PREFAB-RICATING AFFORD-ABILITY

Migrant Housing

LAURA SHIPMAN

By devoting special attention to user needs and the application of improved technology, mass-produced housing can address the specific requirements of small groups.

Left
A hurricane-damaged manufactured home in Nocatee, Florida. 2004

Prior to the disaster of Hurricane Katrina in 2005, the hurricane season of 2004 was one of the most active seasons on record, as reported by the National Oceanic and Atmospheric Administration, with damages estimated at $45 billion. The paths of the most destructive hurricanes crisscrossed the state of Florida. By November 3, 2004, all sixty-seven Florida counties had been federally designated as disaster areas.

The difficulties of disaster response are especially complicated for the approximately 300,000 migrants who work in Florida's agricultural industry. Annual family incomes do not exceed $10,000 per year, and farmworkers often live in dilapidated mobile homes that are extremely vulnerable to storm damage. The hurricanes of 2004 destroyed or damaged hundreds of units of farmworker housing, exacerbating an already-severe shortage in affordable housing. According to the Federal Emergency Management Agency (FEMA), the fourteen Florida counties most damaged by the storms are home to approximately one-third of Florida's farmworkers, some of whom are undocumented and thus cannot receive housing relief from FEMA.

Advocate Rob Williams of Florida Legal Services brought the situation of Florida's farmworkers to the attention of Design Corps. Working as a fellow on the Design Corps team, I received the assignment. We agreed that as migrant farmworker housing was rebuilt, there was a need to assess the shortcomings of preexisting units and seek a new housing model. We wanted to develop pleasant homes that would withstand hurricane-force winds, be sensitive to the needs of farmworkers, be flexible and adaptable to ensure longevity, and be produced in a way that could be duplicated on multiple sites throughout Florida's agricultural regions, to address the widespread shortage of housing for these laborers.

DeSoto County

After completing our discussions, we traveled to migrant farmworker housing camps in the Arcadia and Nocatee areas of DeSoto County, Florida. These locations had been hard-hit by the storms of 2004 and are heavily populated by migrant farmworkers.

Our overall impression of housing in the area, beyond the immediate devastation wrought by the hurricanes, was the dilapidation and overcrowding that had preceded the storms.

There were three types of housing typically used for farmworkers:

1. Old houses converted into farmworker housing.
This type of dwelling was problematic because the houses were often in pronounced disrepair before they were converted to rentals for farmworkers, and thus were structurally susceptible to storm damage.

2. Concrete masonry unit block housing.
This construction type weathered the hurricanes relatively well, and a few units had only minor window and roof damage. However, their interiors were often stark.

3. Manufactured housing and trailers.
Most of these units were more than twenty years old, and therefore predated many of the improvements that have been made in manufactured-housing construction techniques. They had weak structures and inadequate tie-downs to resist hurricane forces.

Once we had assessed the migrant farmworker housing situation in post-hurricane DeSoto County, we began conducting market research on the best construction practices, with special sensitivity to the culture, needs, and desires of the end users. By including farmworkers in the design process, Design Corps was able to formulate solutions that addressed the clients' highest priorities. In this way even the most limited resources were transformed into the most valued product.

In our planning, we adopted a long-term-value approach rather than emphasizing a short-term emergency response to the crisis. Past emergency-housing models, such as the FEMA type, provided a short-term

solution that becomes poor long-term housing. This is directly due to design choices. As the designer of our project, I was charged with creating housing that would gain in value over a thirty-year life span. Manufactured housing built in other states, when designed properly, has already demonstrated this capacity.

Next we conducted initial investigations into possible site configurations, construction types, and hurricane design responses.

The durability of HUD housing bolstered our belief that well-designed and well-constructed manufactured housing was a sound choice for farmworker housing recovery.

With these findings in mind, our design process evolved to pursue a completely manufactured construction process, because of the ease of installation and reduced scope of site work that are typical of modular construction. We are continuing to investigate post-manufacture improvement options such as storm-shutter systems and better tie-downs. And while environmental issues are not primary to the rapid response needed by this group of users, we are researching the best ways to ensure that these homes are environmentally sustainable.

Left
Laura Shipman (seated at left in center photograph) leads a farmworker focus group.

We researched the use of containers and manufactured and modular building methods. We also considered kinetic structures that could fold down into a hurricane-protection state, and we tried flexible modular units that would begin as a steel structural frame with modular living pods that could plug in as families grew or more space was needed.

One of the unexpected findings after the hurricanes of 2004 was the hurricane resistance of housing built by the U.S. Department of Housing and Urban Development (HUD) after 1994. As stated in a letter from Lori E. H. Killinger, director of governor's relations for the Florida Manufactured Housing Association, to Thaddeus Cohen, secretary of Florida's Department of Community Affairs, dated September 13, 2004:

In sum, the Department of Highway Safety and Motor Vehicles findings were clear that: the newer homes, built since HUD changed its building code in 1994, performed (without exception) admirably. It was not uncommon to see several destroyed homes with the newer HUD homes standing alone with the only damage being from flying debris. To further substantiate that finding, after touring the area, Governor Jeb Bush was quoted as saying that the new construction and installation standards for manufactured homes worked.

Farmworker Focus Groups

A critical aspect of our process involved obtaining input from local migrant farmworkers. By including farmworkers in the design process, Design Corps was able to formulate solutions that addressed the clients' highest priorities. In this way even the most limited resources were transformed into the most valued product. We conducted focus groups as a method of participatory design to ensure that our schemes would be geared toward the intended end users' needs. Juanita Mainster, hurricane coordinator for the Redlands Christian Migrant Association (a farmworker advocacy group), helped facilitate and translate for the focus groups.

Because of the farmworkers' busy schedules, our family meetings were arranged so that parents could attend while their children stayed an extra hour at a daycare center. There were two main components of the participatory-design focus groups: personal information and design input. For the former component, we administered a survey to elicit personal information and information on current housing conditions. We learned that the migrant families that participated were all originally from Mexico and had families ranging in size from three to eight members. They worked in the citrus and tomato industries in Florida, Michigan, North Carolina, Ohio, Pennsylvania, and South Carolina. They lived in apartments, rental homes, and trailers; space, light, and outdoor playing space for children were important to them. One of their primary concerns was making sure the housing would be waiting for them when they returned each season.

