On Tightness and Looseness

When building in mild climates, the boundaries between inside and outside are often blurred. Windows and doors are opened. Walls open, thin, or dissolve altogether. Clothes and shoes yield to bare feet and naked, exposed skin. As seasons change or as day recedes into night, however, we are often reminded of the relatively narrow definitions that we prescribe for thermal comfort.

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With a cool evening breeze, exposed arms search for sleeves, wraps and sweaters. Windows and doors close and we gradually build layers of thermal protection that envelop and warm us.

In a similar way, as the temperature and humidity increase, we often retreat from exposed conditions to find shelter and protection. We add sleeves, wraps, hats, and roofs to shelter us from the sun, and we seek cooling breezes, water, and air. In many tropical and subtropical areas, high humidity levels require us to either stretch our definitions of comfort or succumb to chemical and mechanical devices that alter either our bodies or the air that envelopes us.

While we all have an innate understanding of these kinds of comfort issues, it is exceedingly difficult to define them in a precise manner that is useful for the design of buildings and their environmental systems. The most commonly-used definition of thermal comfort is "that condition of mind that expresses satisfaction with the thermal environment."[1] This leaves many questions to be addressed by national and international organizations, as they seek to develop standards for thermal comfort. For instance, given the tremendous range of individual responses to comfort criteria, how can a sufficient sampling be conducted to become representative of the human condition? And even if such a sample were possible, how do you adjust such a global standard to accommodate the regional preferences of populations that may vary dramatically from place to place? Without such adjustments, does a global standard risk irrelevance?

Once we establish and/or endorse a specific standard for thermal comfort, there are also significantly different positions on how best to respond to issues of thermal comfort. As Ken C. Parsons notes, "it is interesting that one of the major issues concerning thermal comfort is the apparent conflict between a so called 'western' approach, which attempts to 'seal' a building and control the internal environment to constant levels of air temperature appropriate to western behavior and clothing, and an adaptive approach where people can adapt to a wider range of conditions that complement their culture in hot (or even cold) climates."[2] Both approaches have their advocates and detractors. They also point towards two very different kinds of architectural responses to the problem of thermal comfort.

This paper examines the ideas of architectural "tightness" and "looseness" as strategies for addressing thermal comfort in subtropical areas. Two recent projects in Florida serve as case studies: Project Re:Focus and the Quinlivan Passive House.

PLACE AND VARIABLE COMFORT CRITERIA

In both scientific and popular discourses, it is common to see climatic conditions overly generalized, defined strictly by geographic, thermal, and/or topographic denominators. If we look closely, however, we find a tremendous variation in temperature, humidity, wind patterns, rainfall, solar insolation, and cloud cover, even in relatively similar regions and/or climatic bands.

> In Florida, a cool dry season and a warm, rainy season constitute a strong climatic cycle. Seasonal climatic changes are often slight, but the daily temperature ranges at some times and places may exceed the average annual ranges. Climatic differences also occur over short distances. Variations in the topography and in the daily weather produce a finely structured mosaic of microclimates.[3]

