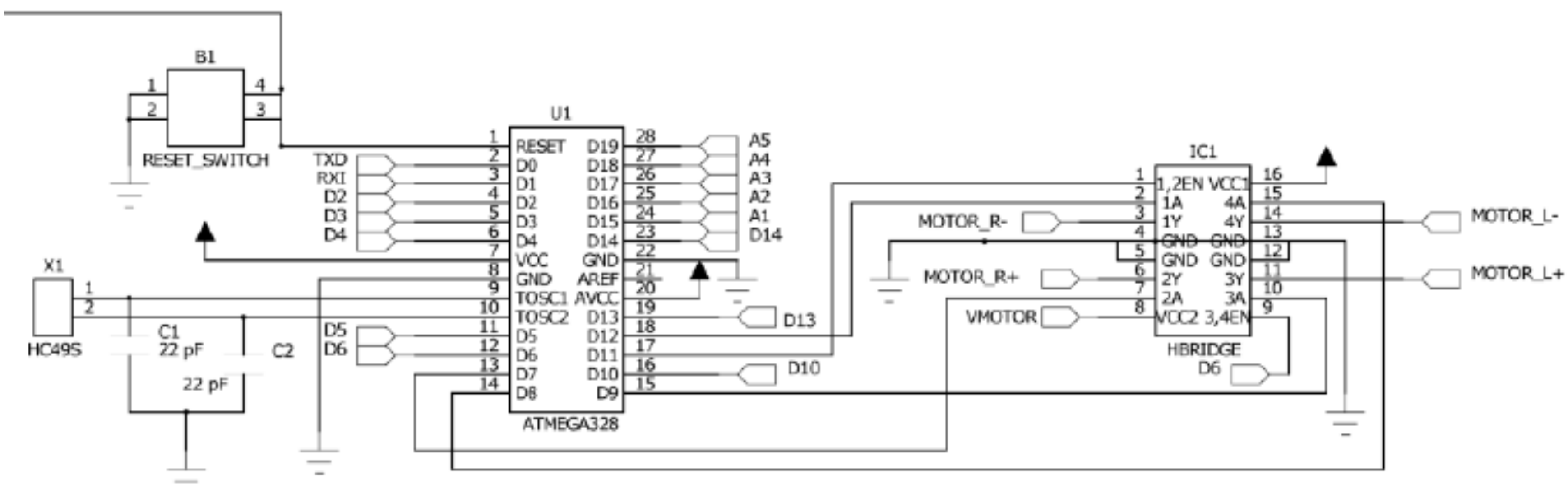
Team LED

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

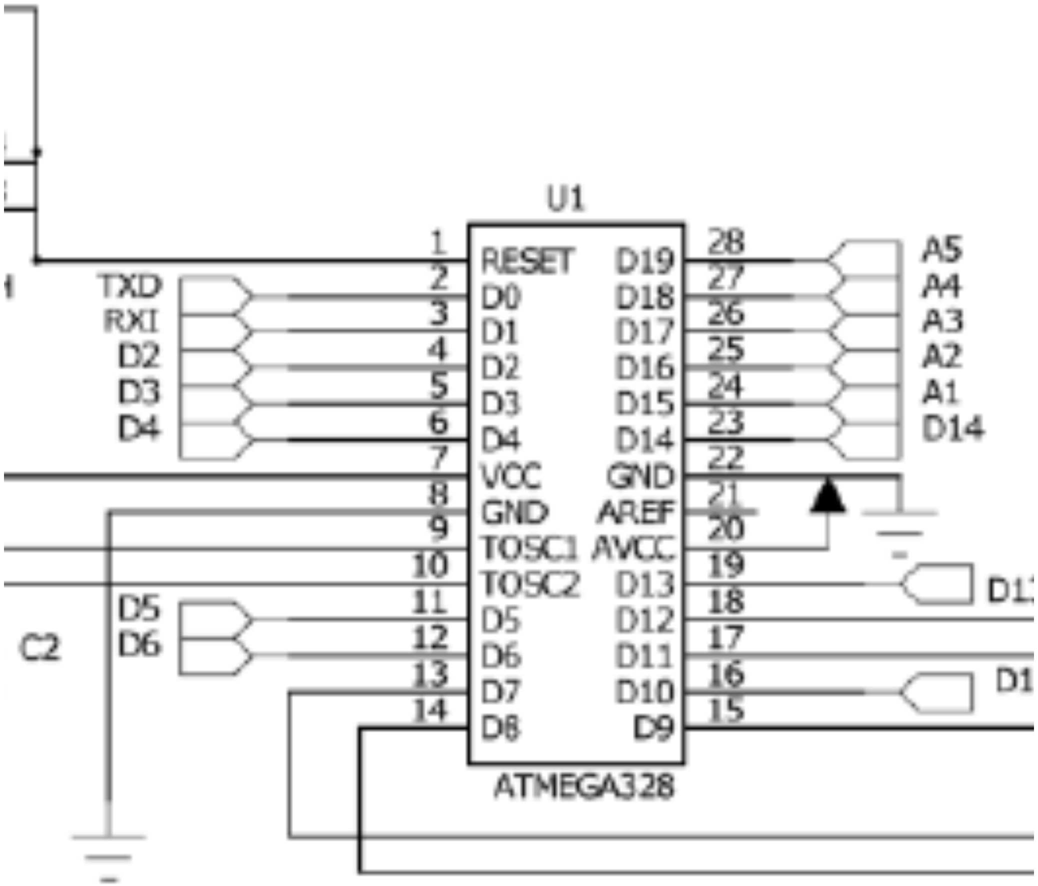


Microprocessor & H-Bridge

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



Microprocessor

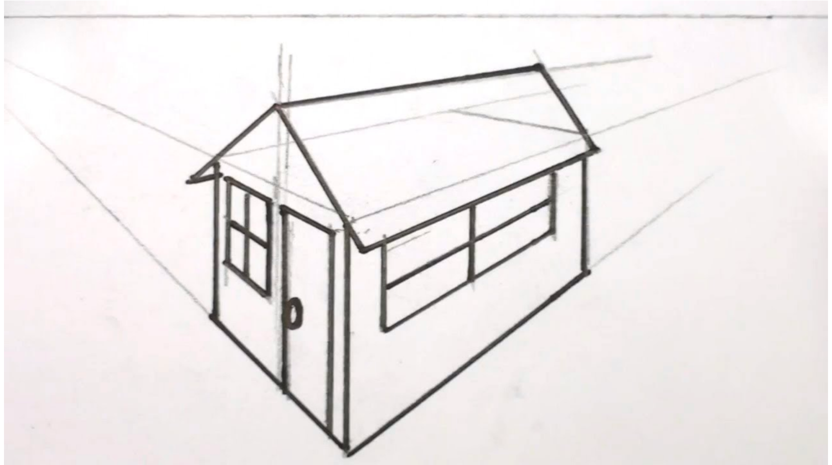


Outline

- Electronic Design Representation
- Mechanical Design Representation
  - Orthographic Projections
  - Isometric Projections
  - Computer-Aided Design (CAD)
  - Computer-Aided Manufacturing (CAM)
