

Skin Deep? Building Envelopes + Spaces

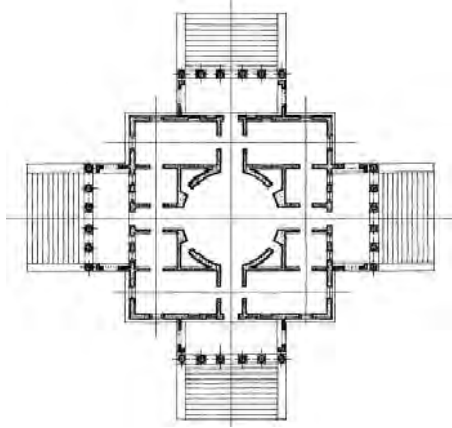
Sustainable architectural design approaches at multiple scales

by **Matt Fajkus**, AIA, LEED AP, Assistant Professor of Architecture, The University of Texas at Austin



The Classical House

Villa Rotunda, Palladio



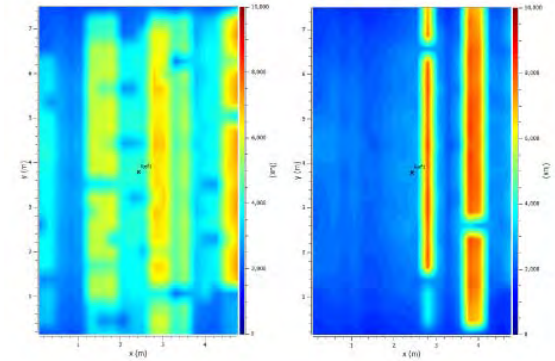
The Modern House

Villa Savoye, Le Corbusier



The Future House?

