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# Resilient Design: 7 Lessons from Early Adopters

**As storms reveal weaknesses in our built environment, some project teams have adopted more robust, durable design features.**

*By Katharine Logan*

Whether it's two five-hundred-year floods in eleven years, a 50% increase in the number of tropical storms in the North Atlantic, or severe droughts and wildfires in some regions, the context of building is changing. And with those changes, a new design parameter is emerging: resilience.

"Resilience is the capacity to adapt to changing conditions, and to maintain or regain functionality and vitality in the face of stress or disturbance," according to a working definition from the Resilient Design Institute (RDI). Along with this definition, RDI is developing a set of principles (see sidebar, "Principles of Resilient Design,") that build on early thinking by RDI president and BuildingGreen founder, Alex Wilson, to guide resilient design (see "Resilient Design—Smarter Building for a Turbulent Future").

Meanwhile, practitioners designing buildings in places on the front lines of climate change and resource uncertainty are applying these or similar principles drawn from regional lessons to design buildings that are better suited to a changing world. We asked some of these pioneering practitioners to share their lessons learned.

## 1. Listen to the Land (and the Water)

### *Gulf Coast Research Laboratory*

Located on a forested bay head on an inlet to a bayou that leads out to the ocean, the University of Southern Mississippi's Gulf Coast Research Laboratory (GCRL) lost classrooms, laboratories, administrative offices, and exhibition areas to Hurricane Katrina in 2005. Seven years later, Lake | Flato Architects had begun schematic design for the GCRL's 28,000 ft2 replacement facility when Hurricane Isaac roared through.

"Resiliency was a huge issue," says Matt Wallace, AIA, project architect at Lake | Flato, "and something we talked about from the very beginning." In fact, designing for resilience on this project redefined what the very beginning meant. "First, we wanted to think about the land," says Wallace. "The most important thing for resilient building is to understand how the land can do the work for you."

A thorough site evaluation preceded design. Drawing on the analysis of geologists, ecologists, and other environmental experts over a four- to five-month period, the evaluation provided the design team with an understanding of the site's zones of sensitivity and its trees' relative capacity to buffer wind. Applying that information, the design team was able to place the new facility on the most resilient and best buffered part of the site—and even to adapt the building program to use the site's best assets: its trees.

Image: HOK

*HOK's design for Project Haiti, an orphanage built by the U.S. Green Building Council in the wake of the devastating 2010 earthquake there, uses resilient design elements—like a structural system made robust by branching elements inspired by nature, as well as rainwater catchment and onsite renewable energy.*

The strongest trees on the site grip the earth with root systems capable of withstanding winds of 180 miles per hour. Instead of a single building, which would have entailed clearing this windbreak, the facility will consist of smaller, grouped buildings that can be tucked among the old-growth trees. The buildings' foundation system uses helical piers (also known as screw piles or helical piles) to minimize damage to tree roots.

The most damaging aspect of a hurricane, however, is not always wind; major storm-surge flooding can be far worse; elevating buildings can be the most practical response. "When dealing with storm surge, the higher the better," says Wallace. "That being said, humans still have an innate need to connect, or be close, to the ground." Unusual along the Gulf Coast, the upper elevations of the GCRL site rise three feet above the post-Katrina 100-year floodplain defined by the Federal Emergency Management Authority (FEMA). With this head start, the design team was able to define a "build zone" comprising areas in which no more than three steps (or a 30-foot-long, handrail-free ramp)

Illustration: Matt Morris

*In addition to siting it above the 100-year floodplain, the design team for the Gulf Coast Research Laboratory considered durability of building materials in the salty environment and their implications for marine health—assuming that the buildings might one day end up in the ocean.*

would connect finished floor levels to the ground.

"All buildings eventually end up in the ocean," said a GCRL client rep at a design charette early in the process, articulating the unfortunate reality of rising storm surges that dwarf events of recent memory as well as historical benchmarks. As designers of a marine education center, the project team took that seriously. Once the design team had located the facility to best advantage, it turned its attention to the sustainability of the materials the building would use.

