Sustainable Construction, Where We Stand - Education and Research Perspective

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What is “Green” Building?
Design and construction practices that significantly reduce or eliminate the negative impact of buildings on the environment and occupants in five broad areas:

- Sustainable site planning
- Safeguarding water and water efficiency
- Energy efficiency and renewable energy
- Conservation of materials and resources
- Indoor environmental quality

Environmental Impact of Buildings*

- 65.2% of total U.S. electricity consumption ¹
- > 36% of total U.S. primary energy use ²
- 30% of total U.S. greenhouse gas emissions ³
- 136 million tons of construction and demolition waste in the U.S. (approx. 2.8 lbs/person/day) ⁴
- 12% of potable water in the U.S. ⁵
- 40% (3 billion tons annually) of raw materials use globally ⁶

* Commercial and residential

Benefits of Green Building

Environmental benefits
- Reduce the impacts of natural resource consumption

Economic benefits
- Improve the bottom line

Health and safety benefits
- Enhance occupant comfort and health

Community benefits
- Minimize strain on local infrastructures and improve quality of life

Economic Benefits

Competitive first costs
- Integrated design allows high benefit at low cost by achieving synergies between disciplines and between technologies

Reduce operating costs
- Lower utility costs significantly

Optimize life-cycle economic performance

Economic Benefits

Increase building valuation and ROI
- Using the income-capitalization method: asset value = net operating income (NOI) divided by the capitalization rate (return). If the cap rate is 7%, divide the reduction in annual operating costs by 7% to calculate the increase in the building’s asset value
- Quantify financial benefit in terms of Return On Investment (ROI) instead of payback time.

Decrease vacancy, improve retention
- Marketing advantages

Reduce liability
- Improve risk management
**Productivity Benefits**

- Improve occupant performance
  - Estimated $29 – 168 billion in national productivity losses per year.
- Student performance is better in daylit schools.
- Reduce absenteeism and turnover
  - Providing a healthy workplace improves employee satisfaction
- Increase retail sales with daylighting
  - Studies have shown ~40% improvement

**LEED**

Leadership in Energy & Environmental Design

A leading-edge system for designing, constructing, operating and certifying the world’s greenest buildings.

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**Why Was LEED® Created?**

- Facilitate positive results for the environment, occupant health and financial return
- Define “green” by providing a standard for measurement
- Prevent “greenwashing” (false or exaggerated claims)
- Promote whole-building, integrated design processes

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**LEED covers many different types of buildings and construction.**

**LEED-NC**: LEED for New Construction and Major Renovations/Additions (for commercial and institutional buildings, released in 2000)
**LEED-CI**: LEED for Commercial Interiors (public release: Winter 2004)
**LEED-CS**: LEED for Core and Shell (public release: Winter 2004)
**LEED-H**: LEED for Homes (public release: 2006)

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**LEED-NC® in the USA**

Federal Government Use:
- General Services Administration (GSA)
- LEED Certified projects beginning in 2003
- U.S. Air Force
- LEED Application Guide for Lodging
- U.S. Army Corps of Engineers
- Adaptation of LEED SMRT
- Department of State
- Department of Energy (DOE)
- Environmental Protection Agency (EPA)
- Grant for LEED Existing Buildings
- U.S. Navy
  - Grant for LEED Residential

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**Why Was LEED® Created?**

- Use as a design guideline
- Stimulate green competition
- Establish market value with recognizable national “brand”
- Raise consumer awareness
LEED-NC® in the USA

State Government Use*: California, Maryland, Massachusetts, New Jersey, New York, Oregon, Pennsylvania, Washington

Local Government Use*: Austin, TX, Arlington, VA, Boulder, CO, Chicago and Cook County, IL, Los Angeles, CA, Portland, OR, San Jose, CA, San Francisco, CA, Seattle, WA

*Not limited to these examples

Technical Overview of LEED®

- Green building rating system
- Existing, proven technologies
- Evaluates and recognizes performance in accepted green design categories
- LEED product development includes existing buildings, commercial interiors, multiple buildings, core & shell, homes, etc.

Technical Overview of LEED®

- Whole-building approach encourages and guides a collaborative, integrated design and construction process
- Optimizes environmental and economic factors
- Four levels of LEED-NC certification:
  - Certified Level: 26 - 32 points
  - Silver Level: 33 - 38 points
  - Gold Level: 39 - 51 points
  - Platinum Level: 52+ points (69 possible)

LEED-NC® Point Distribution

Five LEED credit categories

National Association of Home Builders (NAHB) Green Ratings for Homes

- Three Levels (Bronze, Silver, Gold)
- Seven General Criteria

National Association of Home Builders (NAHB) Green Ratings for Homes (Cont.)

