INFORMED INFRASTRUCTURE

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Sensitively Restoring Historic Structures *to Meet Today's* Engineering Standards

BY FRANK MONASTRA, P.E., LEED AP

Restoring the integrity, significance and character of a historic building—while bringing modern-day efficiencies and comfort—can be a lengthy process fraught with challenges, but a completed project is always worth the effort.

Repurposing an old, abandoned building exemplifies responsible environmental stewardship through recycling materials and restoration. Designers and engineers must work together to find practical, cost-effective solutions to fix years of structural decay, insect and rodent infestations, and extreme weather exposure, while also complying with local zoning regulations and special architectural standards.

Historic preservation projects call on a planner's full repertoire of tools and skills, whether it's determining how to shore up a dangerously sagging covered bridge, securing national energy-efficiency designation for a century-old office building or returning a beloved timekeeping landmark to a city. Although the challenges often exceed expectations, a successful project preserves a piece of history and results in a highly desirable structure that can bring economic benefits and inspiration to a community.

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Built in 1901 and located on the original Montgomery County Fairgrounds in Dayton, Ohio, Barn No. 17 has been completely disassembled and rebuilt a little more than a mile away at its new location in Carillon Historical Park.

Dayton's Historic Education

Preserving part of a community's history sometimes means relocating structures and managing a blend of new construction and historic restoration. That's certainly the case for two projects at Carillon Historical Park in Dayton, Ohio. Operated by the nonprofit group Dayton History, the park is a repository for 3 million artifacts and provides the public access to authentic historical structures. It also offers a unique educational experience in one of the city's most-visited destinations.

Contractors are nearly finished with the relocation and restoration of the historic Barn No. 17 that served as a horse stable since 1901 at the recently repurposed Montgomery County Fairgrounds. The project began in April 2019 as workers completely deconstructed and reconstructed the barn—one plank of wood at a time—at its new location.

Barn No. 17 is a large, true timber-frame structure that served as a support building rather than housing public exhibitions. It served as a place to prepare for the next activity or rest after a long day and was a "silent witness to 120 years of county fairs, races and a whole host of special events," says Brady Kress, Dayton History president and CEO.

"These kinds of support structures are often forgotten and lost due to neglect or fire," notes Kress. "This new addition adds a different kind of building to the museum campus … county fairs, car races, stunt flights, circus acts, downtown parade staging, award ceremonies and political events all occurred near the shadow of Barn No. 17. These stories will now be shared, along with a taste of regional agriculture in an area of Carillon Park few guests see."

New Home for Historic Timepiece

Near where the barn is being erected stands Brethen Tower, which is home to the historic Callahan Clock. Built in 1892, followed by a redesign of the clock shell in 1919, the timekeeper was a centerpiece in downtown Dayton on top of the city's first skyscraper. When the building was razed, the city asked Dayton History to provide a home for the clock.

Woolpert provided civil and structural engineering for the 100-foot observation tower with observation viewing available at 75 feet. Funding from the local Brethen Foundation enabled the preservation of a significant piece of local history through the installation of the clock in the park. Kress called the project a dream the organization had since it adopted the clock in 2006.

To determine the design for the tower, Woolpert collaborated with Kress and architect John Roll, president of Roll & Associates, to determine the aesthetics and desired architectural features. Woolpert designed a traditional steel-frame structure using weathering steel material, which develops a protective rust coating and provides an industrial aesthetic. The tower's deep foundation system consists of 12 augercast piles that extend 40 feet into the ground. The steel frame will resist forces generated from a 90-mph windstorm.

Opened to the public in late 2018, the interactive and interpretive tower features panels that educate visitors about the history of the clock, the surrounding landscape and transportation corridors. The refurbished, well-lit clock is visible to drivers entering the Dayton city limits along Interstate 75. Brethen Tower has become an important historical anchor for the 65-acre campus and an asset to the community.

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The historic Callahan Clock was built in 1892 and originally located atop Dayton's first skyscraper. The clock was preserved when the building was razed and is now installed atop the Brethen Tower in the city's Carillon Park.

Meeting Today's Energy-Efficiency Standards in Yesterday's Structures

Making historic structures energy efficient can become a logistical headache for designers and engineers. Some may think it's impossible to come close to meeting today's energy ideals in a building constructed during a time of few safety regulations or construction standards.

The 150,000-square-foot Bushnell Building in Springfield, Ohio, was completed in 1893 and is on the National Register of Historic Places. Originally an office building built by Asa S. Bushnell, a two-term Ohio governor, the Wright brothers frequently visited the building to meet with their patent attorney to obtain the patent for the airplane. There are many striking aspects of the building, including the terracotta panels with cherubs and swags of fruits and vegetables above the windows; and lion heads, which adorn the cornice. The façade also shows off two

stone wreaths containing Bushnell's initials, which flank the centermost arch.

Administered through the National Park Service, the National Register of Historic Places records historic districts, sites, buildings structures and objects significant in American history that are worthy of preservation. The Register accepts listings recommended by a professional state review board. Currently, more than 95,000 properties are listed.