Thinking about both acute natural disasters and longer-term issues, the team assessed materials for their durability in the salty environment and their implications for marine health. For example, to resist both rot and corrosion, the facility's rainscreen cladding uses cement board.

Plastics are among the worst ocean contaminants. A wood substitute made of recycled plastic may generate value from waste and offer additional years of service, but "if that's going to be floating around in the ocean one day," says Wallace, "is it worth having on the building just to have an extra ten years of use out of it?"

Zinc and copper, often favored for their durability, can leach into the watershed and wreak havoc on the marine environment. Instead of a zinc roof, the team selected pre-weathered Galvalume, which is coated with an aluminum-zinc alloy to resist corrosion. For plumbing, the team devised a hybrid system using PVC underground to prevent copper leaching into the watershed, and copper above to prevent a storm surge carrying PVC out to sea.

Illustration: Kendal Claus and Phil Zimmerman

*The design team for the University of Southern Mississippi's Gulf Coast Research Laboratory (GCRL) placed the new facility on the most buffered part of the site, and instead of a single building, which would have entailed clearing a key windbreak of old-growth trees, the facility will consist of smaller, grouped buildings.*

## 2. Speak the Vernacular

### *The National Estuarine Research Reserve*

The National Estuarine Research Reserve (NERR) on the Gulf Coast is a network of protected areas established for long-term research, education, and stewardship. The protected areas provide essential habitat for wildlife; offer educational opportunities for students, teachers, and the public; and serve as living laboratories for scientists.

Even before Hurricane Katrina, the trailers that served as the NERR Grand Bay Coastal Resources Center (CRC) at Moss Point, Mississippi, suffered periodic flooding. High-water lines around their sides marked the level of the latest inundation, and power failed for multiple weeks a year, during which the buildings grew too hot and dark to work.

So when the time came for Lord, Aeck & Sargent Architecture, in collaboration with local architect Studio South, to design a new research and interpretive center, their design challenge was clear: "We need the building to function when the power's out and there's five feet of water on the ground," the client partnership of the National Oceanic and Atmospheric Administration, the Mississippi Department of Marine Resources, and the U.S. Fish & Wildlife Service told the design team.

Drawing on the expertise of Lord, Aeck & Sargent's historic preservation studio, the team turned to the rich potential of the region's vernacular solutions: porches, screens, deep overhangs, shutters, and ample daylight. "We need to rediscover the benefit of all this stuff functionally," says Jim Nicolow, AIA, principal and director of sustainability at the firm, "but it also ties back to the region culturally."

The new, LEED Gold-certified research and interpretive center is a building

# Principles of Resilient Design

The 10 principles of resilient design, developed by Alex Wilson and the Resilient Design Institute, are [posted on that organization's website](), along with accompanying resilient design strategies.

1. **Resilience transcends scales.** Strategies to address resilience apply at scales of individual buildings, communities, and larger regional and ecosystem scales; they also apply at different time scales—from immediate to long-term.

2. **Resilient systems provide for basic human needs.** These include potable water, sanitation, energy, livable conditions (temperature and humidity), lighting, safe air, occupant health, and food; these should be equitably distributed.

3. **Diverse and redundant systems are inherently more resilient.** More diverse communities, ecosystems, economies, and social systems are better able to respond to interruptions or change, making them inherently more resilient. While sometimes in conflict with efficiency and green building priorities, redundant systems for such needs as electricity, water, and transportation, improve resilience.

4. **Simple, passive, and flexible systems are more resilient.** Passive or manual-override systems are more resilient than complex solutions that can break down and require ongoing maintenance. Flexible solutions are able to adapt to changing conditions both in the short term and the long term.

5. **Durability strengthens resilience.** Strategies that increase durability enhance resilience. Durability involves not only building practices but also building design (beautiful buildings will be maintained and last longer), infrastructure, and ecosystems.

6. **Locally available, renewable, or reclaimed resources are more resilient.** Reliance on abundant local resources, such as solar energy, annually replenished groundwater, and local food provides greater resilience than dependence on nonrenewable resources or resources from far away.

