ARCHITECTURE JURY NARRATIVE

CONTEXT

UNC Charlotte's 2013 Solar Decathlon entry, UrbanEden, is inspired by the city of Charlotte's commitment to revitalizing its city center. A growing New South city, Charlotte has a metro population of 2.2 million. The UNC Charlotte team values the benefits and reduced carbon footprint of an urban lifestyle, with easy access to businesses, cultural sites, parks, and public transportation. At the same time, we feel these advantages shouldn't be gained through the loss of a connection to nature, to the outdoors. The team therefore decided that the generative theme of our design would be a private connection to nature in the city, an UrbanEden.

PARTI

The team developed a design concept that blurs the line between inside and out by creating a series of connected indoor and outdoor rooms that combine into a single healthy environment: the interior completely adaptable to maximize comfort year round and seamlessly connected to a private plant-filled exterior living space, sunny in winter and shady in summer. This outdoors is distinguished from the "great outdoors" in that it is contained within a spatial definition that allows for contemporary life to continue outside, either physically or, if the weather doesn't permit, then visually.

This, then, is the architectural parti, but there is an analog and equally important energy parti: the concept of creating a baseline of energy savings through the lifestyle manifested by the architecture. In our case, when you are outside living, you aren't inside burning energy to heat, cool, or light your space. More time outside in the context of contemporary urban life translates to energy savings. Therefore the same architectural gesture that accomplishes our desired improvement in quality of life is also the baseline for delivering the central technical requirement of the Solar Decathlon: saving energy ….because everyone knows that the first step toward the practical implementation of renewable energy systems is a reduction in demand. Without considering a single PV module, appliance, or energy dashboard, we are well on our way to the central competition goal of creating energy independence.

DESIGN

UrbanEden consists of four indoor modules, each with an outdoor component. Thick insulated concrete walls on the east, west, and north façade facing the street cradle the interior living space, creating a visual and aural separation from the urban context. On the building's south side is the exterior living space, enclosed by a lush vertical garden that creates a private connection to a hybrid urban/ natural environment. Transition between these interior and exterior living spaces is provided by a high performance floor to ceiling glass wall that allows for exacting interior environmental control while maintaining a constant and

seamless connection to the outside. Public and private spaces are defined formally as essentially tectonic assemblies of concrete, glass, and steel, providing an openness that feels expansive in a small square footage. These spaces are separated by a service module, a stereotomic volume of wood from which the bath and mechanical room are carved.

This indoor/outdoor partnership is central to the gestalt of our design goals, but is eminently practical. The 822 square feet of expensive high performance indoor space is doubled with relatively inexpensive outdoor space, lowering the overall square foot cost of the building while considerably increasing its livability and appeal in our climate.

The building is approached by a path along the north façade defined by an overhang marking the main entrance. Here, the service module is offset to the south creating a cantilevered porch entrance and introducing formally the separation between public space to the west and private to the east. The porch does what porches do, providing both protection from the weather while fumbling for your keys and a connection to the street-life of the neighborhood. It is also a transition space preparing the departure from the city into the refuge of home through a 180-degree change in direction and the continuation of the ceiling plane from the porch into the interior.

From here, the main entry opens into the kitchen for convenience, but the initial visual image is of the interior space opening into an expansive garden to the south. Kitchen and living modules combine into a single large room designed to be a communal flex space. Living room furniture easily moves outside through expansive openings in the southern curtain wall allowing the kitchen counter to modulate into a full-sized table that seats eight. The entertainment console swivels open to allow TV viewing in the outdoor portion of the living room while simultaneously serving as a privacy wall for the guest Murphy bed thus exposed.