  - Autonomous Vehicle Chassis
- HMC Design Example

Design Representation

- How to represent a 3-dimensional object on a 2-dimensional page?
- With Projections!
  1. Orthographic
  2. Isometric



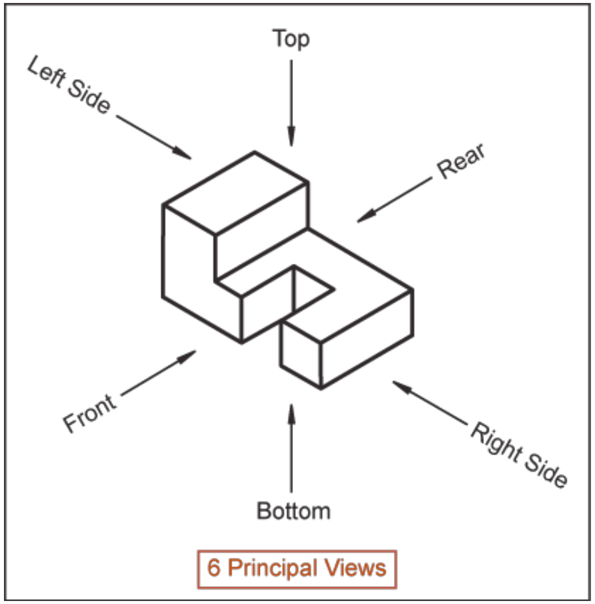
https://www.youtube.com/watch?v=3H4APnHa9Es

Orthographic Projection

- Used by Greek and Roman astronomers and engineers

orthos "straight"
+
graphic "drawing"

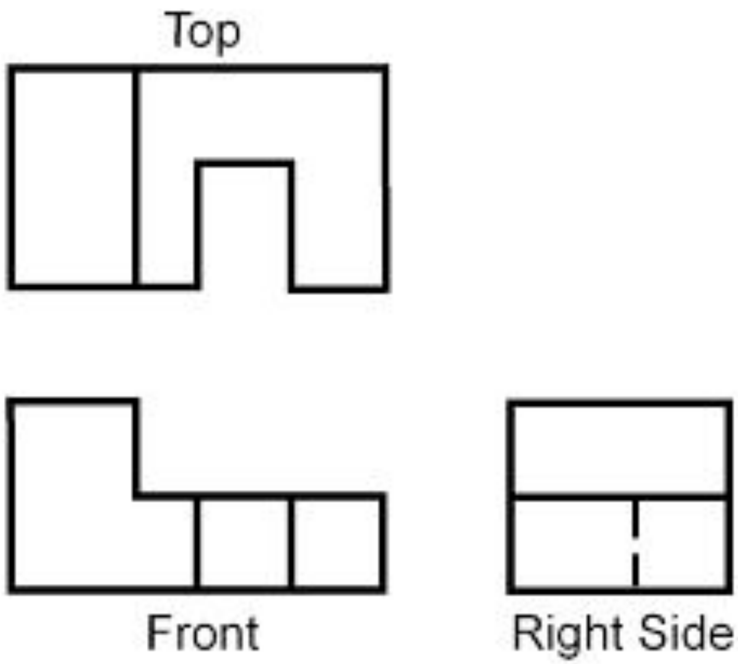
- We use 3 different views:
  - E.g. Front, top, and side views



