The ecoMOD project at the University of Virginia School of Architecture is intended to create a series of ecological, modular and affordable house prototypes. The goals are to demonstrate the economic and environmental potential of prefabrication, and to challenge the modular and manufactured housing industry in the U.S. to explore this potential. In the context of this research and design/build evaluate project, an interdisciplinary group of architecture, engineering, landscape architecture, business, environmental science, planning and economics students are participating in the design, construction and evaluation of the project. The project is imbedded in the curriculum of the university.

The first completed house is currently being evaluated as part of a process to determine the environmental impact of the homes during their life cycle; perceptions of the homes by the owners and neighbors; the energy efficiency of the design and equipment; the feasibility of their transfer to the modular housing industry; the life cycle costs; and the financial viability of taking the prototypes into production. The results of the evaluations will influence later designs, and the evaluation methods and recommendations will be made publicly available. The project will continue through 2010 at a minimum.
Centralized within a climate-controlled facility, prefabricated residential construction offers material and transportation efficiencies, as well as the opportunity for stricter quality control. Although several U.S. companies have developed EnergyStar-rated models, and sell quality homes superior to conventional stick-built construction, few are seriously considering the environmental impact of their methods or materials.

Among the most surprising trends in prefab housing is growth at the upper end of the market. Whereas public perception suggests prefabricated homes are inferior products only appropriate for the least affluent, upscale builders increasingly recognize the financial and logistical advantages of centralized fabrication. Although they seldom emphasize the prefab nature of the construction, major U.S. home builders such as the Pulte and Toll Brothers are transitioning from site built to pre-built for their middle and upper-middle market rate houses. Major home builders clearly recognize that the future is in prefab, which can typically offer a more predictable product with more control over quality, schedule and price.

However, the benefits of these investments are not filtering down to the lower end of the market. Manufactured housing, the technical term for transportable trailers built to the U.S. Department of Housing and Urban Development (HUD) building code, is still the least expensive way into the new housing market. While the HUD code has gotten more restrictive in recent years with tighter guidelines for insulation and the attachment of the trailers to foundations, the fact remains that manufactured houses are still inferior products. They are difficult to finance, built with the cheapest possible materials, and tend to depreciate in value. In contrast to HUD code homes, prefabricated homes that use modular, panelized or component prefab elements are built to the code of the local jurisdiction. Unlike HUD code houses, these homes are considered permanent construction, and do not face financing problems, and therefore tend to appreciate in value in the same way as a site built house.

The availability of affordable housing in the U.S. is a growing problem. As construction costs increase and home values continue to grow, the challenge of buying a home in many markets is becoming insurmountable for many. House values have increased 20% in just the last two years, while incomes for middle and lower class Americans have remained flat. In addition, manufactured houses are designed for the width and orientation of suburban lots. No major manufactured home company offers models designed for urban lots with the entry side facing the street. The typical single-wide module for these homes measures 12'-0" to 14'-0" wide by 48'-0" long – a size nearly impossible to transport into most tight urban areas. By default, families in the affordable housing market are being pushed to the periphery where they have to take on the added financial burden of driving everywhere.

It is in this context that the ecoMOD project was developed. ecoMOD is a collaborative research and design/build project at the University of Virginia School of Architecture focused on creating well-designed and well-built homes that cost less to live in, minimize damage to the environment, and appreciate in value. The goal of ecoMOD is to create a series of proto-typical ecological and modular houses for low-income families. Over the next several years, UVA architecture, engineering, landscape architecture, business, environmental science, planning and economics students and faculty will provide a minimum of four prefabricated houses. Through partnerships with Piedmont Housing Alliance (PHA) of Charlottesville, Virginia and Habitat for Humanity of Greater Charlottesville (HFHGC), the homes will be placed in established communities. PHA will sell three of the homes to low-income families in the Piedmont region with down payment and financing assistance.
The first PHA house, called the OUTin house was designed, prefabricated, and sited in the Fifeville neighborhood of Charlottesville on 7 1/2 Street. It is being sold as a two-unit condominium (basement unit sold separately from the upper two floors), and includes a rainwater collection system that delivers potable water, an extremely energy efficient construction system, a solar hot water collector, and landscape of native, drought tolerant plants.

ecoMOD2 – known as the preHAB house – is a panelized design that will house a family displaced by Hurricane Katrina. Constructed in partnership with HFHGC and the HFH affiliate in Jackson County, Mississippi, the design is intended to demonstrate the potential of prefab for Habitat affiliates. HFH is already pursuing panelized construction with their “Operation Home Delivery” project focused on delivering wall panels from around the country to be set up in the hurricane devastated Gulf Coast region. The goal with the preHAB house is to take this one step further, by designing a home that can be pre-fabricated in various ways – panels, room-sized modules, and/or smaller components.

