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Bottom line thinking on energy.

SUMMARY OF CHH POST-OCCUPANCY EVALUATION

Oregon Health & Science University's Center for Health & Healing (CHH) is the first medical facility in the world and one of the largest projects in the nation built to LEED Platinum standards. Completed in 2006, located in the South Waterfront District in Portland, Oregon, the 16-story, 412,000-square-foot building has eight floors devoted to physician practices, surgery and imaging; three floors that house a health and wellness center; four floors dedicated to education and research activities, including space for a biomedical engineering program; and ground floor retail, including a pharmacy, optical shop and a café.

A Post Occupancy Evaluation of the CHH, is one of only a few comprehensive, peer-reviewed research reports attempting to measure the impact of high performance buildings on its occupants. The evaluation focused on the following questions:

- Are energy and water costs reasonable?
- Are the occupants satisfied with building performance?
- Are there indications that building design has influenced health and productivity?

RESOURCE UTILIZATION – ENERGY & WATER

Energy Analysis

This task utilized a New Building's Institute protocol focused on energy use. Occupant density and plug load corrections and weather normalization was performed by an energy analyst contracted by the owner, who also identified differences between the original design and as-built conditions to help analyze changes between projected energy use and actual performance. Using the Energy Star Portfolio Manager, data from the project's Measurement and Verification Plan, and eQUEST energy simulation software, energy models were updated and then calibrated with utility bills to generate savings estimates. Outcomes included: summary of energy and water costs; energy use index; Energy Star rating; and comparison with performance targets established during design..

Occupant Survey

The building's impact on occupant satisfaction and illness symptoms was analyzed using an occupant survey based on the New Buildings Institute (NBI) Building Performance Review (BPR) protocol, refined by the research team, to address: Indoor environmental quality; respiratory symptoms; and productivity related issues.

Occupant Absenteeism

This task compared absenteeism data from the new Center for Health and Healing building with absenteeism data in the previous building occupied by the employees.

O&M Recommendations

Current building operation and maintenance practices were reviewed by the POE team, to identify areas that may need additional attention and to further improve building performance. This task resulted in a brief summary of key issues and potential savings opportunities. Activities included: interviewing facilities site management and engineer team (CB Richard Ellis, Inc, and OHSU Facilities and Real Estate); reviewing areas of concern noted in the Occupant Survey; beginning the implementation of improvements as a result of this study's findings.

ENERGY

The project energy performance goal was a 60 percent energy cost savings over baseline. The project team submitted for LEED certification projecting 58 percent energy cost savings (49 percent energy savings compared to an ASHRAE 90.1-1999 baseline) and earned all 10 LEED energy efficiency points. Savings associated with the central utility plant (CUP), which were not eligible for LEED consideration, boosted projected savings to just over 60 percent. Including the CUP, the energy use index (EUI) (for the conditioned space) of the proposed building was 110 kBTU/sf-yr.

Based upon a full year of utility billing data, the post occupancy evaluation determined that that building has achieved 40 percent energy cost savings and a 32 percent energy savings over baseline. The current Energy Star rating of the building is 77 (while there is no truly comparable building to the CHH in the CBECS database used by Energy Star, a medical office building rating was used as the closest available approximation).

The POE illuminated the importance of realistic plug load estimates for design and energy modeling purposes. The actual plug loads, metered as part of the study, were found to be between 1.25 and 2.00 watts per square foot. Modeled plug loads had been fixed at 0.75 watts per square foot. This variance in modeled plug loads vs. actual plug loads was identified as the most significant contributor to the difference between predicted and actual energy savings. The increased plug load not only directly increased electrical consumption, but resulted in decreasing in heating energy requirements and a corresponding increase in cooling energy use.

The POE also pointed out the need to optimize CUP performance in order to attain desired energy use and cost savings, and recommended the specific steps to be taken to achieve this level of performance.

WATER

The project goal was to offset potable water consumption by a minimum of 50 percent and the POE has determined that the building is realizing an overall 49 percent reduction in potable water use.

The building captures rainwater from all surfaces, collects groundwater that is de-watered from the underground parking garage and has an in-building wastewater treatment plant that processes 100 percent of the building's grey and blackwater to produce clean effluent. The local water quality authority is very pleased with the performance of the treatment plant and rates it an "A+" facility, with "no detects" in water samples.

OCCUPANCY SURVEY

The post occupancy evaluation of OHSU's Center for Health and Healing shows variable satisfaction with the interior environmental quality, ranging from a high of 65 percent rating daylight positively to a low of 35 percent positive for voice privacy. Similar variations have been found in other LEED buildings.

Lighting

In the CHH building, 47 percent had positive ratings for the "amount of light for working" compared with a positive score of 65 percent for daylight. Review of the open-ended comments show concern with shadows on work surfaces.

Acoustics

The feedback regarding privacy was lower, with only a 35 percent positive rating for voice privacy and 42 percent for visual privacy. This is somewhat surprising given that the majority of respondents were in private offices, which normally have better ratings for both voice and visual privacy. The biggest problem

with acoustics was noise from outside of the building, with 55 percent expressing negative opinions. The open-ended comments suggest that noise from a construction site nearby was a primary problem.

