**Green Development**

**Objective:** Building and communities that are:
- More profitable to build or retrofit
- Less expensive to run
- Healthier and more comfortable to occupy
- More productive to work in

http://video.google.com/videoplay?docid=-2132922994665540382
http://video.google.com/videoplay?docid=-7586231362865604680
The built environment is a significant part of a global problem...

- 12% of fresh water withdrawals (340 billion gallons per day)
- 37% of all energy used, 68% of all electricity
- 60% of raw materials used, 25% of wood harvest
- 50% of fossil fuels consumed
- 35% of CO$_2$ emissions; 49% of SO$_2$ emissions; 25% of CFC emissions; 25% of NO$_x$ emissions; 10% of fine particle emissions
- 40% of non-industrial solid waste
- $60 billion in medical expenses (sick building syndrome)
Green Development

Question:

How and to what extent can we build efficient and convenient infrastructure systems providing optimal service at least cost with minimal negative impacts on the economy, natural and cultural systems for the longest appropriate life spans?
Credible alternatives to engineering solutions as usual

- Cradle to Cradle Approach
- Eco-Efficiency and Effectiveness
- Green Building Concept (LEED rating)
- Eco-materials, Green Materials
- Natural Building Techniques
- Learning from Nature and Native Cultures
- Life Cycle Analysis (LCA)
- Appropriate Technology
What are Green Buildings?

Green buildings are buildings that are environmentally responsible, profitable and healthy places to live and work.

Environmental, Social, Economic Benefits with Proper Planning, Design, Material Selection, Construction
Making the Business Case for High Performance Green Buildings – 10 top economic reasons for green buildings

- In the event that up-front costs are higher they can be recovered through lower operating costs
- Lower operating costs
- Better employee productivity
- Enhance health and well being
- Reduce liability
- Tenant costs can be reduced significantly
Making the Business Case for High Performance Green Buildings – 10 top economic reasons for green buildings

- Property value will increase
- Financial incentive programs are available for green buildings
- Communities will notice your effort
Green construction: (energy-efficient building and office design)

Case study: Pennsylvania Power and Light lighting system retrofit

- RATE OF SICK LEAVE: -25%
- LIGHTING ENERGY: -69%
- ANNUAL OPERATING COSTS: -73%
- WORKER PRODUCTIVITY: +13%
- RETURN ON INVESTMENT: +540%

FROM: Greening the Building and the Bottom Line, Rocky Mountain Institute, 1998.
Leadership in Energy and Environmental Design (LEED) Rating System

- Developed by the U.S. Green Building Council in 1999
- Addresses the impact of a building on natural systems
- Provides standard for what constitutes a green building
- Six categories in the rating system:
  - Sustainable Sites
  - Water Efficiency
  - Energy and Atmosphere
  - Materials and Resources
  - Indoor Environmental Quality
  - Innovation and Design Process

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Natural Building Techniques
Building Materials: Some important factors to consider

- Energy required to produce materials
- Energy required to deliver materials
- Toxicity of the materials
- Environmental impact from extraction and production processes (waste)
- Ability to recycle
- Maintenance required
- Material lifetime