We also conducted an exercise that gave participants a chance to design desired amenities for the home. Through this process we discovered that the exercise was slightly too complicated and needed to be simplified for future use. However, as we went through the questions individually, we were able to obtain the necessary insights into the family's preferences and concerns.

The second aspect of the group meeting was intended to get direct feedback on designs we had begun to develop based on farmworker research and participatory-design work conducted by Design Corps fellows in previous years. We set up models and drawings, and the participants viewed the designs, asked questions, and gave us their comments. The families generally preferred the two-bedroom design as it was best-suited for family needs. They liked the combined kitchen/dining/living space configuration because the open area made it possible to gather as a family and easily keep an eye on the kids. The participants also liked the sliding shutters for storm protection and off-season security. Many said the design's central housing plan appealed to them because it was reminiscent of the housing designs they had grown up with in Mexico.

Single Men's Focus Group

We also scheduled a meeting with single male migrant farmworkers who had lost their trailer in a fire. They were struggling to find alternate housing because of the hurricane-induced housing shortage, and they had been forced to pay exorbitant rents for substandard living quarters in trailers.

By including farmworkers in the design process, Design Corps was able to formulate solutions that addressed the clients' highest priorities. In this way even the most limited resources were transformed into the most valued product.

Right
Laura Shipman for Design Corps
Migrant farmworker housing, preliminary design, one-bedroom version

Above
James Sweeney for Design Corps
Migrant farmworker housing, two-bedroom version. Rendering of the manufactured design. 2007

Their initial input was simply that any housing would be better than what they currently had, but after further discussion specific and valuable input emerged. The men were currently working in construction because the citrus crops had been damaged by the hurricanes. For the rest of the year they worked mostly in Georgia and North Carolina. Their biggest complaints about the trailers were their small size and dark interiors.

When we showed the workers the initial housing-design concepts, they said they preferred the scheme with the covered porch, and they would not mind having four men sharing a big room. They liked the option of having the toilet and shower separated from each other. They strongly favored central heat, as their trailer had burned down because of a space heater. They also jokingly commented that they liked the design's metal siding because it would not burn. Overall, they liked the two-bedroom design best, mostly because its two separate rooms would make it possible to bring in a family member. They also liked the exterior accessibility of the utility room with a sink for washing up after work.

Meetings with Advocates and Growers

Our process also involved meetings with two local large-scale growers, as they have the resources necessary to provide their workers with good housing. One of the growers asserted that providing housing was a fundamental responsibility that his business had to its employees. He was able to give direct advice in terms of possible sites and appropriate construction techniques to enhance longevity and limit maintenance needed on the units. The other grower we met with did not provide housing for his farmworkers, like most large growers, because of cost and the concern with liability. After we presented our designs and discussed the long-term affordability and improved quality of these units, he stated that the company was considering building fifty farmworker units and this design could be one of the models considered.

In addition, we met with other farmworker advocates, such as activists from Catholic charities and organizers at the HUD farmworker forum, who shared with us their opinions on farmworker needs and their thoughts about our designs. We also had a meeting with the manufacturers to clarify our specifications in relation to typical methods of manufactured-housing construction.

Design Development

The two-bedroom unit was the one chosen for manufacture. The central plan allowed for a shorter corridor, creating a more efficient use of space. It was also the design preferred by farmworkers and advocates involved in the process.

The unit measures 56 feet x 14 feet x 12 feet 6 inches tall. Features include:

- a hurricane-resistant structure designed to handle winds of up to 110 miles per hour;
- nine-foot ceilings and increased glazing to provide a well-lit, spacious-feeling interior environment;
- energy efficiency through low-emissivity windows, a radiant barrier to prevent heat gain, and operable clerestory windows to allow for passive cross-ventilation;
- sliding window shutters for storm protection and off-season security;
- a two-bedroom design that can accommodate singles or families;
- a floor plan that allows for a utility room with a large sink adjacent to the exterior entry.

To a designer who had just completed her undergradate architecture studies, the most eye-opening part of this experience was learning just how many non-design factors are involved in producing this type of housing. Collaborating with advocates in other fields, going through the funding and approval processes, and interacting with farmworkers all broadened my perspective on the varied roles the designer must play in order to provide responsive and effective architectural advocacy.

Above
Delivery of the manufactured unit.
2008

Market Modular

GREGORY HERMAN

Two very different parties—architecture students and a manufactured housing company—combine strengths to yield affordable, well-designed housing.

Left
Students Sheana Mitchell and Lisa Skiles on a site visit to the modular house factory in Anderson, Missouri

Pedagogical Objective: A Modular House?

Design/build programs often jeopardize their own viability because of pitfalls inherent in the production process. The desire to create well-designed, affordable housing has become the goal of many architecture programs in recent years, but the inability of these academic groups to engage enhanced processes of production often blocks real innovation. This essay describes a design/build house project recently conducted at the University of Arkansas School of Architecture's Design/Build Workshop (D/BW). The workshop had previously produced three affordable-housing projects, and when I became the sole instructor of the D/BW in 2003, I wanted to continue in the tradition of these successes with a new project during the spring semester.

We set out to explore the conventional, market-produced modular house, inserting ourselves into the construction process as designers, in order to create a house that was affordable and available to an individual or family of low to moderate income.

We chose the modular process because it was well suited to our goal of producing an affordable home for a low-income buyer. By taking advantage of the conveniences and economies of modular housing (for example, weatherproof assembly-line construction), it seemed we might be able to stay within our tight budget of approximately $60 per square foot, including land and all other costs. Furthermore, the efficiency and speed promised by modular producers gave us hope that we would have a finished product by the end of the semester.

As designers our objective was not to fully activate a conventional modular process; the interventions of architecture students would have been unnecessary for that aim. Rather, we wanted to work within some aspects of the conventional modular production process as a learning experience.

