3D Laser Imaging Helps Restore a 19th-Century Firehouse

Updating a historic Rhode Island firehouse took more than a typical renovation. A Faro 880 laser created a highly accurate 3D image of the structure, allowing builders to dismantle and rebuild it with great precision. To keep things green, the owners installed geothermal and solar energy systems to reduce carbon dioxide emissions. Here¹s how a 119-year old firehouse can be turned into a 21st century home.

By Lisa Palmer Sep 30, 2009

"The only thing keeping the bricks in place was gravity," David Hacin says. Hacin, the architect in charge of preserving the historic Newport, R.I., firehouse, shared his observation with homeowner Clint Clemens shortly after removing the structure's roof. Clemens peered inside the 1-foot-thick outer wall to see for himself: The interior mortar, which had been made from local beach sand when the building was constructed in 1887, had turned to a fine dust.

Clemens and his wife have a history of living in unique homes. Their first was an 800-square-foot converted chicken coop on the former farm of John Quincy Adams. More recently, they lived in a lighthouse in Tiverton, R.I. So when the firehouse appeared on the market in 2006, they could immediately picture themselves living there--only buying a historic landmark involved more work than they realized. "It's like signing up for the military," Clemens says. "You're in it for four years."

Known locally as Redwood Hose 8, the firehouse had last seen active duty in 1912. And although it was now a crumbling ruin, it sat smack in the middle of Historic Hill, Newport's National Historic Landmark District, so simply demolishing it was not an option. Clemens, a commercial photographer and owner of a 3D imaging company, decided to preserve the building with the tools he knew best. Using a Faro 880 laser attached to a tripod, Clemens fired off 30 million measurements along three sides of the home. This enabled him to create a 3D image of the two-story structure accurate to 2 millimeters--and to rebuild it with the same precision.

Contractors dismantled Hose 8 brick by brick, lowering the masonry to the ground one bucket at a time, until nothing was left but the building's foundation. Each brick was painstakingly cleaned, tested for strength and stored--until, as Hacin put it, the time came to "put Humpty Dumpty together again."

Clemens was determined to reduce his new home's carbon-dioxide emissions to near zero. So to control the building's climate, he chose to install a geothermal system that would take advantage of the natural temperature gradient deep underground. That proved a challenge as well. First, a 55-foot-long truck had to be maneuvered up a one-way urban street. Then, for three long days, metal rammed earth, until the drill finally bored into a geothermal aquifer 850 feet below the surface. Relief from the noise came in the form of a geyser, shooting 200 feet in the air at 150 gallons per minute.

The open-loop geothermal system supplies radiant heat to the floors and to a forced-hot-air system. Flip a switch, and 45 minutes later (as Clemens times it) the system pumps cool air into the home. Though the $32,000 geothermal system is considerably more expensive than traditional HVAC, a 30 percent tax credit this year will offset the costs. Clemens estimates the system will pay for itself in six years and last more than 30.

A solar thermal array that sits discreetly on the roof supplies all of the home's hot water; extra solar heat is redirected into radiant-heat flooring in the basement. An exterior propane tank supplies fuel for the kitchen stove, and Clemens purchases wind-generated power to supply all of the electricity.

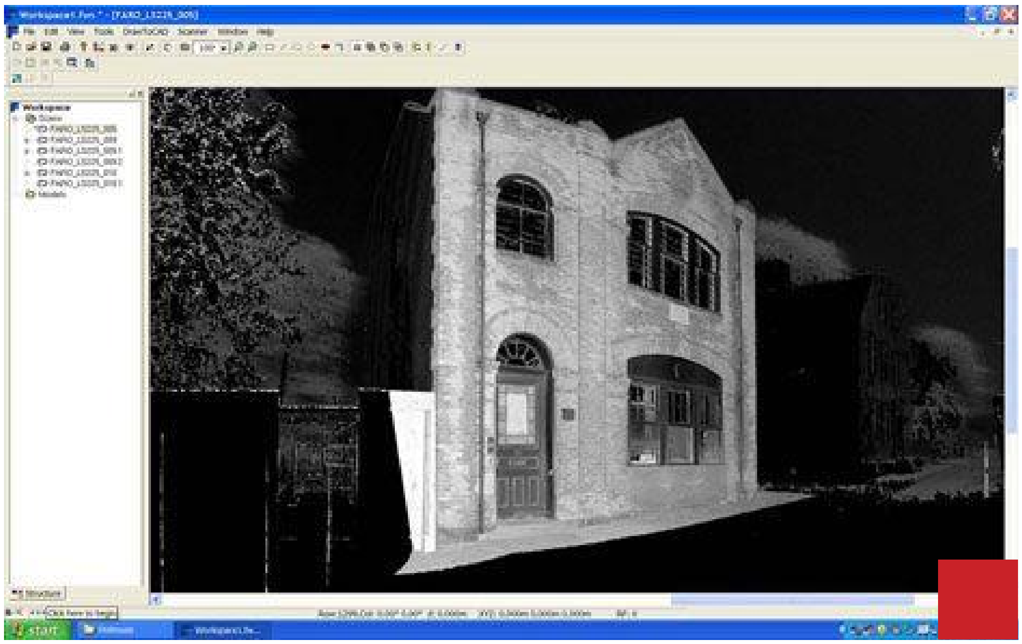
Most of the wood in the home has been certified by the Forest Stewardship Council, while other materials were repurposed from the original building--including many of the bricks, the roof capstones and a few of the windows. The brick exterior is now a veneer covering a wooden structure--not four layers thick, as in the previous construction.

