Mind the Gaps: Post-Occupancy Discoveries from Design to Operation

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BuildingEnergy Boston

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Agenda

Introduction

What is Post-Occupancy Evaluation?
  ◦ Value Proposition
  ◦ Process

Case Studies
  ◦ Commercial: Parks & People
  ◦ Multifamily Residential: Radian
  ◦ Science & Technology: Shire Genetics Lab

Wrap-Up / Recap
About the Speakers

Patrick Murphy, PE, LEED AP BD+C
• MEP Project Manager and Senior Mechanical Engineer
• 10 years’ experience designing high-performing buildings, including more than 20 LEED projects, including three LEED NC Platinum projects and one net zero off-grid project.

Chuck Stellberger, PE, LEED AP BD+C
• Mechanical Engineer and Energy Modeler
• Energy modeling, energy audits, and sustainability consulting across commercial, laboratory, and healthcare projects, including more than 20 LEED projects.
About the Company

Vanderweil Engineers is a full-service MEP/FP and technology design firm headquartered in Boston with over 400 employees committed to delivering high-performing, sustainable buildings.
Learning Objectives

1. To understand the value proposition of post-occupancy review.
2. To learn the process by which owners and MEP engineers execute a post-occupancy program.
3. To learn about common findings in MEP-based post-occupancy reviews.
4. To understand how the findings from post-occupancy reviews can affect future designs.
Agenda

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  ◦ Science & Technology: Shire Genetics Lab
  ◦ Multifamily Residential: Radian

Wrap-Up / Recap
What is Post-Occupancy Evaluation (POE)?

• POE is a high-level evaluation of MEP system performance and overall occupant experience.

• The project team revisits the site 1-3 years after substantial occupancy.

• The project team issues a report summarizing findings and makes recommendations for improvement.
Value Proposition: Client

- Engages the design team during/beyond the warranty period
- Enhances owner understanding of their building and design intent
- Provides recommendations for improved operations
- Outlines corrective actions for issues
Value Proposition: Design Team

- Solicits candid feedback on building design, maintainability, and performance
- Analyzes real-life performance data to evaluate design decisions
- Follows up on commitments made by the project (EUI, IEQ metrics, etc.)
Value Proposition: Design Team

- Incorporates lessons learned into future designs
- Deepens the client relationship
- Opportunities to conduct energy audits and retrocommissioning
How is POE Different From...

• ...M&V or an energy audit?
  • POE is not focused solely on energy consumption
  • POE does not include energy model calibration

• ...retro-commissioning?
  • POE occurs before retro-Cx
  • POE does not alter system operations

POE is a higher-level and shorter process than either of these activities.
POE Process

- Follow up with the owner 1-3 years after occupancy
- Outline POE process and value proposition
  - Send questionnaire
  - Request utility data
  - Schedule site visit
- Evaluate utility data, compare to energy model
POE Process

• Conduct site visit:
  • Interview owner and occupants
  • Interview facilities staff
  • Inspect the building systems
POE Process

- Issue report with findings and corrective actions
- Follow up with owner to review findings and next steps
POE Process

Questionnaire and Interviews

- Building controllability and complexity
- Equipment maintenance and warranty issues
- Energy performance
- Physical installation
- Project closeout & training
- Occupant comfort
- Overall occupant experience

<table>
<thead>
<tr>
<th>Assessment Area</th>
<th>Score (out of 5)</th>
<th>Notes</th>
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</thead>
<tbody>
<tr>
<td>General System Performance:</td>
<td>★★★</td>
<td>Controls issues stem from the user interface and the interaction between the master controls and the individual systems control.</td>
</tr>
<tr>
<td>Building Controllability:</td>
<td>★★★</td>
<td>The Energy performance has not been calibrated with the model. However, the overall energy use for the whole building is in line with the model.</td>
</tr>
<tr>
<td>Energy Performance:</td>
<td>★★★</td>
<td>There have been a few issues with actual installation. However, the water heater was placed in a way that has made the access to instantaneous hot water slightly difficult. The hot water tank is a few minutes to store in the showers that are across the building.</td>
</tr>
<tr>
<td>Physical Installation:</td>
<td>★★★</td>
<td>The building has been well maintained although the controls specialists have not been easy to be in contact with. A potential next step would be to work with RMS to determine whether lighting controls are available.</td>
</tr>
<tr>
<td>Project Closeout:</td>
<td>★★★</td>
<td>The occupants have been very satisfied with room-level thermal comfort, temperature control, and layout. The lighting fixtures have been an issue occasionally but the lights can be dimmed and tend to alleviate the problem.</td>
</tr>
</tbody>
</table>
POE Process

