Green BIM Meets Design-Build

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Sustainability: The New Moral Obligation

Local

- Sustainable Living
- Community Assets
- Good Jobs

Global

- More Money
- Reliable Clean Energy Supplies
- Quality of Life for Everyone
- Lower Greenhouse Gases
- An Abundant and Healthy World
- Quality of Life for Community

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Sustainable Design Goes Beyond Green

- Design Matters
- Alternative Energy & Distributed Power System
- Cultural Commitment to Sustainability
- Integration of Planning, Design, Construction & Operations
- Collaboration
- Codes & Regulations
- Adaptive Reuse of Existing Building

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“A new business model for construction management is emerging and will become the norm over the next five years. This model responds to owners’ increasing focus on outcomes rather than output, on life cycle rather than first cost, and on the ‘triple bottom line’ of business, environmental and social impacts.”

-CMAA Foundation, Future Focus 2012: The Road Ahead for Professional CM
The Importance of Life Cycle

Key Considerations:

- Good fabrication is critical regardless of fabrication location
- Life span of building determines the durability of the façade
- ROI
- Environmental impact
- Techniques:
  - Life cycle assessment (LCA)
  - Life cycle cost analysis (LCCA)
- Establish benchmarks
- Whole-building approach
- Embodied energy
Full Integration

**DESIGN**
- Energy analysis
- Develop Commissioning processes
- System specifications

**COMMISSIONING**
- Test & verify systems
- Training of maintenance staff
- 3D as-built model with product data, warranty info, etc.

**OPERATIONS**
- Inventory of physical assets
- Update asset database
- Scheduled maintenance
- Continuous monitoring of systems

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“Opportunities for green architectural strategies are rife in the conceptual and schematic design phases. They are sparse during design development.”

BIM Energy Modeling & Analysis

- Energy analysis can be performed on a 3D model during conceptual design
- Design changes can be made early to optimize energy usage
- The architect and MEP engineer work collaboratively early in the design process rather than later
- Energy analysis is now a science
- Different building systems and loads impact each other and overall building performance
- Building design and energy analysis data can now be linked
BIM Performance Analysis: Key Value

- Ability to manage an enormous amount of parameters and variables
- Ability to model over time and to account for the change in seasons
- Allows new building forms to be explored
- Early analysis (at the conceptual level) and feedback
- Links analysis data to schedule and cost
- Performance can be determined early
- Early involvement of fabricator and builder
- Helps develop early procurement strategy
BIM Simulation Process

- Create 3D model
  - Establish roof and floor
  - Connect walls to roofs or floor above
  - Make sure all areas within the analysis are geometrically bound
- Collect any relevant operational data or history
- Determine appropriate simulation or analysis tools
- Consult with mechanical engineer to interpret data
- Establish methodology for transferring model surface areas to multiple analysis tools
- The simulation team must input variables outside of the space of boundaries (weather, location, etc.)
How Can BIM Help?

- Daylighting Analysis
- Environmental Air Quality
- Sustainable Site Development
- Sustainable Materials
- Water Conservation & Harvesting
- Renewable Energy
- Passive Heating
- Computational Fluid Dynamics
Daylighting Analysis

- 3D model is used for geometry generation
- External shading devices can be analyzed
- Several daylight simulation applications available
- Variables can be changed and tested using BIM
- Daylight analysis provides data about the quality, evenness, and penetration of light
- Daylight autonomy
Environmental Air Quality

- Natural ventilation reduces energy usage
- Fresh air improves air quality
- BIM assists in designing a system that uses natural ventilation as much as possible

**Important design factors:**
- Building site location and orientation
- Building mass
- Window types and locations
- Efficiency of building envelope
Sustainable Site Development

- Building location and site orientation can be analyzed using BIM
- Sun provides light, heat, and power for free
- Building mass and dimensions
- External elements (shading devices and landscaping)
- Rainwater collection
- Find the solar south
Sustainable Materials

- Materials require energy to manufacture and install
- Limitations on the raw resources to produce building materials
- Material usage justification is needed
- Materials have diverse impacts regarding energy and water usage
- Material selection affects human health
- What is the life span of the material or assembly?
- Is the material made from recycled content?
Water Conservation & Harvesting

- Rainwater is a free resource
- Reduce the need for municipally provided water
- Rainwater can be collected from the roof, parking lot, or site runoff
- Storage in cisterns
- Rainwater usage:
  - Irrigation
  - Toilets
  - Chillers
- Historical data and analysis allows calculation of how much rainwater is available
- Analysis of project’s water needs determines the necessary amount of storage systems
Renewable Energy

- Energy demand must be known in order to optimize the use of renewable energy sources
- Solar and wind energy depend on climate and place
- Testing for wind and solar capability should be done at the micro-site level
- Other considerations:
  - System and equipment efficiency
  - Space needs for solar or wind power equipment
  - Maintenance capabilities
  - Performance monitoring
Passive Heating

Dynamic Thermal Modeling

- Simulates the heat transfer processes occurring in and around a building
- Models conduction, convection, and radiation heat transfer processes of envelope components
- Modeling data is integrated with room heat gains, air exchanges, and HVAC
- Ideally suited to work with a 3D model
- Modeling of radiant heat transfer can determine its impact on occupant comfort
- Predict contaminant dispersion and smoke migration in and around buildings
- Study the long-term effects of diurnal heating
- Visualize where condensation occurs and the amount of liquid that is condensed

Example: Autodesk Ecotect Analysis

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Computational Fluid Dynamics