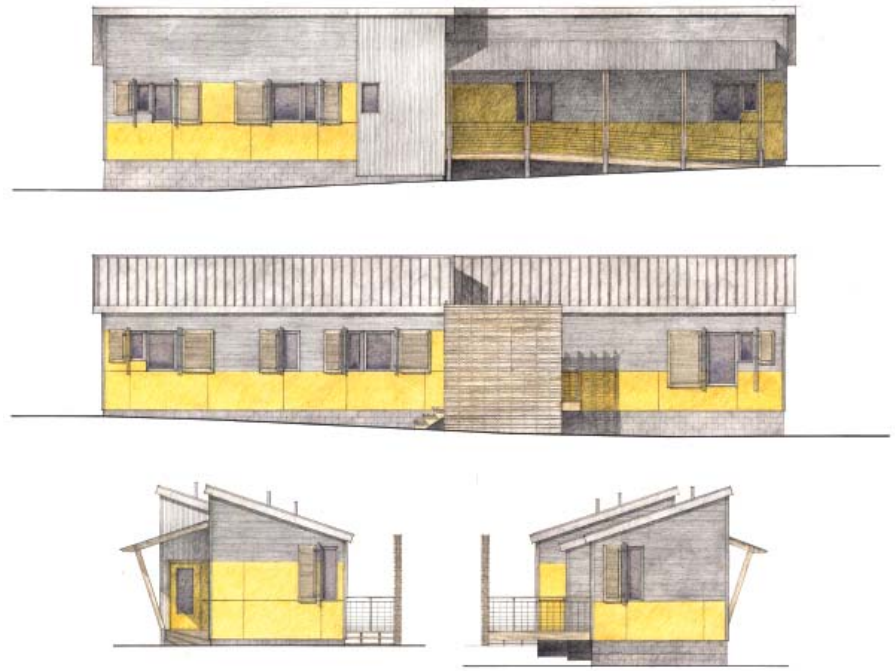
A modular manufacturer would construct the house through the framing stages and complete the mechanical, electrical, and plumbing work, providing us with an impressively solid building "carcass" for the project. The students, who shared the duty of making regularly scheduled factory visits to monitor the progress of construction and respond to builders' questions, would then design and install all exterior finish components and materials as they saw fit to make the project meet the needs of the stakeholders—city officials, bankers, realtors, representatives of the manufacturer, and neighborhood advocates. This promising combination of industry resources, stakeholders, and the students' sweat equity provided what we felt to be a unique model for the kind of collaborative work we sought. More important, this scheme allowed each contributing party—the manufacturer and the students—to offer the best of their abilities.

Changes in Sponsorship Cause Changes in the Design Process

Full-cost sponsorship of the D/BW project houses completed in 2001 and 2002 (for which I served as faculty coinstructor) had been provided by a local bank that ultimately also chose and approved the purchaser of the house. Though these projects were successful from both a social and an academic standpoint, the bank redirected its community efforts and decided not to continue sponsoring our D/BW projects. The new project was instead supported by the modular manufacturer and by the city of Fayetteville, which provided Community Development Block Grant (CDBG) funding for the purchase of the building lot and, as the final cost of the house threatened to exceed our initial goal, further discretionary funding.

Design of the house began with a student competition resulting in a team-designed project. We then presented the winning entry to the stakeholders. This was to be a house sold on the market, designed and built without the input of a pre-chosen buyer; under such circumstances the sponsors wanted local interests to have an opportunity to comment on the project, helping to ensure the salability of the constructed house.

Left and right
Design/Build Workshop
Modular house. 2003. Framing model by Andy Kim; elevation renderings by Amy Koenig



All parties in attendance made a number of suggestions and requests. With an eye toward minimizing purchase price, the representative from city hall asked that the cost be no higher than 60 percent of median income guidelines as determined by the U.S. Department of Housing and Urban Development. This demand was a daunting obstacle in Arkansas, where median incomes are low even by regional standards. Additional limitations emerged as panel members offered their input. In a discussion of exterior cladding materials, the direction of the conversation naturally turned toward maintenance costs, and the city representative requested that the house be clad in “maintenance-free” vinyl siding. While vinyl siding was a standard finish cladding material offered by this particular modular manufacturer, the student designers wanted to explore other options. After some consideration they expressed their desire to finish the house in a combination of painted cement-fiber siding panels and corrugated galvanized aluminum panels (the latter is particularly inexpensive in this part of the country, as it is a common cladding material for poultry-raising facilities). The city representative, still insisting on low-maintenance cladding, offered the following compromise: if we used a painted material, it was to be applied to a height no higher than one person could reach with a roller and without a ladder. We felt we had assisted the city official in coming to a new understanding of what could be considered maintenance-free.

Other issues came to light during the semester, as would happen in any collaborative design process. The manufacturer’s representatives expressed some concern about the roof design. The roof of a factory-made modular house is constructed as a group of hinged planes that are folded in upon themselves for shipping. The house arrives at its final site sheathed and ready for cladding, except for areas that will be covered by the roof. The roof is then unfolded and set into place on top of supporting knee-walls. Our manufacturer’s houses are always outfitted with low double-pitched roofs, but the students’ design called for two major single-pitched roof volumes. When our single-pitched roof was unfolded on site, the unsheathed and unclad tops of the exterior walls directly beneath the ridgeline of the roof pitches would be exposed to the elements.

Naturally, these unprotected areas troubled the manufacturer. However, after much negotiation, including our solemn promise to be on site with materials to sheathe and “weather-in” the exposed under-ridge vertical surface as soon as the roof was raised, the modular builder agreed to our single-pitched roof design. The roof profile and the general form of the house turned out to be continuing points of contention. At our meeting with local stakeholders, the bankers and real estate agents implored the students to consider the pressures of the housing market. A more conventional-looking house would be easier to sell than our unusual one. In addition to the corrugated metal siding and single-pitched roofs, we intended to paint the house school-bus yellow. The city had assured us that the low cost of this house would allow it to sell regardless of its appearance, but we took the comment to heart and thoughtfully considered the difference between designing for ourselves and designing for an already-stigmatized market sector.

Success?
In addition to the support provided by the city and the manufacturer, other donating sponsors began to appear as the project gained visibility in the community and our efforts picked up steam. These sponsors, including window manufacturers, finish material suppliers, and metal shops, proved crucial to meeting our design and budgetary goals. However, the ad hoc nature of the donations made us realize that a project of this sort can never be a true prototype, despite our wishes to the contrary. Because academically sponsored design/build projects rely so heavily on material donations, sweat equity, and the fluctuating availability of government funding, each project is unique. This realization led to much debate among the students about whether and how we had succeeded in our project.

