I2SL
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

## Presentation Summaries

**Presentation 1: 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.

**Presentation 2: Case Study: University of Chicago Greg Engel Laser Lab, presented by Interactive Building Solutions and Zentel Tech**

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

When Greg Engel came to the University of Chicago as an Assistant Professor, he knew that a stable and reliable laser lab would enable science that could be done nowhere else and that productivity gains from not constantly tuning equipment would increase competitiveness for grants. He collaborated with IBS to renovate an existing space. The collaboration yielded several innovative approaches for precision environmental control and a very stable lab environment for the scientist.

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.

The scientist, Greg Engel, collaborated with Joe Jozsa from IBS and Bryan Lee from Zentel, who are precision environmental control specialists. Meeting Greg's design objectives required innovation in many aspects of the lab design including the lab layout, construction, mechanical equipment, testing/balancing and controls. Greg had experience from previous laser labs that gave him a good understanding of mechanical systems and Joe and Bryan had a basic understanding of the science that Greg was performing. This gave them enough common ground to share ideas and brainstorm on innovative solutions.

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.

The room layout and location of air supply and return grills was critical to the successful design. A detailed understanding of the lab procedures and specific requirements on the laser table itself informed the layout. Discussions yielded a design with the supply diffusers around the perimeter of the room and providing a high volume of supply air at a low velocity with the return above the lab table.

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.

All design decisions require compromise, i.e. a particular alternative may improve performance but add cost. Greg notes that one of the greatest benefits to his collaboration with Joe and Bryan was their being able to accurately quantify and offer advice on the pros and cons of various design alternative, allowing him to make well informed decisions.

**Presentation 3: Case Study Fermilab IERC: a design process influenced by a culture, presented by Fermilab, Perkins and Will, and ARUP**

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

The Fermilab Integrated Engineering Research Center is the coalescence of Fermilab's vision, mission, and direct output of the major initiatives of the laboratory's strategic plan.

These initiatives spark the design dialogue between the occupants in the space, the fundamental use of and the physical message the design portrays, as well as the rational and intention behind creating a building that considers collaboration and integration as a part of its ethos.

This 84,000gsf signature building connects to iconic Wilson Hall. The delicate and intentional nature of the design connects to the iconic structure through materiality, massing, scale, and procession.

The project's mission is to provide a laboratory space which not only houses the research but fosters exploration and innovation among the researchers who occupy it, and inspires them with its design. As science evolves, so does the need for the space that houses it. Through modular planning principles, controllable building systems, and future-thinking performance parameters, the IERC will meet the needs of today's researchers as well as those of tomorrow.

Program elements are in the building based on their scientific needs. Because a significant fraction of the laboratory program requires low-vibration, high-bay space, and it is most cost effective to provide low vibration environments on grade, the Ground Level is devoted to those labs. To improve the quality of laboratories as workplaces, an equipment chase is adjacent to each lab. These chases allow noisy, heat-producing, or otherwise disruptive equipment to be located adjacent to, but outside of, the labs. Laboratory services, such as a process cooling loop, can also be distributed through these chases, effectively centralizing shared resources.

Other laboratory program requires a close connection between laboratory and the workplace (office and collaboration space). These labs, and associated workplace spaces, have been placed on Levels 1.

Together, this modular organization for the IERC creates an adaptable platform for both the known scientific work at Fermilab today and the unknown needs of the future.

The Fermilab Integrated Engineering Research Center (IERC) project will comply with the HPSB by seeking to consume 30% less energy than an ASHRAE 90.1-2013 Baseline building. The program for this building contains a predominance of electronics testing and fabrication spaces, with moderate chemical usage, and research equipment focused spaces. Energy conservation strategies will focus on opportunities to reduce overall building energy consumption without impacting life safety considerations or good laboratory design practice. Anticipated strategies include the following overall project sustainability goals:

1. Selected spaces within the building will be evaluated for their ability to operate under expanded thermal comfort range when possible. By enabling a wider acceptable temperature range, the building can reduce the reliance and associated energy consumption stemming from comfort cooling.
2. Plug-load management.
3. Water performance goals for this project are 40% reduced consumption or less potable water than code defined baseline calculated. In addition to low-flow restroom fixtures, we will specifically focus on water reducing/water efficient laboratory equipment including fixtures and safety showers.

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.

This presentation will focus on the tapered design process that the team embraced as the project progressed. As the Integrated Engineering Research Center architectural design compliments Wilson

Hall, the design process developed for the project compliments the culture, heritage and the way Fermilab works.

Points include a mix of structured user work sessions, design charettes, and informal conversation to collect scientific and technical requirements for the building. A mix of technology and visualization mixed with informal hand sketches and conversation real time with the client to arrive at new ideas as a team.

User sessions are planned and scheduled to collect large amounts of information at a regular rhythm to absorb information about the activities and scientific requirements to information the design. These in-person sessions gather much information, as well as report out the current status to ensure stakeholders understand the process and the design direction. In order to take deeper dives into pockets of scientific requirements that needed more definition, the design team implemented weekly, more conversational screen share conference calls.

During the full day design charrettes, the design team explores design options in tandem with Fermilab through the filter of Fermilab' s goals for the IERC project. An early worksession dedicated to an exploratory charrette of the site infrastructure and boundaries to determine the best location for the building footprint. The massing of the building was studied through the lens of its respectful relationship to Wilson Hall while adapting to the requirements of the building's function. Once the program for the building was established and the site constraints were analyzed, the team reconvened for another building design charrette to discuss the holistic design approach and the evolving design expression of the exterior and the interior of the IERC project.

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.

There are two design case studies that will be presented as a part of collaborate, the design processes of the Hybrid Labs and the Project Core and Project Lab clean environment criteria.

The IERC will house electrical and mechanical engineering disciplines on Level 1. These disciplines work in a variety of scientific environments, from clean room environments to office space. The evolution of the hybrid lab considers the bench and space requirements of electronics testing and construction activities, while creating a workplace concept that maximizes adaptability and collaboration. The multiple function use of the space is echoed in the need for multiple zones within the hybrid lab workstation. The hybrid lab environment bridges between the enclosed offices required for quiet, focused work and the enclosed dry laboratories for electronics testing. The balance of workspace environments provides the choice of space to both maximize collaboration and flexibility while still maintaining the technical requirements to support the science.

Clean environments are required for the construction and testing of assemblies in the IERC, however the amount and the classification level required was determined through an evolving conversation. Some adjacent activities do not require clean classification, while others do. The design team worked closely with Fermilab to determine the scientific processes for each of the project labs to design a configuration that optimizes their current and projected future needs, while creating an adaptable framework to meet the needs for Fermilab project work yet to be established. In order to meet the requirements while balancing the cost of facility, the design team took an approach that analyzed the current clean environment to determine the performance of the environment required.

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.

The Perkins and Will team designed and lead the process of Science Point of Contact (SPOC) and Departmental Point of Contact (DPOC) through a series of four 2-day work sessions to gather programmatic information from the researchers to understand the function and needs of the hard working research spaces. Activities to collect information included existing laboratory tours of all of the current spaced with functions anticipated to move into IERC, initial collection of information through questionnaires and interviews, and regular meetings to review progress and refinement of the criteria of the research spaces. The Fermilab IERC management team worked with the SPOC and DPOC representatives to collect interim information to keep the process moving forward.