Floor to ceiling glass and a continuity of floor surface clearly define indoor and outdoor living areas as components of a single space. Moving through the southern glass transition to the outdoor portions of these rooms the ceiling height rockets up as it is defined by the frame of the movable PV rack some 13 feet above the floor plane. Vertical plant walls wrap this space, attaching to the columns of the PV rack and terminating 7 feet above the floor, thus creating a large horizontal opening above and ¬¬running the full length of the space that reads as a series of large, high windows. These elements define a space that is much taller and vaster than the interior, conjuring the common feeling of awe in the face of natural expanse. ¬

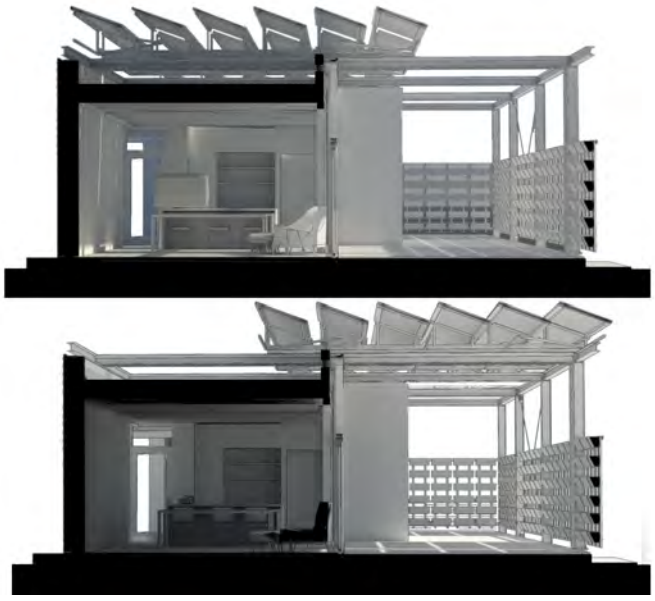
At the same time, the plants create the privacy of an inner sanctum. Each section of the exterior walls is planted to enhance the designed use of the associated space, with the living room focusing on beauty through sight and smell and the kitchen on edibles. Though the plants are dense enough to create the privacy, they are porous enough to allow for ample natural ventilation and an intricate play of sunlight, manifesting a complex and ever-changing sensory experience.

Transition from these public spaces to the privacy of the bedroom flows from either outside or in. From the outside, one crosses a bridge past two shallow raincatchment ponds in front of the southern face of the service module which protrudes into the exterior living zone creating, along with densely planted walls, a private nook that makes up the outdoor southern half of the bedroom. From the inside, the transition into privacy is prepared with a change in materiality and lowered ceiling height by moving into the southern end of the service module, the bathroom, a space carved out as a passageway to the bedroom. The interior portion of the bedroom is small but amply outfitted with storage. A retractable desk can transform the completely glazed southeast corner into a small office that opens out onto the privacy of the outdoor section of the bedroom.

MATERIALS

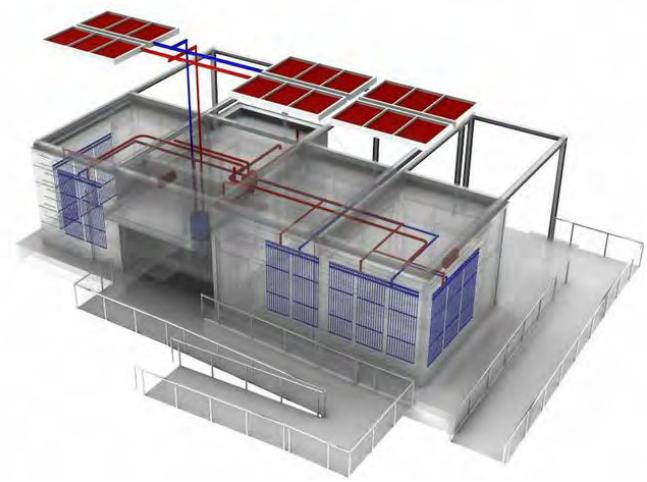
UrbanEden's central architectural gesture is the synergizing of an urban connection to nature with energy efficiency. Put in another context, this concept could be summarized as low-impact, low-embodied energy, or perhaps even as a variation on the definition of sustainable design. Of course, then it was important for us to carry this concept through in our materials selection and we did so at every turn. Highlights include a steel structure with over 90% recycled content, extensive use of rapidly renewable laminated bamboo for interior and exterior finish, non-toxic thermally modified wood flooring and decking, and locally produced plant based paints and finishes inside and out.