- Branch of fluid dynamics
- Uses numerical methods to predict fluid flow
- Requires millions of calculations
- Used to understand airflow and heat transfer processes around buildings given space boundaries
- Used in single instances of time due to time needed to perform computations
- Can be used to provide detailed insight into specific parameters
- Helps determine velocity and temperature of airflow through openings and into adjoining spaces

Associative exchange of Revit data with Autodesk Simulation CFD
Considerations for BIM Selection

- Capable of conceptual-level analysis
- Capable of importing of programmatic information (XML)
- Model import capability (2D or 3D) via gbXML
- Model can be build within the application (start from scratch or trace over 2D CAD)
- CFD is 3D, not just 2D
- What is the computational engine based on?
- Multi-core or cloud computing capability for faster processing
- Can select specific equipment (either listed or imported information)
- Capable of LEED® analysis
- California Title 24 2014
- Consulting services
Design-Build for Green Retrofits

- Definitions
- Benefits of green retrofit and current market
- Design-build approach to green retrofits
- Software tools for green retrofits
- Case study: Swinerton San Diego office

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Definitions

**Design-Build** is an integrated approach that delivers design and construction services under one contract with a single point of responsibility.

New Construction

**Green Retrofits** are those that result in significant improvements to existing building performance in terms of energy, water, and human health and fundamentally enhance the building value.
Green retrofits are expected to triple to an $18 billion market by 2015 in major projects alone.
Green retrofits can be completed with no money out of pocket and can be cash-flow positive from year one with new innovative financing methods such as PACEnow.

When the financed amount is paid off, there are years of significant savings ahead.

Doing nothing costs money.
Benefits of Green Retrofits

ADD VALUE ASSET

- Increased workplace productivity and health
- Compliance with legislation; risk mitigation
- Ability to secure financing
- Lower operational costs
- Lower maintenance costs
- Better corporate image and prestige

Increased marketability and rental income
The Value of Green Labels

Added value of green labels in commercial buildings in the US

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**Sources:**
- Institute for Market Transformation, 2011. Premium calculated as average of estimates reported in five independent studies.
Other Market Drivers

Energy Disclosure Policies

Source: http://www.buildingrating.org/content/us-policy-briefs

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Other Market Drivers

**Codes & Challenges**

- **Better Buildings Challenge**
  - 20% reduction in energy use by 2020
    - [http://energy.gov/better-buildings](http://energy.gov/better-buildings)

- **California’s Best Buildings Challenge**
  - 20% reduction in energy, water, and waste by 2014

- **Architecture 2030**
  - 100% carbon neutral by 2030
    - [www.architecture2030.org](http://www.architecture2030.org)

- **California Green Building Code**
  - [www.bsc.ca.gov](http://www.bsc.ca.gov)
One-stop shop, single point of project responsibility

Integrated approach:

- Benchmarking
- Auditing
- Design and engineering
- Rebates
- Financing
- Procurement
- Construction
- Green building certification
- Operations verification
**US EPA ENERGY STAR Portfolio Manager®**

Ranks a building’s performance on a scale of 1–100 to identify its potential for improvement.

Requires actual energy consumption and very basic building data (square footage, % of occupancy, etc.).
Design Modeling Tools

- DOE EnergyPlus 8.0.0
  (free download at http://energy.gov)

- IES (Integrated Environmental Solutions)

- Autodesk Green Building Studio

- Bentley AECOsim Building Designer and Energy Simulator
Operations Tools

Time to Invest in Smart Building Management

- Wireless sensors and cloud computing have made smart building management affordable
- Sensors collect data from equipment and transmit it to a single command center, including when equipment needs to be replaced or is close to failure
- This “continuous commissioning” pays for itself in 1 to 2 years
LEED Certification Tools

- **IES TaP**: Collaboration portal with analytical calculation tools that create LEED-ready documentation; great for energy calculations

- **AECOsim Compliance Manager**: Centralized LEED storage and submissions; includes checklists, wizards, calculators, and supports Google Maps for project location and materials distance calculations for local sourcing

- **GreenWizard**: Connects to LEEDonline for submission and provides a library of products that can be shared among different projects within the same firm
Case Study: Design-Build to Net Zero

The Swinerton San Diego Office Project
Every Journey Has a Starting Point

Planning → Business Drivers → Vision & Innovation

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Planning Stage

Project Success Is Won or Lost in This Phase
Interior vs. Exterior Renovation
Strategy: HVAC

Analyze Initial Costs vs. Lifecycle Costs

- Photovoltaic Panels
- Energy Monitoring
- Hot Water
- Heating & Cooling
- Ventilation
Strategy: Design

- Using building modeling technology to support continuous collaboration and “visualize the future”
- Design reflects Swinerton’s desire for a fresh, progressive, and modern space
- Cost control
Strategy: Construction

- It’s all about the details
- Key trade contractors
- Self-performing work
Strategy: Facility Operations

It’s Different When You Have to Pay the Bills

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Key Design Features

- Attract young, innovative employees
- Localized branding
- Openness leads to collaboration
- Private vs. public space
- Where is the kegerator? Event space
- “Fresh and timeless” design inspiration
- 18’ high ceilings
Lighting Strategy

**Natural Lighting** “Let the sun shine…”

**Artificial Lighting** “Less is more…”
Achieved through GPS-tracked skylights
Solar Distributed Power System

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Flexible Workstations
Summary and Conclusions

- Building has become a model for adaptive reuse
- High-performance buildings can only be achieved through integration
- Improved employee satisfaction and recruiting efforts
- Achieved balance between sustainability, technology, and vital work environment
- Sustainable design can be beautiful
- Seeking LEED Platinum certification
- 100% of energy costs offset by 75 kW solar array