The first preHAB house will be sited on an empty lot in a 1960’s affordable housing subdivision in the city of Gautier, Mississippi.
facilitate the decision process, but in reality, the webs were mostly treated as a documentation of a decision. During the break between the two design studios, the client decided to change the site, forcing the team to respond to a complex challenge. The students set about redesigning the house for the new narrower lot. The change significantly delayed the development of the design, but forced the team to address the adaptability of the design to various sites. The challenge was repeated again two weeks before the end of the spring semester, as the team was headed into the construction phase. A series of events led to another site change—still in the Fifeville neighborhood—but a site with a different solar orientation, topography, and urban context. Once again, the design had to change, and the schedule was delayed. As with the first site change, the design team responded by exploring the ways the design could be more easily sited on various topographies, and in various microclimates.

The start of the construction process for ecoMOD1 was delayed by nearly two months. The students fabricated eight small modules for the two-story house in a decommissioned airport hangar owned by the university, and transported them to the infill site. Unlike conventional modular houses, the students designed their modules to fit the proportion of urban infill sites, and to be easily transported along narrow streets. The modules were less than half the size of a typical module, allowing for the use of a less expensive crane, and the possibility of moving the modules through the narrowest streets with the tightest turning radii.

The majority of the design studio students elected to stay in town after their graduation, and participate in the construction process. The team worked through all the logistics themselves, including coordination between various building trades, material procurement, and transportation.

The funding for the tools, and a significant percentage of the summer student fellowship money was provided by a local non-profit funding organization. The remainder of the funding was raised by the Project Director via grants and donations. The students devised strategies to work around the more sophisticated equipment that was beyond financial reach. For example, one company uses pneumatic devices to allow the modules to ‘hover’ as they move along the assembly line. The students built the eight modules in a single line in the hangar, and only moved them when it was time to transport them at the end. For this, they designed and fabricated a set of ‘house skates’ using left over framing material on wheels to roll the modules over a trailer, where they were lowered on to the bed. Conventional jacks were used to lift the house, and three or four people easily pushed the modules while on the “skates”.

Each completed house is to be monitored and evaluated carefully, with the results guiding the designs of subsequent houses. The evaluation process occurs in two overlapping courses with participation from students and faculty from architecture, engineering, commerce, business, environmental
science, landscape architecture and planning. As of this writing, the evaluation is approximately 70% complete, with a more thorough analysis available in the spring of 2007.

The ecoMOD1 evaluation team is looking carefully at the choices made by the design/build team. This includes the following: 1) monitoring the energy efficiency and water use of the house, contrasting the data with simulations and comparable homes 2) thorough life-cycle assessments of the materials and construction process 3) a post-occupancy evaluation with the eventual homeowners, including questions about thermal and lighting comfort, as well as evaluation of the design hypotheses set out in the design phase 4) an affordability analysis comparing the cost of both the prototype and the eventual production model to other available modular homes 5) a cost/benefit analysis and investigation of the design's suitability for production with a major manufacturer, and 6) a summing up of the key recommendations, including a prioritized list of issues for the next design/build team to consider.

Preliminary conclusions indicate the following: 1) while the potable rainwater collection system will save the homeowners money and reduce the home's environmental impact, the cost of the filtration equipment negates the efficacy of recommending it for city locations where the municipal water supply is relatively inexpensive 2) stricter guidelines need to be established to make sure the emphasis on building material efficiency at the hangar during the off-site construction process is not lost during the final phase on site, where a dumpster was available 3) while the design adequately addresses shading from the summer sun, it does not appear to sufficiently address the potential positive contribution of solar heat gain during the winter months 4) the material life cycle assessments so far support the design decisions, but additional research is required into a comparison of the cemimentitious lap siding (as selected for ecoMOD1) versus the more conventional choice of vinyl siding; as well as corrugated gavalamue roofing versus a membrane or asphalt shingle roof 5) the centralized air handler and ductwork – located in the middle of the conditioned space appears to contribute to the energy efficiency of the mechanical system 6) the combined effect of the energy efficient wall and roof system (structural insulated panels), the equipment and the passive design strategies seem to indicate a minimum of a 40% reduction in energy costs for the homeowners and 7) the preliminary financial analysis indicates that if the ecoMOD project were a for-profit business venture, it would be able to successfully find a niche in the largely underserved market for ecological, prefabricated and affordable housing. The architectural and financial evaluation will be complete in May of 2006, and the building monitoring and performance evaluation will be complete one year after the homeowner(s) moves into the space(s).

The copyright registration process has begun for the design of ecoMOD1, including four adaptations to various solar orientations and topographies. At a minimum, the design drawings for ecoMOD1 and ecoMOD2 will be available for purchase by the summer 2006. The designs will be marketed to affordable housing organizations throughout the mid-Atlantic region, and the ecoMOD team will soon thereafter begin the process of speaking with modular builders about taking some of the designs into production.

The most significant impact of this project has yet to be evaluated – specifically the degree to which this form of reality-based service learning contributes positively to the professional lives of the students. The results of that evaluation will be revealed over the course of many years.

As of this writing, one former student is on her way to Sri Lanka to participate in the post-Tsunami rebuilding effort as a United Nations employee, and another is designing affordable housing for a large corporate architecture firm.

Visit the ecoMOD website at www.ecomod.virginia.edu.

This article is adapted from a more extensive piece to appear in "Eco Architecture 2006," published by the Wessex Institute of Technology.