SHOWCASE PROJECT: UC BERKELEY: JACOBS HALL

SOLUTION OVERVIEW

Jacobs Institute for Design Innovation houses classroom, office, studio, lab, and mechanical workshop space for UC Berkeley's College of Engineering. Winner of the 2016 Higher Education Energy Efficiency and Sustainability Best Practice Awards and selected as an American Institute of Architects (AIA) 2016 Top Ten Project, the building is designed to exceed AIA's 2030 Commitment target by using 90 percent less energy than the national median for university buildings.

The project was conceived by the College of Engineering as an interdisciplinary hub for students and teachers from across the university who work at the intersection of design and technology. It is designed as a collaborative, project-based educational space featuring open-plan workshops for hands-on interdisciplinary learning. The center provides students with access to state-of-the-art prototyping tools such 3D printing and laser cutting equipment, with spaces for design-related lectures and events.

The building accommodates up to 2,000 students per semester and is open 24 hours/day for student access, although primary occupancy is 60 hours/week. In addition to housing about 15 classes, the facility can be used to host camps, enrichment programs, labs, and competitions during the summer.

The tiny corner site, formerly a volleyball court, lies at the northern edge of campus within a dense, diverse context. An existing two-level basement lies directly beneath 35 percent of the site.

SECTOR TYPE

Education

LOCATION

Berkeley, California

PROJECT SIZE

24,000 Sq. Ft.

FINANCIAL OVERVIEW

$23.4 Million (Whole Building Cost)

SOLUTIONS

The project's confined site helped shape the architectural solution. A narrow floor plan, only 54-feet wide, coupled with 14-foot ceilings, allows for ample daylight harvesting and natural ventilation

through operable windows. The building envelope includes external shading devices tailored to the south, east, and west exposures, with high-performance glazing and cool roofing. Although relatively bright lighting is required for the workshop, efficient fixtures and controls are used to manage lighting energy use. After five months of operation, the building is performing within EUI projections. View current performance via UC Berkeley's MyPower energy dashboard, part of their Energy Management Initiative (EMI).

UC Berkeley's Energy Use Policy, part of the EMI, played an important role in embedding energy efficiency across campus, including at Jacobs Hall. The Policy applies energy efficiency to campus life and affects all departments by formalizing such measures as acceptable room temperature setpoints and "outlawing" of single pass cooling systems and constant volume fume hoods. From a design and construction standpoint, the Policy also requires that all future capital projects include dedicated building utility metering to tie back into campus energy dashboards as well as consultation with the Energy Office during project planning so that these projects at a minimum will use 30% less energy than California Building Code (Title 24), with a goal for a "no net increase" in energy use.

The following energy efficiency measures were implemented at Jacobs Hall:

- RENEWABLE ENERGY: A 74 kW photovoltaic array provides ~60 percent of the building's energy requirement. Adjacent Soda Hall steps up to the south away from the site, affording excellent solar access.
- HIGH-PERFORMANCE ENVELOPE: A highly insulated envelope – with exterior insulation, rain screen cladding, and integrated sun-shading on three exposures – manages external building loads. ENERGY STAR®-rated cool roofing and high-albedo paving help to further reduce cooling loads in warm weather.
- DAYLIGHT: The narrow building floorplate presents a shaded façade to the south for optimum daylight harvesting. Large north-facing windows and interior glazing help to reduce internal glare. One-hundred percent of instructional spaces above the basement and 85 percent of all regularly occupied spaces have views to the outdoors and are sufficiently day-lit to allow lights to be off during daylight hours. The lighting power density of the building is 0.8 watts per sq. ft.
- PASSIVE VENTILATION: All public, teaching, and office spaces (except the basement) are designed to rely primarily on daylight and natural ventilation from operable windows. The building opens to the prevailing winds, allowing 100 percent of instructional spaces above the basement level and 85 percent of all regularly occupied spaces to be naturally ventilated. Mechanical ventilation provides added fresh air when windows are closed, providing 30 percent additional outside air above code requirements or when deemed necessary from active carbon dioxide CO2 sensors located throughout the building.
- EFFICIENT HEATING & COOLING: Comfort during warm seasons is supplemented with ceiling fans, and on extremely hot days with mechanical "bump cooling," through the use of a purposefully undersized cooling coil in the air-handling unit. Heating is provided primarily by highly efficient hydronic radiators, which may be supplemented when needed from the mechanical supply air system.
- ORIENTATION: The building is oriented on an east-west axis for optimal solar benefit. This creates a wind-protected, sunny courtyard to the south while enhancing building access to passive solar heating, daylighting, natural ventilation, and a continuum of indoor/outdoor

