Sustainable Buildings

Course Number: SU-02-203

PDH: 4

Approved for: AK, AL, AR, DE, FL, GA, IA, ID, IL, IN, KS, KY, LA, MD, ME, MI, MN, MO, MS, MT, NC, ND, NE, NH, NJ, NM, NV, NY, OH, OK, OR, PA, SC, SD, TN, TX, UT, VA, VT, WI, WV, and WY

State Board Approvals

Florida Provider # 0009553 License #868
Indiana Continuing Education Provider #CE21800088
Maryland Approved Provider of Continuing Professional Competency
New Jersey Professional Competency Approval #24GP00025600
North Carolina Approved Sponsor #S-0695
NYSED Sponsor #274

How Our Written Courses Work

This document is the course text. You may review this material at your leisure before or after you purchase the course.
After the course has been purchased, review the technical material and then complete the quiz at your convenience.
A Certificate of Completion is available once you pass the exam (70% or greater). If a passing grade is not obtained, you may take the quiz as many times as necessary until a passing grade is obtained).
If you have any questions or technical difficulties, please call (508) 298-4787 or email us at admin@PDH Pro.com.

Module 1: Introduction

Learning Objectives

By the end of this section, you will be able to:

- **Evaluate** the environmental and economic impacts of conventional versus sustainable building practices.
- **Analyze** the benefits of integrated design and pre-construction planning in reducing lifecycle costs.
- **Identify** the specific regional resources and microclimate advantages available for green building in San Mateo County.

Executive Summary: Transitioning to sustainable building practices addresses the significant environmental footprint of the built environment—responsible for 25% of atmospheric CO_2—while simultaneously improving occupant productivity and reducing both initial construction and long-term operating costs through strategic "Integrated Design."

Technical Overview: Impacts of the Built Environment

Conventional building practices have profound impacts on regional infrastructure and the global environment. On average, standard construction generates **2 to 2.5 pounds of waste per square foot** and contributes significantly to carbon emissions. By implementing better building practices, Professional Engineers can:

- **Reduce infrastructure burdens** and local waste stream volume.
- **Enhance indoor air quality (IAQ)** and natural lighting levels.
- **Improve occupant health**, resulting in lower absenteeism and higher testing scores in educational facilities.

For commercial owners, the investment in green building is often recouped through productivity gains that can exceed the project’s total construction cost over the building's lifecycle.

Green Building in San Mateo County

San Mateo County serves as a premier location for green building due to a high density of expertise and favorable environmental conditions.

Regional Engineering Resources

- **Expertise:** The county and its neighbors host the largest concentration of green building professionals and material suppliers in the country, reducing the "cost premiums" often associated with sustainable materials.
- **Climate Utilization:** The outdoor climate is temperate for much of the year, allowing for comfortable indoor spaces with minimal energy loads for heating and cooling.
- **Microclimate Response:** Engineers can design specifically for diverse microclimates, from coastal zones to mountain-top environments.
- **Site Integration:** Projects can utilize public transit systems, walkable town centers, and local biodiversity in landscaping and site plans.

Design Fundamentals: Planning Ahead

The most critical phase of the building process occurs during the **design stage**. Decisions made here dictate the performance of the building for its entire life.

Optimization Strategies

- **Cost Management:** Studying alternatives during design is the most effective way to find solutions. Conversely, changes made during construction are the primary cause of budget overruns.
- **Space Efficiency:** Through careful analysis of actual functional needs, projects can often reduce square footage without sacrificing utility.
- **Standardization:** Utilizing conventional 2-foot dimensions of milled lumber in layouts can save approximately **$1.20 per square foot** in wood-framed construction.

⚠️ **Safety Constraint:** Sustainable decisions regarding overall size, material types, and mechanical systems must be committed to during the design phase. Once ground is broken, the project is committed to its systems, and the opportunity for high-level efficiency benefits is largely lost.

Photo: Philippe Cohen

The Leslie Shao-ming Sun Field Station was designed with a goal of net zero carbon emissions on an annual basis, a goal which they are monitoring and reaching. To accomplish this, the lower set of solar collectors on the building have a dual role: heating the building in the winter and shading the windows in the summer. The roof mounted photovoltaic panels turn sunlight into electricity for the building. The integrated design of both passive and renewable sources of heat and energy resulted in a building where only the herbarium requires air conditioning.

Integrated Design ("Whole Building Design")

Integrated design requires viewing the building as a series of interrelated systems—structural, mechanical, electrical, and interior finishes—rather than isolated components.

Engineering Applications of Integrated Design

- **Passive Ventilation:** Using operable windows allows for the reduction of expensive ductwork and air handler sizing.
- **Thermal Mass:** Incorporating the thermal mass of concrete structural members can slow indoor temperature fluctuations, mitigating the need for conventional AC.
- **Resource Synergy:** Sloping roofs can simultaneously provide daylighting and funnel rainwater for irrigation storage.

💡 **Design Tip:** Effective integrated design requires early-stage collaboration. For example, reducing electrical lighting loads via daylighting requires coordination between the architect (glazing), the electrical engineer (lighting controls), and the mechanical engineer (HVAC load calculations).

🧮 **Calculation Note:** The Leslie Shao-ming Sun Field Station serves as a benchmark for space optimization. By analyzing functional requirements, the design team reduced the footprint from 12,000 square feet to 9,800 square feet.

Equation 1-1:

$$C_{\mathrm{sav}} = \frac{A_{\mathrm{orig}} - A_{\mathrm{final}}}{A_{\mathrm{orig}}} \times 100$$

Where:

- **Csav** = Percentage of construction cost/material saving (%)
- **Aorig** = Original estimated area (sq. ft.)
- **Afinal** = Final optimized area (sq. ft.)

Calculation: ((12,000 - 9,800) / 12,000) * 100 = 18.3% reduction in construction costs and material consumption.

How to Use This Manual

The guidelines and checklist are organized into thirteen technical areas following a standard construction sequence:

1. **Planning & Site Work**
2. **Foundations and Framing**
3. **Systems and Interior Finishing**

Engineers should use these guidelines to inform **written specifications**, ensuring green materials and methods are documented as project requirements in advance.

Checkpoint Quiz

1. **According to the text, what is the primary reason projects exceed their budgets?**
   a) High cost of green materials
   b) Making changes during the construction phase
   c) Regulatory delays in San Mateo County
   d) Over-engineering mechanical systems

Answer: (b). The text states that making changes during construction is the most common reason for budget overruns.

2. **Which strategy allows for the reduction of mechanical ductwork and air handler size?**
   a) Using triple-pane windows
   b) Implementing operable windows as part of the ventilation system
   c) Increasing the insulation R-value
   d) Using fly ash in the concrete foundation

Answer: (b). Integrated design allows operable windows to replace or supplement mechanical ventilation, reducing equipment size.

3. **What is the estimated cost saving per square foot for a wood-framed house laid out on conventional 2-foot dimensions?**
   a) $0.50 per square foot
   b) $1.20 per square foot
   c) $2.00 per square foot
   d) $3.50 per square foot

Answer: (b). Planning ahead for 2-foot dimensions of milled lumber saves approximately $1.20 per square foot.