We also went for a major innovation by choosing a geopolymer cement concrete (GCC) for our mass walls. We wanted the longevity and thermal properties of concrete, but conventional Portland cement is a carbon emissions monster, being responsible for somewhere between 5 and 8% of the world's collective carbon footprint. Our building uses a geopolymer cement concrete mix developed at UNC Charlotte that looks and performs the same but is chemically a completely different animal. The result is an up to 90% reduction in associated carbon footprint. As far as we know, ours is the first building in the world to use geopolymer cement as part of the insulated envelope of a building. This small, essentially plug and play substitution alone, if emulated in all building projects, could be world changing. We felt the high profile platform of the Solar Decathlon was the perfect venue to introduce this building technology to the world.



PASSIVE, HYBRID, AND ACTIVE SYSTEMS

In energy efficient buildings, the lines blur between architectural and systems design for a number a reasons not the least of which is the necessity to take advantage of passive heating and cooling which is eminently connected to building form. Charlotte has slightly more heating than cooling degree days, so we started our systems development with classic



passive solar design for a mixed climate. Our house faces directly south and is long and thin on the east west axis. In the winter southern glazing allows low winter sun to access interior mass while in the summer that same mass takes heat out of the air to help stabilize the interior environment when diurnal temperature swings allow for some kind of night flush.

In conventional passive solar design, the mass component is usually limited to an insulated concrete floor slab, but in UrbanEden the mass has moved to the walls in the form of fully insulated precast panels. This seemingly innocuous choice is part of major experimental innovation. By markedly increasing the surface area and related volume of our thermal mass in the passive solar context, we have been able to implement a hybrid passive/active hydronic radiant heating and cooling system that, unlike conventional hydronics, uses only pump energy to accomplish temperature changes.

Embedded in our precast panels are arrays of small diameter capillary tubes. In the summer, the concrete slowly takes on ambient heat from the interior space during the day. At night, water is moved through the capillary tubes to copper fin heat exchangers on the roof. The combination of the large surface areas of both the interior wythes of concrete and the embedded tubes creates a very efficient transfer medium for heat. Since the night sky, especially on a clear night, is a giant reservoir for radiant heat transfer, theoretically our system should be able to cool the concrete and hence the space with a very low delta T between interior and exterior environments. The result is cooling without using compressors or refrigerants, in other words essentially passive cooling. In the winter, we rely on old school passive solar heating that requires no input of mechanical energy whatsoever. The combination results in very efficient, low-tech solar heating and cooling.

Passive cooling is enhanced through ample natural ventilation created indoors by non-aligned window and door openings that encourage full room ventilation rather than the “wind tunnel” effect typical of symmetrically aligned fenestration. When openings are closed, a high performance ERV guarantees air exchange while maintaining interior temperatures. The ERV also has a MERV12 filter to insure healthy indoor environmental quality in the face of fluctuating city air conditions.

The backup to these passive and hybrid HVAC strategies are two 23 SEER mini-split heat pumps sized to be able to deliver peak heating, cooling, and dehumidification loads independently of other systems. This approach guarantees complete climatic control year round to maximize the comfort profile of the space for a variety of potential occupants.

Additional systems include efficient water distribution contained within the service module, hyper efficient hot water heat pump, raincatchment, edible plantings, and an 8.5KW PV system.

