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optimization, reporting and much more.  
Instructors: J. C. Kallberg, M. N. Se  
University: University of Massachusetts Lowell  
Units: 12.5  
Last: 12.25pm 8/16/14  
Last: 12.2 Appt 8/3/14

Spring 2008 This is a CI course that satisfies the peace requirement.

3.003 Principles of Engineering Practice

# 3.003

# Principles of Engineering Practice



## Engineering the Future of Solar Electricity

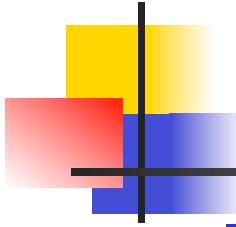
### Project 1A,B

A: Solar Electricity Generation System Constraints

rate limiting factors

B: Materials Selection

Constraints, FOM analysis

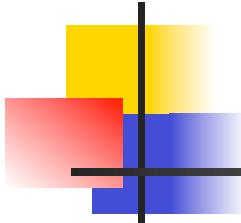


# University of Tokyo

- SolaLoco
  - Koseki vs. Salvucci
- *GridSol*
  - *Toriumi vs. Fitzgerald*

*May 27-June 1*

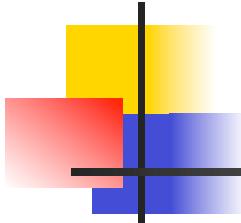
- *Trip to Tokyo*



# Project 1A,B,C,D Execution

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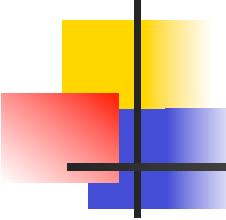
- Each project status review will be presented by a team leader.
  - Take notes from meeting before
  - Manage delivery of commitments
  - Report results to the group (BIRAC format)
    - Goal
    - Progress
    - Next steps
- U Tokyo is part of your team
  - Post on new global website



# Engineering Practice

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



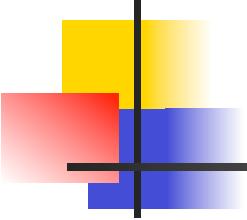
# Engineering the Future of Solar Electricity

## Problem

- What fraction of US/global power consumption?
- Timeline for deployment?
- Markets and applications?
- Roles of Government, Users, Investment, Performance, Sustainability?

## Constraints

- Design-limiting attributes and specifications
  - Figures-of-Merit, estimates, rules-of-thumb

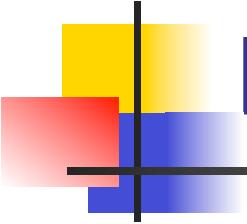


# Project 1A: due 4-6

## Electricity Generation System Constraints

### Applications: FOM Comparisons

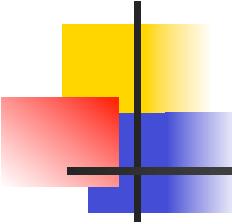
- Strengths
  - Attributes of solar electricity
  - Optimization plot
    - x vs. y with maximum for solar attributes
- Weaknesses
  - Barriers
    - Crossover point to solar advantage
- Competition
  - Local power
    - Gasoline: energy/unit volume



# P1A: Social and Political Factors

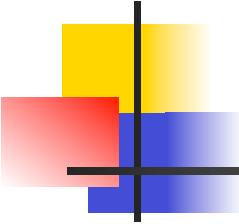
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- Solar technical language
- Solar benefits
  - Availability, security, reduced transmission losses, grid independent, grid load leveling
- Greenhouse reduction
- Jobs



# 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.

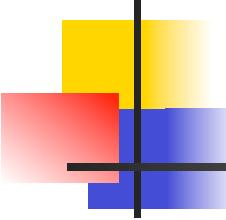


# P1B: Materials Factors

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- Materials

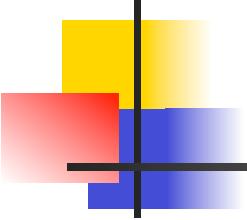
- Absorption: energy gap
- Charge collection: p-n junction, diffusion length
- Reflectance: AR coating, texture
- Current extraction: contacts, shading
- Light trapping: optics



# P1C: Engineering Practice

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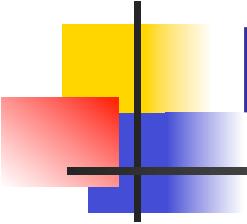
- Module
  - Interconnection, shading, uniformity
- Manufacturing
  - Extraction of materials, process flow, thin film vs. wafer, throughput, yield
- Deployment
  - Reliability
  - Control circuits, compatibility
  - SWAP: size, weight and power
  - Safety, skill set



# Engineering the Future of Solar Electricity

*Teams: local power; grid connected power*

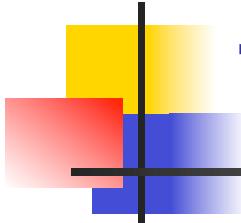
- Project 1A: *due 4-6*
  - Electricity Generation System Constraints
- Project 1B: *due 4-13*
  - Materials Selection
- Project 1C: *due 4-27*
  - Solar Cell Solar Cell Design
  - Module Manufacturing Platform
- Pentachart Summary Presentations: *due 5-4*
- Project 1D: *due 5-6*
  - Final Report and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



# Project Planning

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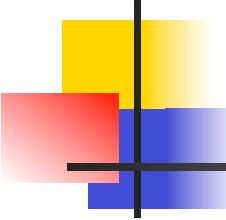
- Timeline
- Resources
- Problem Definition



# The Solar Cell

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- 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

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- 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.

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Spring 2010

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