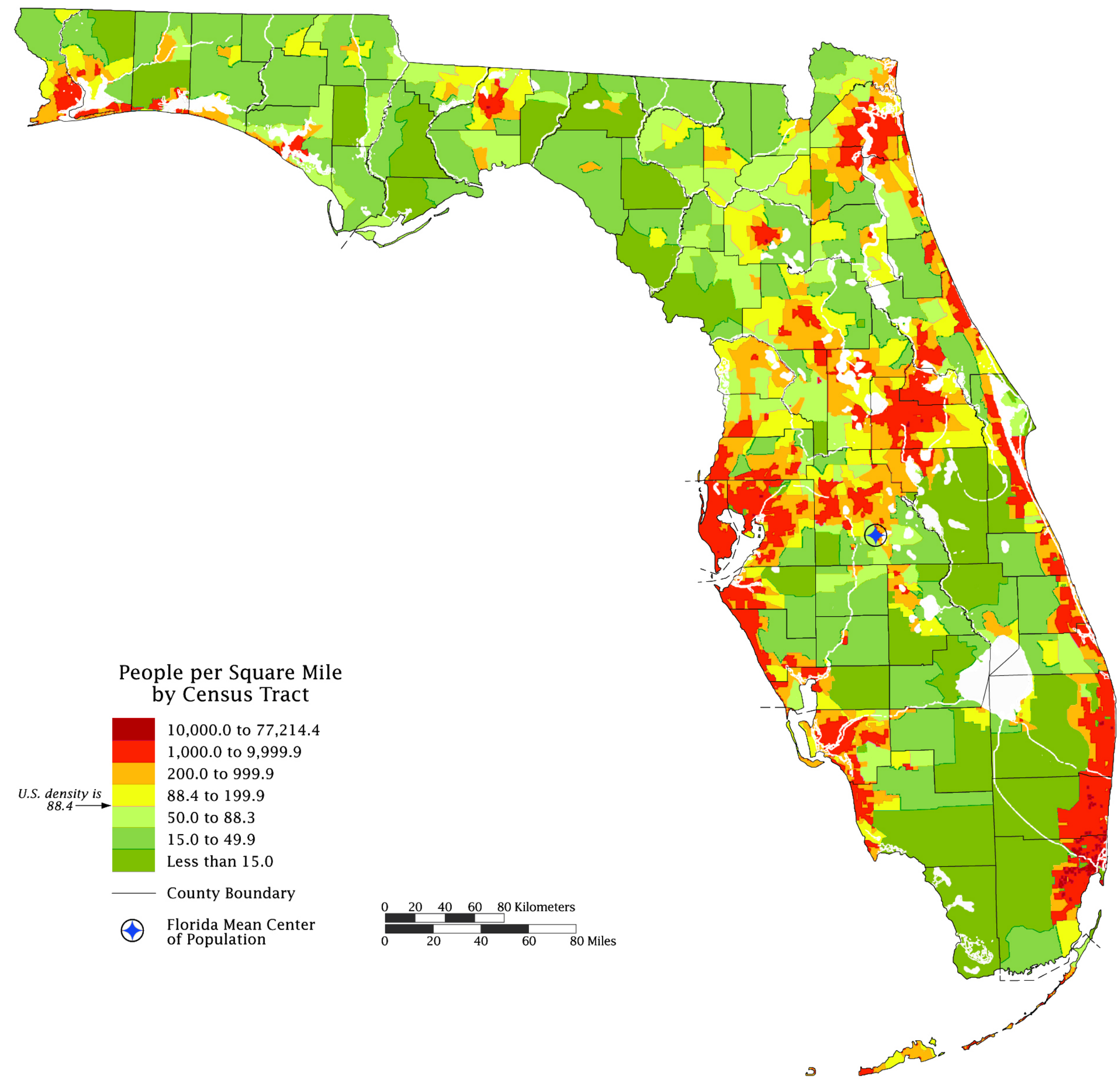
The geographic particularities of Florida's peninsular shape significantly impact the region's climate. In the spring,

> The increased exposure to the sun's rays, or insolation, warms the land and water surfaces, but water temperature does not increase as quickly as land temperature. This creates a temperature differential between the land and the surrounding water that causes air to circulate along the shores of lakes and seas. Since Florida has a long coastline, these sea breezes influence a large area and are important influences on local weather. The sea breeze effect is year-round but is greatest during summer.[4]

While sea breezes affect both coastal and inland areas, their effect along the coast is much more pronounced. We find the coastal areas to be perceptively and measurable more windy than inland areas. The average annual wind speeds in coastal cities like Tampa (8.3 mph), Miami (9.2 mph), West Palm Beach (9.6 mph), and Key West (10.9 mph) can be contrasted with inland cities like Gainesville (6.3 mph) or Tallahassee (6.2 mph).[5] While these numbers all appear small, the difference of 2.9 mph (255.2 feet per minute) between the average annual wind speeds in Miami and in Gainesville can translate into significant perceptual temperature differentials of five degrees Fahrenheit (5°F) or more.[6]

The influence of moderating sea breezes that cool the coast somewhat in the warmer months of the year is important for Florida, given the large numbers of people who live in the cities that line Florida's coasts.