MF Studies



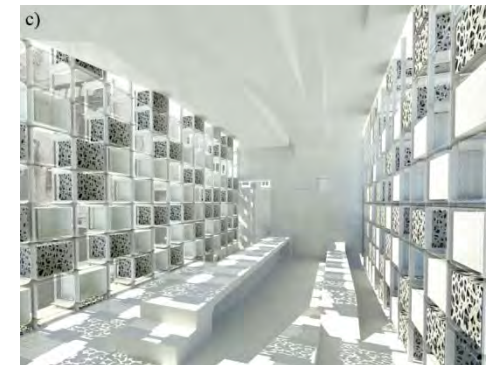
Form > Function

Symmetry as Standard



Function > Form

Asymmetry as Standard



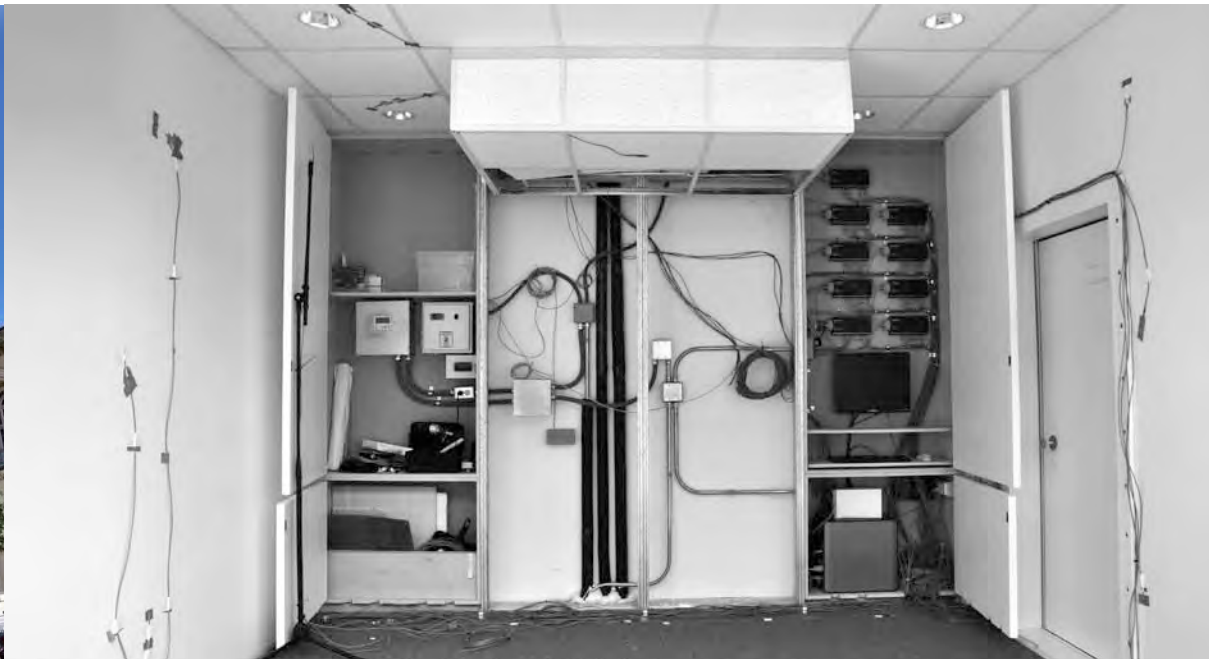
Light/Energy > Function > Form

No Universal Formal Standard

Integral Daylight/Thermal Testing

The University of Texas at Austin Facade Thermal Lab

- Collaboration Point Between Architects and Engineers: Daylight Design
 - Students and Professionals
 - Testing of Innovative Facade Components and Systems for Daylight and Thermal Optimisation

