Bridgewater State University–George A. Weygand Hall

Bridgewater, Mass.

Market: Higher Education
Size: 170,000 sq. ft.

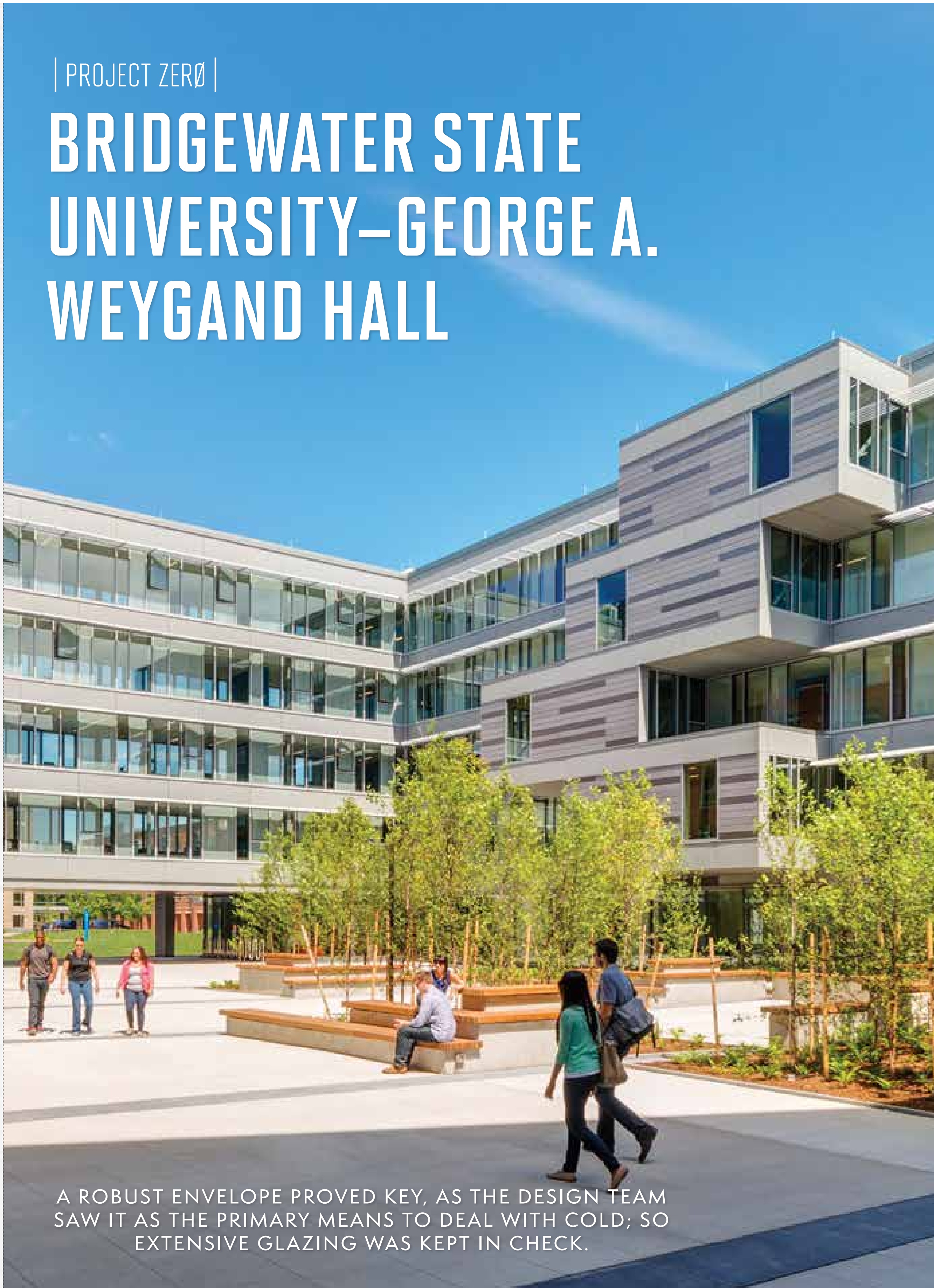
Owner: Massachusetts State College Building Authority
Architect: Perkins+Will
M/E Engineer: Rist-Frost-Shumway
Structural Engineer: Odeh Engineers
General Contractor: Bond Brothers
Landscape Designers: Mikyoung Kim Design
Owner's Representative: RF Walsh Collaborative Partners
Hardware Consultant: Campbell McCabe
Lighting Designer: Available Light
Commissioning Agent: Sebesta
Civil Engineering: Nitch Engineering

