Hands-on learning: the ecoMOD project

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Abstract

ecoMOD is a research and design/build/evaluate project at the University of Virginia that aims to create a series of ecological, modular and affordable housing units. The project is a partnership of the UVA School of Architecture and the UVA School of Engineering and Applied Science. The goal of the project is to provide a valuable educational experience, while demonstrating the environmental and economic potential of prefabrication – challenging the housing industry in the U.S. to explore this potential. It is a hands-on educational initiative for students and faculty to work together to address the issues of environmental sustainability and social justice. When addressing these increasingly important topics, the case for a 'real world' project, compared with traditional classroom learning, is clear: the next generation of building industry professionals are best served by projects that involve 'real buildings' with 'real budgets' because these are the situations they will face as professionals. By offering advanced students an opportunity to test drive their design ideas, and collaborate with other emerging professionals, these students can benefit from the supportive feedback loop of academia, and more carefully hone their critical thinking skills.

Keywords: sustainable design, design–build, affordable housing, prefabrication, architectural education, engineering education, interdisciplinary collaboration, critical thinking.

1 Introduction

In establishing ecoMOD, the intent was to create a project that would be grounded by the realities of budgets and materials, while striving to address the two most important challenges facing the next generation of designers: the significant environmental impact of the buildings, and the growing economic divide between high-income and low-income individuals. In the context of this

WIT Transactions on Ecology and the Environment, Vol 113, © 2008 WIT Press
www.witpress.com, ISSN 1743-3541 (on-line)
doi:10.2495/ARC080171

multi-year project, interdisciplinary teams of architecture, engineering, landscape architecture, historic preservation, planning, business, environmental science and economics students are participating in the design, construction and evaluation phases of the project. The ecoMOD teams are working to create well-designed and well-built homes that cost less to live in, minimize damage to the environment, appreciate over time and can be easily replicated.

The UVA students and faculty involved in ecoMOD are providing several prefabricated housing units through partnerships with Piedmont Housing Alliance (PHA) of Charlottesville and Habitat for Humanity International (HFHI). [1] In the context of the three ecoMOD projects completed thus far, five housing units have been created – two single family detached homes, an accessory unit behind one of them, and a two-unit condominium. PHA has sold the condominium units and one of the detached homes to low-to-moderate income families in Charlottesville Virginia – with down payment and financing assistance – and plans to subsidize the rent on the accessory unit for a low-income occupant. The other single-family home was built in partnership with HFHI in Gautier, Mississippi for a family displaced by Hurricane Katrina.

Working with affordable housing organizations, ecoMOD is able to provide homes for those in need, while also creating prototypes that can be replicated by modular housing manufacturers. The designs have been licensed to Modern Modular of New York, and the efforts are in the works to find manufacturers and other affordable housing organizations to reproduce them. Each completed housing unit is being monitored and evaluated carefully, with the results guiding subsequent designs.

The students learn not only about the process of design, but about how to be effective collaborators by ensuring their most important ideas make their way into the built work. The project is structured to allow students and faculty from diverse fields to come in and out of the process, and take part in all phases of the project – *design, build* and *evaluate*.

ecoMOD is embedded in the curriculum of the University of Virginia, and draws both graduate and undergraduate students. Undergraduate students are typically involved during their final year, and on the engineering side often use the project to frame a thesis project. The curriculum has been recognized nationally and internationally as a model for architectural and engineering education focused on sustainability. [2]

To date, sustainable residential design has been a luxury reserved for the wealthy. Yet it is individuals at low and moderately low-income levels who can truly benefit from the reduced energy, water and maintenance costs associated with environmentally responsive homes. The ecoMOD project is committed to bringing sustainability to affordable housing by re-imagining the idea of "home" through thoughtful, efficient and ecological design.

The full potential of prefabrication in the housing industry, whether at the scale of walls panels, room-sized modules or structural components, is still to be discovered. Prefabricated construction can help reduce both construction costs and utility bills. In fact, this has always been presented as the promise of prefab housing. So why have the many architecturally significant prefab house designs

from the last eighty years not lived up to this potential? Why are the Case Study homes now high end housing? Why did Buckminster Fuller and Jean Prouvé never get beyond a few exquisite prototypes? Why are the many beautifully designed homes that have appeared in Dwell magazine beyond the means of those in the bottom half of the income scale? Why aren't we living in neighborhoods of prefab Frank Lloyd Wright Usonian homes, rather than the 'ranch burgers' and McMansions we find ourselves in today?