The Bushnell Building's new owner sought to restore downtown Springfield to its former glory and pair history with energy efficiency by achieving Leadership in Energy and Environmental Design (LEED) certification from the U.S. Green Building Council. Protecting the environment and bringing jobs back to the community were priorities. More than 90 percent of the demolition materials were recycled. Construction waste was either recycled or diverted from landfills.

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The 150,000-square-foot Bushnell Building in Springfield, Ohio, is among the 95,000-plus structures on the National Register of Historic Places. The building was completely renovated and modernized, earning LEED certification.

When Jim Beck, Woolpert engineering lead, became involved with the project, the building was in poor condition. Beck and the Woolpert team faced the challenge head-on to convert an "energy hog" of a building to meet the LEED concept of not consuming more materials than necessary. The first simple changes, such as enclosing the building to prevent heat loss and improve operations of the building's systems, resulted in energy savings and improved the interior environment for occupants.

Saving energy continued through the installation of ventilation sensors, which bring fresh air into the building whenever carbon dioxide emitted by occupants is detected in a room. Daylight harvesting sensors were installed to turn off LED lights in rooms when there's enough sunlight coming in from windows. In addition, a water-source heat pump recycles waste heat from one part of the building for use elsewhere in the building.

"Often when people design buildings, they don't really consider energy savings," adds Beck. "Smart building controls allow you to use energy efficiently."

Installation of new, energy-efficient windows was permitted by the Ohio Historic Preservation Office, and each had to strictly adhere to historic guidelines and inspection. Trims around the windows were required to be dimensionally accurate to maintain the historical façade.

Despite the painstaking attention to detail required for the laborious project, Beck found a new appreciation for the value of historical restoration. "Before, I didn't understand how memories and history could outweigh the cost of renovating a building," he says. "Once I started to understand the concept of saving resources, not sending material to the landfill, and I saw how the restoration could be done; that changed my opinion."

From Cereal Factory to Conference Center

Improved energy usage also was an objective of the restoration of the Cerealine Building owned by Cummins Inc. in Columbus, Ind. The six-floor, 30,000-square-foot structure was built in 1880 as a factory to make cereal. Although it had been renovated many times through the years, Cummins recognized the building's significance and wanted to restore it in a historically appropriate manner.

As historical restoration projects get underway, the team's first task is evaluating the building's overall condition, structure and systems to determine what's usable and the possibilities for preserving or restoring the building, according to Bill Dougherty, who was then Woolpert's facilities market director.

"It's true sustainability," notes Dougherty. "We use sustainability a lot for smaller things, like saving paper or recycling material, but saving a building and reusing it is the best form of sustainability."

According to Dougherty, if an old building still has a strong structural system—beams, foundation, columns and walls—then the windows, roof and interior systems such as lighting and HVAC can be replaced without damaging the historical integrity of the structure.

"If it's a sound building, you can always do something with it," he says. "The structure itself, the building envelope and what holds it all up, is the most important thing. If that's in poor condition, you have to look at whether it's worth saving."

Cummins wanted to restore the Cerealine Building for use as a conference center on its campus, but the building had been changed several times through the years. Floor lines didn't match up with windows. The HVAC system from a previous renovation was inadequate for the building and couldn't be repaired. The roof was failing.

A key design task was ensuring the look of the building's historic exterior was maintained. New energy-efficient windows matching the original windows—curved at the top with similar panes and mullions—were installed into the same window openings without changing the size or location. The beautiful brick exterior also was preserved. A new roof shored

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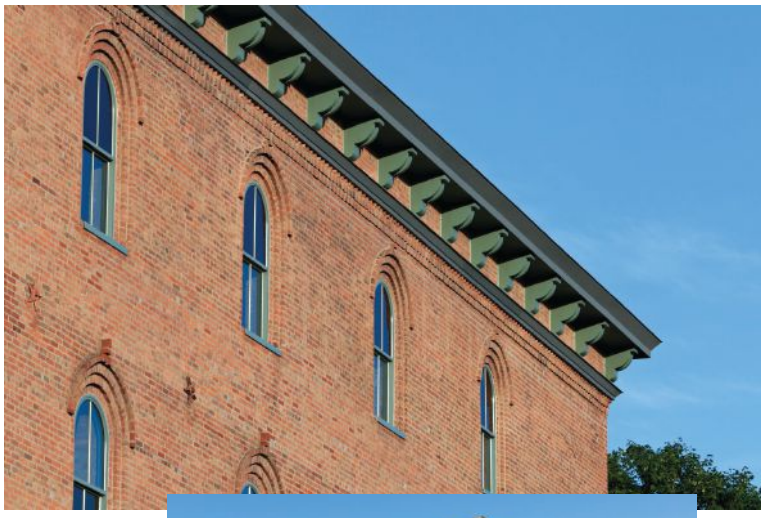

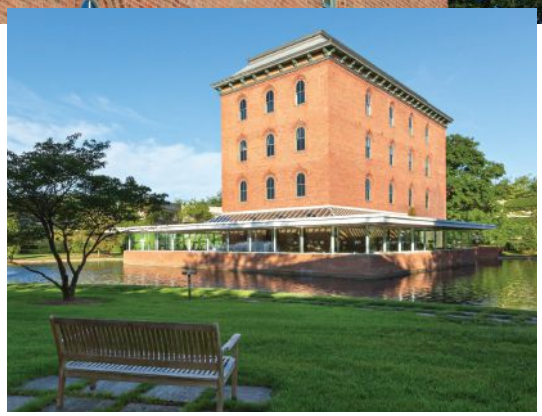

Restoration of the Cerealine Building in Columbus, Ind., built in 1880, transformed the historic structure from an old, dilapidated factory into a beautiful, modern conference center.

up the envelope of the building, and a state-of-the-art HVAC system was installed to provide heating and cooling throughout the entire building.