7. **Resilience anticipates interruptions and a dynamic future.** Adaptation to a changing climate with higher temperatures, more intense storms, sea-level rise, flooding, drought, and wildfire is a growing necessity, while non-climate-related natural disasters, such as earthquakes and solar flares, and anthropogenic actions like terrorism and cyber-terrorism, also call for resilient design. Responding to change is an opportunity for a wide range of system improvements.

8. **Find and promote resilience in nature.** Natural systems have evolved to achieve resilience; we can enhance resilience by relying on and applying lessons from nature. Strategies that protect the natural environment enhance resilience for all living systems.

9. **Social equity and community contribute to resilience.** Strong, culturally diverse communities in which people know, respect, and care for each other will fare better during times of stress or disturbance. Social aspects of resilience can be as important as physical responses.

10. **Resilience is not absolute.** Recognize that incremental steps can be taken and that total resilience in the face of all situations is not possible. Implement what is feasible in the short term and work to achieve greater resilience in stages.

very much of its place. It sits well up above the flood plain on galvanized piers and trusses. Traditional hurricane shutters provide protection from storms, shade from the sun, and natural ventilation. High ceilings provide passive cooling by allowing heat to rise above occupied strata. Clerestories admit daylight deep into interior spaces. And when the water does rise or the power goes out, a screened research porch provides a place where occupants can continue to work in comfort, with critical equipment on a backup generator and boats able to come and go.

Two 6,500-gallon cisterns collect rainwater, which is used for flushing toilets and for landscape irrigation, reducing potable water consumption by 40%. With consumption at 120 gallons per day, a full cistern provides enough water for three months' use without rain. Rainwater retention ponds collect cistern overflow and site runoff, reducing soil erosion and pollution and acting as firebreaks around the building.

Hurricanes are not the only impacts the CRC needs to anticipate. Because the native landscape is managed with prescribed fires (controlled burns that help prevent wildfires), fire-wise design principles were a particular priority for the project. In addition to the rainwater retention ponds, a rain-absorbing gravel path and lawns of St. Augustine grass form a 100′ firebreak around the building. A metal roof resists airborne sparks, fire-prone non-native plant species have been rooted out, and an onsite weather station provides near-real-time weather data for fire management, with a 16,500-gallon fire suppression system standing by.

While many of the strategies that foster resilience are the same strategies that improve environmental performance under normal operating conditions, Nicolow finds resilience carries more weight with clients. "With energy efficiency, we're in evangelical mode, where we're selling the owners on it," he says, "whereas [with] resilience, they get it immediately. It affects how they use the building."

Photos: Lord, Aeck & Sargent

*The LEED Gold National Estuarine Research Reserve (NERR) on the Gulf Coast sits well up above the flood plain on galvanized piers and trusses and incorporates vernacular solutions such as overhangs, shutters, and daylight to reducing energy loads, improving comfort and increasing resilience. Two 6,500-gallon cisterns collect rainwater.*

## 3. Learn from Nature

### *Project Haiti*

The Genius of Biome is a tool developed in collaboration between HOK and Biomimicry 3.8 as a resource for brainstorming how a design project might take lessons from ecologies of place. The approach begins with profiles of how species native to a project's biome have adapted over the long term to develop place-specific resilience and efficiencies, and then asks what lessons those adaptations offer for building. HOK brought the Genius of Biome approach to the firm's pro bono work as the U.S. Green Building Council's design partner for Project Haiti, the replacement of an orphanage and children's center knocked out of commission in Haiti's devastating 2010 earthquake.

"This project was well suited to explore the connection between biomimicry and resiliency," says Thomas Knittel, AIA, senior principal with HOK, lead designer for Project Haiti, and co-author of the Genius of Biome report.