Although Gainesville, Florida is typically thought of as having a mild, comfortable climate, ambient outdoor conditions actually meet temperature and



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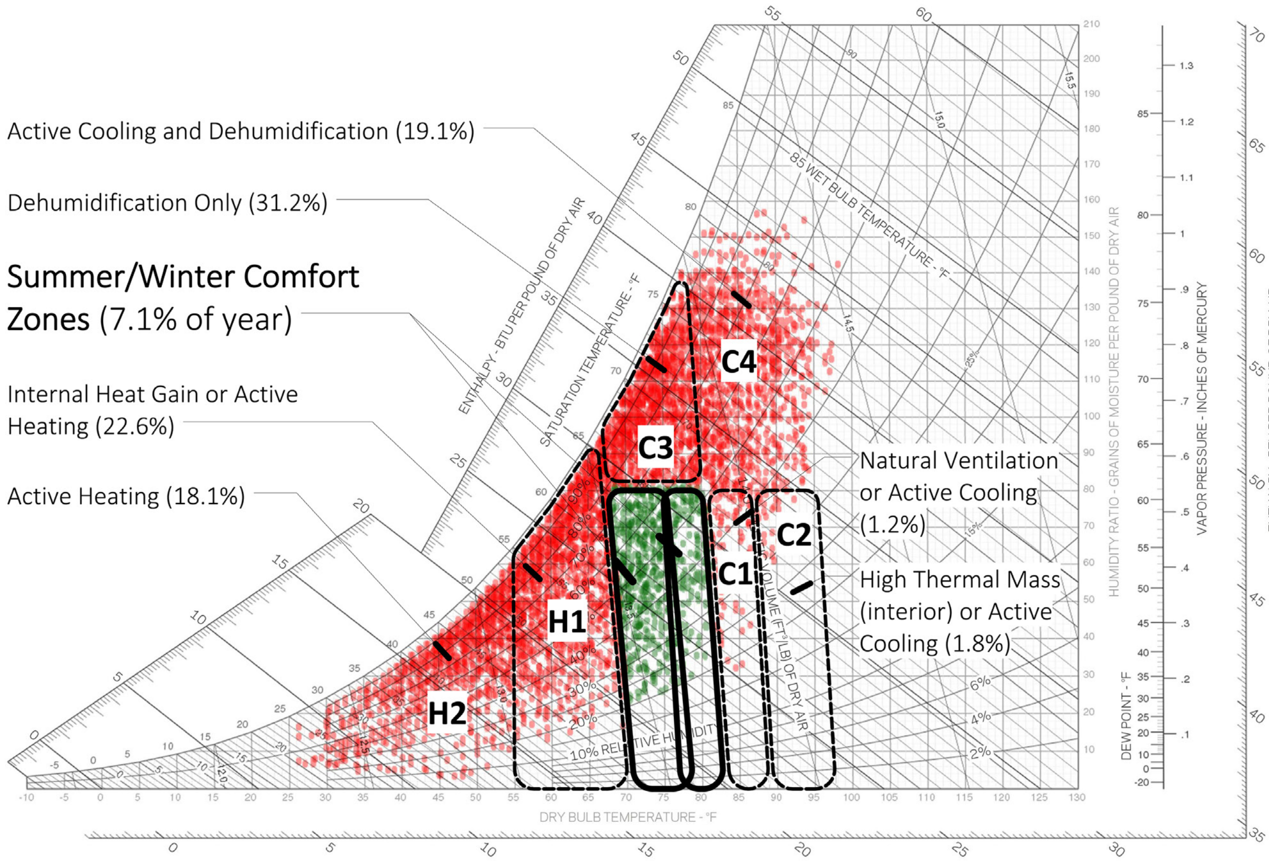
humidity requirements for comfort an average of only 7.1% of the year (621 of 8760 total hours). The percentage of time that is comfortable varies by month: Jan 5%, Feb 14%, Mar 11%, Apr 20%, May 6%, Jun 5%, Jul 0%, Aug 0%, Sep 3%, Oct 7%, Nov 9%, and Dec 6%. The psychrometric chart in Figure 02 shows us that those areas outside the ideal comfort conditions are cooler, warmer, and/or more humid.