- Lot Design, Preparation and Development
- Resource Efficiency
- Energy Efficiency
- Water Efficiency
- Indoor Environmental Quality
- Operation, Maintenance, and Homeowner Education
- Global Impact
Sample of Sustainable Construction Related Courses in US

- Sustainable Building Method – Penn State – Concepts sustainable and green design
- High-Performance Green Building Delivery Systems – University of Florida – Overview of high performance green buildings, LEED criteria discussed in detail

Sample of Sustainable Construction Related Courses in US (Contd.)

- Sustainable Practice: Design and Construction – Colorado State University – Covers design, construction, energy, economic issues etc.
- Sustainable Construction -Texas A & M Univ. - Covers sustainable construction methods and materials includes international perspective
- Sustainable Construction – Southern Polytechnic State University – Covers primarily LEED certifications and related issues
- Sustainability – Carnegie Mellon University – Covers concept, overview, attitudes and values
- Sustainable Facility System -Virginia Tech – Introduces means, methods, and analytical practices associated with sustainable built environment

“Sustainable” Construction Management Curriculum

- Sustainable Site
  - Site Planning (ARC363)
  - Soils (CON302)
  - Hydraulics (CON303)

- Water Efficiency
  - Site Planning (ARC363)

“Sustainable” Construction Management Curriculum (Cont.)

- Energy and Atmosphere
  - Mechanical, Electrical, and Plumbing (ARC262)
- Materials and Resources
  - Materials and Methods of Construction I and II (CON161 and CON162)
- Indoor Environmental Quality
  - MEP (ARC262)
Research Perspective – Funding Level for Green Buildings
- 0.2% of all federally funded research (about $193 M on average)
- Dept. of Energy – 4% of the research budget
- EPA – 4% of the research budget
- <0.1 of NSF research budget

Research Perspective – Research Agenda
- Delivery Process and Performance Evaluation
- Integrated Building Systems
- Buildings’ Interaction with Local Environments
- Buildings’ Interaction with Occupants

Delivery Process and Performance Evaluation
- Building Delivery and Operation Process
  - Barriers in Multi-disciplinary Approach in Building Delivery System
  - National Building Information Modeling Standard
- Performance Metrics and Evaluation
  - Characterize the Value of Sustainable Attributes of Buildings

Delivery Process and Performance Evaluation (Cont.)
- Economic and Financial Value of Sustainable Buildings
  - Identifying the Costs and Benefits of Sustainable Construction Within a Financial Model
  - Economic Impact of Policies and Standards related Sustainable Construction

Integrated Building Systems
- Building Form and Envelope
  - Developing Strategies and Technologies for Advanced Envelope Components and Systems
- Lighting and Day lighting
  - Minimizing Energy Use and Power Demand
  - Testing of Effective Light/day light Control Systems

Integrated Building Systems (Cont.)
- Passive, Active and Hybrid HVAC and Controls
  - Innovative climate based HVAC strategies
- Materials Life Cycle Assessment
  - Life Cycle Impact Assessment Methods for Indoor Air Quality, Land Use, Water Use etc.
- Water Use and Management
Buildings’ Interaction with Local Environments
- Ecosystems and Site Design
  - Optimize Landscaping Strategies for Brownfield Restoration
- Land Use, Location, and Transportation

Buildings’ Interaction with Occupants
- Indoor Environmental Quality: Pollutants and Stressors
- Indoor Environments Quality: Occupant Health and Productivity

Next Step
- Stay Tuned for the rest of the symposium
Sustainable Construction - 2013

- Assess current academic construction practices taught in SUNY system
- Identify the relevant environmental issues to construction education
- Identify the key industrial needs from academia regarding sustainable construction
- Identify new promising trends for education & scholarly services in this field

Construction Data - SUNY

- 10 two year degrees - construction
- 3 four year degrees - construction
- 7 two year architecture degrees
- 3 four year architecture degrees
- 6 two year civil degrees
- 2 four year civil degrees

Current Academic Practices

- A course in Environmental Engineering
- Elective area of study

Relevant Environmental Issues In Construction Education

- Hazardous waste disposal
- Recycling and landfills
- Stormwater runoff & erosion control
- LEED & Sustainability
- Others?

- Traditional Environmental courses are more scientifically based and may include water & wastewater courses.