Key Team Members:
Perkins+Will: Yanel de Angel, Dana Anderson, David Damon, Andrew Grote, Jordan Zimmermann, Matthew Pierce, Derek Johnson, Christine DiLallo, Jeff Lewis, Deborah Rivers, Chad Machen
Rist-Frost-Shumway Engineering: Chris Shumway
Odeh Engineering: David J. Odeh
RF Walsh Collaborative Partners: Jack Hobbs, Joe Reilly, Kristi Dowd
Mikyoung Kim Design: Mikyoung Kim, William Madden
MSCBA: Eduard Adelman, Amanda Forde, Janet Chrisos
Bridgewater State University: Beth Moriarty, Joe Amato, Karen Jason, Mary Lou Frias, Mike Gomes, Justin McCauley

Text: Barbara Horwitz-Bennett

| PROJECT ZERØ |

BRIDGEWATER STATE UNIVERSITY–GEORGE A. WEYGAND HALL



A ROBUST ENVELOPE PROVED KEY, AS THE DESIGN TEAM SAW IT AS THE PRIMARY MEANS TO DEAL WITH COLD; SO EXTENSIVE GLAZING WAS KEPT IN CHECK.

Decoding Net Zero for the Masses

A thoroughly vetted net-zero-ready design for a Bridgewater State University residence hall is now serving as a model for future dormitories.

In delivering Weygand Hall, not only did the Perkins+Will-led team create a net-zero-ready 170,000-sq.-ft. residence hall coming in at 54 kBTU/sq./ft., it more importantly, introduced a model to advance residence hall planning and design. "Our process and documentation is now helping others rethink the way they are doing things," states Yanel de Angel, AIA, LEED AP, project architect, senior associate with Perkins+Will's Boston office.

Publicly available—and having been publicly presented by many members of the P+W design team—its net zero pilot study has documented the process involved in creating the 500-bed dormitory, including analysis of dozens of strategies that can help significantly reduce energy usage in dorms—a 54% reduction in the case of Weygand Hall.

Highlights of the design include a geothermal system with heating and cooling delivered through a highly efficient valance system; shower drain heat recovery; high-performance glazing and fiberglass window frames; high wall and roof insulation levels; exterior shading devices; lighting controls; and window kill switches which shut off the air conditioning when the windows are open.

Other high-performance strategies included high-efficiency lighting, low-flow fixtures, a list of acceptable plug-in equipment, mandatory eco-living training, planted green roofs and white membranes to reduce the heat island effect. "It took a lot of work to get there," says Dana Anderson, AIA, LEED AP, managing principal of Perkins+Will's Boston office, as the building team thoroughly analyzed and modeled a much longer list of potential approaches.

"The university hadn't even intended to go net zero," notes de Angel. "They were surprised to see how certain strategies would give them a better long-term value, and how simple some of the technology was."

Ultimately, Anderson says the client is excited about the project. "They learned a tremendous amount and I believe they're already utilizing some of that knowledge for future building projects."

TIMELINE

- ▶ **November 2010–January 2011**: Design "charettes"
- ▶ **November 2010–March 2011**: Conceptual Design/ Schematic Design
- ▶ **March–June 2011**: Design development
- ▶ **June–December 2011**: Construction documents
- ▶ **December 2011–December 2012**: Construction documents published for tender
- ▶ **January 2012–August 2013**: Construction, change orders and addendums
- ▶ **August 2013**: Present occupancy, comissioning, monitoring building data and tweaking systems

Weygand Hall is not just a dorm, it's a living, learning program. In fact, at the beginning of the school year, resident assistants, dubbed "eco reps," train students about responsible use of energy, with a refresher session conducted the second semester. Essentially, the "residential life people tell the students that if you sign up to live here, it involves a lifestyle change," says Perkins+Will's de Angel.