During the cooling season when there is a high temperature but relatively low humidity, natural ventilation and/or fan-forced ventilation cooling can be used to provide comfort for 1.2% of the year. Use of thermal mass (inside) can provide comfort for 1.8% of the year. Because of the mild temperatures, we can extend the comfort range to include another 31.2% of the year with dehumidification only. Warm temperatures combined with high

Figure 1: Major population centers line the east and west coasts of Florida. Image: Bradley Walters, with source data and base map from the U.S. Department of Commerce, Economics and Statistics Administration, U.S. Census Bureau, http://www2.census.gov/geo/maps/dc10_thematic/2010_Profile/2010_Profile_Map_Florida.pdf, accessed 29 July 2013.



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humidity requires active cooling and dehumidification (19.1% of the year). This is particularly critical during July and August.

During the heating season, internal heat gains can provide comfort 22.6% of the year, leaving 18.1%, or 1588 hours, that require mechanical heating strategies.

Figure 2: Psychrometric chart for Gainesville, Florida. Two center data points are within acceptable comfort ranges, as established by ASHRAE Standard 55-2004 with Predicted Mean Vote (PMV). Darker data points show those temperature/humidity conditions that are outside acceptable comfort ranges, and are keyed to show the various strategies that may be deployed to achieve comfort. Image: Bradley Walters, with data from Climate Consultant 5.4 (Build 5; Build Date : 03/11/2013), developed by the UCLA Energy Design Tools Group.

REGIONAL INFLUENCES

The early history of north Florida belongs principally to Timucuan and Seminole Native American communities. For more than a thousand years before the arrival of European explorers, the Timucuan people embraced Florida's life-giving waters, establishing settlements near rivers, waterways, and oceans. Known best as "People of the Shell Mounds," they lived in close communion with native ecosystems and deployed locally-available materials in their architecture. "Besides collecting shellfish and fishing, they hunted and gathered in the forests and swamps and planted maize, squash, and beans. In their often palisaded villages, they lived in circular dwellings with conical palm-thatched roofs and walls of woven vines caulked with clay."[7] Their populations were quickly and dramatically decimated by the introduction of infectious diseases from Europe and Asia in the seventeenth century. Arriving somewhat later, the Seminole peoples have had a much more significant and long-lived effect in Florida, and provide an important reference for the architectures that have followed.

In response to the climate of Florida and the need for structures that could be erected quickly and/or relocated from time to time, the Seminole peoples developed a new housing typology in the early 1800s. Referred to by the Seminole word for house, the "chickee" was a basic cypress or palmetto log frame structure with a palmetto thatched roof.[8] Within the open frame structure, a single elevated platform was constructed approximately three feet above the damp ground and light fabrics were used to provide varying degrees of privacy and protection from insects.[9] Here we find the basic components of an emergent Florida architecture: 1) large roof to provide shelter from the rain and sun; 2) elevated floor structure to create dry, semi-protected spaces for occupation; 3) open framework to allow for breezes that both cool occupants and dry the structure; 4) locally-available and renewable materials; 5) variable screens, veils, and scrims for privacy and protection from insects.