http://www.engineeringessentials.com/

Orthographic Projection

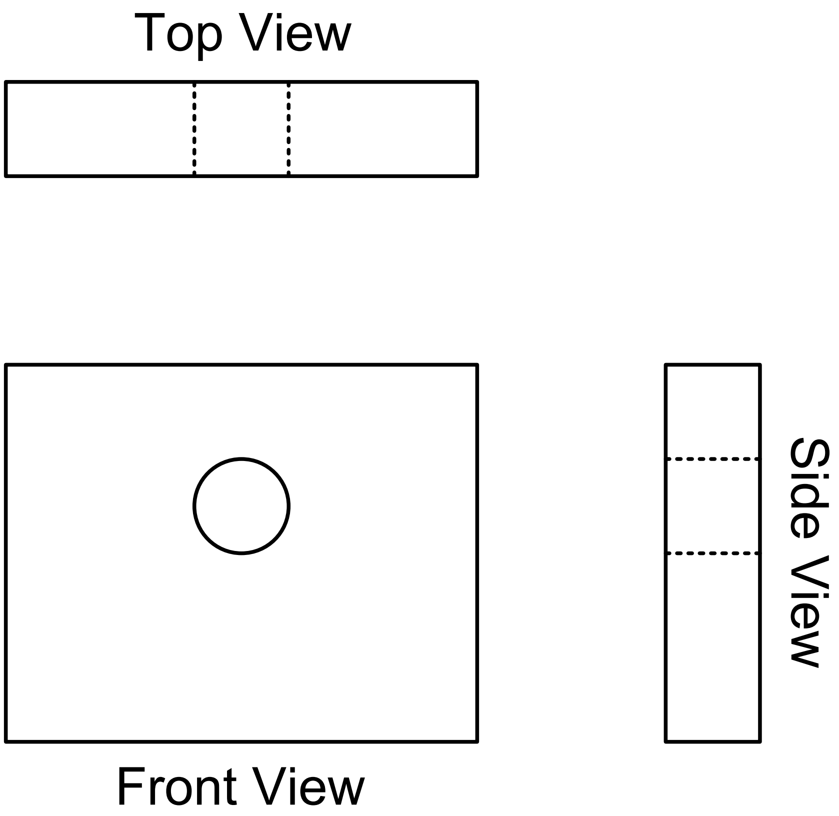
- Example 1



http://www.engineeringessentials.com/

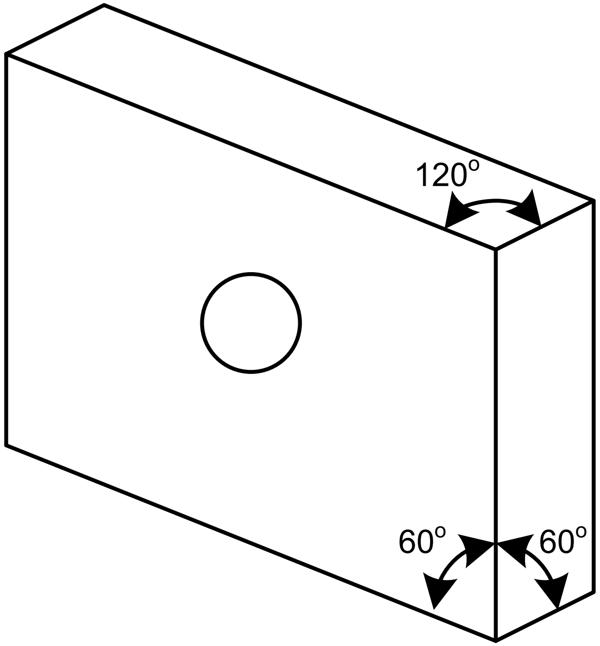
Orthographic Projection

- Example 2

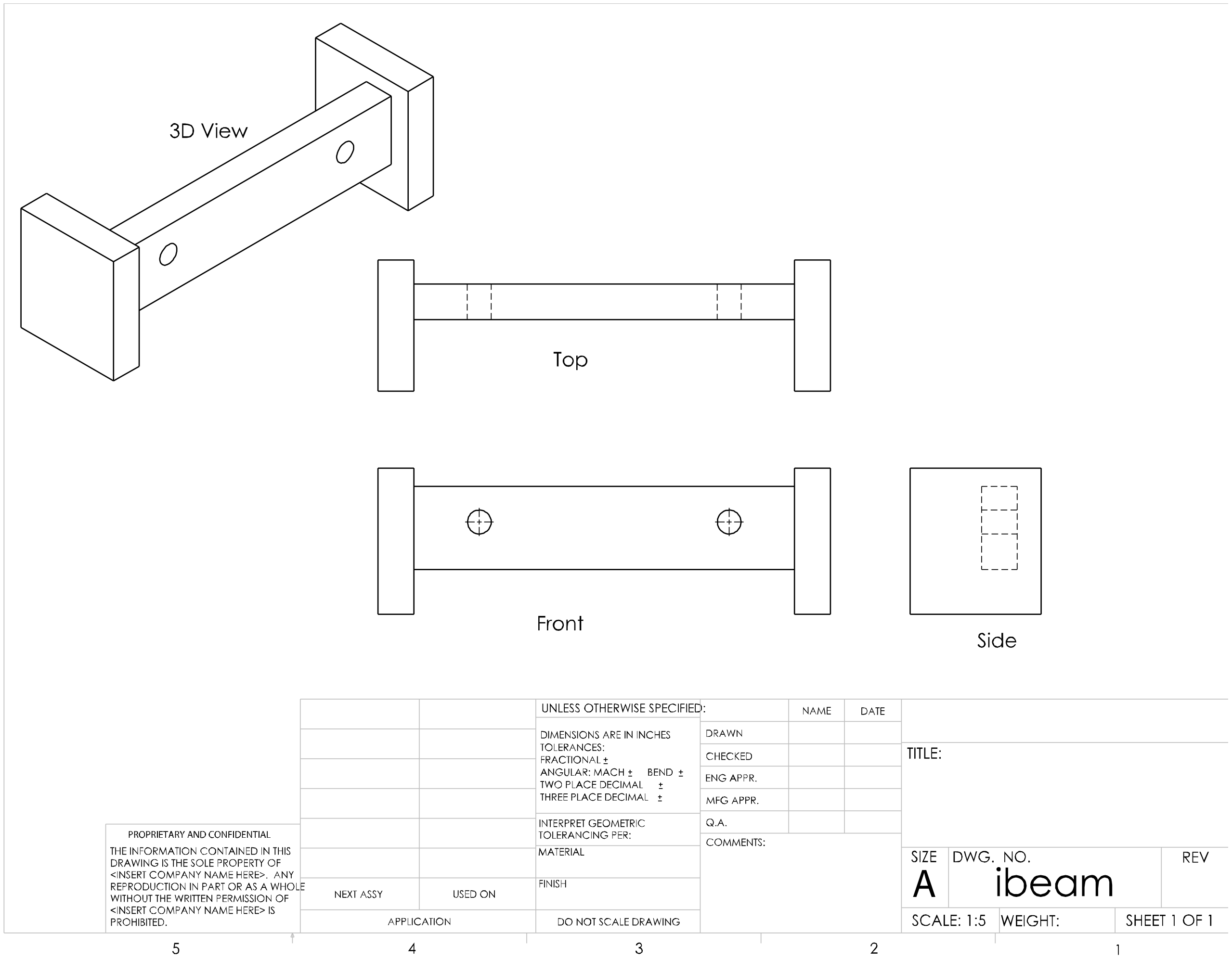


Isometric Projection

- Shows three faces all at once
- *iso* = "equal"
  +
  metric = "measure"
- Preserves distances accurately along each axis
- Angles between each axis are 60/120 degrees