Students, thus far, appear to be taking this responsibility seriously, as two energy analyses conducted to date—one taken six months into operation, and a second a year later—discovered that the building consumed slightly less energy than what was modeled.

"We think this is attributable to how the students are using the building," says de Angel.

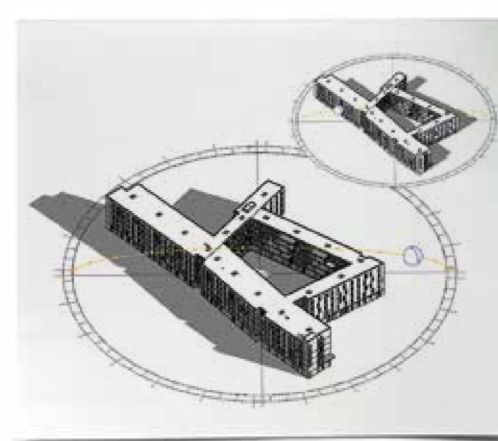
DAYLIGHTING

Unlike typical dormitories with fully double-loaded corridors, Weygand Hall is built around a central courtyard with living-learning pods oriented along single-loaded corridors and the majority of dorm rooms extending into double-loaded corridors with exterior windows on each side for optimal daylighting.

Taking into account solar heat gain on the long southeast and southwest elevations, the building is oriented north-south, with a slight 12-degree tilt from the north.

To boost thermal performance, Perkins+Will specified double-pane, low-E glazing with an argon gas infill. While triple glazed units were considered, it wasn't pursued due to the cost and greater structural support required by the need for additional mullions and hardware.

Metal frames were also considered for their thermal break technology, however, fiberglass window frames were chosen based on the material's very low heat transmission qualities, which translated into greater interior comfort.



Single-loaded corridors around a central courtyard is a key element in helping deliver the daylight the team counted on in lowering lighting power density.

LIGHTING

With minimized lighting power density (LPD) established as a high priority for energy reduction, Weygand Hall is set up around an interior courtyard, surrounded by living-learning pods to maximize daylighting.

A mix of LED and fluorescent technology is integrated with a robust lighting controls system tied into the daylighting design to drive LPD to 27% below baseline.

Occupancy sensors are installed in every public space, and each room has its own lighting controls.

While the team investigated sensor technology for the dorm rooms, with four to six students constantly coming and going, it didn't make sense. "For every five technologies that we ultimately deployed, there were one or two that we didn't choose," explains Chris Shumway, P.E., principal, mechanical engineer, with Rist-Frost-Shumway Engineering, Laconia, N.H. "We made an effort to use the right technologies for the right applications."

Lighting controls work in concert with daylighting measures to minimize the dorm's LPD. LED task lights are also deployed in each room.

In order to control plug loads, the team also helped the university furnish a list of acceptable equipment and appliances. Included on that list is the requirement that all student task lights be LED.

"WE DECIDED AGAINST MANDATORY PLUG LOAD CONTROL; INSTEAD WE EDUCATED STUDENTS TO TURN OFF DEVICES."

Yet another solar heat mitigation strategy involved the use of fritted panels with 40% and 60% frit density for the large curtainwall areas of the courtyard. In fact, Perkins+Will was surprised to discover the strategy was projected to reduce heat gain by 15%.

"This meant that we didn't need to put shades everywhere," explains de Angel. "You learn something new in every project."

Based upon solar shading studies, horizontal exterior shading was placed on the southeast and southwest exposures. In addition, a brise soleil shading system was validated through analysis and energy modeling, and interior shades were set up in specific locations.

The courtyard itself provides additional shading with the cantilevered learning pods shading the corridor and inside study areas.

In terms of glazing placement within the 40:60 window-wall ratio, this was determined based upon where the building structure best leant itself to natural shading—for example, on the elevations shaded by the courtyard—and in the public areas.