We see many of these same basic components elaborated upon and further developed during the nineteenth century, as the native populations were displaced and the territory was gradually settled by new residents. We can trace this process through a series of evolving house forms, as documented by Ronald W. Haase and collectively referred to as "Cracker" homesteads. Not in any way intended as a pejorative term, Haase used "Cracker" to refer to "the backwoods country folk who cracked their corn to make meal, a staple in their diet that was used for everything from corn pone to corn fritters and to the most delicious of all pan foods, 'hush puppies,' fried right in the same gritty fat as the day's catch. North Florida's early settlers inherited this identity as 'corn crackers' but they personalized the meaning of the word. It became a reference to the sharp, loud crack of the leather whips used to drive cattle or inspire a tired mule to pull harder on the plow." [10] In a broader sense, "Florida Cracker" has been used to refer to a class of largely poor, landless people who began to build homesteads in this region.

These people constructed a wide range of building types, ranging from the one-room "single-pen" to the two room "double-pen" or "saddlebag" and the "dog-trot," which introduced an open breezeway between its two principal enclosed areas. Larger, more complex houses were also developed, including the "I-House," "Florida Plantation," and the more self-conscious "Four-Square Georgians," built following the Civil War.

To address the climate of the region, early Cracker homes were porous by design, constructing both large and small fissures to allow for natural ventilation to occur. This was important not just for thermal comfort, but also to allow the wood members to dry sufficiently to avoid premature decay. One particularly important variant of the Cracker house was the dog-trot, where the living and sleeping areas were shaped as separate modules, each placed under a larger continuous roof. The space between the modules allowed for sheltered outdoor living spaces and invited breezes to cool the home.

While it is possible to overly romanticize the simple, rustic forms of these houses, it is also possible to recognize that there are a series of operating principals at work that can transcend their specific historical forms. There emerges a common 'language' of making, one informed by the particularities of the region and its peoples, that we can refer to as a "vernacular" tradition. Ronald Haase uses this term to describe "the native language or dialect of a particular region or place" in his writings about indigenous architectures of north-central Florida.[11] Used as a linguistic strategy, the term moves beyond visual, formal, and historical antecedents to suggest operative relationships at work between and amongst numerous interrelated yet independent systems. To engage vernacular traditions requires a practiced understanding of the interplay between responsive architectures of a place and their underlying motivators.

This was precisely the objective of many architects in the early and mid-twentieth century, as they sought to reconcile vernacular traditions with new material possibilities, new mechanical cooling systems, new socio-cultural frameworks, and new formal and/or artistic objectives in mind.

A particularly significant and important body of work emerged in Sarasota, Florida, including work by such luminaries as Paul Rudolph, Bert Brosmith, Ralph Twitchell, Victor Lundy, Tim Seibert, Jack West, Philip Hiss, Gene Leedy, and Mark Hampton, amongst others. The work is collectively known as the "Sarasota School of Architecture," although there is no such formal educational institution that uses this name. Built between 1941 and 1966, these projects are broadly identified by their attention to climate and site, large sunshades, innovative ventilation systems, oversized sliding glass doors, open stairs, and operable windows.

Writing in 1957 as a native southerner and practicing architect in Florida, Paul Rudolph perhaps best articulated the possibilities of a regionally-inspired and regionally-specific architecture:

> What are some of the special attributes which the South has in her traditional architecture which might be nourished today? 1) The raised cottage to escape the dampness, 2) the dog trot to obtain the maximum amount of ventilation and to provide a shaded area, 3) the chimney placed tangentially to the main structure so that the principal structural members are not violated, 4) grilles and trellises to filter the light, and 5) the hinged sections at the windows to control the sun are each still valid and should be incorporated into our designs today. In other work we find that 6) the principal living quarters were often placed on the second floor, utilizing masonry at the ground, and wood above. 7) Modular construction, and 8) an enveloping well-ventilated roof with verandas, often on four sides of the structure to protect the openings as well as the walls from the intense sun.[12]

In the examples of the Seminole chickee, the early Cracker homesteads, and the mid-century work of the Sarasota School, we see a consistent interest in developing architectures that are responsive to their local context. They each focused on putting in place certain frameworks and loose envelopes that provided sheltered spaces for occupation.

