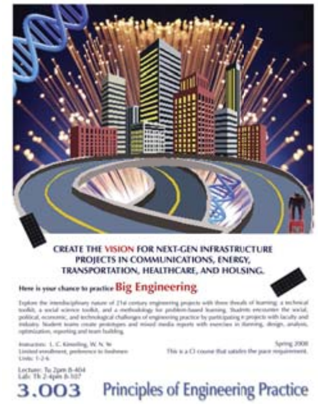

3.003
Principles of Engineering Practice

Engineering the Future of Solar Electricity

- Teams
  - Local power generation and use
    - Automobiles, irrigation pumps, telecommunications
  - Grid connected power generation and use
    - Solar farms, homes, manufacturing plants
- Project 1A
  - Solar Electricity Generation System Constraints
    - Rate limiting factor
  - due 4-6 (15min/team research update)

3.003 Project Purpose

- The Engineer
  - builds from a toolbox
  - designs for needs
- The Materials Engineer, additionally, must imagine limits
  - Define the limits of a technology platform
  - Design for technology scalability
  - Rate limit for learning curve
- 3.003 Final Project
  - Problem: Emergence of solar electricity
  - Constraints of application platforms
  - Scalability of platform
  - Long term solutions

Solar Electricity Facts

- A 100x100 square mile solar cell array in Nevada
  - could provide 100% of US electrical power requirements
- A single 175W Si solar cell module
  - Generates 12,000 kW-hr of electricity over its 30 yr lifetime
  - Can produce electricity over 30yrs to offset 13,600 lbs of CO_2
    - After subtracting $C0_2$ from mfg
- Each kW-hr of energy generated by a local solar installation
  - Is worth 3.3 kW-hr of utility power generation
  - Transmission losses and other inefficiencies
- 5 x 60W incandescent replaced by 12W fluorescent light bulbs
  - Offsets 440 lbs of coal + 860 lbs of CO_2 each year
- Green plants are 3% efficient
  - Converting sunlight + H_2O + CO_2 into sugar

Engineering the Future of Solar Electricity
Teams: local power; grid connected power

- Project 1A: *due 4-6*
  - Electricity Generation System Constraints
- Project 1B: due *4-13*
  - Materials Selection
- Project 1C: *due 4-27*
  - Solar Cell Solar Cell Design
  - Module Manufacturing Platform
- Pentachart Summary Presentations: due *5-4*
- Project 1D: *due 5-6*
  - Final Report and Presentation

Project Planning

- Timeline
- Resources
- Problem Definition

Engineering Practice

1. Problem Definition (B)
2. Constraints (I)
3. Options (R)
4. Analysis (A)
5. Solution (C)

Project 1A: *due 4-6*
Electricity Generation System Constraints

Applications: FOM Comparisons

- Strengths
  - Attributes of solar electricity
  - Optimization plot
    - x vs. y with maximum for solar attributes
- Weaknesses
  - Barriers
    - Crossover point to solar advantage
- Competition
  - Local power
    - Gasoline: energy/unit volume

Walk the Big Dig

- Thursday, April 1
  - Meet at Inbound MBTA at 12:55p
- Learning
  - Big Infrastructure Engineering Challenges

Infrastructure Change Issues

- New technology requires changing multiple components.
- Multi-vendor interoperability must be considered.
- Expected rewards in one area are sometimes accompanied by risks of disruption in other more critical application areas.
- Capital cost of infrastructure upgrade vs. sunk cost of existing.
- Missing or incomplete backward compatibility leading to replacing more equipment than will benefit from the upgrade.
- Incomplete value-chain availability, particularly in early stages of new technology.
- New skills availability and adoption.
- Changes in Economic Marketplace.

The Solar Cell

1) Principles of operation
2) Relevant performance metrics
3) Design for performance
4) Design for manufacturing
5) Design for application
6) What scale of production is consistent with (6)?

Project Execution

- One Project assignment is given and divided into parts for concurrent engineering by teams.
- One solution will be submitted per team. All members of the team receive the same project grade.
- Teams will complete four project stages during the term.
  - Plan; Initial Findings; Solution Consistency among Teams; Final Presentation to Panel of Experts
- The final deliverables are:
  - 20 minute presentation (5-10 slides), during which all workgroup members must speak.
  - Two days later, edited slides and a final two-page report.

Principles of Engineering

- Understand *ethical practice* in terms of absolutes, context and the possible.
- Be able to *communicate* with a purpose targeted to an audience.
- Be aware of the *constraints* of public, private and academic practice.
- Be able to apply fundamental *science to system* applications.
- Be able to execute at all levels of design: *problem definition, estimation, figure-of-merit, rules-of-thumb and 'sanity checks'*.
- Be able to execute total system *design for sustainability*.
- Be aware of *robust manufacturing* design: performance, constraints, variation, process capability.
- *Practice through team projects: problem definition, information acquisition, data analysis, tradeoff plots, optimization.*