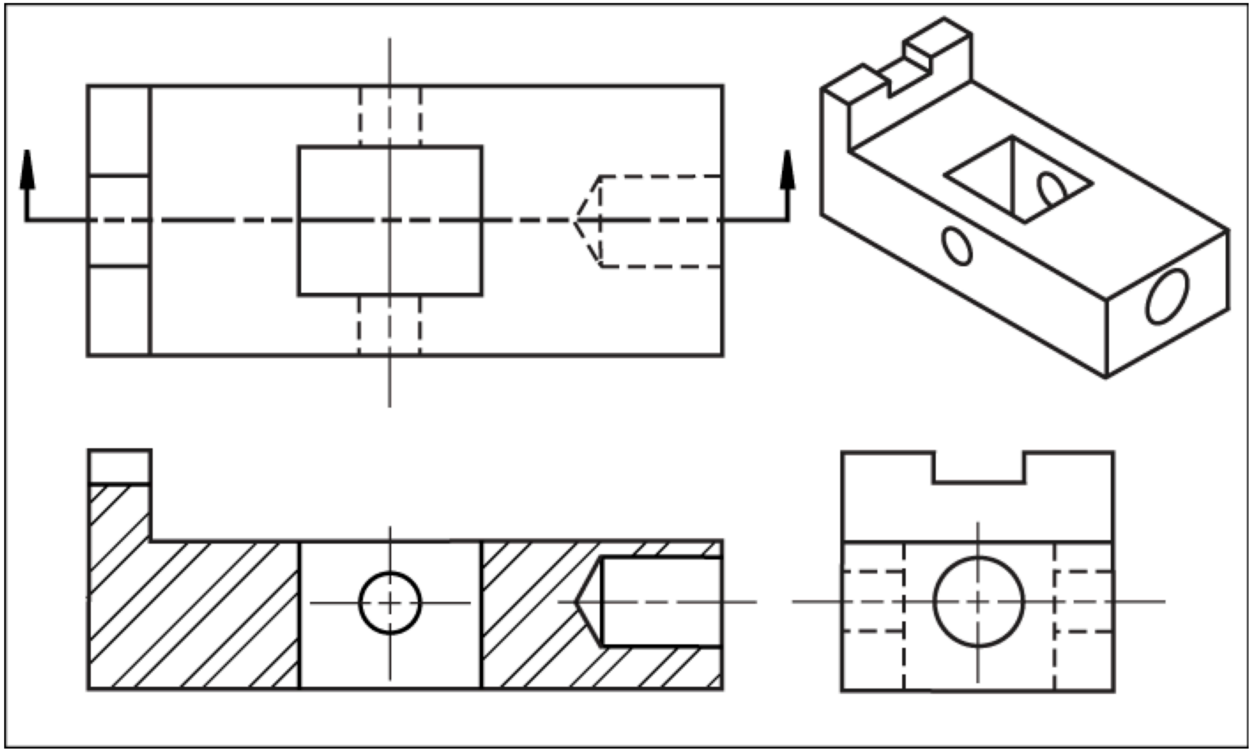


Example: I-beam



Lines

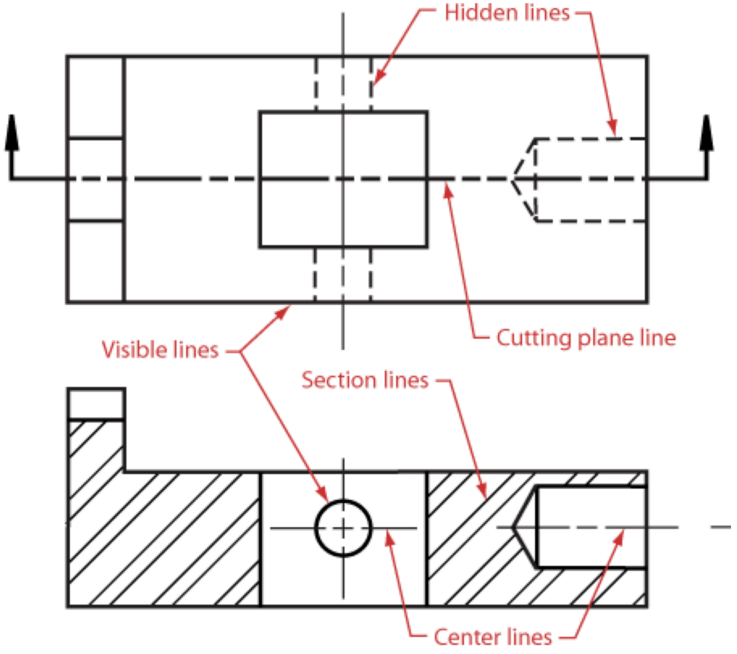
- Four common line types



http://www.engineeringessentials.com/

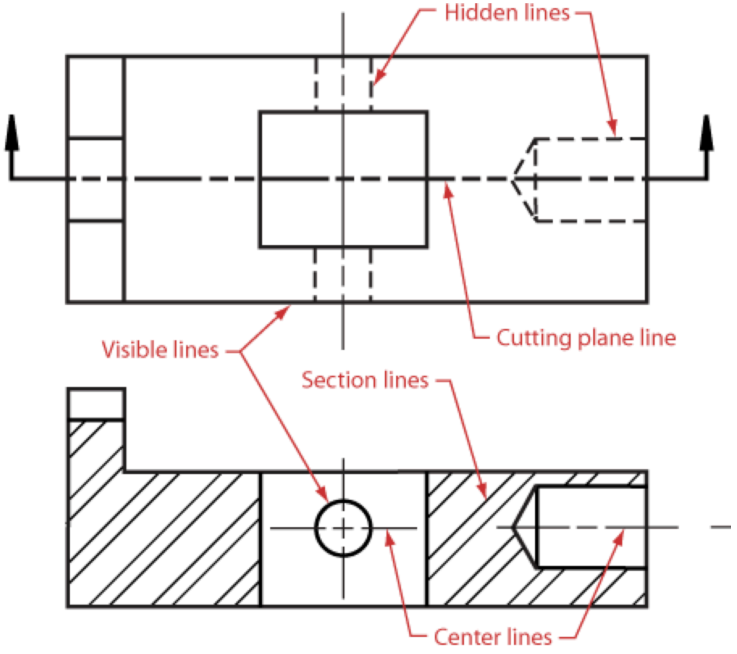
Lines

1. Visible
   - Represent visible edges and boundaries
   - Continuous and thick (~0.5mm)
2. Hidden
   - Represent hidden edges and boundaries
   - Dashed and Medium thickness (~0.4mm)