With protection from sun and water as principal considerations, thermal comfort was somewhat marginalized. These structures required and relied on active, engaged owners and occupants to manage their own thermal comfort. People would literally "adapt" by modifying their activities and clothing levels to provide comfort. In many instances, they also interacted with their architectural envelopes, adapting the structure itself by opening, closing, or altering moveable portions of the envelope to address hourly, daily, or seasonal climatic concerns.

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VERNACULAR TRADITIONS + ADAPTIVE STRATEGIES: PROJECT RE:FOCUS

Constructed in 2010, Project Re:Focus is a solar-powered house that aims to directly draw from the vernacular architectural languages of this region. The house is defined by an independent rigid frame and canopy roof structure. Beneath the roof, a series of panelized modular components are used to create enclosed areas for occupation. Three modules are combined on one end to create Live/Work/Eat spaces, two modules are combined on the other end to create Sleep/Bathe spaces, and one module remains open between them as a covered breezeway and entry area.

The house uses a set of rigid structural steel frames to resist lateral (wind/seismic) forces and structural insulated panels (SIPs) that resist gravity and thermal loads. The two systems work in concert to form the basic enclosures of the house. The rigid frames wrap the outside of the thermal enclosure, minimizing the potential for thermal losses through bridging and also becoming a sub-structure for locally-acquired and site-specific materials to be applied to it. They also support a roof canopy of photovoltaic (PV) panels.

The overhead PV system is supported by the structural steel frame and held above the roof surface of the modules nested beneath it. It provides shading

Figure 3: Project Re:Focus. Note operable exterior wood screen system to allow for occupants to open or close the house and open breezeway through the center of the structure. Image: David To and Bradley Walters / University of Florida.

for the living module, breezeway, and bedroom module, preventing direct solar exposure of the roof and dramatically reducing solar gains. With the array covering the breezeway, it also creates a shaded outdoor transition space, providing a gradual entry into the cooler living and bedroom areas.

In the same way that the roof structure incorporates a layered, breathable approach, the wall assemblies are composed of numerous layers working in concert with one another. For most of the house, the outermost layer is comprised of a fine screen of acetylated wood members, providing a porous screen that shelters other surfaces from the sun while allowing for air and view to penetrate them. The wood screens are suspended over composite panels, which in turn, have an air space behind them. The SIP panels serve as the core insulative material, with then a series of panelized interior surfaces hung over air spaces on the interiors. The flooring is refinished heart-pine lumber that was salvaged from a historic home in nearby Micanopy, Florida.

The framework structure of the house is designed to accommodate a wide array of regionally-specific exterior wall systems and interior finishes. The modules that define the enclosed areas of the house can be transported as complete units or disassembled and flat-packed for shipment by container or truck. The modular design also allows components to be configured in numerous arrangements to expand or shrink the house depending on the needs of the family unit or site constraints. It is a particular variant of mass customization, deploying industrialized processes to ultimately create an exceedingly particular architecture, suited to its social, cultural, physical, and climatic context.

The multi-layered approach to the exterior enclosure and roof reduces the load on the heating, ventilating, and air conditioning (HVAC) system and enhances the ability of the house to provide cooling. But this house remains a project that consciously engages the active and adaptive occupant to ensure comfort. Screen panels can be opened or closed manually to provide different degrees of shade and/or enclosure. In addition, large door systems can be opened to facilitate cross-ventilation or enclosed as needed during heating seasons.