Self reported productivity

Forty percent of the respondents said the CHH building made work easier than their previously building, while 52 percent said their performance had not changed, and 7 percent said the new building made their work more difficult. When asked to focus on their individual workspace, 38 percent said environmental conditions made their work easier and 18 percent said conditions made their work more difficult (43 percent said there was no effect on their work).

Is the CHH building successful from the occupants' perspective?

Because there were no performance goals set for CHH occupant satisfaction and comfort, it is difficult to conclude whether the building's interior environmental quality is a success. If 50 percent satisfaction is the criterion for judging success on environmental quality factors, then four out of the ten environmental factors would be considered successful.)

Environmental Factor	Percent Positive Rating
Views	66
Daylight	65
Overall lighting	64
Air quality/ventilation	59
Amount of light for work	47
Temperature conditions	45
Visual privacy	42
Voice privacy	35
Noise conditions	34
Ability to adjust lighting (28%), temperature (18%), ventilation (15%)	21% (average)

REFLECTIONS ON THE POE PROCESS

The findings of the post-occupancy performance assessment were evaluated to assess: whether the building performance review process provided the information needed by the facility operator to identify and solve problems; the value to the developer and design team in determining lessons for future projects; and the value of the process to inform broader research questions related to green building performance.

Overall Value of Assessment

Building management, the design/development team and the researchers felt that the assessment provided useful information regarding occupant satisfaction and building performance. The findings related to the energy performance of the building were particularly valuable in terms of uncovering the reasons that certain systems were not performing as anticipated. As one engineer noted, while it is never pleasant to be confronted by design flaws, the opportunity the building performance assessment provided to learn about them was very valuable.

Shortcomings of Assessment Protocol

The importance of having a follow on process to address the findings of post occupancy performance assessment was noted by both building management and the project team— there was no clearly articulated process for following up on findings related to occupant satisfaction levels. The need for a process to address


Photo Credit: Sally Painter

OHSU Center for Health & Healing (CHH)

findings in the occupant satisfaction arena could be addressed in part through more explicit goal setting by the building owner related to desired occupant satisfaction levels. For example, if goals were set for the percentage of occupants who would find thermal comfort to be at a satisfactory level, findings related to such levels would be more likely to be integrated into follow up building management efforts.

Value of Baselines

The design and research teams emphasized the value of baseline data on occupant satisfaction in order to evaluate the overall impact on occupants. Also, incorporating factors such as job satisfaction, morale, and other contextual factors such as unit reorganizations, etc. would help control for these factors in determining the specific impacts of green design on building occupants.

On the energy side, it is very important to remain aware of the specific baseline used to compare the results of the energy analysis. There are a number of baselines that can be used to benchmark energy performance and there is currently a debate in the energy community about which baseline is most appropriate. Until there is a general consensus, it is important to clearly state which baselines are referenced in these types of energy studies.

Training and O&M "Hand Off"

Developing more systematic processes for training operations and maintenance staff on building operations was highlighted as a critical investment to achieve optimal building performance.

Metering and Data Analysis

Investing in the resources required to meter and to evaluate data is also important. While there are multiple software packages available to help with the capture, integration and analysis of data from multiple meters, only people can interpret the meaning of such data to determine results and to recommend any necessary actions. One advantage of more finely tuned metering is the ability to bill resource use back to different departments (currently, billing is based on engineering estimates of usage).

Plug Loads and Tenant Education

When energy data collected through the performance assessment indicated that energy use was higher than anticipated, a walk through survey revealed significantly more equipment being used in many of the tenant spaces than had been anticipated during the design process. This finding suggests the importance of developing more accurate means to assess true energy needs and plug loads and possibly ways to control changes to plug loads. This could include a better understanding of how occupants will use

technology. Incorporating a standard "walk through" into post-occupancy assessments will help identify the ways tenants "self-manage" comfort by bringing in fans, lights and other amenities to manage thermal comfort and access to adequate light.

Tenant Engagement in Design – Closing the Loop

More thoughtful engagement of building tenants in estimating their needs and providing feedback on the implications of these needs on building design was also identified as an opportunity to better align building design with occupant needs and expectations, and to engage tenants in behavioral change to reduce overall building energy use. Ultimately, research leading to a more refined understanding of the nature of work—how people use information technology, manage equipment, inhabit building space, etc., will be required.

Building Expectations

Another lesson learned from this process was the importance of communicating the design parameters and performance expectations of a building with its users.

Leveraging Data Collection

LEED certified buildings are committed to follow-up documentation of whole-building performance. There are opportunities to incorporate data gathered for LEED certification into more comprehensive post-occupancy assessments, leveraging the time invested by staff in data collection and analysis.

Investment of Resources

Given the clear payback from identifying issues requiring attention and related resource efficiency gains, post-occupancy assessments are a justifiable investment. To ensure that a POE will be conducted thoroughly and with all necessary means, project owners should include funds for the effort early on in project development budgets.