The answer is three fold: first, the economic model of these visionary projects typically depended upon the assumption that once the brilliance of the designer's idea was recognized, the project would go into production, and significant savings will result. These projects often depend too much on the potential cost efficiency of the production phase and not enough on controlling hard costs in the prototype. If it costs 200% more to build a prototype, it is unlikely the production versions can come in below the cost of a comparable site-built home. The financial efficiencies of prefabrication are typically between 15 and 40% compared to on-site construction.

Secondly, many contemporary prototypical designs are dependant upon the assumption that the industrialized housing industry in the U.S. will radically transform itself. Transformation is indeed possible within the housing industry, and to some degree it is happening already. It is believed that more than 25% of new housing starts are panelized, manufactured housing [trailers], or modular. However, housing in America will not transform overnight, and designs that are dependent upon a complete rethinking of the materials and the standard labor practices used today will remain marginal.

Thirdly, regarding the affordable housing aspect, the era of the single family detached dwelling as 'affordable for all' is drawing to a close. Across America, especially in urban centers, it is becoming increasingly difficult for individuals and families below 100% of the area median income (AMI) to purchase and own a detached home. The American dream of a modest single-family home with a yard and a white picket fence is moving further away from reality, forcing many who strive for this exact dream to live in distant suburbs or rural areas. The impact of this is felt nation wide, as the sprawl of suburban development begins to choke our communities. An alternative version of this dream is beginning to become clear. This revised American dream involves mixed income neighborhoods of mostly attached dwellings (townhomes, condominiums, apartment style complexes) in pedestrian friendly neighborhoods with direct access to shared outdoor spaces and convenient public transportation. It is in this alternative American dream that the ecoMOD housing units hope to take root.

The ecoMOD project strives to be both visionary and practical. The designs explore the potential of prefabrication, while rethinking certain aspects of it. While some practices within current conventional industrialized housing can be accepted, others must be directly challenged. Conventional prefabricated homes are sited without any consideration of solar or wind orientation, or local hydrology. The buildings themselves are aggressively 'site-less' – seemingly adaptable to any environment, yet entirely separate from their surroundings. In contrast, the intent of the ecoMOD designs is to create site-specific homes, using

natural lighting and ventilation, non-hazardous materials, renewable energy, and energy-efficient systems to help reduce environmental impact and improve occupant health.

2 ecoMOD guiding principles

The following outlines the guiding principles of the ecoMOD Project. With each new team of designers, builders and evaluators, the principles evolve.

2.1.1 Size

- keep it small – but design it carefully
- make it feel larger than it is
- attach dwellings to minimize land usage, and reduce costs

2.1.2 Design

- design for today: people will accept contemporary design if its functional, comfortable and beautiful
- create spaces and elements that are flexible and have multiple functions
- use universal design principles to create spaces for all occupants, including those who are physically impaired
- bring in natural light, but diffuse it
- design to minimize the need for air conditioning
- design details and surfaces to minimize the need for maintenance

2.1.3 Siting

- carefully consider topography, urban context, wind and sun
- develop on brownfields rather than on green ones
- strive to recharge all stormwater on site
- use native, non-invasion, and drought tolerance planting

2.1.4 Costs

- work within the financial constraints of current affordable housing
- offer green upgrades, with clear cost / benefit information

2.1.5 Efficiency

- reduce operating costs: people can afford better homes if utility bills are lower
- select equipment and appliances that minimize energy and water usage
- use passive and daylighting design strategies to minimize energy use
- allow occupants to control systems
- provide easy to understand feedback on mechanical and water system performance, so occupants can adjust them accordingly

2.1.6 Materials

- strive for efficiency in thermal resistance and material use
- eliminate off-gassing whenever possible

- reuse or reclaim whenever possible
- make environmentally and socially responsible material choices
- select durable, low-maintenance materials

2.1.7 Mass customization

- offer variations at multiple scales – modules, panels, components
- offer modular options to add onto homes rather than replacing them
- design for site- and client-specific responses
- offer modules scaled for urban infill

2.1.8 Evaluation

- analyze the affordability of the completed projects
- monitor the energy and water usage, and the thermal comfort of the homes
- assess the environmental impact of the materials and methods
- apply the lessons of the evaluation phase to the subsequent projects
- present the information to the public

2.2 Design, build, evaluate

The projects are broken into three overlapping and intentionally cyclical phases, allowing the teams to *design, build* and *evaluate* the housing units.