Curricular Demands

- SUNY requirements
- Local campus requirements
- Accreditation requirements
- Program objectives
- Faculty and advisory boards weigh course tradeoffs
**Sustainability - Who Is Responsible?**

- Large percentage of points are addressed in design
- Contractor needs to be aware
- Owner - ultimately must “buy” in

**Proposal - Integration**

- Integrate green/sustainability into existing courses
- Industry provide examples??

**Integration Based Upon LEED**

1. Sustainable sites:
   - Erosion & sediment control - NYSDEC
2. Building commissioning
3. Construction waste management
4. Recycled content materials

**Integration Based Upon LEED (cont.)**

5. Regional materials
6. Certified wood
7. Construction IAQ management plan
8. Low emitting materials

**Where from here?**

- Plan to grow sustainable construction education
- How to partner with industry

**Thank you!!**

Questions??
Comments??
Thoughts??
Introduction
- What are Green Highways?
- Why Green Highways?
- History
- Elements
- Re-usable Materials
- Innovative Techniques/Materials
- Conclusion

What is a Green Highway?
A Green Highway integrates transportation functionality and ecological sustainability.
- Components of a Green Highway
- Made with permeable materials
- Utilizes recycled materials
- Restores natural watershed areas
- Minimizes impact to in-situ locations

Why Green Highways?
- Lower energy use
- Less emissions
- A decreasing amount of quality water
- Lower the impact that infrastructure expansion will have on the ecosystem
- It is our duty!!!!

History
- “Green” is a new name on some older ideas
- SHPPO and Environmental Agency requirements.
- Spoils with no home, Lack of C&D landfills to place material caused recycling revolution on civil sites.
- Money (Municipalities and DOT’s stretching there dollar)

Elements of a Green Highway
- Permeable materials
- Materials to control storm run-off and erosion control
- Materials to improve quality of run-off, reducing oils and volatiles
- Takes into effect habitat with seasonal limitations on waterways work and tree removals
- Construction of wetlands
- Construction of context sensitive elements
Permeable Materials

Urban Heat Island (UHI). Water on pavements raises urban temperatures an average of 2-10 degrees F.

Source: www.pavegreen.com

Storm Run-off Control

Other Considerations:
- Temporary seeding
- Stormwater diversion structures
- Detailed inspections weekly and after 0.5 inch rain events

Water Quality

Bioretention Soil
Wildlife Considerations

Indiana Bat: Endangered Species
Contract documents have seasonal limits on clearing and tree removals

Other considerations are taken when working near water to consider fish spawning periods and when fish are dormant

Recycled Materials

- Embankments
  - Crushed concrete
  - Recycled Asphalt Pavement (RAP)
  - Shredded Tires
- Subbases
  - Rubblized concrete
  - Recycled Asphalt Pavement (RAP)
  - Furnace Slag
- Pavements
  - Recycled Asphalt Pavement (RAP)

Subbases (Rubbilization)

Method of pulverizing PCC Pavement using a resonate breaking machine. Vibration works from bottom up creating a crushed stone type of material to be graded and resurfaced.

Wetlands Construction

Shredded Tires

Pavements

Recycled Asphalt Pavement (RAP)

- Process of milling asphalt, adding liquid and resurfacing
- Process can be cold in place or batched
- Low energy and cost effective
- Suite-Kote Corporation of Cortland, New York
Typical Road Section

Potential Green Section

Other Areas of Interest
- Low Energy Asphalt (WMA)
- Automated Equipment (smoother riding surfaces)
- Making roads smarter vs. wider
- Bio-Diesel Equipment
- Destiny has been on the cutting edge of green site-civil construction.

Where to Go?
- People need to understand that this is not a fad, we need to instill a completely new mindset.
- With buy in will come innovation
- Standards are still being developed but will be constantly changing due to increase in the problem (funding for infrastructure upgrades)
Managing LEED on the Cayuga-Onondaga BOCES Project

Managing LEED on the Cayuga-Onondaga BOCES Project

Joseph W. Delaney, P.E., CCM
Dr. David T. Boyle

AGENDA

- Managing LEED
  - Project Description
  - LEED Program
  - LEED Project Controls
- Owner’s Perceptions
- Lessons Learned
- Questions Comments

Project Description

- **Scope**: 192,000 square-foot, new area Occupational Center for the Cayuga-Onondaga BOCES. Located on a new 45-acre campus, replaces 36-year-old facility. Scope also includes relocation of equipment and furnishings.
- **Cost**: $43 million
- **Schedule**: 10 months for design, 15 months for construction.