Dougherty admits that historic preservation sometimes comes with unforeseen risks to the budget, such as another recent project where contractors found an 8,000-pound safe hidden behind a wall during demolition. You have to figure out cost-effective ways to come up with a solution, he notes.

"Walking into the Cerealine Building today, you know you are going into a historical building. But the new use feels like it was its original purpose," says Dougherty. "It doesn't feel like a factory. You have all this brick and ornate ceiling pieces, and the stairways are unique. It's one of a kind."

Bridging the Past and the Future

Each of Ohio's approximately 100 remaining historic covered bridges also could be called one of a kind. In the United States, only Pennsylvania, which has about 200, has more historic covered bridges. At one time, Ohio had more than 1,000 of the unique structures, which have a distinct barnlike appearance.

The bridges are covered to protect the structure, but that cover also created a romantic allure. They were used as "kissing bridges," and buggies would stop in the middle of the bridge so occupants could share a quick kiss under cover.

The overhead covering of covered bridges protected the structural timbers from weather damage, but the years haven't always been kind to the spans. Vandalism, weather and lack of maintenance have taken a toll and diminished the historic legacy for future generations.

According to Ron Mattox, Woolpert transportation engineer, the bridges are "part of our heritage."

"They show how things were done back then and how genius some of the designers were. The creativity of the builders comes through," says Mattox. "I love walking under the bridge and looking at the details and what makes the bridge unique."

Mattox has worked on dozens of historic bridge-restoration projects with Woolpert and other firms. He said not every structure can be saved, and it's important to first look at what needs to be fixed to make it functional again.

"Our first thought about the structure is, 'What's there? What do we want to take back, and what do we want to get rid of?'" he explains.

Some modern engineers stabilize a covered bridge using steel plates bolted into place, but that's not the route Mattox likes to take. "It will function, but it doesn't look at all what it was originally built to look like."

"One of the things we learned early on is you need to use the same building techniques they used originally," adds Mattox. "I am sure some contractors would pull out a chain saw and go at it. All our plans require a timber framer on your project, and the contractor had to have completed five timber-frame bridges. These framers are experienced in this type of structure—using a hammer, mortise and chisel, and cutting out the joints the same way they did."

Restoring a covered bridge appropriately also means using the same types of materials. Mattox notes that timber beams for a bridge may measure 6 inches by 11 inches by 50 feet and

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Built in 1886, the Foraker Covered Bridge over the Little Muskingum River near Graysville, Ohio, was completely rehabilitated after its 92-foot span had begun to sag. The work was completed in 2016, and the project earned the Historic Bridge Award as presented by the Federal Highway Administration, Ohio Department of Transportation, State Historic Preservation Office and the County Engineers Association of Ohio.

may require using more than a dozen such timbers. Today, finding that size of timber made of white oak would be too pricey, so junctions are used to piece smaller timbers together. A century ago, about 95 percent of covered bridges were built using white oak, because of its water-resistant qualities.

In 2017, such detailed attention to restoration methods led to Mattox and Woolpert Engineer Tom Less being awarded Ohio's Statewide Historic Bridge Preservation Award for their work on Monroe County's Foraker Bridge, built in 1886. A previous restoration project left the 92-foot-long bridge sagging 11 inches.

While historic restoration is a goal, meeting modern safety standards means installing steel rods under the floor to help carry heavy loads, shifting from wooden shingles to metal sheeting to decrease weight, and spraying fire retardant over the interior of the bridge.

A project with the Ohio Department of Transportation proposes installing heat sensors, fire alarms and security cameras as monitoring devices to safeguard these historic treasures. The project also proposes installing barcodes that could be scanned by smartphones to give visitors the history of the bridge and other tourist information for the area.

Preserving History

Although historic restoration comes with an array of challenges and often a few unexpected hurdles for designers and planners, the results of a successful project bring many benefits. Restoring an old building instead of tearing it down can preserve the heritage and character of a city, while also aligning with environmental stewardship and providing business space for modern needs. Rebuilding a 19th-century covered bridge adds an intangible special quality to Sunday drives. And finding a new home for an iconic timepiece or historic barn can provide a lasting, important link to the past.

For planning professionals such as Dougherty, it's immensely rewarding to come to the end of long days of hard work with a completed restoration project, but there are even better payoffs as time passes.

"When you see an empty, dilapidated structure in your city transformed into a beautifully restored building that is functioning again, it's inspiring; and you get a sense of pride because you know that building will be appreciated, even loved, for generations to come," he says. II

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