Affordable, Green Buildings Hit Home For Students And The Community

University of Virginia
University of Virginia Patent Foundation

For most of its 50-plus year history in the United States, the prefabricated or prefab home has been the ugly stepsister of the housing industry, disparaged for substandard quality and lack of design aesthetic. But a confluence of factors — from the advent of green building technologies and a natural disaster to the latest financial crisis — has prompted innovative architects to take a second look at the modular home.

After building an award-winning prefab home with a small army of students, John Quale, associate professor at the University of Virginia (UVa) School of Architecture, realized the modest modular offered him a wealth of opportunity: Building prefab homes in collaboration with the community would allow him to create environmentally conscious, energy-efficient and affordable housing — while providing a unique, hands-on learning experience for students.

Winding His Way to Sustainable Housing

Quale never intended to teach architecture or pioneer sustainable building practices in the modular housing industry. His is one of those circuitous career paths that in retrospect, seems to make perfect sense.

As an undergrad at the American University School of International Service, he concentrated on international development and Asian studies. He spent time as a magazine photo editor before enrolling in the master of architecture program at UVa. After graduation, he worked on fantastic high-end residential and commercial projects for prestigious architecture firms, all the while looking for an opportunity to practice sustainable design.

“The ’90s was the era of the ‘starchitect,’ and there wasn’t anyone with a design agenda that included sustainability,” says Quale, who is a Leadership in Energy & Environmental Design (LEED) accredited professional.

Building a Solar-Powered Trojan Goat

Soon after Quale began teaching at his alma mater, a longtime UVa professor of electrical and computer engineering, P. Paxton Marshall, Ph.D., came looking for a member of the architecturefaculty to help build a home for the inaugural Solar Decathlon. The annual event, sponsored by the U.S. Department of Energy,challenges collegiate teams to design, build and operatecost-effective and energy-efficient houses totally powered bythe sun.

Their collaboration produced the Trojan Goat, a 750-squarefoot, solar-powered modular home designed and built by architecture and engineering students on the UVa campus and transported to the National Mall in Washington, D.C. Energized by the experience — the Trojan Goat won first place for design and livability and second place overall — Quale saw an opportunity to apply what they had learned from the competition to the affordable housing market.

“The Trojan Goat wasn’t something that could be replicated in the real world,” he says of the home, which cost more than $350,000 to build. “I realized I wanted to do something similar, but with a social conscience.”

As an electrical engineer keenly aware of the country’s energy issues, Marshall shared his colleague’s concerns.

“The green movement caught on in the building industry, but affordable housing lagged behind, which meant those who could least afford it were saddled with higher utility bills,” he says.

ecoMOD: Build, Design, Evaluate

In 2004, the two professors established ecoMOD as a partnership between UVa’s School of Architecture and School of Engineering and Applied Science and began looking for housing partners to collaborate on future building projects.

The goal of the design, build, evaluate project — which is fully integrated into both schools’ curricula — is to create prefab, affordable housing units using rigorous standards for sustainable design. Guided by Quale and Marshall and various other faculty members and outside advisers, students from the architecture and engineering schools would spend a year designing the modular home, build over the summer, and then monitor and evaluate the finished product for an entire year.

“The University of Virginia’s ecoMOD project is a terrific example of what can be accomplished when researchers from different fields of study come together to solve the world’s problems,” says W. Mark Crowell, executive director and associate vice president for innovation partnerships and commercialization at UVa. “Through this project, the University of Virginia’s architects and engineers are pushing the boundaries of sustainable design to create affordable housing solutions, for our community and yours.”

ecoMOD1: The OUTin

Using a decommissioned airplane hangar owned by UVa, the first ecoMOD team started constructing its inaugural project: the OUTin, a two-unit condominium to be placed in a Charlottesville neighborhood. The condominiums, funded by the Piedmont Housing Alliance, became home to two of the housing organization's clients.

"John was convinced there were economies of scale in off-site construction, where you have all your tools and labor there and you're sheltered from weather," says Marshall.

The OUTin condo was designed to merge the inside and outside, making the entire site habitable and usable. The condo project also included the area's first potable rainwater collection system, a solar hot water panel and sustainably forested wood flooring from Virginia.

A New Semester, a New House

Since the OUTin condo was completed in 2005, ecoMOD has built a total of six housing units, collecting a slew of awards and major press coverage in magazines such as Metropolis, Dwell and Architectural Record.

Each project is different from the last: one ecoMOD home was transported to Mississippi, where the local housing industry was hobbled by Hurricane Katrina; others have been strategically sited to aid in neighborhood redevelopment. Another was built as an accessory dwelling unit (ADU), behind an existing home. At 398 square feet, the ADU is the smallest building in the world certified by LEED, the internationally recognized green building certification system.

Quale says response from the community has been overwhelmingly positive — a large number of builders and other businesses have served as advisers and donated resources. When it makes sense, ecoMOD teams have pursued grant funding and the expertise of UVa faculty from other disciplines — such landscape architecture and historic preservation.

"Ten years ago, very few architecture schools offered handson building opportunities like ecoMOD," says Quale. "And although there are programs like ours around today, the collaborative nature of ecoMOD and the evaluation component set us apart."

Systems Testing and Homeowner Feedback

In the evaluation phase, students analyze the home's environmental impact, energy performance and comfort levels, among other factors. Homeowner feedback as well as air temperature, humidity and utility-usage information gathered by a monitoring system installed in each ecoMOD home are also part of the comprehensive process.

Energy-efficient construction methods employed for ecoMOD1, such as the use of high-performance structural insulated panels, help the condominium outperform a comparable conventional home of the same size by 65 percent to 70 percent.

"I think we've done the best with insulation and sealing our homes," says Marshall. "Our homes are very well-insulated and tight."

ecoMOD4: Going for Gold

The ecoMOD4 project, a townhouse built in partnership with Habitat for Humanity of Greater Charlottesville, is likely to be the design that comes closest to net-zero energy usage. The hope is that the home, which features geothermal heating and cooling combined with solar panels, will also be certified gold or platinum through LEED.

"We've made good progress designing an energy-efficient home, lowering upfront costs and the cost of operating the

home, and incorporating advanced technology but still creating affordable housing," says Marshall.

At $125 or less per square foot, the cost to build an ecoMOD home is well below the national average for a stick-built home and within the budgets of housing organizations such as Habitat for Humanity. Even more importantly, the utility costs for ecoMOD homes are also significantly decreased.

"The homeowner who lives in our ADU is our best spokesperson because he loves living there and tells everyone how about how low the utility bills are," says Quale. "That's what's most rewarding, to see students go through the process from design to build to the homeowner moving in. And once homeowners live in [our homes], they really understand and appreciate what we were trying to do with the design. They get it."

The Student Experience

To date, more than 300 students have participated in ecoMOD, many of whom have been inspired to embark on careers that include a dedication to sustainability.

"I'm particularly proud of the value of this project for student education," says Marshall. "There's nothing else that provides students with a holistic experience like working on an ecoMOD team."

The University of Virginia Patent Foundation has licensed its copyrighted designs to affordable housing organizations and continues to pursue nationwide commercialization channels so that ecoMOD designs may be built across the country.

"It's all about getting the designs and the concept of sustainability out there," says Quale.

ecoMOD continues to vigorously partner with organizations in the nonprofit sector, providing students with real-world project experience and a service-learning opportunity — while contributing to the inventory of affordable, sustainable housing.

"I've learned that students can accomplish a lot more than I ever believed possible," says Marshall. "They can be out addressing the real problems of society."

This story was originally published in 2011.

To see available technologies from research institutions, click here to visit the AUTM Innovation Marketplace.