Report and Follow-Up

- Document questionnaire and interview findings
- Provide analysis of energy performance vs.
  - Modeled design
  - Similar buildings (i.e. Benchmarking)
POE Process

Report and Follow-Up

- Suggest corrective actions
- Review lessons learned
- Celebrate what went right!
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Wrap-Up / Recap
Case Study #1
The Sally & Butch Michel Center for Parks and People
Baltimore, MD
Case Study #1
Center for Parks and People

Parks and People is a Baltimore non-profit which works to revitalize neighborhoods and communities through hands-on cleaning and greening of the natural environment.
Case Study #1
Center for Parks and People

- Historic renovation of Park Superintendent House
- New construction of offices and community rooms

Headquarters building (10,000 SF)
Superintendent’s building (4,700 SF)
Case Study #1
Center for Parks and People
Case Study # 1
Center for Parks and People

Energy Conservation Measures:

• High-performance envelope
• Green Roof
• Low Flow Plumbing Fixtures
• Composting Toilets
• Photovoltaic Array
• Electrical vehicle charging station
• Daylighting optimization
• Geothermal Variable Refrigerant Flow (VRF) System
• Natural ventilation
• Energy recovery ventilation
• Expanded thermal comfort conditions
Case Study #1
Center for Parks and People

Certified LEED Platinum!

- 49.3% energy cost savings compared to ASHRAE 90.1-2004
- Energy Star score of 100
- Metered energy use of 43.1 kBtu/ft² (March 2015 through February 2016)
Case Study #1
Center for Parks and People

- Mechanical Highlights:
  - Geothermal VRF system
  - Natural ventilation backed up by mechanical energy recovery ventilation

![Diagram of Building-side-loop and Geothermal wellfield]
Case Study #1
Center for Parks and People

- Electrical Highlights:
  - PV array
  - CFL lighting
  - Daylight optimization
Case Study #1
Center for Parks and People

- Plumbing Highlights:
  - Low-flow fixtures
  - Composting toilets in the Superintendent’s building
Case Study #1
Center for Parks and People

Utility Data Analysis:

Electric Consumption (Avg. kWh/day)

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<thead>
<tr>
<th>Month</th>
<th>2015</th>
<th>2016</th>
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</thead>
<tbody>
<tr>
<td>Feb</td>
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<td>Mar</td>
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<td>Feb</td>
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<td></td>
</tr>
<tr>
<td>Mar</td>
<td>393</td>
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</tr>
</tbody>
</table>

Construction | Occupancy

Feb to May 2015: Construction
Jun to Mar 2016: Occupancy
Case Study # 1
Center for Parks and People

Utility Data Analysis:

Energy Use per Square Foot (EUI; kBtu/ft²)

- U.S. Office Median EUI: 67
- Modeled Energy Use: 51
- Actual Energy Use: 43
POE Highlights:

• The organization is thrilled overall with their new building

• Thermal comfort in open office, conference, and corridor spaces

• Daylight and views

• Headquarters building energy use
Issues raised:

- Occupant comfort in private offices
- Superintendent’s house A/C use
- Ceiling fan control
- Groundwater pump shut-off
- Composting toilets
Lessons Learned:

• Thermal comfort

• Contractor availability and training

• Composting toilets: design vs. actual frequency of use

• Occupants moving into a new building are generally satisfied, but there is always room for improvement.
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Wrap-Up / Recap
Case Study #2
Shire Pharmaceuticals: Genetics Laboratory
Lexington, MA

Intro
What is POE?/Process
Case Studies
Recap
Case Study #2
Shire Genetics Laboratory

- Lexington, MA
- 190,000 ft² over four stories
- Completed in 2012
Case Study #2
Shire Genetics Laboratory

Intro
What is POE?/Process
Case Studies
Recap
Case Study #2
Shire Genetics Laboratory

Mechanical Highlights:

• Heat-shift chiller

• Chilled beams in lab spaces

• Low-pressure air distribution design

• Laboratory exhaust energy recovery

• Condensing boiler plant
Case Study #2
Shire Genetics Laboratory

- Electrical Highlights:
  - Lighting power density reduction
  - Daylighting control
  - High process loads ranging from 5-60 W/ft² in each room

For context, offices typically have loads of 2 W/ft²
Case Study #2
Shire Genetics Laboratory