The design team took inspiration from a culturally significant keystone species, the kapok tree, for the structure of the balcony support system and the shading elements in the building envelope. The kapok-inspired branching diagrid of the balcony support system, in which the cross-sectional area remains near-constant above and below the fork of the branches, is known technically as "mother-daughter branching," an apt motif for an orphanage. The kapok bark's ability to shed heat, using a combination of surface texture and tannins, inspired the orphanage's bamboo outer skin, which shields exterior walkways and vertical surfaces from direct sunlight while allowing daylight and air to pass through, contributing to the building's passive environmental control system. "The building skin takes nature's strategy," says Knittel, "and adapts it into a design principle."

Reflecting on the design principles used on the orphanage, Knittel notes, "Resilient systems are diverse, redundant, and distributed, as opposed to efficient." The notion of efficiency that resilient design practitioners commonly take issue with is the efficiency that makes a system "fracture critical." Fracture-critical systems rely on one feature—for example, a fracture-critical bridge with no redundant supporting elements, putting it in danger of collapse if a single support fails. A fracture-critical building may lack operable windows or daylight penetration, so if power fails, the building becomes unusable.

Port-au-Prince provides no reliable grid of any kind. The most common solutions to water, energy, and waste depend on truck or diesel generators, in stark contrast to the project's LEED Platinum and net-zero objectives in all three categories. Achieving those objectives required robust, locally appropriate, and replicable solutions.

For Project Haiti's energy needs, the design team developed a tiered and redundant system in which photovoltaics, wind, and a bio-digester all contribute energy (while the bio-digester also treats waste), with enough energy stored to weather a multi-day storm in the building's areas of refuge, and some left over to power streetlights and public charging stations with a USB port for mobile devices.

To ensure a safe water supply, a closed-loop system collects, treats, and stores water onsite, with a water collection system on the roof funneling water to an underground cistern. Twelve-foot ceilings provide for good stratification of air for passive cooling. The structural system is a concrete frame, a simple structural grid that also contains redundancies in case of partial failure in an earthquake. The system had another virtue, says Knittel: "Local workers could easily learn to build it well."

## 4. Simplify, Simplify, Simplify!

### *Peace Island Medical Center*

On San Juan Island in the Pacific Northwest, power outages are not uncommon, especially when the winter winds blow. Lying in the rain shadow of the Olympic Mountains, the island receives only 20 inches of rain a year. Potable water comes from drilled wells, which sometimes in summer run dry. Designing a community hospital for San Juan, the Peace Island Medical Center (PIMC), which won a 2013 AIA Healthcare Design Award, forced Mahlum Architects to consider issues of resilience from the outset.

The PIMC achieved an energy use intensity (EUI) of 80 kBtu/ft2·yr. A typical hospital in the Pacific Northwest scores around 265, and the national median for hospitals nationwide is over 400. The drastically reduced energy demand enables the hospital to function readily on backup generators.

So how did PIMC do it? "We used the simplest heating and cooling systems we could, based on the clinical program for the space," says Erik Goodfriend, healthcare studio director at Mahlum.

**Project Haiti Resilience Features**

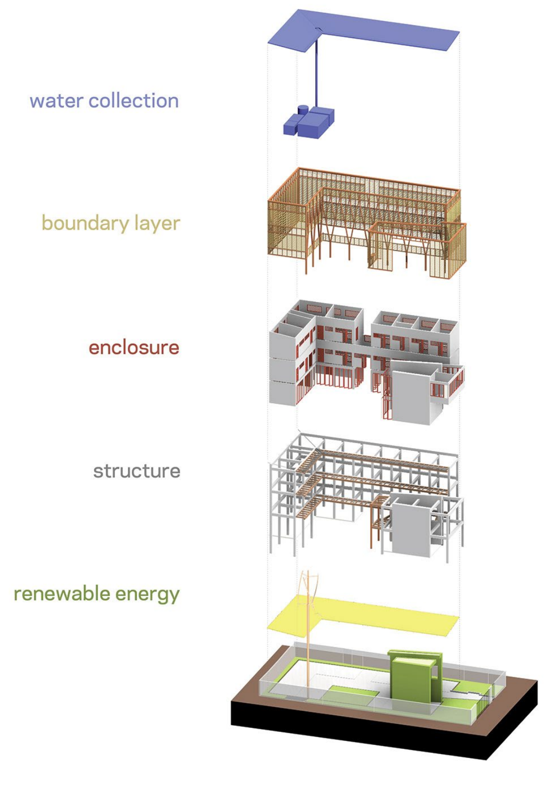



Image: HOK

*The design team for Project Haiti developed a tiered and redundant system in which photovoltaics, wind, and a bio-digester all contribute energy, with enough energy stored to weather a multi-day storm in the building's areas of refuge.*