Cayuga-Onondaga BOCES

Leadership in Energy and Environmental Design (LEED)

- Define green building
- Promote integrated design
- Recognize environmental leadership
- Stimulate green competition
- Raise consumer awareness
- Transform the building market
Why LEED on the BOCES Project?

- Promote state-of-the-art building technologies
- Demonstrate emerging technologies
- Save on energy costs
- Improve indoor air quality
- Minimize negative impact of the building on the environment
- Bring positive recognition to the BOCES

LEED Certification Point System

- Innovation and Design Process (5)
- Indoor Air Quality (15)
- Materials and Resources (13)
- Energy and Atmosphere (17)
- Water Efficiency (5)
- Sustainable Site (14)

Managing LEED - Project Controls

- Documentation
- Cost Control
- Schedule Control
- Quality Control

Communications - Documentation

- LEED Matrix
- Construction Phase Credits
- LEED Letter Templates

LEED Matrix
Construction Phase Credits

- **Waste Management**
  - 75% of all waste diverted from landfills
  - Waste management plan
  - Document compliance

- **Local and Regional Materials**
  - 20% of materials manufactured within 500 miles
  - 20% of those also extracted within 500 miles
  - Document compliance

- **Construction Phase Indoor Air Quality**
  - Best practices
  - Building flush out
  - Document compliance

Cost Control

- The LEED process affects the life cycle cost of the facility.
  - Likely will increase capital costs
  - Likely will reduce operating and maintenance costs

- Must establish a budget for the LEED credits being pursued.
- Perform detailed estimates for alternatives to establish which credits to pursue.

Schedule Control

- Already aggressive schedule
  - 10 months for design
  - 15 months for construction

- Design must encompass the elements to obtain the LEED credits

- Construction impacts
  - Geothermal system
  - HVAC flush out procedure

Cost vs. Budget

<table>
<thead>
<tr>
<th>LEED as a % of Construction Costs</th>
<th>Cayuga-Onondaga BOCES (3.6% of total)</th>
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<tbody>
<tr>
<td>Construction Phase IAQ</td>
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<tr>
<td>Construction Waste Management</td>
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<td>Geothermal Heating System</td>
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<td>Other Design Enhancements</td>
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<tr>
<td>LEED Administration</td>
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<tr>
<td>Commission</td>
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Quality Control
- Integrated Design Approach
  - High level of interaction among design disciplines.
  - Employ innovative technologies.
- Building Commissioning Process
  - Prerequisite to certification
  - Commissioning authority
  - MEP equipment must be designed, installed, and calibrated to operate as an integrated system.

Owner’s Perceptions
- Start the process early
- Designate a LEED Champion
- Use project site as real-time classroom
- Use LEED to Plan

Educational Use of Project Site
- Geo-Thermal Curriculum
- Solar Energy
- Alternative Fuel Station
- Bio-digester Partnership

Hire The CM Early
- Voter Approval 12/14/04
- Complete Design 1/9/06
- SED Approval 2/17/06
- Distribute Bid Packages 2/23/06
- Commence Construction 4/17/06
- Occupy Campus 9/1/07

You Need a LEED Champion
- Geothermal heating/cooling system
- Geothermal heated sidewalks
- LEED certification initiative
- Building flush out
- Boiler capacity reduction
- HVAC system compatibility

Time/ Cost Matters
<table>
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<tr>
<th></th>
<th>Conceptual Estimate May-01</th>
<th>CM Estimate January-06</th>
<th>Bid Results March-06</th>
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<tr>
<td>General Contractor</td>
<td>$21,740,100</td>
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<td>HVAC</td>
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<td>$26,352,950</td>
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LEED Impact on Planning

• Cost within $3,200 on $42.1 million project
• Rejection of all “down-sizing” options
• Upgrade of the roofing system
• LEED accreditation
• Building flush out and full commissioning of HVAC system
• Numerous other green features

Lessons Learned

• Engage CM early on in the LEED process
• The Owner should establish the guiding principles for the LEED program.
• The LEED process needs a champion
• Establish a responsibility matrix with ball-in-court
• Establish a budget for the LEED credits being pursued

Lessons Learned - Continued

• Start the documentation process early on. Consider an interim submission.
• Utilize an integrated design approach.
• Create a master CPM.
• Create special provisions for the construction phase LEED credits.
• Utilize LEED and commissioning to enhance project quality.

Thank you!

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Questions and Comments