• Plumbing Highlights:
  • Rainwater collection for cooling tower makeup and toilet flushing
  • RODI reject/reclaim system
  • pH neutralization system
Case Study #2
Shire Genetics Laboratory

POE Highlights

• Sound attenuation — far exceeded owner’s expectations

• Chilled beams functioning as intended

• Lighting levels in laboratories
Case Study #2
Shire Genetics Laboratory

Issues raised and lessons learned:

• Humidity control in laboratory spaces

• Snow entering the OA intake

• Energy recovery unit shifts into and out of economizer mode

• Importance of commissioning process
Introduction

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Wrap-Up / Recap
Case Study #3
The Residences at Radian Boston
Boston, MA
Case Study #3
Radian Boston

- 300,000 ft², 26-story mixed-use residential high-rise
Case Study #3
Radian Boston

- 300,000 ft², 26-story mixed-use residential high-rise
Case Study #3
Radian Boston

Certified LEED Gold
• 32.2% energy savings compared to ASHRAE 90.1-2004
• 25.8% energy cost savings compared to ASHRAE 90.1-2004
Case Study #3
Radian Boston

Energy Conservation Measures:
• High-performance envelope
• Energy Star appliances
• High-efficiency air distribution
• Energy recovery ventilation
• Condensing boiler plant
Case Study #3
Radian Boston

Mechanical Highlights:

- Ventilation provided via ERU in combination with operable windows in residences.
- Local space conditioning via water-source heat pumps (WSHPs) supplemented by a condensing boiler plant and cooling tower.
Case Study #3
Radian Boston

- Electrical Highlights:
  - Mixed CFL and LED lighting scheme beat code-maximum lighting power by 10%
  - Energy Star appliances specified in residences allowed credit against plug loads in Baseline energy model.
Case Study #3
Radian Boston

- Plumbing Highlights:
  - Electric water heaters local to each dwelling unit; space constraints within the residences required suspension over washer/dryer setups

![Diagram of domestic water heater, clothes dryer, and clothes washer connections](image)

- Domestic water heater
- Clothes dryer
- Clothes washer
Case Study #3
Radian Boston

POE Highlights:

• Residence experience: overall thermal comfort, lighting, and layout.

• Maintenance clearance in mechanical penthouse

• Decentralized heating and cooling
Case Study #3
Radian Boston

Issues raised:

• Electric water heater serviceability

• Energy recovery unit controls

• Thermostat placement in studio apartments

• Sound and vibration traveling from mechanical penthouse

• Window frames
Lessons learned

- Importance of off-season commissioning
- Necessity of a thorough punchlist
- Impact of value engineering

Foam panel vibration isolation inside the Radian penthouse.
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Wrap-Up / Recap
Recap: Value Proposition

Keeps the design team engaged beyond the warranty period.

- 3.5 years after the building was initially occupied, the design team remains engaged in helping the owner.
Recap: Value Proposition

Better understanding of their building and why it was designed a certain way.

• Parks and People: DHW circulation pump
  Relatively small (and low-power) pump causes wait for HW in bathrooms but was necessary to achieve project’s energy efficiency goals and limit the DHW loop’s first cost.

• Radian: DHW heaters
  The need to maximize rentable square footage forced the DHW heaters into a tight space.
Recap: Value Proposition

Provides recommendations and corrective actions

- Upgrade lighting from CFL to LED
- Install vibration isolation hangers
Recap: Value Proposition

Incorporates lessons learned into future designs

Our plumbing engineers push back on placing equipment in access-challenged spaces.

- Domestic water heater
- Clothes dryer
- Clothes washer
Recap: Value Proposition

- Analyzes real-life performance data to evaluate design decisions
- Follows up on commitments made by the project (EUI, IEQ metrics, etc.)

Energy Use per Square Foot (EUI; kBtu/ft²)

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<tr>
<td>Parks and People: performing 15% better than anticipated!</td>
<td>43</td>
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Recap: Value Proposition

Deepens client relationship

As part of our POE of Parks & People, we were able to engage the architect and the greater Baltimore sustainable design community in a celebration of the project’s LEED Platinum achievement.

We continue to work with that client and receive referrals due to this work.
Is POE Worth It?

• **Yes!** Assuming that:

  • The project team desires the data
  
  • The project team needs to follow up with and impress a good client
  
  • The project team believes there will be good lessons learned from the project
Questions?

Parks & People
Baltimore, MD

Shire Genetics Lab
Lexington, MA

Radian Boston
Boston, MA
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