The team tailored the 34,000 ft2 hospital's environmental control systems to the different needs of each of four program areas. In emergency and imaging departments, mechanical HVAC—using a conventional VAV system and ground-source heat pumps—provides robust, automatic, 24-hour conditioning. In in-patient areas, which are intermittently or partially occupied, controllable radiant panels provide heat, and operable windows provide cooling and ventilation. Supplemental fans prevent air changes from falling below code minimums. The outpatient clinic, which accounts for about a third of the building's area, uses the same set-up as the inpatient areas but with a more basic fan exhaust to provide fewer air changes. The surgery, operating only a few days per week, is equipped with a dedicated fan coil unit, which can be shut down when the surgery is not in use.

"The whole building needs only one guy to operate it," says Goodfriend, "and if anything breaks down, he can fix it."

In an emergency, the hospital can continue to function on a modest generator and ambient daylight. And if ferries don't run or planes can't take off, the hospital's provision of service is itself resilient, using an Internet connection and telemedicine to continue to treat patients in situ.

The design team tackled water resilience with the same vigor as it tackled energy resilience. At the eleventh hour, however, San Juan County regulatory authorities withheld approval of the water conservation strategies, and the project's budget for rainwater storage tanks and onsite sewage treatment was redirected to pay for connections to municipal water and sewer systems and associated increases in system development fees.

Photos: Benjamin Benschneider and Mahlum Architects

*On San Juan Island in the Pacific Northwest, power outages are not uncommon, so the Peace Island Medical Center uses efficient, simple mechanical systems that can be powered on a modest generator, with patient rooms and other key spaces lit by ambient daylight.*

## 5. Build (for) Community

### *Vernonia High School*

In 2007, a 500-year flood severely damaged or destroyed all of the schools in Vernonia, a small town of just over 2,000 people in Northwest Oregon. It was Vernonia's second "500-year flood" in eleven years. (A 500-year flood is one with 1 in 500 odds of happening in a given year: there's nothing—except the odds—stopping it from happening more often). In 2012, a new K–12 school, designed by Boora Architects to achieve LEED Platinum certification, opened on higher ground. "It was just a given that whatever we built for them was going to be more than a school," says Jim Harold, AIA, project architect at Boora. "It was going to be a refuge for a community."

With that objective, the school combines the resources of three schools, a community center, and an emergency shelter into a single facility. Its gyms and athletic equipment serve the recreational needs of the larger community. The media center, art rooms, and meeting rooms host adult education, workforce training, and senior citizens' activities. The school's health clinic serves the community at large. And, in an emergency, the facility can house the entire population for up to a week.

To achieve all that, the design prioritizes passive and place-based solutions. The building is oriented to maximize northern and southern exposures, and double-height, top-lit spaces admit daylight deep into the building. All classrooms enjoy daylight, views to nature, and natural ventilation, so that even without electricity, they remain pleasant and fully functional.

A well insulated, carefully detailed building envelope of high-quality materials keeps heating and cooling to a minimum. Most of the exterior walls are exposed tilt-up concrete panels, with a weep system for interior and exterior sealant joints between panels. All interior joints are fully taped with silicone sheet membrane. Four inches of rigid insulation complete the envelope assembly, with spray-foam insulation covering all structural connections.

In-floor radiant tubing distributes heating and cooling. For heating, a wood-pellet-fired boiler uses waste sawdust from a local plywood mill. For cooling, an evaporative chiller uses night temperatures to cool water, which is stored in a 50,000-gallon tank underground.