As with any construction project, certain design aspects were modified or omitted completely in the field. For instance, the students designed, fabricated, and installed operable cedar shutters for all windows in the house. After we were finished with the project, a field person privately hired by the modular manufacturer's representatives returned to the house and permanently fastened the shutters to the cladding of the house. The same person completed an aspect of the project we had left incomplete: the porch railings had been designed as horizontal cables, but instead they were installed as vertical cedar posts. These very visible changes were like wounds in the design and were frustrating for many of those who had worked on the house, including myself. Throughout such moments we tried to remind ourselves of our larger successes.

Other aspects of our process figured into our self-evaluations. As expected the house sold quickly at the target price of $60,000, although our final cost per square foot (including donations) was slightly more than $60 per square foot. The city covered the cost overage to keep the selling price at the predetermined amount. The owners are reportedly very pleased with their house, and with the subsequent arrival of their two children, they are considering adding a small third bedroom.

If we had not used the modular process, we would not have been able to produce a house of even this limited scope in such a short time. We were satisfied, and even fascinated, with this process throughout our involvement with the manufacturer. In our next D/BW project, we intend to reengage the modular process and investigate its particularities. We will continue our collaborations with the city of Fayetteville and take advantage of the city's CDBG funding as a way of ensuring that our houses sell at or below the projected sale price. We will continue to seek donations as a further means of reducing costs. However, given the constant flux that characterizes our resource streams and the housing market, all we can be assured of is that our design/build efforts must be dynamic if they are to succeed.

Above left
Corner detail

Above
West elevation of the completed house, with porch and entrance

ecoMOD: Exploring Social and Environmental Justice through Prefabrication

JOHN QUALE

Beyond hopes and good intentions, can prefabricated affordable housing bear out its claims of fostering social and environmental justice?

Left
ecoMOD3 team
SEAMproject, Charlottesville, Virginia. 2007. Students assemble the separate rental unit.

In today's real estate market, ecologically sustainable homes have been mostly reserved for the wealthy. Yet the health concerns associated with indoor air quality, as well as the financial burden of unnecessarily inflated utility costs, point to the need for homes that are both environmentally responsive and affordable for low-income people.

Prefabrication can be a cost-effective method of construction, and highly energy-efficient homes have lower utility costs, making sustainable prefabrication an ideal formula for affordable housing. Currently, however, prefabricated homes are seldom designed for energy efficiency, and most environmentally sustainable homes are expensive to build.

The hypothesis of the ecoMOD project at the University of Virginia School of Architecture is that by combining prefabrication with sustainable design strategies, we can generate a series of housing prototypes that lower operating costs for homeowners while reducing the overall environmental impact of the buildings. As director of the project, my mission for ecoMOD is to demonstrate the environmental and economic potential of prefabrication, and to challenge the modular and manufactured housing industry in the United States to explore this potential.

There are a couple of different ways to simultaneously address social equity and sustainability in a university design program: through design/build projects that offer a direct response to a specific community need, or through speculative design/research projects that seek to have a broader (albeit more abstract) impact. The ecoMOD research and design/build/evaluate project aims to blend the best of these worlds to achieve results that are both tangible and forward thinking. The project, which is part of the university's curriculum, is intended to create well-built homes that cost less to live in, minimize damage to the environment, and appreciate in value.

A group of students in architecture, engineering, landscape architecture, business, environmental science, planning, and economics are split into teams that participate in the design, construction, and evaluation phases of this multiyear project. We are providing prefabricated housing units through partnerships with Piedmont Housing Alliance (PHA) of Charlottesville, Virginia, and Habitat for Humanity (HFH). PHA provides financial counseling and develops housing units in Charlottesville and the surrounding five counties. The ecoMOD teams also aim to find a modular house manufacturer to produce each of the house designs and to market them to individuals as well as to affordable-housing nonprofit organizations similar to PHA and HFH.

Prefab

Newly built low-income single-family homes in the United States tend to be some variety of manufactured or prefabricated housing. These homes are affordable and easily installed, but they are usually built in ways that waste resources and foster indoor air quality problems. Most prefab homes are sited with no consideration for local hydrology or solar or wind orientation. The buildings themselves are aggressively "siteless"—seemingly adaptable to any environment, yet entirely separate from their surroundings. In contrast, the intent behind the ecoMOD designs is to create site-specific homes using natural lighting and ventilation, nonhazardous materials, renewable energy, and energy-efficient systems to help reduce environmental impact and improve residents' health.

Fully 25 percent of new homes constructed in the United States are prefabricated as manufactured, panelized, or modular units. While this statistic may surprise some, the trend toward prefabrication is likely to continue. As prefab house manufacturers become more market-savvy and start offering more personalized options, a "mass-

customized" housing market will become a reality. In a sense this situation already exists. The vast majority of new site-built homes across the country use standardized wood-framing methods. From the simplest HFH starter house to the largest suburban trophy home, the structural system for American homes is largely the same; the only differences are in square footage and finishes. Job sites for most stick-built dwellings are essentially small, temporary factories, requiring equipment and raw materials to be delivered to the house site. Prefabrication simply centralizes this process in a factory instead.

The Environmental Impact of Housing and Design

We have entered the twenty-first century with the knowledge that the construction and operation of buildings is the sector of the U.S. economy that uses the most fossil fuels. Not surprisingly the United States is also releasing more greenhouse gases than any other nation in the world. The average American single-family home is responsible for the emission of more than 22,000 pounds of carbon dioxide each year, due to the use of electricity and oil- or gas-powered appliances and equipment. This is more than twice the amount of carbon dioxide emitted by the typical American car in a year. The reality is that inefficient McMansions are more harmful to the environment than gas-guzzling SUVs.

It is clear that architects and engineers must take greater responsibility for the environmental consequences of their creative efforts. Studies are beginning to demonstrate that building design can affect everything from students' grades to public health. There is a growing realization that buildings, nature, and humans are inextricably connected. I have always urged my students to recognize this interdependence. I ask them to be simultaneously intuitive and rigorous, poetic and practical, artistic and scientific. I believe this is the best way for designers to address the environmental impact of the housing industry. The field of architecture has a hybrid quality that lends itself to this dual focus; successful architects display both intellectual discipline and artistic inspiration.

While it is well known that prefabricated building techniques can save time, money, and materials, their potential environmental benefits remain largely unrecognized. Off-site construction can significantly reduce a building's environmental impact and embodied energy. The inherent efficiencies of centralized fabrication include climate-controlled, year-round construction, better quality control, significant reductions in construction waste, minimized usage of energy and water, just-in-time delivery methods, and fewer trips for fewer people to remote construction sites.