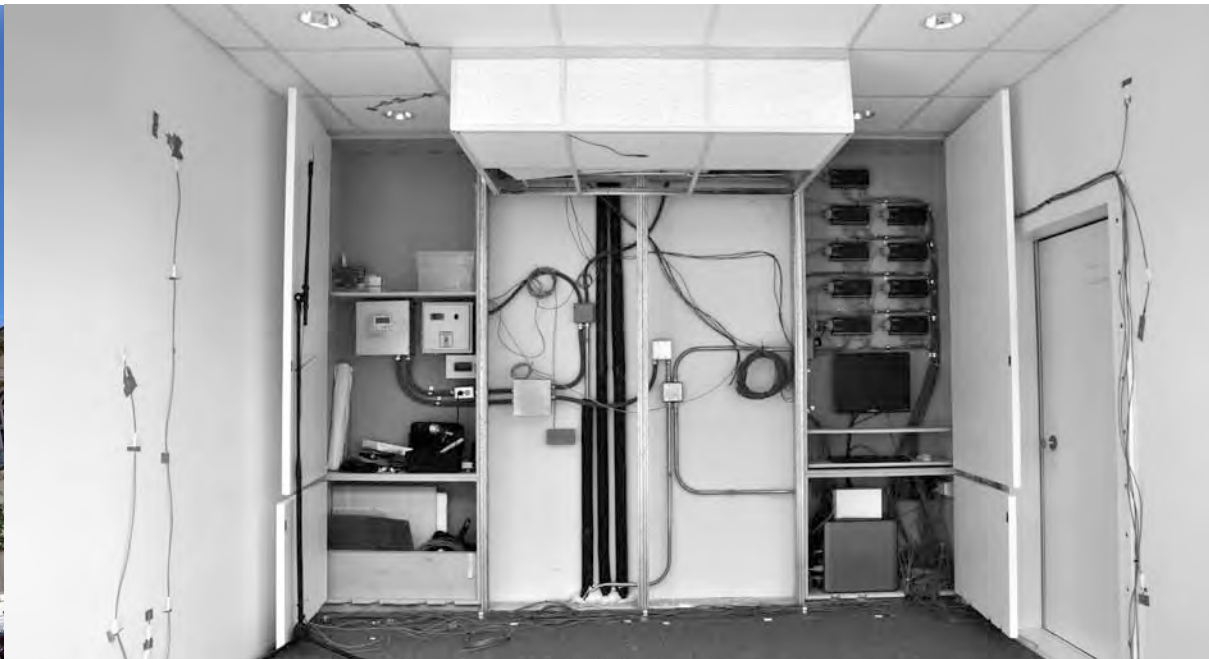


Director of Thermal Facade Lab: Matt Fajkus

Integral Daylight/Thermal Testing