Where large amounts of glass appear, fritting was added to the glazing, reducing the need for shading.

Controlling the Plugloads

In a residence hall, domestic hot water and plug loads, by far, are the largest energy consumers, so ramping down these loads were a priority.

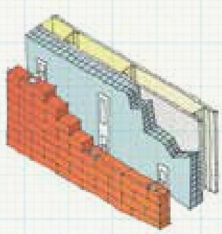
A shower drain heat-recovery system (described in more detail on page 15) made a notable dent in the former, and an aggressive educational approach to plug loads proved an effective tack on the latter.

Together with the BSU's facilities department, the team developed a sustainability charter that included a comprehensive operational plan with a specific list of equipment which students were—or were not—allowed to bring in to the dorm. One of the latter were mini-refrigerators. Instead, Energy Star-rated, full-sized refrigerators are provided in each suite. Although this involved a greater upfront cost, the payback was calculated to be around three years.

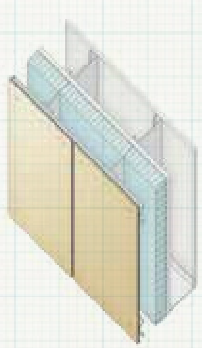
The university also investigated the possibility of installing plug load controls.

"They ran a test for a semester with a control group and another group, but it turned out that the students took the message to heart, says de Angel. "So we decided not to do it, and instead educated students to turn off devices."

In considering insulating materials, the main criteria for the envelope was ease of installation , durability, ease of replacement, cost, toxicity and flammability.



For the brick wall assembly, four in. of exterior rigid insulation was applied bring the R value to 27.



Mineral fiber was applied to rainscreen and spandrel glass applications. Elsewhere, spray foam insulation was used to seal cracks and holes.

ENVELOPE

Located in New England, the main duty of the building enclosure was to preserve interior heat during the cold winter months. To achieve this goal, the building team went about designing the envelope with a low 60/40 glazing ratio and insulating the walls and a roof with high thermal resistance.

In evaluating various insulating materials, the main criteria for Weygand Hall included climate relevance, ease of installation, durability, ease of end-of-life replacement, cost effectiveness, toxicity, flammability and environmental impact.

Ultimately, spray polyurethane foam (SPF) insulation was used to seal cracks and holes, rigid panels were installed behind the roofs and walls, fiberglass batts were chosen for the interior acoustical separation and mineral fiber was applied to the rain screen and spandrel glass applications.

For the brick assembly wall, fiberglass batt and SPF were considered for the metal stud wall, but dismissed out of concern that the metal studs would act as a thermal bridge when coming into contact with the exterior sheathing, thereby compromising thermal resistance performance by 15%. Instead, four inches of exterior rigid insulation was applied, bringing the assembly's total R-value to 27.

To help ensure that all the enclosure components would coordinate well, the team built a large-scale mock-up of the building's window area. "All the contractors and subcontractors kicked the tires all the way through that process and came up with strategies on how to install all those components," explains Shumway. "Bringing together all the pieces in real-life, full-size, really helped the process."

"We also had a great contractor who brought in the different trades at the right time," adds de Angel.

Another best practice involved bringing in Simpson, Gumpertz & Heger, a Watertown, Mass.-based building envelope quality control group.

"They not only gave feedback on the drawings, but showed up on-site to look for things that could be improved and talked to the owner and contractor about different solutions," says de Angel.

"THE CONTRACTORS AND SUBS KICKED THE TIRES ALL THE WAY THROUGH THE PROCESS AND CAME UP WITH HELPFUL STRATEGIES."

HVAC

In addition to geothermal wells, the dorm taps the wind to make heating and cooling consumption relatively low. These strategies, combined with the tight enclosure, means Weygand Hall turns its heat on much later in the season, compared to other BSU dormitories.

Starting with window orientation, the team studied wind roses, seasonal winds and prevailing winds to determine optimal placement to capture wind flow. While the university has traditionally used single- and double-hung windows for residential halls, casement windows were chosen to support air flow without compromising safety.

