SOLAR DECATHLON DESIGN CHALLENGE 2021
OFFICE BUILDING (OB) CATEGORY
VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

1021 Prince St. Renovation

PROJECT SUMMARY

The Washington-Alexandria Architecture Center has served as an urban extension of the VT School of Architecture + Design since 1980. The WAAC distinguishes itself on its interdisciplinary, international, and individual focused learning environment. With a pedagogy of freedom and responsibility, the WAAC sets the stage for students to learn from a multiplicity of actors, and interests designing in the modern urban setting.

The main building, 1001 Prince Street holds the history of its original construction as a elementary school for girls as well as the memory of past WAAC student design build projects. The 1021 Prince Street building next door was only recently absorbed into the WAAC's facilities in 2019. In 2020, prompted by the pandemic and opportunity to reevaluate the performance of 1021 – the WAAC is taking on the challenge of adaptively reusing and renovating 1021 into a zero energy building that showcases the WAAC as an embodiment of its pedagogy and its future.

PROJECT DATA

Location: Alexandria, VA, USA
Climate Zone: 4A
Lot size: 9,553ft²
Building size: 32,770ft²; 4 stories
Occupancy: 400 pax
Target Source EUI: 68.5 kBtu/ft²/year
Existing Average Utility Cost: $22,000/year
Projected New Average Utility Cost: $15,525/year
Construction Cost:
- Renovate existing space $2,700,000
- New Construction: $5,200,000
- Exterior Skin Replacement $350,000

TECHNICAL SPECIFICATIONS

Existing wall, roof, and foundation R-value: 10.47, 42.0, 3.37 ft²·°F·h/BTU
Renovated wall, roof, and foundation R-value: 35.78, 76.44, 3.37
New construction wall, roof, and foundation R-value: 35.19, 62.74, 4.32
New window U-value, SHGC: .14 Btu/h·ft²·F, .30
Curtain wall U-value, SHGC: .17 Btu/h·ft²·F, .24
Building Technologies: High efficiency windows, on site PV, ground heat exchange, ERV system, radiant heating and cooling, improved envelope
On site PV: Roof mounted poly-crystalline solar panels

DESIGN STRATEGY

Reflecting on the urgency of improving building performance to promote the health and well-being of the individual, as well as the greater societal well-being in reflecting community equity and addressing climate change - our team approached the renovation with a primary focus on achieving zero-net energy consumption. The building is strategically peeled of its inefficient envelope and adapted to promote daylighting, use of recycled materials, and utilization of renewable and passive energy strategies: on-site rooftop photovolatics, a ground source heat pump, vent-able solar gain space, and active systems-control monitoring. Finally, the WELL Building Standard was used to establish a stringent approach to environmental quality, comfort, and occupant health.

Project Highlights

ARCHITECTURE // Additions to the south and east sides meet program requirements without overwhelming the scale of the neighborhood, and maximize solar access for daylighting and solar energy production. Reclaimed and recycled materials address sensitive historical material contexts without the sustainability concerns of traditional materials. Glazing is sized, located, and shaded for optimal daylighting and heat gain management. Interior architecture prioritizes occupant comfort by addressing program needs through efficient and agile design strategies.

ENGINEERING // Active building HVAC controls monitor interior and exterior conditions to effectively provide spaces with a comfortable temperature, humidity, and air-change range. Radiant Floor Systems take advantage of the concrete composite decks' existing thermal mass and are fed by high-efficiency water-to-water geothermal heat pumps. Mechanical ventilation is handled by ERVs to control humidity and improve energy savings on HVAC and is monitored via sensors. Lighting fixtures are replaced with LEDs and are monitored and controlled via movement sensors to minimize waste.

MARKET ANALYSIS // Project utilizes dynamic flex space planning as a financially efficient approach. Adaptable spaces provide a stage for school/office functions and community engagement functions. Flexible event spaces can also be rented to the community to offset construction costs. By reusing the existing structural frame and installing pre-manufactured building elements, the project slashes construction costs for the school and minimizes neighborhood construction interruption.

DURABILITY+RESILIENCE // Updated fenestration and exterior envelope significantly improved thermal, air, and moisture control. On-site energy collection and storage allows the building to become a place of refuge in the event of a power outage or grid failure.

EMBODIED ENVIRONMENTAL IMPACT // The life cycle assessment goes beyond the cradle to the grave scope and looks beyond the building life cycle. Retaining as much of the existing building as possible lowered the building's embodied environmental impact during demolition and upfront construction. Trade-offs were made while installing systems to significantly lower operational carbon at the expense of increased upfront carbon.

INTEGRATED PERFORMANCE // HVAC loads are reduced by retrofitting the existing structure with efficient building materials, and are supplemented by onsite solar energy generation. Active and passive systems adapt to weather conditions and HVAC needs while reducing reliance on mechanically conditioned air. Expanded access to daylighting encourages more comfortable spaces and reduces electrical loads from lighting fixtures.

OCCUPANT EXPERIENCE // The occupant experience and interior design was informed by a comprehensive occupant survey of current users of the building which identified essential occupant needs as: flexible collaborative spaces, natural light, and connections to nature. Based on these results, the design utilized biophilia distributed throughout interior walls, ceilings, and screens, to enable a connection to nature. Sustainable materials such as terrazzo is used transition spaces, while wood flooring is used in areas where users would occupy the place relatively longer. The proposal also addresses acoustics' control by integrating acoustic materials directly into design features and light fixtures.

OCCUPANT COMFORT + ENVIRONMENTAL QUALITY // The International WELL Building Standard was implemented as a framework of design strategies and performance criteria. Utilizing a standard that combines best practices in design and construction with evidence-based health and scientific research allowed the project to provide high environmental quality and occupant comfort.

ENERGY PERFORMANCE // Most of the exterior walls are kept intact, and their R-values improved with 6-inches of rigid Rockwool insulation. The new windows are triple-paned and have a U-value of .14 with argon fill and a low E coating on the second surface. Newly created daylight spaces are integrated with areas lit with new LED lights and will efficiently use natural light and use smaller amounts of energy and heat in mechanical lighting. Extra power generated will be used to charge batteries for emergency backup, and the rest will be sent back to the grid.