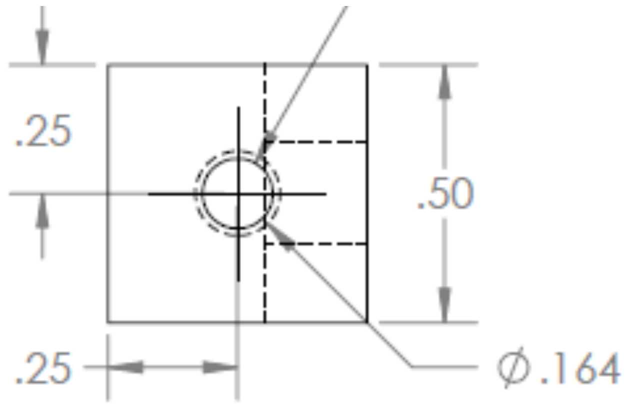
Lines

3. Center
   - Represent axis of symmetry
   - Long dash – short dash, thin (~0.3mm)
4. Phantom
   - Represent imaginary features
   - Long dash – short dash – short dash, thin (~0.3mm)



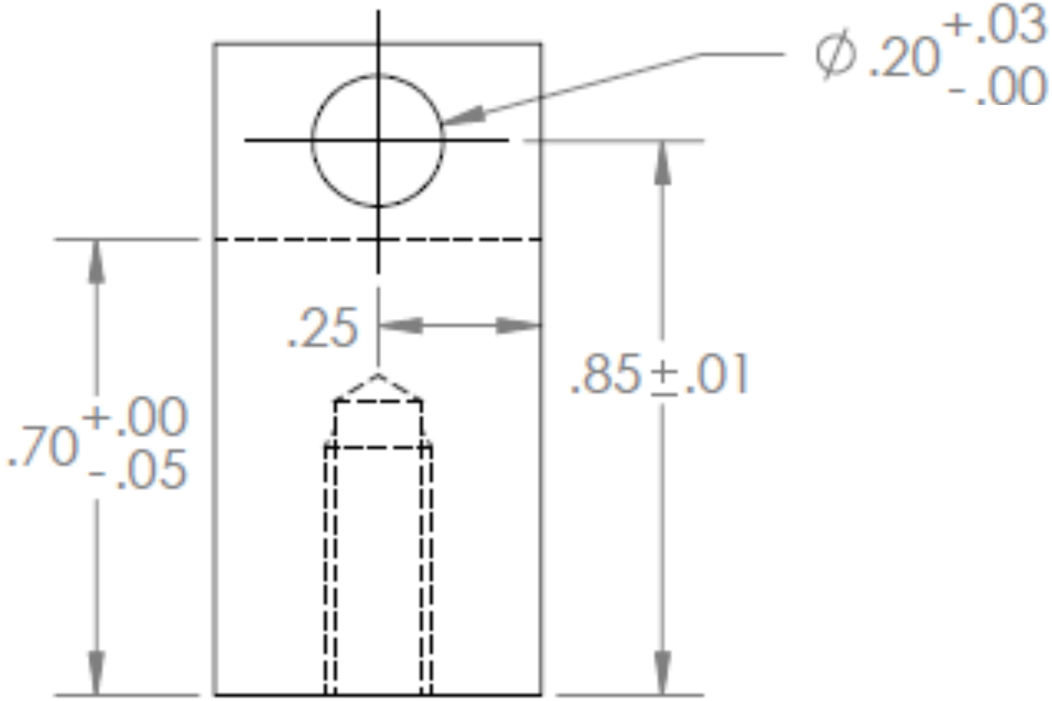
Dimensioning

- 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
- Holes are specified by their diameter (∅)