These systems, supported by a diesel-fueled backup generator, enable the school to operate comfortably during prolonged power outages—within limits. To reduce the size of the generator, and its demand for fuel, the team elected not to try to meet the heating, hot water, and cooking needs of 2,000 people simultaneously. Instead, a system of transfer switches allows heating, hot water, and cooking to take turns.

As architecture, the building offers an unconventional take on disaster preparedness. Instead of preparing for disaster with a "bunker" approach, handsome materials composing generous, well-lit spaces offer a warm invitation to gather a community. "The community isn't going to love their building and cherish it unless it's visually delightful," says Jones, highlighting a human element of resilient communities.

## 6. Design for Failure

### *Center for Culinary Excellence*

Johnson and Wales University's Center for Culinary Excellence in Providence, Rhode Island, sits on a site previously reclaimed from the ocean, only five feet above sea level, with storm surges predicted to fourteen feet, water on two sides, a setback of barely a hundred yards, and a location on the windward side of a hurricane barrier protecting downtown Providence.

Are there some sites that just shouldn't be built?

"I don't think there's anywhere that's really safe," says Blake Jackson, sustainability practice leader at Tsoi/Kobus and Associates. "We've built human habitats where we have, and you have to make a stand somewhere." There are certain areas we should designate as no-build zones, he says, "but when they're already completely occupied, you have to think more creatively about the problem—and about solutions."

Tsoi/Kobus took the site's elements of hazard as design inspiration by raising it so that its primary program takes place above the predicted surge level. Below that, a "sacrificial" ground floor of lobby, storage, and parking can be inundated without compromising the building's operation. To re-establish a connection to the ground, the new construction project mounds recycled asphalt from the previously impervious site into a huge grass-covered

Photos: Jeffrey Totaro

*With the Johnson and Wales Culinary Center in Providence, Rhode Island, located well within expected coastal storm-surge territory, a "sacrificial" ground floor of lobby, storage, and parking can be inundated without compromising the building's operation. A grassy berm accommodates rainwater storage tanks while buffering some of the surge force.*

berm that raises the apparent grade, accommodates rainwater storage tanks, buffers some of the surge force, and lends the architecture a dynamic contrast between the "grounded" end of the building and the volume that seems to hover.

On this site, the ocean crashing through the ground floor is not a question of whether, but when; and so the design team turned it into a question of how. Instead of designing the building to withstand the enormous forces generated by the ocean torquing on the building's entire ground-floor surface area, the team used an off-the-shelf assembly to allow the lower nine feet of curtainwall panels to break away, leaving only the structural columns standing in the surge.

"The building will survive and be usable the next day," claims Jackson, "instead of being out of commission for years, or even having to be scrapped altogether."

Notwithstanding its dramatic behavior on deluge day, the building is "mostly designed for normal," says Jackson. He emphasizes the priority of the building as architecture for everyday human use and promotes designing in a way that "allows resistance to inspire the architecture" rather than becoming its primary expression.

## *Spaulding Rehabilitation Hospital*

Spaulding Rehabilitation Hospital, located on a remediated brownfield parcel in the former Navy yard of Charlestown, Massachusetts, is the first building on the Boston Harbor to raise its ground floor in anticipation of sea-level rise. It has some three feet of freeboard above the 500-year floodplain level.

"We have to design as though everything will fail," says Robin Guenther, FAIA, principal at Perkins+Will. For example, rising sea levels may revise flood levels. "Yes, I'm raising the building," Guenther says, "but that doesn't let me out of considering what the materials are on the ground floor." She notes that a number of hospitals in New York were unable to pump their basements after Superstorm Sandy because hazardous building materials had contaminated the water. "There's a burden on all of us to consider the materials and furnishings that might get washed away, especially if their future is to be in Boston Harbor."

As at the Johnson and Wales Culinary Center, Spaulding's ground floor can be flooded without affecting the hospital's main functional spaces, all of which are located on upper levels. Spaulding's rooftop cogeneration system will continue to provide heat and power independently of the electrical grid, a task made easier by the hospital's relatively low EUI of 150 kBtu/$ft^2$·yr. "As you move along this continuum of deeper green design," says Guenther, "you inherently improve buildings' resilience. The very features that improve performance actually improve the long-term viability of those buildings when grid services are disrupted."