Left
ecoMOD1 team
A decision web enables comparison of the value and impact of structural insulated panels versus conventional wood-stud construction.

In the design phases of the ecoMOD project, I challenge my students to address issues from a variety of viewpoints and to articulate aesthetic, technical, ecological, social, and financial justifications for their ideas. These justifications are at the center of our complex decision-making process. Any construction project, no matter how conscientiously executed, will harm the environment. It is important to recognize this at the outset of design. Choices are seldom clear-cut, and each design strategy has ecological advantages and disadvantages.

To facilitate the design process I require my students to use "decision webs" when making important design choices. The webs help us track our thought processes and recognize the complex array of issues affected by each decision. The teams do not always agree, and decisions occasionally become compromises. Yet we are constantly aware of the potential danger of watering down good ideas by choosing the strategy that the most people could agree upon. Finding just the right balance between productive collaboration and "design by committee" is an ongoing concern.

ecoMOD1: Designing the OUTin house

The first prototype, ecoMOD1: the OUTin house, was completed in early 2006 in the Fifeville neighborhood of Charlottesville, Virginia. The house was constructed as eight small modules and includes a potable rainwater collection system, a solar hot-water panel, non-volatile organic compound (VOC) finishes, and locally and sustainably forested wood flooring.

The OUTin house combines the best of panelized and modular prefabrication techniques. The primary structural system is structural insulated panels (SIPs), making the assembly process relatively quick and easy. The Virginia-based SIP manufacturer R-Control provided panels with precut windows, doors, and electrical chases. By utilizing wall and roof panels that are assembled into eight separate modules, the OUTin house takes advantage of the "outsourcing" potential of prefabricated SIPs and the off-site-assembly advantages of modular construction.

Right
ecoMOD1 team
OUTin house, Charlottesville, Virginia. 2006. Placement of the prefabricated modules on the foundation

In response to the lack of modular systems appropriate to urban lots, OUTin uses modules that are 18 feet long and either 10.5 or 12.5 feet wide. This allows the modules to be transported on narrow streets with tight turning radiuses. The site for the OUTin house, a historically African-American neighborhood with mostly early- to mid-twentieth-century houses, is not accessible for conventional manufactured or larger modular sections. In one of our several meetings with the members of the Fifeville Neighborhood Association, we discussed the possibility of an urban modular system that could be used to bring in more houses at a lower cost, helping to stabilize the neighborhood against the encroaching forces of gentrification. The modular concept and the associated environmental strategies were well received by the community. Surprisingly, no community members expressed concerns about the contemporary language of the house design.

By using smaller modules, turning them ninety degrees from the norm—the long dimensions are side to side on a narrow lot, rather than front to back—and staggering them, the OUTin house takes advantage of the structural opportunity to create outdoor spaces defined by the side walls of the modules. In an attempt to blend outdoor and indoor spaces, the entry deck, which is the primary outdoor space, has direct access to the primary public interior space. By making outdoor spaces part of the modular strategy, the specifics of a given site become integral to the process of laying out any version of the OUTin house.

In developing the prototype, the team made all the decisions about the implementation of the OUTin house. However, if the house design goes into production, the developer or homeowner will determine the final form. To assist with this process, the house is based on a modularity that operates at three scales. The largest scale, defined by the site and other ecological considerations, establishes the orientation of the building, its relationship to the existing topography, and the scope of

energy- and water-efficient strategies. The next scale, defined by budget and occupant requirements, determines the number of modules and rooms, and their relationship to each other. The smallest scale, defined by the cultural context and the preferences of the homeowner, dictates the materials, finishes, and other details.

A Three-Pronged Environmental Focus

The OUTin house addresses issues of ecological sustainability through three primary strategies: site specificity, water efficiency, and energy efficiency. To address site specificity the open side of the house faces south to receive sun during the winter, and overhangs shade it in the summer. The house is flexible enough to be placed on a variety of sites and adaptable enough to adjust to climatic and topographic concerns. The house's water-efficient features include a solar hot water panel and a potable rainwater collection system. The solar panel is an affordable solution for most homes, but the rainwater collection system is cost-prohibitive for most affordable-housing organizations. ecoMOD secured a separate grant to implement the water-system upgrade in the first house. However, the system does demonstrate that the technology it uses is both available and effective.

To achieve energy efficiency, the house uses SIPs for wall and roof construction, a method that is significantly more efficient than conventional framing. A continuous zone of foam installation and properly sealed joints significantly reduces unwanted heat gains and losses. Unfortunately SIPs are a mixed bag in terms of sustainable material selection. The oriented strand board (OSB)

Above
The kitchen of the OUTin house features a work station with a fold-down table and countertop. Behind it is a custom enclosure for mechanical equipment.

Right
View of the entry deck, with rainwater collection infrastructure and shade trellis to provide structure for native vines in summer

sheathing the SIPs contains binding agents with formaldehyde, which will off-gas into the living space. To address this concern, all OSB exposed to the interior of the OUTin house is sealed with a product that does not include VOCs. OSB without formaldehyde and other non-VOC wood-panel products do exist, but they are cost-prohibitive as well. All of these ecological measures also effectively reduce the cost of utility bills, translating directly into more money in homeowners' pockets.

Evaluating the OUTin House

After the project was completed, the OUTin house evaluation team assessed the design process, the financial and environmental consequences of their selected construction techniques and building materials, and the affordability and other financial aspects of the house, among other elements. The team's analysis of the materials used largely supported the decisions made. Despite the off-gassing of the OSB and the petroleum-based expanded polystyrene foam, the energy saved through the efficiency of SIPs made them the right choice. For flooring materials the design team had decided that sustainably forested poplar would have less environmental impact than bamboo. The evaluation team analyzed the overall life-cycle of the two materials and the energy required to transport the bamboo from China to the United States, and agreed that poplar flooring was also a sound decision. Non-VOC paint was a good choice from the standpoint of indoor air quality, but the evaluation team found that non-VOC paint was less durable than conventional paint and would have to be reapplied sooner.

With regard to energy efficiency, the evaluation team found that the design decisions were appropriate within the context of an affordable-house budget. The house will save the family at least 60 percent in utility costs compared to those incurred by a conventional wood-stud structure. The solar hot-water system was noted as a particularly good choice. It was a reconditioned system, causing less of an environmental impact than putting a new one into service, and it will reduce the energy required to heat the water in the home by as much as 80 percent.