2.2.1 Design

The ecoMOD mission is focused on investigating the different ways in which prefabricated housing can be socially, environmentally and economically responsible. The goal of the design phase is to foster integrated and interdisciplinary collaboration throughout. The design process presents students, faculty and community members with a unique opportunity to learn from previous examples, while at the same time outlining and executing proposals for housing units that seek to improve the quality of prefabricated design. The process is iterative and multi-faceted. The participants are required to synthesize complex information, and effectively collaborate to make decisions.

2.2.2 Build

Each ecoMOD team has the opportunity to build the prototype they design. The goal is to not only provide our affordable housing partners – Piedmont Housing Alliance and Habitat for Humanity – with actual homes, but to expand on that opportunity to test prefabrication as a workable solution for the lack of well-designed affordable housing in the U.S. The prototypes are fabricated at a decommissioned airfield hangar owned by the University of Virginia, and shipped either as modules or panels to their final destination. Based upon extensive research into the prefabricated housing industry and advice from modular homebuilders, the fabrication processes are structured to mimic what a company would expect if the home designs were taken into production.

Figure 1: Deborah Ku, UVA undergraduate architecture student and Barrett Eastwood, ecoMOD3 Construction Director working on a bay window for ecoMOD3 at the decommissioned airport hangar where the ecoMOD modules are constructed. Photo credit: Ping Guan.

2.2.3 Evaluate

Once the design and construction phases of a conventional house are finished, the project is generally considered complete. One of the goals of ecoMOD is to not only fabricate socially and ecologically sustainable prefabricated houses, but

Figure 2: One of the modules for ecoMOD3 arriving on site in the Fifeville neighborhood of Charlottesville, Virginia. Photo credit: Stephanie Harvin.

to also evaluate the result. Architects, engineers, and the prefabrication housing industry seldom monitor or evaluate their efforts. The 'evaluating ecoMOD' process is built on emerging strategies and protocols for the analysis of a completed building. Each evaluation process may include analysis into environmental impact of the systems and materials; energy performance; affordability; human comfort; constructability; and thoughtful placement within a community.

Figure 3: Interior of the accessory unit for ecoMOD3 in Charlottesville, Virginia. Photo credit: Scott Smith Photography.

3 The value of hands-on learning

In the abstract world of a normal architectural design studio or a standard engineering course, a professor will emphasize principles and have students try different strategies. Yet as students gain confidence in their newly found skills, it is helpful for them to test their design ideas with an actual building site, a client, a deadline, a budget, and most importantly with the shared knowledge of collaborators in related disciplines. By going beyond building design, to take on a construction budget and a schedule, and ultimately assembling construction materials into a prototypical building, the challenges of making difficult decisions are more clearly brought to the forefront. The most successful students in these situations are not the ones who simply display their design skills, but the ones that also learn how to reflect on the design process as its happening, and strategize for the success of the team.

To guide the studios and seminars within the project, the Project Director has created a strategy for emphasizing guiding principles, while making sure the students develop critical thinking skills for their own individual design process.

This method is refined each semester, but at its core is the idea that its more important to listen and ask questions than to provide students with preconceived answers. From year to year, the forms and finishes of architectural design change quickly, just as the definitions of an environmentally- or socially-responsible architecture evolve continuously. So rather than present information