And if HVAC equipment, also located on the roof, fails anyway, the building's operable windows will prevent an otherwise functional hospital being evacuated due to overheating. Spaulding's operable windows, although not viable for primary ventilation, were included as a pure resilience feature—one that, along with a well-insulated envelope, is critical in any design for resilience, according to Guenther. "Ecosystems that are resilient have multiple redundant systems, so they are not fracture-critical," says Guenther. "We don't want to have our buildings dependent on any one element."

## 7. Make Every Day Great

### *Southeast Louisiana VA Medical Center*

Hurricane Katrina knocked out seven of sixteen acute-care hospitals in the New Orleans area for more than two years, crippling healthcare delivery in the region. The new 1.7 million ft2 Southeast Louisiana VA Medical Center, designed by Studio NOVA (a joint venture of NBBJ, Eskew+Dumez+Ripple, and Rozas Ward Architects), replaces one of the devastated facilities with a building explicitly designed to remain functional during an emergency, and to continue serving its patients and community. The hospital's five-day "defend-in-place" capability enables it to remain fully operational during severe natural disasters, accommodating and providing for up to 1,000 staff and patients. (The project was originally designed to a seven-day mandate, but budget constraints reduced what was built to five.)

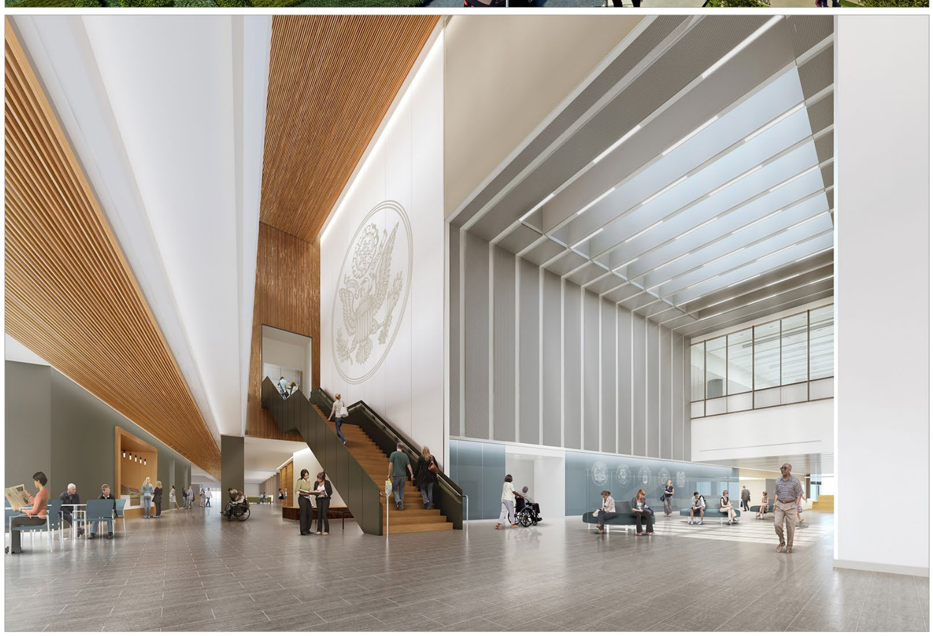
"It's easier when the client hands you a program with these requirements in it," says Margaret Montgomery, AIA, principal at NBBJ, "but if our clients don't ask, I think we should ask them: in a disaster, how functional do you want to be?"

To achieve its objectives for resilience, the VA Medical Center uses a suite of interlocking strategies. "One of the first smart things we did," says Montgomery, "was not locating any critical services below the flood plain. Nothing on the first floor is mission critical." All critical components, including the emergency department, are located at least 21 feet above base flood elevation. In a flood, the parking garage ramp to the second floor doubles as a boat dock, and a helicopter landing pad on the roof enables air lifts to continue.