Tolerances

- Tolerances are the permissible limits of variation in a dimension



Datum Features

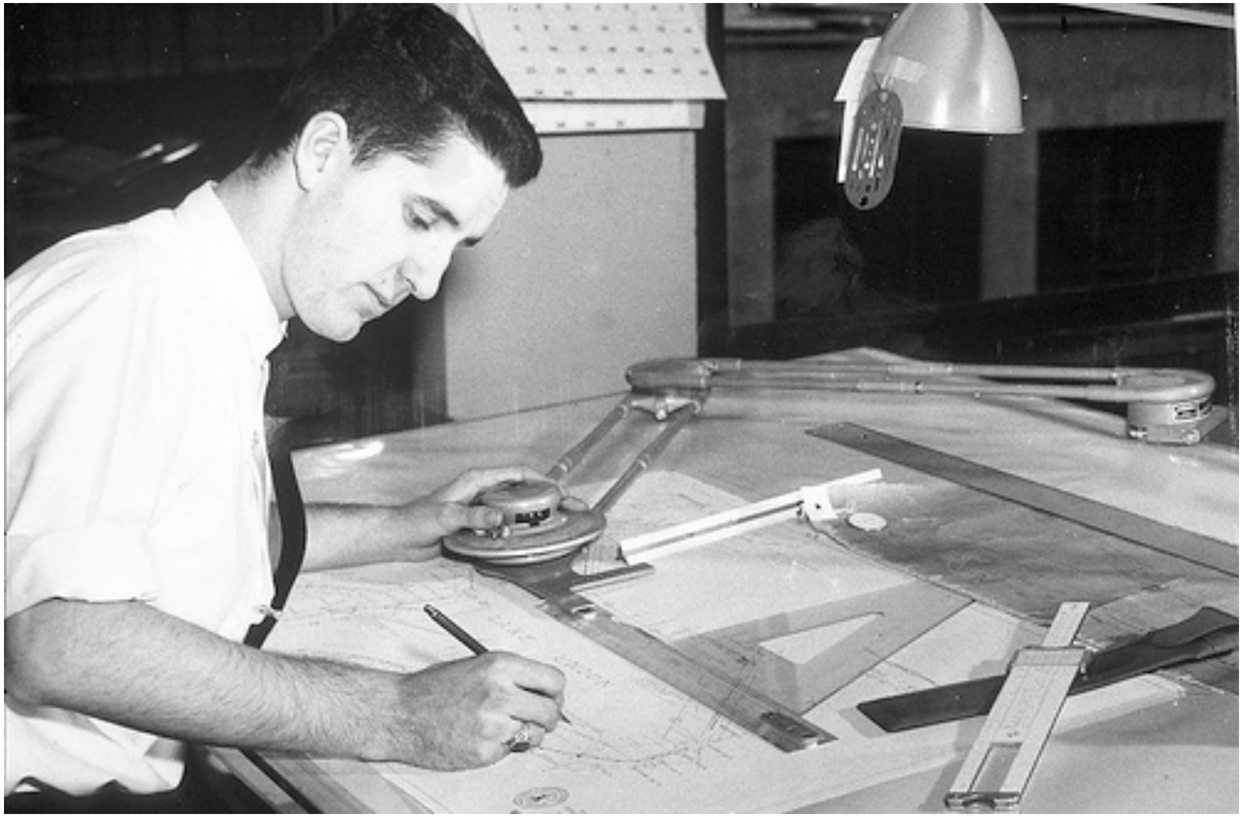
- Datum features
  - Are specially labeled, physical features of real parts
  - Are used to align the part
  - Make measurements from a consistent edge

  - Description:

http://www.zeiss.com/4125682000024CFA5/EmbedTitelIntern/ASME_Y14-5_2009_GDT-Tandler/$File/ASME_Y14-5_2009_GDT-Tandler.pdf

Computer-Aided Design

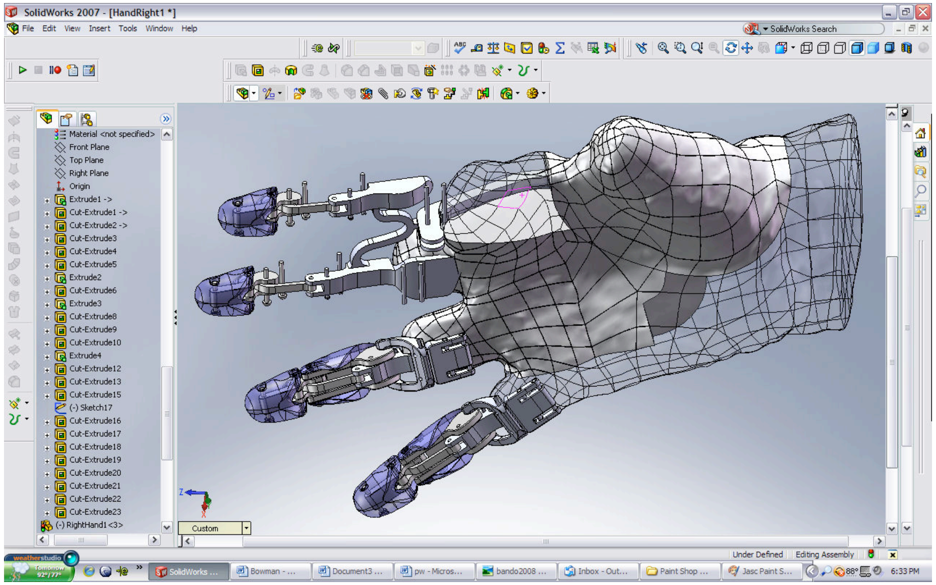
- Traditionally we used the drafting table