LIGHTING

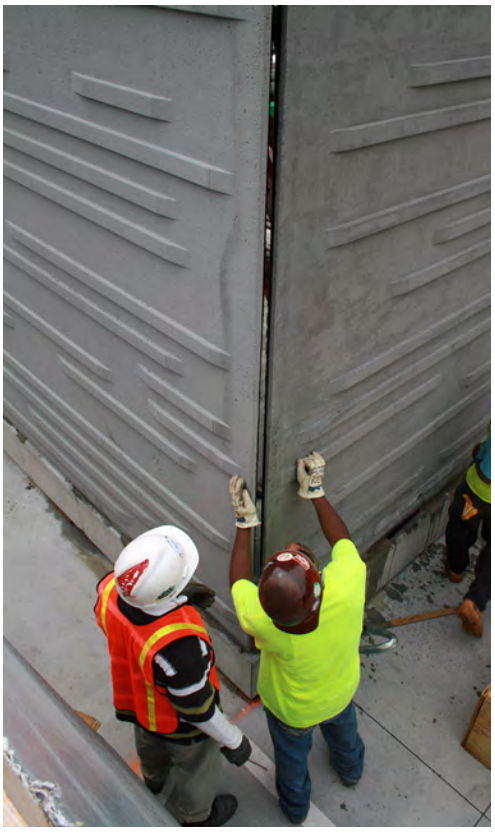
As for lighting, again passive and active systems work in tandem. The overall design goal was to provide adequate lighting for both ambiance and varied tasks through the creation of independent zones that support the programmatic goals of creating multi-use space and reducing energy consumption.

A baseline is created through ample daylighting balanced through fenestration spread across all four building faces, with a focus to the south. Shading is accomplished horizontally rather than vertically through an automated PV rack that slides over the southern outdoor space allowing for exacting attenuation of direct sunlight based on the season or the weather of a particular day without changing the view shed provided by the glazing. In other words, the rack uses the sun to make energy while blocking the sun to save energy. In the dead of winter when the rack is fully retracted because full sun is desired to maximize solar gains, the center of the living space serves as a sun room with areas of both public and private spaces always shaded throughout the day. For example, the kitchen is shaded in the morning by the protruding service module while the northwest zone of the living room is shaded later in the day by the main section of the western wall which is fenestration-free. With the entertainment system in the open position, the entire living room is protected from direct sunlight.

More exacting control that allows the creation of rich and varied light throughout is enabled through independent task and ambient lighting controls in each module, both indoors and out, allowing multiple configurations. All fixtures are dimmable. Color rendition and light distribution were carefully considered through selecting a variety of beam spreads and color temperatures, each chosen for the given application. All bulbs are LED.

CONTROLS

UrbanEden's mechanicals are monitored and controlled by an interactive energy management system that presents information and control options to building occupants. A PC tablet displays a wide array of details, such as temperature within and outside the home, capillary tube system operation, real-time energy use, and energy generation from the home's PV array. Occupants can monitor how their behavior impacts energy metrics and then may choose to moderate their energy use to improve the efficiency of the house. Control functions include moving the PV panel rack, choosing the water heater mode, locking or unlocking doors, and turning lighting on and off. All controls can be carried out remotely via the tablet.



BUILDING ENVELOPE

The backbone to this body of passive, active, and hybrid mechanical and lighting systems is a high performance envelope designed to maximize air tightness and minimize thermal bridging. The core of the system is the mass walls of the public and service pods which are 16" thick continuously insulated precast geopolymer cement concrete panels consisting of two wythes of concrete sandwiching 6 inches (R-30) of polystyrene. The wall to floor connection was carefully detailed to create complete continuity between wall and floor insulation. The service pod is steel studs insulated with fiberglass and continuous exterior foam to break the thermal bridging of the studs while the 11" (R-55) of roof insulation is set over the roof framing also to avoid bridging. The fully glazed southern face of the main living area is admittedly a daring move central to the concept of rooms with combined indoor and outdoor components. As a result, all glazing in the home is high performance low-e, gas filled triple pane with thermally broken spacers, an SHGC of 0.5, and a center of glass R-value of 8. Computer modeling of the window wall indicates performance for the Charlotte climate in line with our energy consumption goals.