The evaluation team questioned the choice of the rainwater-collection system for the home. The choice to install the system led to additional filtration components and the need for regular maintenance. While this system would make sense for a rural site, the team felt that the availability of inexpensive city water made this design element less attractive.

The evaluation team also had doubts about the house's affordability. The design/build team used the financial assumptions of PHA, our affordable-housing partner, who requested a single-family home 1,200 to 1,400 square feet in size that would cost $95 to $105 per square foot. The design/build team almost met these targets by building a 1,390-square-foot home for about $115 per square foot. However, the evaluation team felt that PHA's cost assumptions were flawed because they were based on 2001–2 construction cost and real estate data, when PHA's other similar development projects had begun. Since 2001 average home prices in Charlottesville have increased by more than 60 percent.

Because PHA sells homes at their appraised value, the appraisal was a critical aspect of the financial analysis. While the economics and business students on the evaluation team appreciated the fact that the appraisal came in almost $40,000 higher than an earlier PHA home of comparable size, the high figure created a problem for PHA. We decided to address this problem by finishing off the basement (another 660 square feet) and converting the property to a two-unit condominium. The evaluation team recommended that this kind of multi-unit strategy be considered from the beginning for the next ecoMOD home in the Charlottesville market. While PHA's clients likely would prefer a single-family detached house, the realities of the real estate market indicate that the era of the affordable single-family detached house is over in the city of Charlottesville.

By evaluating the real-world results of the hypotheses of the ecoMOD1 design/build team, the evaluators have helped the first ecoMOD process come full circle, and the knowledge gained has been applied to the next phases of ecoMOD. So far two additional projects have been completed: ecoMOD2, a single-family detached home for HFH in the post–Hurricane Katrina Gulf Coast region of Mississippi; and ecoMOD3, a two-bedroom home and separate studio apartment rental unit for the PHA, which combines modern modules with a green renovation of a restored historic house. The ecoMOD designs have recently been licensed to Modern Modular of New York City.

Above
ecoMOD2 team
The preHAB house in a late stage of construction, Gautier, Mississippi. 2006

As the ecoMOD project heads into the future, we will continue to research, design, and build environmentally sustainable prefabricated homes that meet residents' housing needs and expand the options available for affordable, ecologically sound housing.

Out of the Box: Design Innovations in Manufactured Housing

ROBERTA M. FELDMAN

A challenge is issued for designers to reinvest themselves in the prefabrication of housing in order to tackle our national affordable-housing crisis.

Left
Bryan Bell
Double High House. Model. 2005

The mobile home may well be the single most significant and unique housing innovation in twentieth-century America. No other innovation addressing the spectrum of housing activities—from construction, tenure, and community structure to design—has been more widely adopted nor, simultaneously, more broadly vilified.

A. D. WALLIS, *Wheel Estate: The Rise and Decline of Mobile Homes*

Over the past decade 30 percent of new-home construction in the United States has used prefabricated components, according to the U.S. Department of Housing and Urban Development. A combination of rising housing costs, limited affordable-housing options, and increases in the size and quality of manufactured housing has contributed to the dramatic impact of prefabricated housing on the national housing market. Manufactured housing is the major source of unsubsidized low-cost housing in the United States today.

Despite their importance as a lower-cost option, manufactured housing and its precursors, the trailer and the mobile home, have been reviled by the general public and government agencies. A house built in a factory has been deemed a threat to property values, even though 95 percent of these homes remain on the sites where they are first installed. Manufactured housing is subject to quality-control oversight in the factory, but many still consider it to be less safe than site-built homes, regardless of the fact that manufactured housing is now required to meet the same building standards. Manufactured housing asks us to reconsider deep-seated values attached to the meaning of home: rootedness versus the freedom to move, dwellings built by hand on site compared to those that are mass-produced, and individuality contrasted with conformity.

Fighting Stigma with Tradition

It is ironic that manufactured housing is so stigmatized, given the average American household's mobility, the increasingly transspatial nature of social relationships, and the mass manufacture of virtually all the consumer products and building components that are used in site-built dwellings. The industry's answer to the stigma of manufactured housing is to bring the manufactured dwelling into conformity with the predominant market vision of an ideal of home: rooted in place, with the appearance of a vernacular home. The manufactured house has evolved far beyond the twentieth-century mobile travel trailer, to become a prefabricated dwelling intended as a permanent, site-installed residence.

This process has taken considerable time, however. In the early part of the twentieth century, manufactured housing was characterized by experiments with innovative materials, forms, and construction methods. Yet industry growth was slow, not because of a lack of need but due to insufficient financing, poor quality control, and negative public response. These failures encouraged manufacturers to believe that instead of forging ahead into risky new territory, they would do better to return to the tried and true.[1]

This is exactly what the industry did in the latter part of the century, when manufactured housing experienced dramatic growth. The manufactured house is now designed and constructed as if it were site-built. Stick construction is the norm, and the dominant motifs are reminiscent of historic, handcrafted homes. Despite these relatively upscale design and construction elements, manufactured homes are still more cost-efficient than site-built housing, due to economies of scale in material and equipment purchases, the quality control and continuous manufacture afforded by the factory process, and a reduction in labor costs owing to the lower skill levels required for assembly-line construction.

Socially minded architects once embraced the factory-built house as the answer to shortages in affordable housing. These architects' designs sought to make

1 Sidney Robinson, "The Postwar Modern House in Chicago," in John Zukowsky, ed., *Chicago Architecture and Design 1923–1993: Reconfiguration of an American Metropolis* (Munich: Prestel, 1993), 202.

manufactured homes affordable through machined materials and industrial construction processes. Despite some interesting innovations along the way, architects' interest in social housing through mass production eventually waned, and their role in the manufactured-housing industry became marginal.[2] Architects' ideology of practice and their remuneration structure remain firmly rooted in one-off custom designs, not standardized models or kits of standardized parts.

With housing becoming increasingly unaffordable, recently there has been a resurgence of architectural interest in manufactured housing. Calls for a new prefabrication movement can be read in the pages of the *New York Times*, *Dwell*, and numerous books featuring prefabricated houses designed by architects.[3] These publications targeting the profession and the cultural elite generally emphasize industrial and digital technologies offering mass customization and "high style."[4] The result is a design that brings manufactured housing into conformance with current architectural theories and aesthetic models.