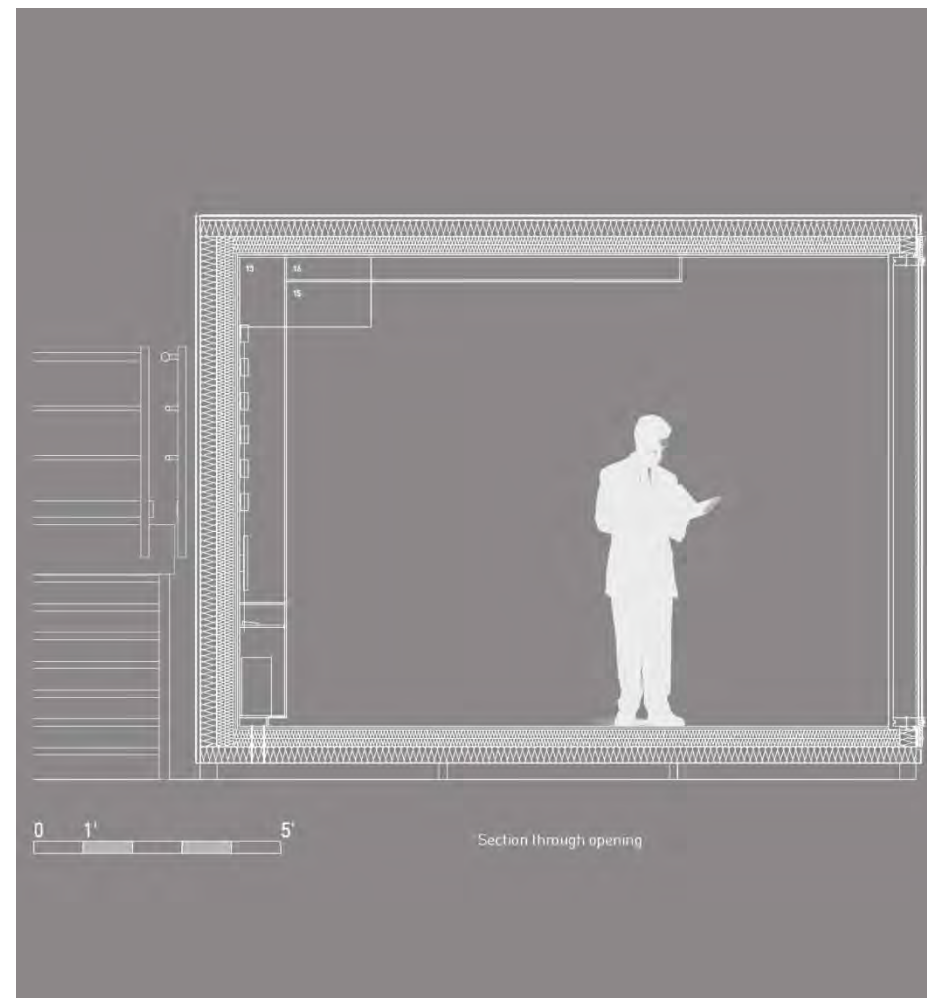
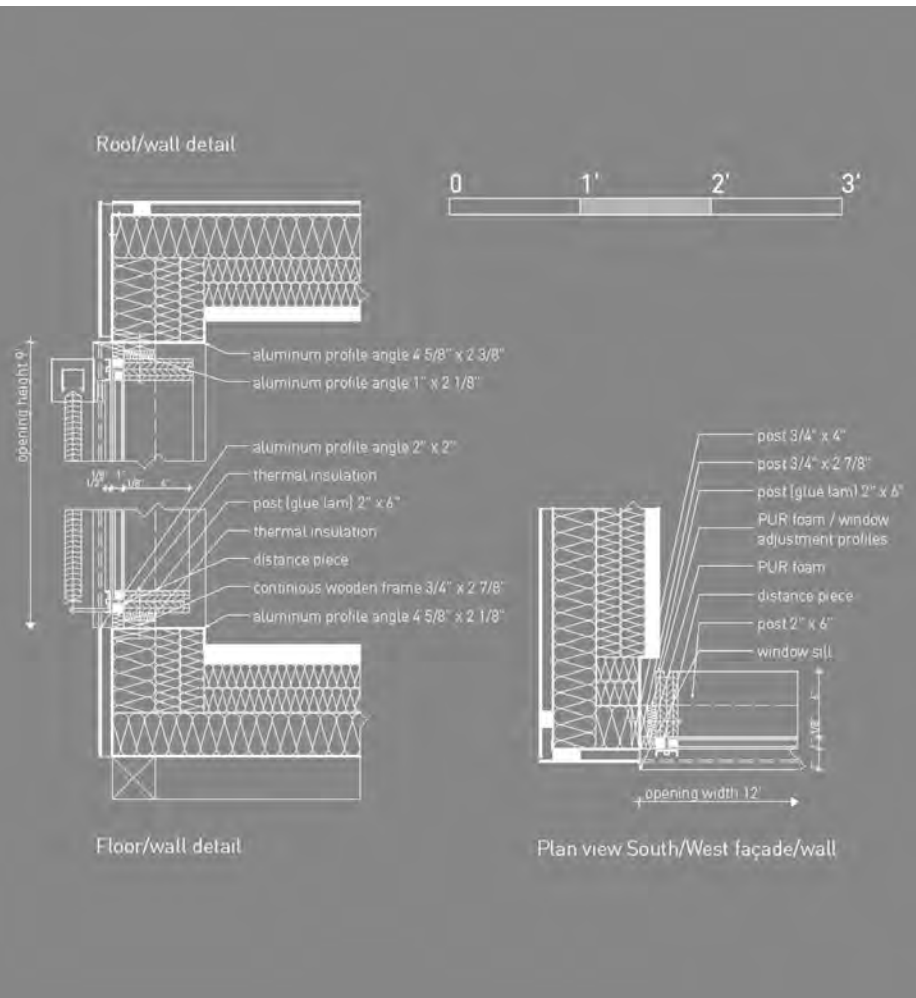
The University of Texas at Austin Facade Thermal Lab