In order to preserve the building's outward appearance, contractors poured a 19-inch-wide concrete trench inside the original fieldstone foundation. Then, they installed a 1-inch-thick steel plate that caps both structures. While Hose 8 appears to sit atop its fieldstone roots, that's an illusion. The steel plate acts as a cantilever, so the building's weight actually rests on the new concrete base. Stabilization rods extend from the roof to the foundation, ensuring that the house meets earthquake codes. It is also rated to withstand winds up to 200 miles per hour. The home's upgrades, Hacin says, "would have been impossible in renovating the existing building."

Inside, insulation packed into the walls increases efficiency while also muffling sound. With no hum from a furnace, the house is so quiet, Clemens says, it's "like you have a pillow over your ears." The home has been engineered as a box, so the interior walls can be reconfigured based on the changing needs of the owners over time. Currently, the French doors of the top-floor master bedroom open to a deck that overlooks the steeple of the neighboring Channing Memorial Church, built in 1880.

Clerestory windows, located high on the south wall of the first and second floors, allow daylight to filter through the interior, reducing the need for electric lighting. Natural light from a copper-trimmed skylight floods the upper levels. It was supposed to be a straightforward renovation, but turning a former firehouse into a single-family home became a lesson in fortitude instead. Two and a half years later, Hose 8 is a cutting-edge green building--and, thanks to Clemens's 3D vision, looks exactly like it did more than 100 years ago.

1



After Clint Clemens bought a 119-year-old firehouse in Newport, R.I., to renovate for his home, he learned that the crumbling mortar meant the entire structure was unsound. Demolishing the historic building wasn't an option, so Clemens, vice president of the 3D imaging company Models From Mars, applied a high-tech solution to the century-old construction problem. He measured the precise dimensions of the original structure with a Faro 880 laser--then used the resulting 3D image to convince the town's firmly preservation-minded historic commission that the firehouse could be totally dismantled and rebuilt to the same specifications.

2

Deconstructing the firehouse one brick at a time was a test of both patience and physics. Workers took measures to stabilize joists while removing individual bricks from the building's exterior. Windows that couldn't be salvaged were reproduced with exact details, down to the weighted sash and antique glass. "This is a historic structure, a work of art," Clemens says. "We are simply stewards of the building, caring for it like you would a fine painting." More than a century of deterioration forced Clemens to work his way back to a blank canvas.

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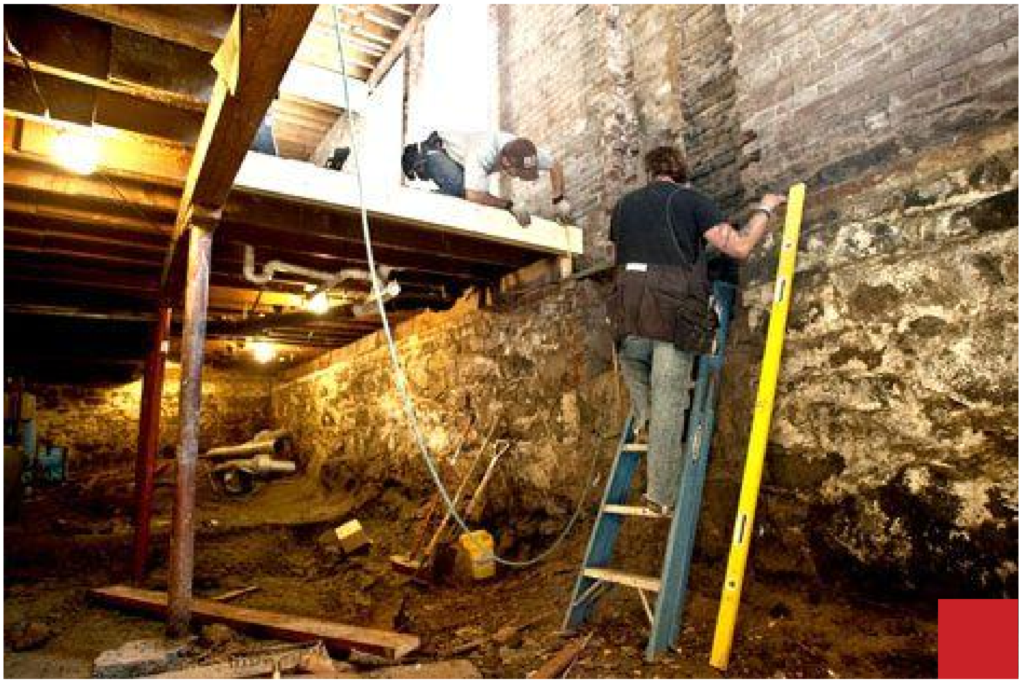
Not your typical teardown. *To reconstruct this landmarked building, the homeowner used 3D laser imaging that measures, to within 2 millimeters, where the original bricks should be placed.*

3

The sorted and stacked bricks are only a fraction of the 28,000 total bricks that workers salvaged for the reconstruction. The original walls were four layers thick, as opposed to one layer for the rebuild, so the tear-down produced thousands more bricks than needed. Neighbors carted off extras to be reused for patios and walkways.