While the affordability of these homes is a consideration, they generally are still not within the economic reach of lower- and middle-income Americans. Rather, most of these designs are intended for a niche market: the "hip" among the middle class who are experiencing the pressures of an unaffordable housing market. Advertisements in *Dwell* tout the advantages and affordability of architect-designed manufactured homes that are available for less than $250 per square foot—a cost substantially lower than that of a similarly architect-designed site-built dwelling, but obviously still beyond the means of most Americans.

What, then, do we do about the millions of families in this country who need safe, decent, affordable housing? How might architects be able to respond to this problem if they reconsidered the design of manufactured housing—especially if they addressed affordability by containing construction costs while sustaining livability? How might these architectural designs foster alternative understandings of the prefabricated dwelling?

Investigating the Possibilities of the "Trailer Home"

Even in the 1930s, when the commercial success of the trailer home was already secure, its value was widely debated. For example, a 1937 issue of *Fortune* magazine reported: "200,000 trailers will swarm on the roads this spring. Whether they betoken a New Way of Life or a plague of locusts is something that makers, taxpayers, hotel keepers, and lawmakers are bitterly disputing."[5] The stigma associated with the trailer home has been so pervasive that, in the latter part of the twentieth century, the industry changed the product name to "manufactured housing," but the name change has done little to alter the public's negative view of this form of housing.

In recent projects eight nationally recognized architects and industrial designers—David Baker, Bryan Bell, Carol Burns, Teddy Cruz, Yolande Daniels, Doug Garofalo, David Khouri, and Ali Tayar—have investigated the design, materials, and manufacturing techniques of factory-built housing.[6] All argue compellingly against the negative stereotypes of manufactured housing, largely by portraying alternatives to the standard manufactured-house design. The diverse proposals are best understood in contrast to the current manufactured housing industry's model: a single-family detached dwelling composed of one or more compact geometric boxes. As in site-built housing, variety in conventional manufactured housing is achieved by modest pushes and pulls of exterior walls and gabled roof heights. Facades typically are made of industrial siding that mimics wood, with small windows punctuating the walls. All of the proposals reinterpret this model, some with more restraint, others more aggressively.

Bryan Bell and Teddy Cruz employ moderate architectural interventions to create visually and theoretically challenging projects. In Double High House, Bell wraps a stack of three manufactured boxes direct from the factory in a rain-screen framework of recycled vinyl siding. This method of screening the rain and sun—peeling the skin from the exterior of the house—transforms the aesthetic language of the conventional manufactured box.

2 Carol Burns Studio, *On the Highway/Home on the Highway: A Manufactured Housing Catalog* (Cambridge, Mass,: Harvard University Graduate School of Design, 1996).

3 See, for example, Allison Arieff and Bryan Burkhart, *Prefab* (Layton, Ut.: Gibbs Smith, 2002); Jennifer Siegal, ed., *Mobile: The Art of Portable Architecture* (New York: Princeton Architectural Press, 2002); and *Dwell* (April/May 2005).

4 Ellen Grimes, "Risky Business? New Economies in the Design and Fabrication of Housing," in Elva Rubio, ed., *Out of the Box: Design Innovations in Manufactured Housing* (Chicago: City Design Center, 2005), 3. Published in conjunction with the exhibition *Out of the Box: Design Innovations in Manufactured Housing*, shown at the Field Museum in Chicago.

5 "200,000 Trailers," *Fortune* (March 1937), 104–11.

6 In 2005 I curated, with the assistance of Dan Wheeler, an associate professor in the School of Architecture at the University of Illinois at Chicago, an exhibition in collaboration with the Field Museum titled *Design Innovations in Manufactured Housing*. Our goal was to counteract the unyielding stigma associated with manufactured housing—commonly referred to as "trailer homes." The eight projects presented here were created for the exhibition.

Above
estudio teddy cruz
Manufactured Site, Tijuana, Mexico. 2005. Rendering

What, then, do we do about the millions of families in this country who need safe, decent, affordable housing? How might architects be able to respond to this problem if they reconsidered the design of manufactured housing—especially if they addressed affordability by containing construction costs while sustaining livability?

Teddy Cruz eschews the prefab box entirely with Manufactured Site, and instead transports abandoned houses and construction materials from San Diego to a hillside on the outskirts of Tijuana. With this move he pays heed to the 837 million people who live in the informal settlements that spring up around rapidly growing urban cores in developing countries. To this new community Cruz adds a modest, flexible, prefabricated structural system of metal uprights, platforms, and stairs of vibrant colors, which give the site visual coherence. Both Bell and Cruz illustrate the wisdom of reusing materials and structures that otherwise would become waste in a landfill.

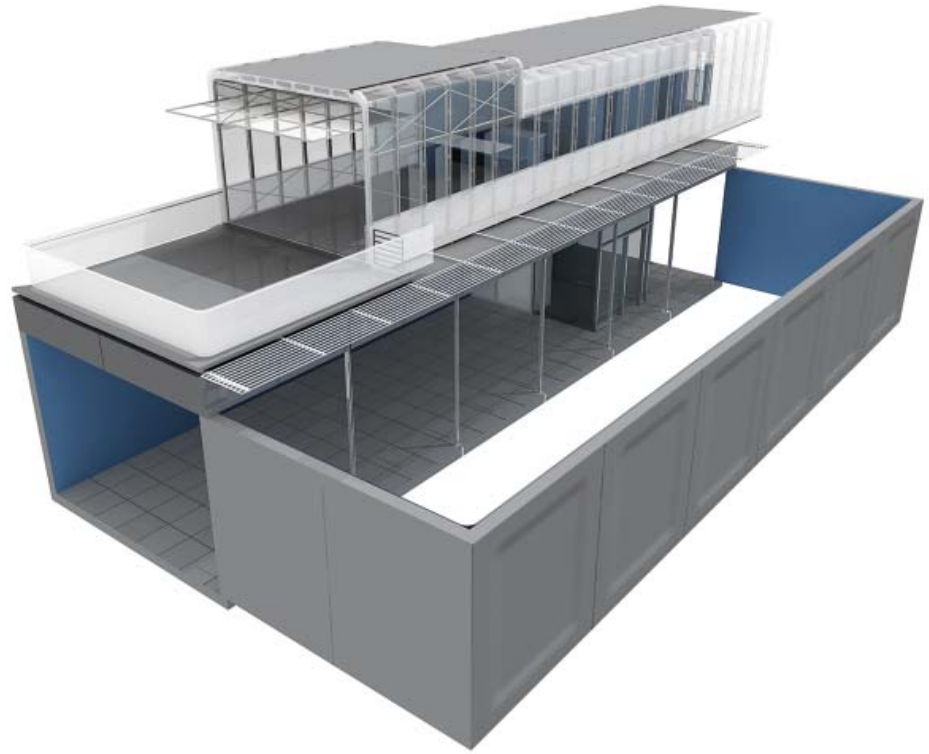
Yolande Daniels and Sunil Bald (of studio SUMO), David Baker, and David Khouri (whose studio is called comma) stretch manufactured-housing technologies to achieve greater adaptability of structure. Daniels and Bald's MiniMax is a high-tech, circuited mesh-covered shell that is expanded both in length and width when installed on the site. Flexibility is achieved by optional program components—such as entertainment consoles, exercise equipment, and home offices—that may be changed or updated as needs require.