DESIGNING FOR EQUILIBRIUM: THE QUINLIVAN PASSIVE HOUSE

In direct contrast to loose and porous building envelope strategies, the Passive House building standard aggressively targets energy performance through the design and construction of air-tight and super-insulated envelopes, designed to eliminate or minimize thermal bridges. It differs from other rating systems in that it is centered on specific quantitative energy performance metrics. While it has only been formalized in the United States since 2007, the earliest research on these strategies dates from the 1970s. The Passive House Alliance United States (PHA-US) notes that "The Passive House standard is the most stringent building energy standard in the world: buildings that meet the standard use 80 percent less energy than conventional equivalent buildings, and provide superior air quality and comfort."[13] This claim appears to be validated by published test data from houses constructed to meet the standard.

There are three central performance criteria that must be met to achieve Passive House Certification: [14]

1. Maximum Heating or Cooling Energy: 1.4 kWh/ft2 or 4750 Btu/ft2 (15 kWh/m2) per year

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2. Maximum Total Source Energy: 11 kWh/ft2 or 38,100 Btu/ft2 (120 kWh/m2) per year. "Source Energy" includes the energy required to produce and deliver the energy to the site, and can be offset with solar thermal and other measures.
3. Maximum Air Leakage: Equivalent to 0.6 air changes per hour at 50 Pascals of pressure (ACH50), (~0.03 ACHNAT)

In addition, the following are recommendations which vary based on specific climate region:

1. Window U-value ≤ 0.14 Btu/hr-ft2-°F (0.8 W/m2/K)
2. Ventilation system with heat recovery with ≥ 75% efficiency with low electric consumption @ 0.68 W/cfm/ft3 (0.45 Wh/m3)
3. Thermal bridge free construction ≤ 0.006 Btu/hr-ft-°F (0.01 W/mK)

The Quinlivan House has been designed to meet these Passive House criteria on a site in Gainesville, Florida. As designed, the thermal envelope includes a 2x6 wood frame bearing wall, cavities filled with dense-pack fiberglass insulation, two layers of 1 ½ inch thick board insulation, and a foil radiant barrier. This provides a thermal resistance in excess of R 40 hr-ft2-°F/BTU. Within this exterior envelope, a continuous air barrier is being provided with a layer of oriented strand board, where all seams and joints are taped to avoid air exfiltration/infiltration. Special attention is required at the foundation, at door and window openings, and at the juncture with the roof to avoid thermal bridges.

Because of the site's location in a warm, humid climate, the vapor barrier is pushed outward in the wall assembly to prevent the migration of moisture-laden air into the wall assembly and/or into the conditioned space of the structure. This helps avoid condensation within the wall cavity.

Figure 4: Quinlivan Passive House. View from northeast looking towards main living/dining/kitchen volume, with guest bedroom and car parking to far right of image. Image: Bradley Walters and Jessica Pace / University of Florida.