4

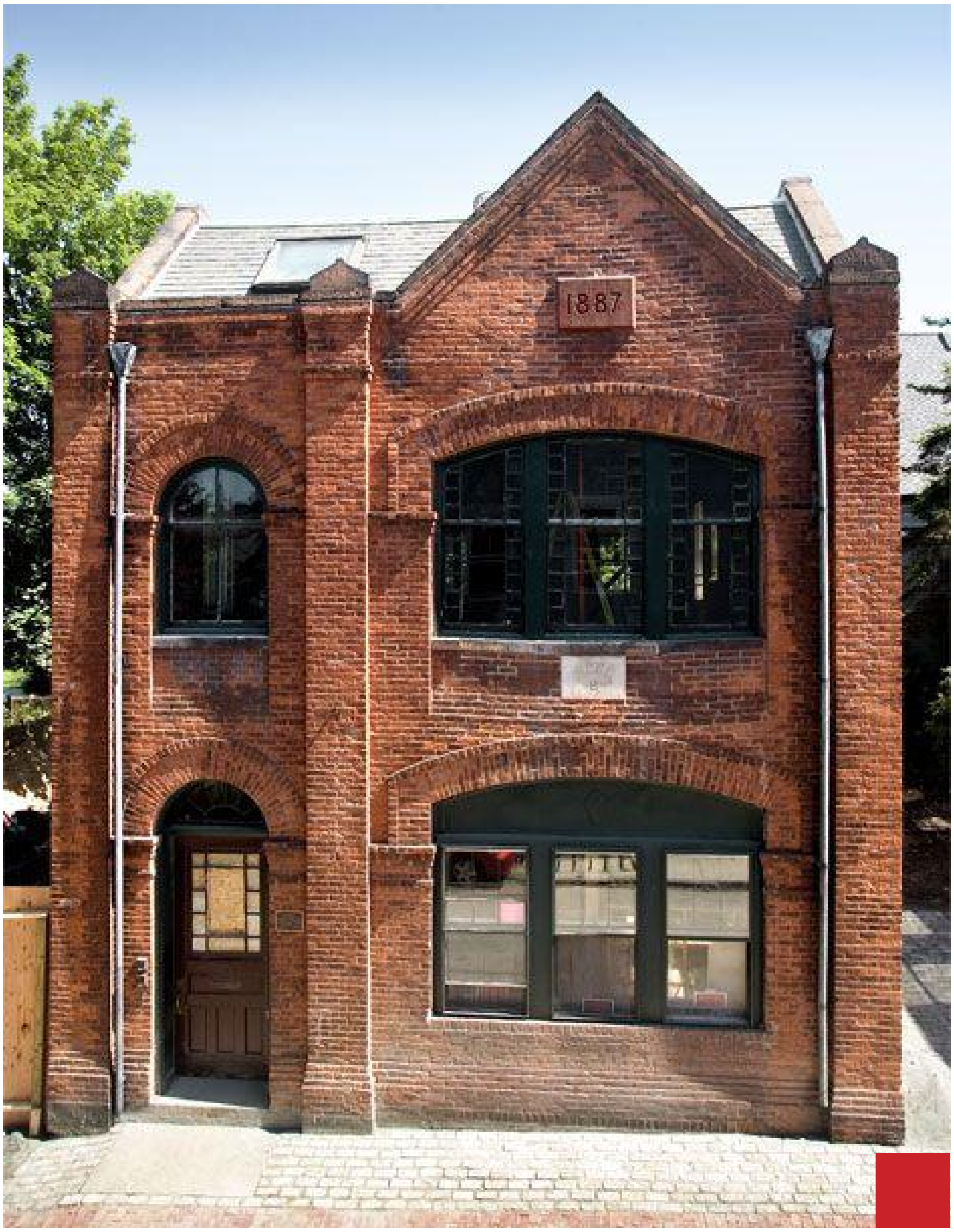


The original mortar and foundation contained local beach sand--seashells and all. Sistered joists against the walls shored up unstable footings.

5

Contractors poured a new concrete foundation just inside the original one, and capped both with the steel plate being stick-welded below. The steel and concrete form an exceptionally sturdy foundation--critical support for soft, century-old brick. Below-ground updates also include a geothermal system and earthquake-resistant rods.

6



Cellulose insulation made from recycled newspaper fills the 12-inch-thick wood-framed walls. Hose 8's exterior brickwork looks like it did before the epic project began. With the restoration, the building may last another 120 years.