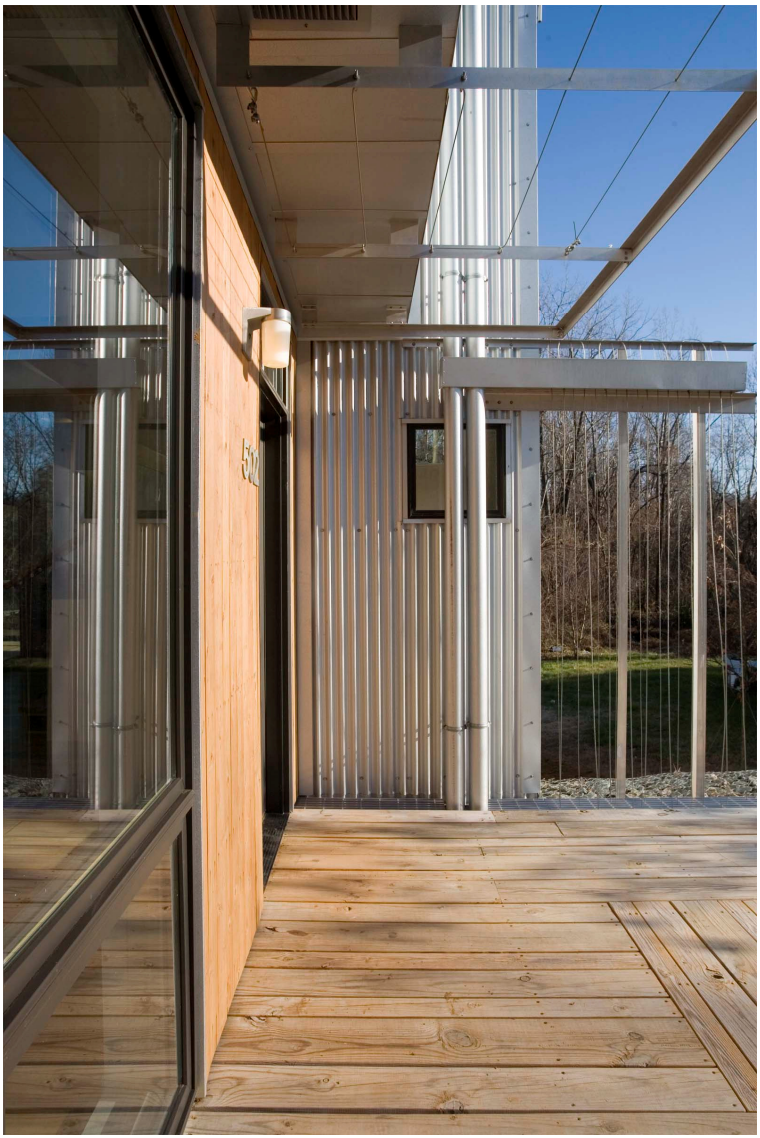

Figure 4: Entry deck and potable rainwater collection system at ecoMOD1, OUTin, a two unit condominium in Charlottesville, Virginia. Photo credit: Scott Smith Photography.

in the form of precise answers (as some students would prefer) assignments and activities are structured to ensure students are constantly asking tougher questions of themselves. A mature knowledge of the process of design can help form of the foundation of a long-term career.

In this sense, the ecoMOD Project is more like a professional design team – with architecture, engineering and landscape architecture firms working with additional outside consultants. The role of faculty is similar that of a principal in one of these firms, with the exception that their motivations are educational, environmental and social, and inherently less focused on earning a profit for the design team.

As a pseudo-professional experience, the challenge of productively working together as a team is another important aspect of the project. Some teams work better than others, and frank discussions about team dynamics and personality profiles are helpful. Getting every single person to take real responsibility for some a task or area of research seems to be the best way to encourage a productive team dynamic. If everyone owns a part of the collective project, all contributions are important. The goal is to get students to think beyond their own ego, and strive for solutions that are for the good of the project.

The physical act of crafting a building is an important aspect of the project for many team members. By allowing designers to get their hands dirty, and figure out the subtleties of materials, connections and detailing, young designers can very quickly improve their design and construction detailing skills. In the ecoMOD projects so far, there have been several examples of extremely skilled designers – with the ability to draw up design schemes with great sophistication – discover that their beautiful drawings can't be easily assembled in the way they intended. Several have come away from the project as skilled carpenters.

4 Conclusion

Design, at its core, is about creatively inventing new ideas and forms through a process of decision-making. By guiding students into these processes, letting them make decisions (within common sense constraints), allowing some mistakes to happen, and asking them many questions along the way, educators can empower the next generation of designers as they attempt to rewrite the future.

References

[1] Further information about the ecoMOD Project is available at www.ecomod.virginia.edu

[2] The ecoMOD Project received the 2007 NCARB Grand Prize, the 2007 AIA Education Honor Award and the 2006-07 ACSA Collaborative Practice Award. It also received special recognition in the 2006 AIA-COTE's Tides Report on Ecoliteracy in Architectural Education. The Project Director and Engineering Director have spoken about the project in the U.S. and abroad on multiple occasions.