Also novel was the use of valance technology. While uncommon in the U.S., Perkins+Will had worked with it on a number of projects and was able to justify the technology's higher first cost and longer payback with a number of other benefits.

According to Shumway, It's a convective heat transfer device—the same principal as a hot water radiator—but it's installed in an upper corner of the room. For heating, the engineer says it takes cooler room air, warms it up and discharges it at the ceiling level. In AC mode, chilled water runs through the coil. "The valance unit takes the warm air in through convective energy transfer and cools it off," explains Shumway.

The cooling process often brings the air below the dew point, thereby creating condensation, so the valance system is built with a means to collect and drain the moisture.

With heat and cold radiating from the pipes, there are no fans, filters or moving parts; very little draft; and little to no maintenance.

Operable windows are a big part of the HVAC scheme. To ensure efficiency, kill switches decouple the room from the HVAC system when windows are open. The building was also oriented to take advantage of prevailing winds.

An aggressive lighting control system allowed Perkins+Will to combine ample daylighting with efficient LED and fluorescent technology to drop Weygand Hall's lighting power density 27% below the university's baseline.

Even though Perkins+Will devised an effective on-site power plan that would power not only the dorm, but another building, economics dictated they put the building into "net zero ready" status until the time was right.

POWER

While on-site power options were thoroughly analyzed and vetted, the university chose not to pursue on-site energy at this time.

"The simple reason is money and space," explains Anderson. "We continue to remind the client about the opportunity and we're hoping that they will move forward with it."

Looking at photovoltaics, it was determined that 225,000 gross square feet of PV panels would be sufficient to offset Weygand Hall's energy requirements, so the roof was designed and built to be PV ready. However, additional space would be required, and since the neighboring quad was used for the geothermal wells, installing PV wouldn't have been pretty, says Anderson.

The building team also studied the possibility of wind harvesting, focusing on turbines generating between 1.5 megawatts and 2 megawatts. "We identified a potential location, put some instrumentation out there, did a one year wind study and verified that it would be a good location," says Anderson.

They found that a 2-MW generator could power the dorm and even another building.

Producing 3,170,000 kWh annually, and taking care of 30% of the campus' power needs, annual energy cost savings are estimated at $787,804. This option offered a better payback of 10 years, as compared to solar, but the initial outlay for all the equipment was still not in the budget.

The Massachusetts State College Building Authority did purchase 2,792,009 kWh for two years from a renewable energy company, amounting to 70% of the residence hall's total energy use. However, because the renewable energy is not generated on site, it doesn't officially count toward net-zero certification.

WATER

The highlight of Weygand Hall's water efficiency design is its shower drain heat recovery system, which utilizes copper piping to recover heat from draining shower water.

"We apply a heat exchanger to the outside of the drain pipe from the showers," explains Shumway. "With 100°F water typically going out to the sewer system, we reclaim 40% to 50% of the energy in that waste water and use it to pre-heat domestic water elsewhere in the building."

With plumbing stacked on the building's four floors, one shower drain heat-recovery pipe is provided per stack, amounting to 35 copper pipes serving the building for an estimated payback of seven years With 140 showers serving the building's 500 residents, the economics of scale are impressive.

While the system does require additional piping, for mid-rise construction of three stories or more, Shumway says shower drain heat recovery is viable.

In terms of the water fixtures, they are all better than code minimum, and the design team was quite selective in choosing them. "Some fixtures offer a better water stream, so we worked with the owner to test out some samples," explains Anderson. "We didn't want to leave behind any maintenance frustrations by doing things a little bit differently."

Shower drain pipe heat recovery in Weygand Hall captures 40% to 50% of the heat lost from showers and re-applies it to domestic water heating.

BSU Project an Open Book

Now that the building has been open for a year, de Angel believes it's time to really get to work. "We have many other institutions wanting to tour the building. They want it [net zero] for their own campuses because they know it has been successful."

Much of this information is available in their project study, which shares energy modeling, life-cycle analyses and payback analyses. In fact, de Angel's seeing a ripple effect as people hear about the project. "We have the data that can benefit future projects and help others raise their expections [for doing net zero projects]."