spaces on the first floor.
- COMPACT MASS: A compact building mass with an efficient skin-to-floor area ratio helps to reduce thermal transfer. A narrow, 55-foot-deep floorplate and 14-foot ceilings promote excellent natural ventilation and daylight penetration.
- BUILDING WATER USE: Ultra-low flow fixtures reduce building potable water consumption by 50 percent.
- LANDSCAPE WATER USE: Drought-tolerant landscaping, sub-surface drip irrigation systems, and advanced, weather-based irrigation controllers combine to reduce landscape water use by 50 percent from baseline. The small size of the site's landscaped area makes efficient use of available land while further reducing water consumption for landscaping. The landscaping and Incense Cedars preserve habitat for native birds and other species.

OTHER BENEFITS

In addition to energy and water efficient design, the project incorporates many best practices in green building and is certified LEED Platinum.

- SUSTAINABLE MATERIALS: The team selected materials based on multiple sustainability criteria, including durability, resource efficiency, and health impacts on occupants. Seventeen percent of all building materials are recycled, including 50 percent fly ash content in foundation concrete and floor slabs, carpet, and steel. Aluminum was required to have 50 percent recycled content. Twelve percent of all materials were regionally harvested and manufactured to reduce embodied energy and carbon footprint associated with shipping. FSC-certified products make up 75 percent of all installed wood in the building. Rapidly renewable materials include rubber flooring and base, linoleum flooring, and agrifiber door cores.
- RESOURCE REDUCTION: The building and site work were "right-sized" to fit on the tight urban site. Material use was reduced through the design of simple forms using a straightforward structural system and conventional manufacturing dimensions.
- LIVING LABORATORY: The exposed structure and building systems reveal to users how the building works, contributing to the program's didactic goals and reducing the environmental impact of avoided applied finishes.
- DENSIFYING DEVELOPED LAND: The project converts a tiny 11,000 sq. ft. site – formerly an underused volleyball court – that is partially underlain by an existing two-story basement. The structure cantilevers 12 feet southward over an existing basement to create sufficient space for the new building while retaining a south-facing courtyard.
- TRANSIT-ORIENTED: Due to its location near transit, no parking was added for the project, with the exception of two handicap-accessible parking spaces. It is estimated that 99 percent of occupants use public transit, cycling, or walking to access the building, and the property has a Walk Score of 86.
- STORMWATER MANAGEMENT: One-hundred percent of the project's roof drainage is piped from the south to the small 1,400 sq. ft. northern landscaped area, where it is delayed, absorbed, and filtered by a bio-swale and rain garden. Excess filtered stormwater is delivered to the city storm sewer.
- INDOOR AIR QUALITY: The team researched all products to ensure that they would create a healthy indoor environment, using no-VOC, vinyl-free, and formaldehyde-free options. IAQ

Management Plans were implemented during the construction and pre-occupancy periods, including a two-week building flush-out.

- WASTE REDUCTION: In spite of an aggressive 13-month construction schedule, 97 percent (1,595 tons) of site and construction debris was diverted from landfills. Recycling and composting stations throughout the building promote ongoing waste management.
- RESILIENCE: Located in a seismically active region, the building was designed to meet University seismic requirements that exceed the California Building Code to enhance life safety and minimize damage in a seismic event. Strategies included the use of simple, self-bracing building forms and high-efficiency seismic systems.
- DURABILITY: Major finishes were selected for durability, low maintenance, and fire resistance. The primary exterior finishes are concrete and metal panels. Primary interior finishes - polished concrete floors and painted drywall - are easily maintained with light cleaning and paint.
- SPACE FLEXIBILITY: The building was designed to provide flexibility in both short and long terms. In the short term, teaching spaces are easily adaptable to evolving curricula and technologies. To the greatest extent possible given the specialized nature of the program, spaces were generalized to allow for future adaptation to unforeseen alternative uses in the long term.

Annual Energy Use
(Source EUI)

Baseline(ASHRAE Standard)
46 kBtu/sq. ft.

Actual(2018)
28 kBtu/sq. ft.

Energy Savings
39%

Annual Energy Cost

Baseline(ASHRAE Standard)
$57,000

Actual(2018)
$40,000

Cost Savings
$17,000

Jacobs Hall

Rooftop Solar Array

Jacobs Hall Envelope