Net Positive - Design/Build Research
Mark Taylor Assistant Prof. - School of Architecture UIUC

Gable Home 2009
Re_home 2011
University of Illinois' Gable Home - Solar Decathlon 2009

"first U.S. finisher – second most affordable house"

U.S. Dept. of Energy’s Solar Decathlon Competition 2009
A disappearing architectural language
The gabled roof allows for an open, spacious interior while conserving square footage and provides a perfect backdrop for southern facing solar collectors.
Entrance / Living Area - CB2
The barn boards that provide a sun and rain-screen to the building envelope are reclaimed from a barn that was being demolished in Rockford, Illinois. During the summer of 2008, the Grenaire family hosted the team as they proceeded to remove all the salvagable boards from the sides of a key barn that had a milking pailor on its lower level. The process of preparing the boards for use on the house required preliminary cleaning before a rough scraping of loose paint flakes. The boards were cut down to 10' to remove the holes where they had previously been held in place on the barn with a two inch batten. Both sides of the boards were painted with a water-based paint before installation on the house. In most cases, the boards were reversed where they were installed on the house. The side that had been on the inside of the barn now faces outside. This was done so the texture of the old wood grain could be seen through the paint, while the heavily painted side of the board faced into the house. Reversing the pattern of board and batten was a design intent that was presented.
The deck around the Gable Home is constructed of reclaimed wood that was salvaged from a grain elevator that was demolished less than five miles away from where the house is now situated in Champaign. With increased centralization of grain storage older grain elevators become redundant and get left abandoned. Often these iconic structures are deliberately burnt as the final unceremonious end to their useful life. Working with a Wisconsin Woodchuck LLC we salvaged approximately 2,000 board feet of old growth 2x6” douglas fir lumber. As the Gable Home only required a few feet wide ramp and 6-foot wide deck we were able to utilize the shorter lengths of lumber that are less desirable to a professional salvaging company. The 2x6” lumber which was nailed together to form the 6” thick wall of the elevator. To enable the lumber to be used as decking we had to separate each board, wash and lightly sand before a treatment of linseed oil was applied to each surface before being attached to a modular treated lumber frame.
Super Insulated Air-tight Envelope
Passive House Standard:
Passive House Planning Package 2007

Specific Space Heat Demand: 15 kWh/(m²a) or (4.75 kBtu/sf/yr)
Pressurization Test Result: ≤ 0.6 ACH @ 50 pascal pressure
Specific Primary Energy Demand: 120 kWh/(m²a) or (38.1 kBtu/sf/yr)

(DHW, Heating, Cooling, Auxiliary and Household Electricity):
Student Design and Built HVAC System (Grad. Mech Eng.) Modeled to achieve Passive House Certification
By Undergraduate Ryan Abendroth

I. Specific Demands with Reference to the Treated Floor Area

<table>
<thead>
<tr>
<th>Specific Space Heat Demand:</th>
<th>14 kWh/(m²·a)</th>
<th>15 kWh/(m²·a)</th>
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<tr>
<td>Pressurization Test Result:</td>
<td>0.6 kWh/(m²·a)</td>
<td>0.6 kWh/(m²·a)</td>
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<tr>
<td>Specific Primary Energy Demand (DHW, Heating, Cooling, Auxiliary and Household (Electricity)):</td>
<td>57 kWh/(m²·a)</td>
<td>120 kWh/(m²·a)</td>
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<tr>
<td>Specific Primary Energy Demand (DHW, Heating and Auxiliary Electricity):</td>
<td>10 kWh/(m²·a)</td>
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<td>Specific Primary Energy Demand (Energy Conservation by Solar Electricity):</td>
<td>492 kWh/(m²·a)</td>
<td>492 kWh/(m²·a)</td>
<td>Yes</td>
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<tr>
<td>Heating Load:</td>
<td>25 W/m²</td>
<td>25 W/m²</td>
<td>Yes</td>
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<tr>
<td>Frequency of Overheating:</td>
<td>%</td>
<td>%</td>
<td>Yes</td>
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<tr>
<td>Specific Useful Cooling Energy Demand:</td>
<td>5 kWh/(m²·a)</td>
<td>15 kWh/(m²·a)</td>
<td>Yes</td>
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<tr>
<td>Cooling Load:</td>
<td>21 W/m²</td>
<td>21 W/m²</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Ryan Abendroth (Architecture) : PHPP Energy Simulator

Mark Adams (Mech. Engineering) HVAC System fabricator
Video Gallery

The videos below are embedded from YouTube. Click on the video twice to navigate to YouTube for more viewing options, such as fullscreen capabilities.

