I^{2}SL
International Institute
for Sustainable Laboratories®
Windy City

Presents

colLABorate 2019

Consilience In the Art of Sustainable Facility Design

Perkin and Will, 410 N Michigan Avenue, Suite 1600, Chicago IL
Thursday, September 19, 2019 – 12:00pm to 5:30pm

“The love of complexity without reductionism makes art; the love of complexity with reductionism makes science.”
― Edward O. Wilson, Consilience: The Unity of Knowledge

The Windy City chapter of the International Institute for Sustainable Laboratories (I^{2}SL) is soliciting presenters for a unique interactive program. We are reaching out to premiere consulting firms and research and university facility managers who are willing to share their experience describing collaborative efforts across multiple disciplines that were instrumental in the synthesis of their facility’s design or operation. Our goal is to explore how an interdisciplinary approach can yield unique and novel solutions in the advancement of sustainable facility design. Specifically, how the building construct was shaped to accommodate the current state of the art and anticipate future technological developments in expectation of changing social and technical norms for continued relevancy in a sustainable world. One specific area of interest is the interaction of scientist as participants in the conceptualization, development, and execution of the building’s design.

Through this we hope to enhance our understanding of the interaction of art, architecture, science, and engineering in yielding unique and special facilities that provide the enhanced performance necessary to address the needs of an energy efficient and environmentally responsible world. This program format will be tailored to enhance the interaction of presenter and participant by promoting a more in depth discussion of ideas presented with greater time for reflection and consideration of the opinions and ideas presented.

Topic Specifics

Program goal is to illustrate and discuss in detail the process and ideas integral in the formation of the design or operation of the building or facility. Specifically, projects that reflect a "consilience" approach linking together principles from different disciplines when forming a comprehensive basis for the project design and execution.

Case Study: National Renewable Energy Laboratory Energy Systems Integration Facility, presented by SmithGroup

Narrative of the project describing the type of project (new construction, renovation, system rehabilitation or upgrade, etc.) and overall design and sustainable goals.

The Department of Energy's (DOE) National Renewable Energy Laboratory's (NREL) Energy Systems Integration Facility (ESIF) in Golden, Colorado was built to study the integration of renewable energy sources into the national electric grid. The 182,500 sf facility houses high-bay laboratory research spaces with an interconnected electrical grid, a high-performance computing data center (HPCDC), and administrative spaces inclusive of offices, conferencing, and visualization laboratories. True to their mission, NREL stipulated that the facility will be highly energy-efficient, with requirements as follows:

- Minimum Building Energy Performance 30% Better than ASHRAE 90.1-2007 with Minimum LEED NC V2.2 Gold Rating. Facility Achieved 36% Better than ASHRAE 90.1-2007 and LEED NC V2.2 Platinum Rating.
- Office Energy Use Intensity (EUI) of 25 kBTU/SF/YR or less. Office Achieved an EUI of 23.
- For Regularly Occupied Spaces, General Lighting Off Daily from 10 AM to 2 PM. Achieved with Extensive Daylighting.
- Data Center Power Usage Effectiveness (PUE) of 1.06. Tier 2 Data Center Operates at an Annualized PUE of 1.04.
- Energy Reuse Effectiveness (ERE) is a Metric Developed by NREL and The Green Grid to describe Data Center Waste-Heat Reuse. Data center will Operate with an ERE of 0.9 or Less (Minimum 10% of Data Center Waste Heat Recovered). Achieved.

List of various disciplines, technologies, or variant design approaches used in the collaborative approach to achieve the design objectives. Include a description of the interaction of these various elements in forming a synthesis of ideas and applications in the formation of the final design.

Design-build team brought together a diverse team of architects, engineers, energy modelers, contractors, and others together to generate solutions that go beyond the program requirements while not exceeding the project budget. The comprehensive design team included architects together with civil, structural, mechanical, plumbing, electrical, and energy modelling engineers. The build team included general contracting together with all relevant subcontractors.

Early building models were generated in Sketch-Up to allow for the testing of various configurations. As the configuration began to take shape, the building was brought into Revit and separate models created for the various disciplines. As the relative disciplines began to input their systems, Navisworks allowed for dynamic modelling, visualization, and collision avoidance.

The design-build team had multi-day workshops a minimum of twice a month in the early phases. Break-out sessions focused on various aspects of the project development followed by summary sessions to update the entire team on progress or other challenges that remained. Potential design solutions were vetted for cost and constructability. If consensus could not be achieved, other solutions were pushed forward. Unresolved issues were assigned to various working groups to develop for the next session.

Provide one or more examples that detail specific design considerations, approaches, or methodologies of a specific aspect of the final design or system operation. Include some description of the specific considerations or elements that were essential in the process.

NREL ESIF is located on the side of a hill on the north side of the NREL campus. Laboratory use was kept to the north to maintain separation from other parts of the campus, with office areas located to the south and oriented to maximize daylighting opportunities. The data center required proximity to the laboratories for system cooling, and a central location was ideal for the sharing of waste heat. With this general arrangement, the team began blocking out the program.

The slope of the hill was advantageous in the block and stack effort as it permitted higher program area functions to efficiently stack above those with smaller area requirements, while best serving the occupants. The collaboration of the entire design build team in these early stages was critical to maximizing the buildings overall efficiency. Early planning for the data center followed a traditional approach and placed mechanical equipment as saddlebags on the sides of the data center. This configuration, however, stretched the limits of the site in a north-south direction and lead to some under-utilized space below. At the same time the contractor identified that the site in that area dropped off significantly and required a significant amount of infill and cost to support.

Based on this feedback, the mechanical equipment locations were further refined. The final configuration consolidated the mechanical equipment directly below the data center equipment. This solution not only minimized the use of fill but improved system efficiency by reducing the amount of piping and lowering resistance in the system. The mechanical room became a 16-foot high elevated floor with the piping for the water-cooled servers located directly below. The potential for water damage to servers was reduced, and security increased for the data center equipment.

The data center mechanical equipment, however, used less than half the area below the data center. As the data center provides beneficial waste heat to the building, the building heating water system was moved from the penthouse to this location to reduce piping runs. With still more space available, electrical partners took a closer look and were able to take advantage of this area to centralize the electrical service.

Describe input form stakeholders, especially the scientific staff, facility owners, or other facility users, that was instrumental in the formation of the final design or facility operation.

NREL scientists, engineers, and program managers were active participants throughout the design process. When the bi-monthly meetings were in Colorado, representatives participated in design review meetings to consider approaches and offer recommendations. In addition to looking for ways to improve system and energy performance, they were also influential in getting the design-build team to think beyond the limits of their project.

As is the case on most projects, the design-build team focuses on optimizing the design and performance of the building. The ESIF, however, is part of a community of buildings. NREL engineers and stakeholders saw data center waste heat as a benefit to the entire campus and any potential limiting it to ESIF as a missed opportunity. While campus waste heat integration was not part of the building program and budget, the design-build team was able to integrate its provisions for future campus extension within the budget available.

This dialogue between stakeholders and engineers with the design team continued well after the project construction was complete to optimize performance. Over the course of this optimization, the design team was made aware of that the water-cooled data center equipment provided could handle noticeably warmer water than the original specification. The design team was able to take this information, analyze it and recommend a straight-forward solution to enhance the quality of the data center waste heat and further improve building performance.

Although the campus waste heat connections remain a future initiative, NREL engineers are able to run the campus heat exchangers backwards in summer months, exporting waste heat to the campus through the existing campus heating water network. With this operating mode in place, NREL does not need to run any boilers in summer and can delay the starting of the main boilers by an additional month in fall.