After lifting critical functions above the high water line, the architects then did the same for critical building services, locating primary utility distribution on the top level rather than in the basement. A spine running along the middle of the hospital distributes the services along its top level and serves as an ordering principle for the hospital's spatial organization and circulation below.

The hospital consists of narrow wings to promote daylighting and to support a need for clear spatial orientation. "Design for veterans, sustainability, and resilience amplifies the basic human needs that we all have," says Montgomery.

In a crisis, the hospital is designed to be self-sufficient in power for a week, with its central energy plant storing



Images: NBBJ

*The Southeast Louisiana VA Medical Center was designed with five-day "defend-in-place" capability, enabling it to remain fully operational during severe natural disasters. Among the design measures was to put nothing "mission critical" on the first floor, which is in a floodplain.*

320,000 gallons of fuel, and a refill pump in a waterproof enclosure above the 500-year flood line. Under normal operating conditions, the hospital's energy use is designed to be as efficient as possible, so that what's required for emergency operation can be as small as possible. EUI for the hospital is estimated at 210 kBtu/ft2·yr.

The building envelope is carefully detailed to withstand Category 3 storms. Rooftops connect to a million-gallon rainwater storage tank, which will not only serve in a crisis but also reduces use of city water under normal operations. A 6,000 ft2 warehouse onsite stores emergency food and water for the defend-in-place period, and all single-occupancy rooms can be temporarily converted to double occupancy to accommodate a potential increase in patients during an emergency.

According to Montgomery, although the technical requirements of designing for resilience may differ from design-as-usual, "a lot of the tools are already in the kit. You just have to think about things a little differently. If we consider resiliency to be part of the programmatic requirements of the project, then we just get busy and design to them."

"The real challenge," she says, sounding a note common to nearly all of resilient design's early adopters, "is to meet those disaster needs in ways that are great every day."

*EBN's guest author for this feature article, Katharine Logan, M.Arch., LEED AP, is a British Columbia-based writer with a particular interest in place and well-being.*

NEWS

# Waiting for Take-Back Programs for Building Materials

**LEED now gives credit for products with extended producer responsibility, or EPR programs, but so far these rarely extend beyond batteries and carpet.**

*By Candace Pearson*



*Take-back programs have caught on for carpet, even outside of California, where they are legislatively required, but logistics and costs have so far hindered manufacturers of other building products from adopting or expanding similar programs.*

If news that the latest version of LEED awards credit for products with extended producer responsibility (EPR) programs only conjures images of prepaid envelopes used to return dead cell phones to their manufacturers, you may not be as off base as you think. Also known as "product take-back," these programs commit producers to creating and financing end-of-life management of their products. According to the Product Stewardship Institute, of the 76 EPR laws in the U.S., 23 are for electronics, 14 are for auto switches, and 10 are for thermostats. The common theme: they typically are geared toward holding manufacturers accountable for the safe disposal of hazardous materials.

However, a lone law in California mandating EPR programs for carpet points to the building product sector's strongest adopter of take-back programs to date. Multiple carpet manufacturers are managing their products at the back end by reclaiming flooring and re-manufacturing it into the same product again in a "closed loop" system that diverts waste from landfills. Programs for other big-ticket building products are harder to find, but a limited number of manufacturers of vinyl siding and roofing panels have systems in place, and others could be poised to follow suit.

## Among building products, carpet rules the EPR game

Interface, the largest producer of modular carpet in the world, says it has reclaimed more than 220 million pounds of carpet since 1994 through its "ReEntry" take-back program. "Carpet retains its value, so from the very beginning, throwing it into a landfill didn't make any sense," according to Eric Nelson, Interface's vice president of strategic alliances. The company accepts any brand of carpet, whether the owner is buying new carpet from Interface or not. Its facility focuses on recycling backing, but it has also moved into recovering nylon fiber—sending any materials that do not work well with its remanufacturing process to other facilities it partners with.

The company benefits by being less dependent on unstable prices of the raw material used to make carpet—oil. "We know that recycling used carpet into new products brings us cost savings by distancing us from the cost-volatility of petroleum," Nelson told *EBN*. "49% of our global footprint is now non-virgin petroleum-based."