Big Ten Network Documentary

http://www.solardecathlon.uiuc.edu/video.html
8 - 10 tornadoes hit the Midwest each year.
1. Optimal Floor Plan?
2. Optimal Structural System?
3. Exterior Insulation Strategy?
Proposed Site Plan – With Provision for Additional Houses:

Figure 2. Energy Farm Field Research Center and Proposed Location for the Element House

Plans and Drawings and Site:
A full set of architectural drawings are available as a Zip download from the following website:

Figure 3. Floor Plan of the Element House
December 2012: Construction Complete
Funding From The Spanish Red Cross and SCW
REMOVAL OF FAILED ELEMENTS

Columns and Beams
The size and placement of steel reinforcement was not clearly identified in the original structural drawing set. Many of the columns on the second floor were poorly constructed. Aggregates in the concrete appear too smooth and too large to form a strong bond. Poor consolidation of concrete in the form-work left rebar exposed to weathering.

Structural Details
The information in the original drawing set for the hospital did not provide sufficient information for the contractor to construct a building that would resist strong lateral forces. The contractors who built the hospital returned to remove the failed elements after the earthquake.

Due to the number of unknowns in the original drawings set one of the two student teams decided the only course of action was to remove the failed building completely and re-master plan the entire campus.

Structural Design
The structural design of the entry canopy and the connection between 2nd floor slab and wall surrounding the interior ramp are areas of major concern. The 7m span of the entry canopy is excessive for the depth of the beam. The walls surrounding the interior ramp provide a poor connection to take up the loads in the surrounding portion of the roof.
**Camejo Health Campus Planning**

**Phase 1: Main Hospital Building and Proposed Future Phases**

**Cholera Screening/Needs Assessment Center**

**Education Pavilion**

**Kay Famm YO Women’s House**

Completion September 2012

**New Hospital**

Emergency Entrance

Emergency/Reception

Outpatient Services

Inpatient Beds

**Temporary Hospital**

To be demolished in 10 years

**Green Corridor**

Healing gardens in between buildings

**Courtyard**

Open courtyard between clinical spaces

**COURTYARD**

Open courtyard between clinical spaces

**Major Road**

**Proposed Campus Plan**

Proposed: Decentralize the campus experience, but centralize buildings along the campus axis

**Retreat/New Build**

The second floor of the existing hospital on the Camejo campus partially collapsed during the earthquake while it was under construction. After initial analyses, our team was concerned about the safety, longevity, as well as the potentially high cost for examining and reconstructing the integrity of the remaining concrete structure. The new proposal for the Camejo Hospital serves as an alternate solution that focuses on utilizing efficiency and cost-effectiveness.

Through reorganizing the campus and the existing program for the hospital, the new Camejo Health Campus will bring a sense of renewal and together to the communities at Leogane.

**The New Camejo Health Campus**

The goals for the design of the Camejo Health campus are to focus on the patient experience not only within the new hospital but also at the campus. We also aim at developing an efficient construction system that will be easy to construct.

The campus provides a welcoming and open feeling upon arrival. The campus is organized in a series of buildings, with the Kay Famm YO Women’s House in the center (will be completed in September 2012). The Cholera Screening/Needs Assessment Center is located near the main campus entrance, so that patients with infectious illness will affect the other patients and visitors on the Camejo Health Campus. An Education Pavilion provides an open space for public health education and performance. The Main Hospital is located in the east end of the site to ensure privacy for patients. A green corridor (healing gardens in between the buildings) unites the campus and provides opportunities for patients and visitors to enjoy outdoors and greenery.