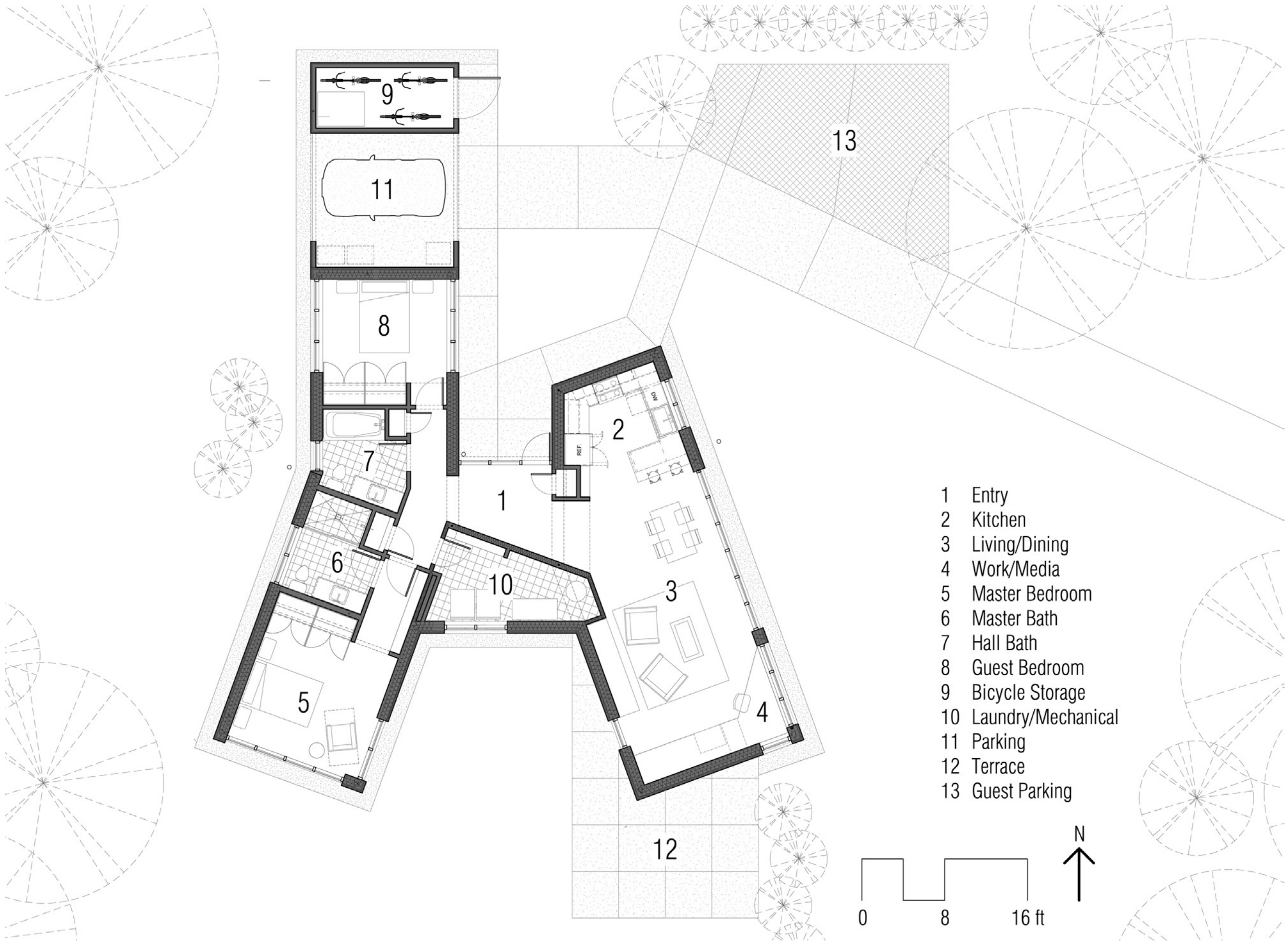

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Figure 5: Quinlivan Passive House Floor Plan, Gainesville, Florida. Image: Bradley Walters and Jessica Pace / University of Florida.

The walls and roofs incorporate a ventilated airspace, lined on one side by a foil-faced radiant barrier. In this manner, the passive house project recalls some of the lessons learned through the earlier work on Project Re:Focus.

CONCLUSIONS

In our heavily mediated and increasingly mobile world, there are few places today where design is determined strictly by vernacular traditions or even where these kinds of traditions are legible. More often, we find the architectural discourse to be one of cross-pollination, as we import ideas and materials from one place to another. As the strictures of narrowly-defined building traditions have given way to global practices, it becomes increasingly difficult to find resonance between a place and its many architectures. This shift has allowed us to create exceedingly refined artistic traditions and ideologies within our discourse, liberating and advancing architecture from isolated silos of craft- or tradition-based building knowledge. In the academy, we relish the freedom to test and develop design proposals that investigate a diverse and wide-ranging set of motivators and metaphors. This is, in many ways, a cause for celebration.

But we must also recognize that it limits the ability of our architectures to be responsive to the particularities of climate and place. To the extent that we can both incorporate deep local knowledge and lateral discipline-based investigations, we may have an opportunity to draw on the strengths of both approaches.

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ENDNOTES

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