Getting Started

• Team
  – Motor / Control group
  – Team Leader
    • Allocate sub-tasks
    • Track Progress
  – Sketch & Identify
    • Mechanism
    • Motors
    • Sensors
    • Circuits
    • Computers
  – Block Diagram
    • Simulink

• Research
  – EC DC Motor
    • Components
    • Principle of Operation
  – Control
    • Real-Time Programming
    • PID Control
    • System Modeling
  – Electronics
    • Digital
    • Power
  – Mechanical
    • Sensors
    • Joints

Getting Started

• Work from success
  – Get to know your parts
    • Samples
  – Get something to work
    • Simple as possible
  – Work independently
    • Drivers / stubs

• Build on success
  – Breadboard (neat)
  – Proto-board
  – PCB

• Build on success
  – Electrical
    • Breadboard (neat)
    • Proto-board
    • PCB
  – Mechanical
    • Wire
    • Scrap metal
    • Waterjet / 3D
Challenges: Motor

- Mechanical
  - Stator Design
    - # Poles
    - Windings
    - Cogging
  - Rotor Design
  - Mechanical
    - Joints
    - Motor Mount
    - Case
    - Circuit Board Mount

- Electrical
  - Power Electronics
    - High Currents
    - O/C Inductors
  - Digital Electronics
    - Switching Logic
      - State machine
    - Angle Sensor
      - Hall
      - Optical

Motor: Mechanical

- Get something to move / rotate
  - Single winding motor
  - Toggle switches on windings
  - Simple stator (no laminations)
  - Simple bearings
    - Teflon / brass
  - No enclosure
Motor : Electrical

- **Design Logic**
  - Altera board
  - Flip-flops
  - PLD
  - Test with de-bounced toggle switch
- **Add H-Bridges**
  - Simulate motor with 3 inductors / resistors
- **Add Rotating Sensor**
  - Rotate by hand
  - Monitor with scope

Challenges : Control

- **Mechanism**
  - Sketch
  - Paper / wire model
  - Solidworks model
    - Conceptual
- **Identify**
  - Sensors
  - Gotchas
    - Mechanical interference
    - Cables / wires
- **Micro-Controller**
  - 8051 board
  - Altera board
- **Simulation**
  - Model layout
Mechanism

- Build a passive joint
- Get optical encoder to work
  - Pulses
  - Angle
- Use OTS PWM to drive OTS motor
- Connections
  - motor / arm
  - propeller / motor
  - joint / sensor

Controller

- Microcontroller
  - IDE
  - Compile & Download
- Set up Real-Time code
  - Main routine
  - ISR
- Turn motor on/off (open-loop)
- Read a sensor value
  - Use stubs / drivers
- Signal processing
  - Integral
  - Derivative
Available Parts

• Browse parts list
• Look up datasheet on Digikey website
  – www.digikey.com
  – Check price before ordering

Demo

• Optical Encoder
  – Datasheet on website
  – Adapter plate
  – Output
• Mechanical Encoder
  – PEC12R-4017F-N0024-ND
• Hall Sensor
  – SS411P
• H-Bridge
  – L298N