The New Hospital continues the idea of concept of bringing outdoors to the clinical spaces. The programmed elements (emergency, outpatient, surgery service, and inpatient beds) are organized in sequence of buildings with a shared courtyard in the middle, to allow maximum use of daylight and natural ventilation in interior spaces. The views to nature not only aid the patients’ healing process but also reduce stress for the medical staff.

The Main Hospital utilizes a 6m x 4m module and is repeated throughout the building. This modular structure allows a clear sequence of construction, as funds become available. The uniformity of the structural system will also enable contractors to use a standardized framework and repeat the reinforced concrete detail.
Building Systems

Concrete bond beam

Light gauge steel channels for interior ceiling finish

Metal lath andscratch coats (interior stucco finish)

Concrete block walls finished with stucco

Ridge/hip cap with continuous caulk at laps

Foam enclosure and tapes sealer

Roof metal panel

Felt underlayment

Sheathing

Light gauge steel truss

Corrugated metal roof panels

Roof underlayment

Sheathing

Light gauge steel truss and roof framing

Photovoltaic panels

Solar-powered batteries, stored in benches in the courtyard

Section B-B'

Outpatient Pavilion

Section C-C'

Clinical Pavilion

Section D-D'

Inpatient Building
A team of four students came to the consensus that there was enough integrity remaining in the first floor of the existing hospital for it to be adapted to serve the purpose of the original two story structure would have provided. Circulation space and redundant elements such as stair wells and large interior ramps were removed and additional ward space, X-Ray facility and on-site pharmacy were proposed. A new addition to accommodate student nurses was proposed over the north wing which suffered no damage as a result of the Haitian earthquake.
COLLABORATIVE RESEARCH

Context:
The Haitian earthquake of January 2010 highlighted a desperate need for the transfer of construction and architectural knowledge to minimize the impact of any future natural disaster. Haiti is an island nation that faces two major sources of environmental disruption: seasonal hurricanes and seismic events. Severe hurricanes occur on the frequency of 1 or 2 per year. Severe earthquakes occur once every 50-200 years. Six research trips were taken over the course of the two-year period following the 2010 earthquake to study the construction needs in Haiti.

The Nature of the Investigations:
Between June 2010 and May 2012 three interconnected research investigations were undertaken in Leogane; the town at the epicenter of the magnitude 7.0 Haitian earthquake. The initial visits established links with stakeholders invested in constructing safer buildings. Initial site visits to schools, hospitals and government buildings, constructed, before 2010 established that key municipal structures, which should have served as places of refuge after the earthquake, fared no better than residential buildings built without professional guidance. Subsequent visits established collaborative relationships with local engineers, suppliers and construction crews to identify shortfalls in Haiti’s building delivery supply chain. Establishing local links was critical to ensure the outcomes of collaborative efforts would facilitate long-term change in the region.

The Learning Outcomes:
In the 2.5 years since the earthquake knowledge transfer has taken place at multiple levels:

Graduate architectural students have applied their theoretical knowledge to a critical real world problem. They exercised judgment in the assessment of historic drawings and data collected from the site, making recommendations, which will potentially save tens of thousands of dollars and hundreds of lives. Undergraduate students have studied the Kay Fann Yo construction methods as an introduction to building technology, seismic design, passive cooling design, and code compliance. Haitian engineers were introduced to the principles of seismic design, something that had not previously been included in their formal education. Local Haitian construction crews were introduced to critical improvements in building methods and approaches.
Principles of Reinforced Masonry Construction

“Kay Fanm Yo” - Women’s House: Construction Manual

Léogâne, Haiti
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WEBSITES:

VIDEO: Haiti Hospital
Open Architecture: Hospital - Haiti
Open Architecture: Kay Famm Yo
Womens House - Haiti
Schools for Children of The World
Open Architecture: Hati School
Solar Decathlon 2009
Solar Decathlon 2009 Videos
VIDEO Documentary: Solar Prairie Home -
Solar Decathlon 2009
Solar Decathlon 2011
University of Illinois Solar Decathlon 2011
- Architecture
University of Illinois Solar Decathlon 2011
- Community Response
University of Illinois Solar Decathlon 2011
- Intergrated Systems
Questions ?