www.filesdirect.com

Computer-Aided Design

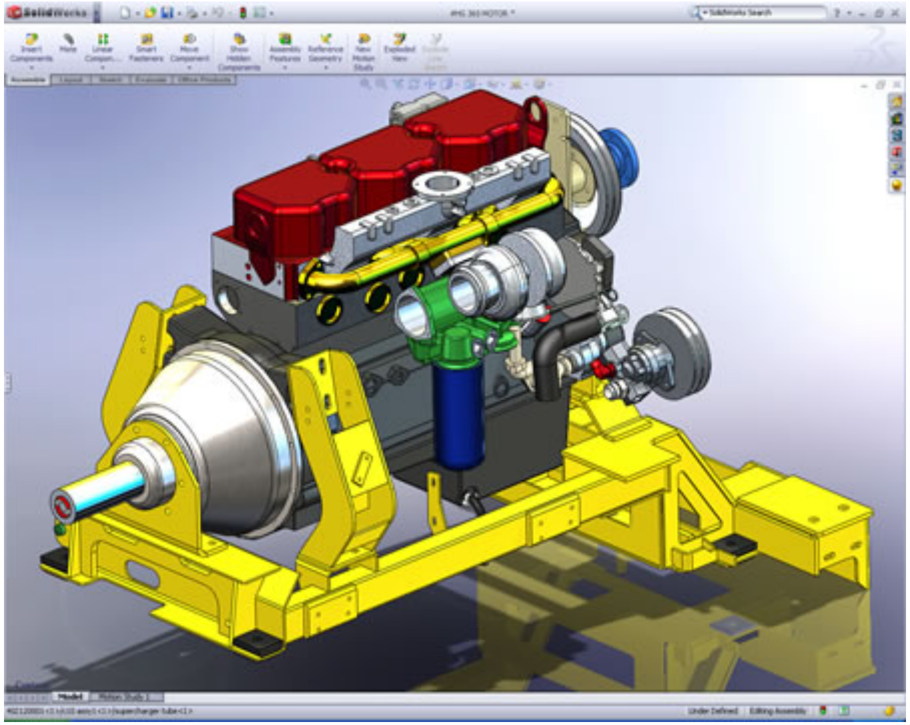
- CAD software has replaced drafting
- HMC primarily uses SolidWorks
  - World's leading CAD tool
  - Relatively easy to use
  - Easy integration with simulation and manufacturing



solidsmack.com

SolidWorks Concepts

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



engineeringlearning.blogspot.com

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://www.youtube.com/watch?v=CP10BwccARY