Baker extends household choice one step further. In his LaCan Project, "podules," or premanufactured steel frame units, are combined in multiple configurations and transported to various locations. For example, a podule could be placed on a single-family lot, or it could be "plugged" into a "mainframe" high-rise superstructure, allowing a family to move their home from place to place.

Pages 212–13
studio SUMO
MiniMax. 2005. Rendering

Left
David Baker and Partners, Architects
LaCan Project. 2005. Rendering

Right
comma
Packed House. 2005. Rendering



David Khouri's Packed House is a manufactured home packed in a black metal shell that encloses and protects it when the structure is in transit. When the house is installed on site, the shell can be placed in various cantilevered positions below the basic unit to fit different site conditions or to add usable space, such as a partially enclosed outdoor area, a basement, a retaining wall, or a fully enclosed addition.

While all of these projects are innovative, they involve additional costs. Bell's screen of recycled vinyl siding gives greater satisfaction as a formal manipulation than as a cost-effective, functional way to shield the building from sun and rain. Cruz's arresting proposal reveals architects' desire for order, even if it costs more. Is it really necessary to provide more formal organization to a favela? In the Daniels/Bald, Baker, and Khouri projects, budgetary considerations take a back seat to technological and formal invention in the service of flexibility. One could assume that technology will solve the problem of affordability through industrialized production, but this assumption has yet to be supported after a century of experimentation and technological progress.

Ali Tayar (whose firm is known as Parallel Design), Carol Burns (of Taylor and Burns Architects), and Doug Garofalo, by contrast, choose to work within available industrial housing practices while pushing the confines of the manufactured box. Both Tayar and Burns use the basic box, but they organize it in different configurations to achieve variety in form.

Tayar's design, house nine, draws its formal language from the 1950s mobile home, while Burns's Homes Off the Highway uses prefabricated wood and glass-paneled boxes. Both designers slide, rotate, and combine these units to create distinctive house forms that connect the building to the site, and interior spaces to exterior spaces. These straightforward adjustments to the conventional manufactured box promise improved livability and a closer fit with the context without significant additional costs.

Top
Taylor and Burns
Homes Off the Highway. 2005. Rendering

Bottom
Parallel Design
house nine. 2005. Rendering of night view

Garofalo's CorPod House is a hybrid design that draws inspiration from the motor home/travel trailer industry and the precast concrete manufacturing industry. The CorPod, a compact pod reminiscent of the Airstream trailer, contains a complete kitchen, bathroom, storage, utilities, and optional entertainment technologies. The CorPod is delivered and rolled into a site-erected concrete panel wall-and-roof shell equipped with conduits for electrical and heating systems. Alternative stacking patterns allow for a variety of single-family and multifamily arrangements. The CorPod recalls General Electric's 1950s experiment with a compact utility core, which did not achieve commercial success because it was difficult to repair. With this problem solved, mass-produced compact utility cores like the CorPod could replace one of the more costly components of today's housing.

The Future of Manufactured Housing

Architectural design can play a key role in encouraging public acceptance of a devalued or unfamiliar form of housing. R. Buckminster Fuller, George Keck, and others are remembered for experiments that turned heads and promised comforts and conveniences that were ahead of their time. Fuller's and Keck's prototypes were never manufactured in numbers greater than a few hundred units, but this was because of costly materials, skilled labor requirements, and limitations on available production technologies—not because the public was not interested.

Decades after Fuller and Keck, architects should be ready for the next step: to significantly reduce construction costs while maintaining durability and livability, especially in comparison with the manufactured-housing industry's current cost structure. Available strategies for cost reduction include strategic space efficiencies in the design of the dwelling unit; resource efficiencies, such as economical use of energy and material resources in construction of the unit; cost-effective construction models and assemblies; and reduction of life-cycle costs through energy efficiencies, increased durability, and ease of repair. If they do not devote attention to these and other strategies for achieving cost savings in manufactured housing design and production, architects will remain marginal to the industry and will have little impact on housing affordability for those who need it most.

The number of homeless people and those living in unsafe and crowded living conditions in the United States is at an all-time high—5 million to 50 million, depending on whom you ask—while the number of affordable housing units is rapidly decreasing nationwide.[7] Site-built housing construction costs continue to escalate dramatically around the country, and the availability and choice of housing for moderate- and low-income families continues to constrict.

The current governmental solution to the pressing need for affordable housing is the provision of subsidies, as opposed to the provision of affordable housing. There is little public desire—and hence no significant political will—to fill these needs. Unfortunately, this strategy is unsustainable; subsidies alone cannot meet the demands of all who find themselves squeezed out of ever-tighter residential markets. In fact, subsidies themselves are decreasing at an alarming rate, giving rise to dire predictions for the future of housing.

Manufactured housing is the *only* option currently available for low-cost newly constructed dwellings. If architects want to have a hand in reducing the costs of building homes, they must vigorously pursue the economical design of this form of housing.

Right
Garofalo Architects
CorPod House. 2005. Rendering of interior

7 The U.S. Department of Housing and Urban Development estimates that 5 million Americans are underhoused or homeless, while the estimate of the Low Income Housing Coalition is 50 million.