Motors continued
and
Prototyping and empirical methods

24-370 - Spring 2011

Professor Steve Collins

Reminders and Announcements

- Syllabus for remainder of semester:
  - Today: Prototyping, Project 3, Motors
  - Commercial manufacturing processes
  - Cost analysis
  - Environmental (Life Cycle) Analysis
  - Ethics for mechanical engineers
- HWs: motors, cost & environment, and ethics
- Individual project encompassing course

Prototyping in the Design Process

- When test physical prototypes?
  - Complex or novel phenomena (hard to model)
  - Performance-critical applications
  - Always used, eventually
- Lessons from Projects 1&2
  - First prototypes failed, second passed
  - Areas for refinement identified, addressed
- Broader applicability
  - Design of a synthetic seat cushion
  - Design of a shell for a consumer electronic device

Project 3 Announcement

- Individual project
- Designing an electromechanical assembly
  - Concept and detail design
  - Motor selection and simulation
  - Manufacturing, Cost, Environment, and Ethics
- See project description: Rescue Ranger Reel
- Due May 5th

Motors: review of mathematical model

- Derive from basic familiar equations:
  - Newton's second law: $\Sigma\tau = J \cdot \alpha$
  - Ohm, Faraday: $V = i \cdot R + L \cdot di/dt$
- And two new ones:
  - Motor torque equation: $\tau_m = K_\tau \cdot i$
  - Back EMF equation: $V_{BEMF} = K_v \cdot \omega$
- Coupled equations for motor dynamics:
  - $V = i \cdot R + L \cdot di/dt + K_v \cdot \omega$
  - $K_\tau \cdot i - \tau_a - b \cdot \omega = J \cdot \alpha$

Matlab exercise

- Download (broken) example code
- Walk through the code
  - See what each part does
  - Fix any broken parts
- Try simulating different situations
  - Constant voltages and applied torques
  - Position control
  - Simulated surface contact
- Interpret trends in current, speed, and power

Motor and gearbox selection

- What are the properties of interest?
  - Potentially all motor properties we have discussed
- Design by selection
  - Discrete number of available devices
  - Strong limitations due to electromagnetics, not salient to the consumer

Prominent Sources

- Small, high-performance robotics applications
  - Maxon: www.maxonmotor.com
  - Micromo: www.micromo.com
- Larger scale machine applications
  - Quick: through catalog distributors, such as:
    - Grainger: www.grainger.com
    - McMaster-Carr: www.mcmaster.com
  - Performance: from manufacturers, such as:
    - Allen Bradley: www.ab.com
    - Baldor: www.baldor.com
- Selection example: Maxon

HW7

- Available today
- Covers motor analysis and selection
- Due Wednesday April 20