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/in^3 materials cost

3dimensionprint.co.uk

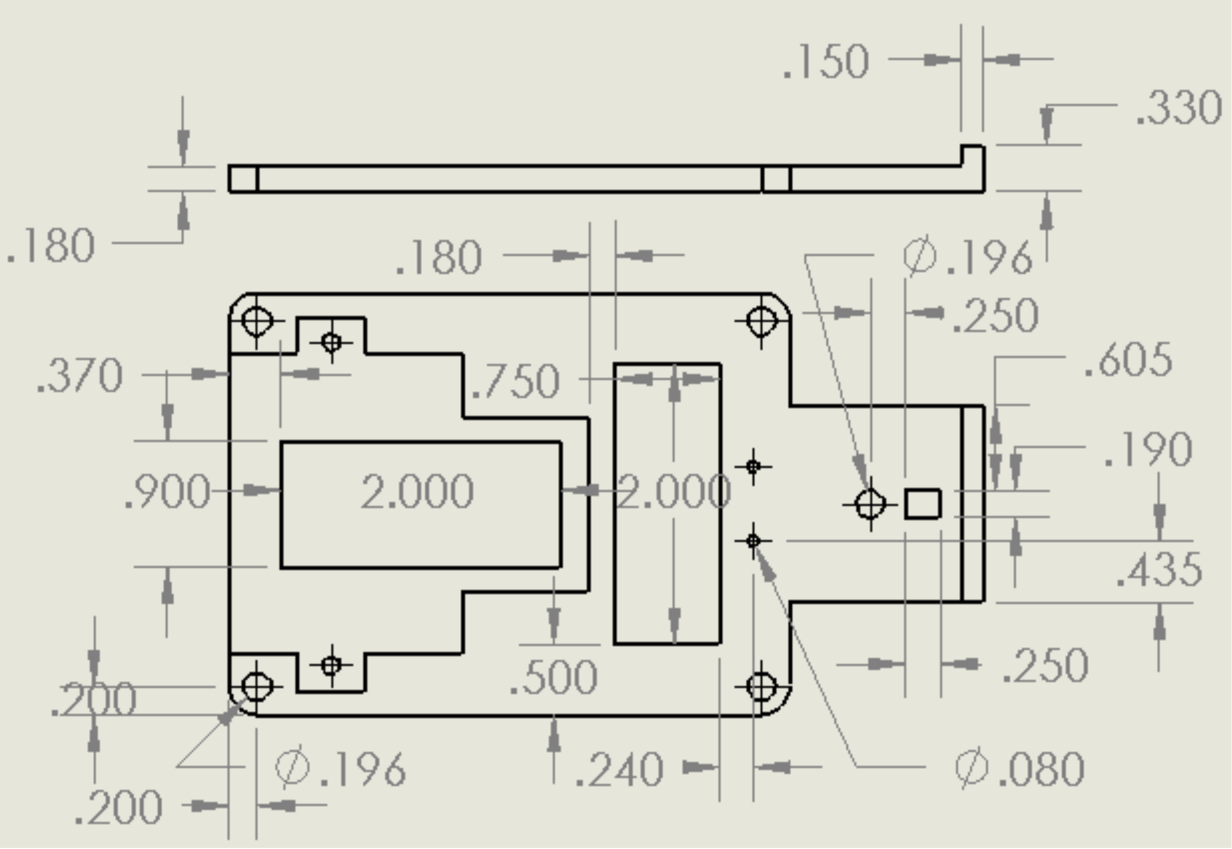
CNC Machining

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

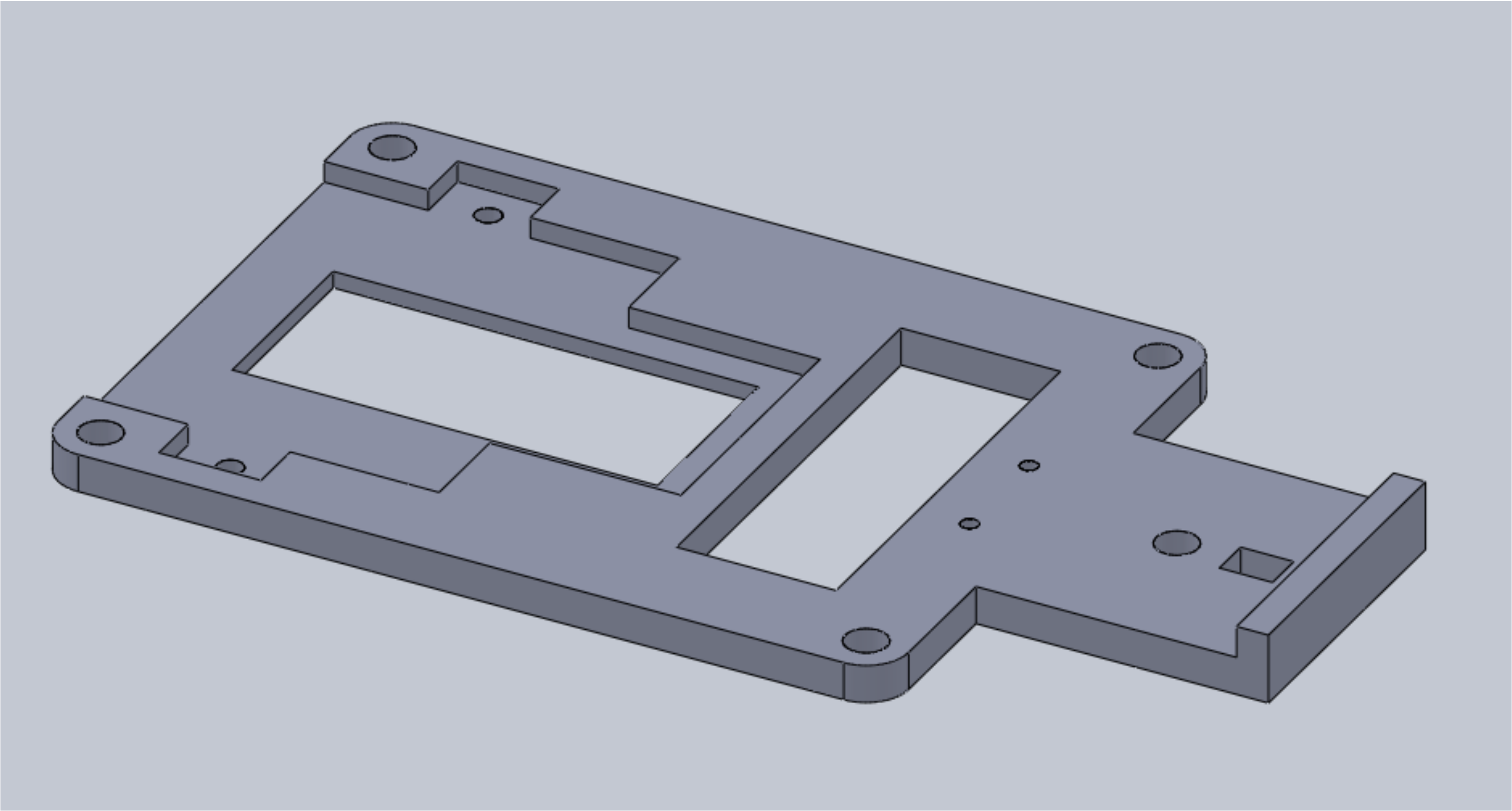
www.cuttingtoolssite.com

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
- You may use the printer for personal projects on a space-available basis at a cost of $10/in^3 payable to Engineering

Outline

- Electronic Design Representation
- Mechanical Design Representation
- HMC Design Example

Examples

- Example 1: Hydrophone Clamp

Examples

- Example 1: Hydrophone Clamp