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
Electronic Design Representation
- Schematic Elements
- Mudduino Schematic

Mechanical Design Representation

HMC Design Example
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
Schematic Symbols

GND (0 V)
Power (V_{DD}/V_{CC})
Resistor
Capacitor
Inductor

nnp
pnp
Diode
Switch

transistor transistor
Power Supply

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

[Diagram showing a power select switch with options for USB Power Source and other inputs.]
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
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
How to represent a 3-dimensional object on a 2-dimensional page?

With Projections!
1. Orthographic
2. Isometric

https://www.youtube.com/watch?v=3H4APnHagEs
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/
Example 1

http://www.engineeringessentials.com/
Orthographic Projection

- Example 2

Top View

Side View

Front View
Isometric Projection

- Shows three faces all at once
  
  \[ iso = \text{“equal”} \]
  
  \[ metric = \text{“measure”} \]

- 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/
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)
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 (Ø)
Tolerances are the permissible limits of variation in a dimension.
Datum features

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

Description:

Traditionally we used the drafting table
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
Computer-Aided Manufacturing

- Automate manufacturing from CAD drawings
  - 3D printing
  - Computer numerical control (CNC) machining
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=CP1oBwccARY
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
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
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/in³ payable to Engineering
Outline

- Electronic Design Representation
- Mechanical Design Representation
- HMC Design Example
Example 1: Hydrophone Clamp
Example 1: Hydrophone Clamp