- Pairing Quantitative and Qualitative Results
 - Full-Scale Testing Facility on UT Campus
 - Iterative Loop Created Between Virtual and Physical Daylighting Design Process



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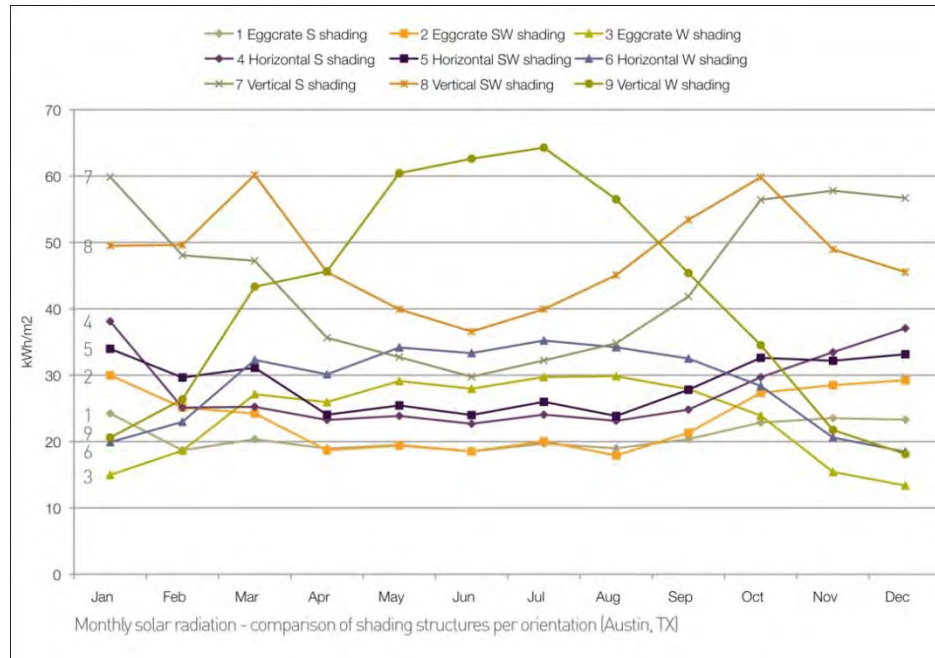
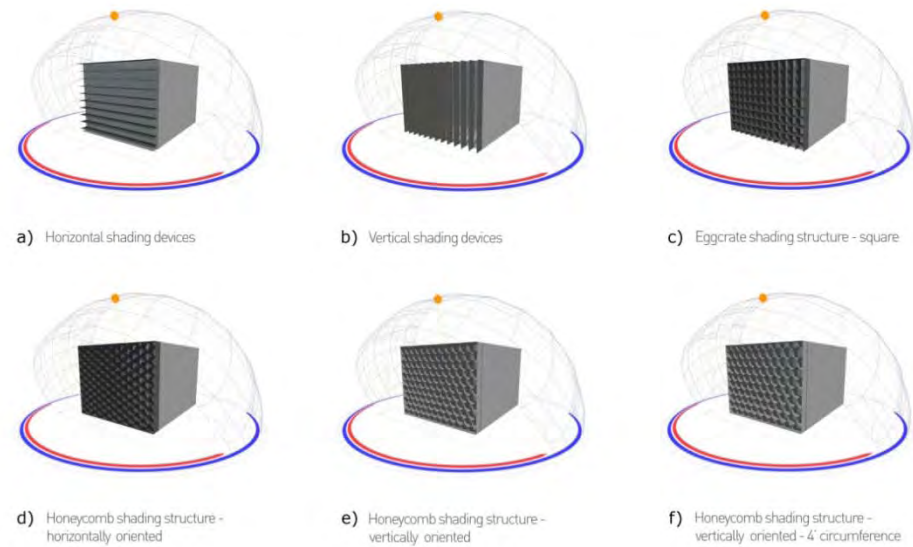


Shading Structure Research

Benchmark Analysis

- Matrix of Typical Shading Devices

- Relative Performance Evaluation
- Groundwork for Proposal

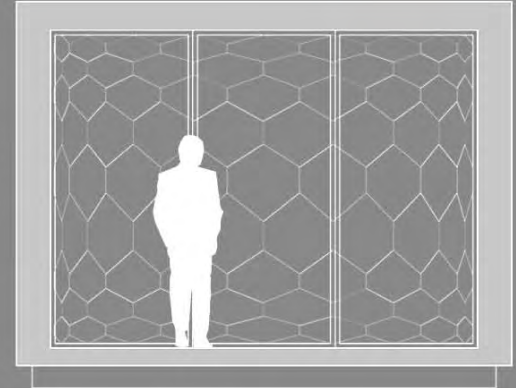
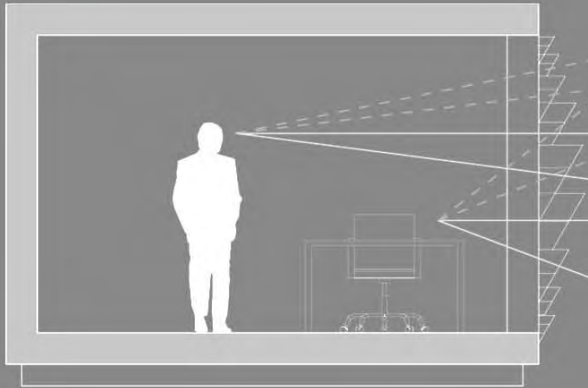
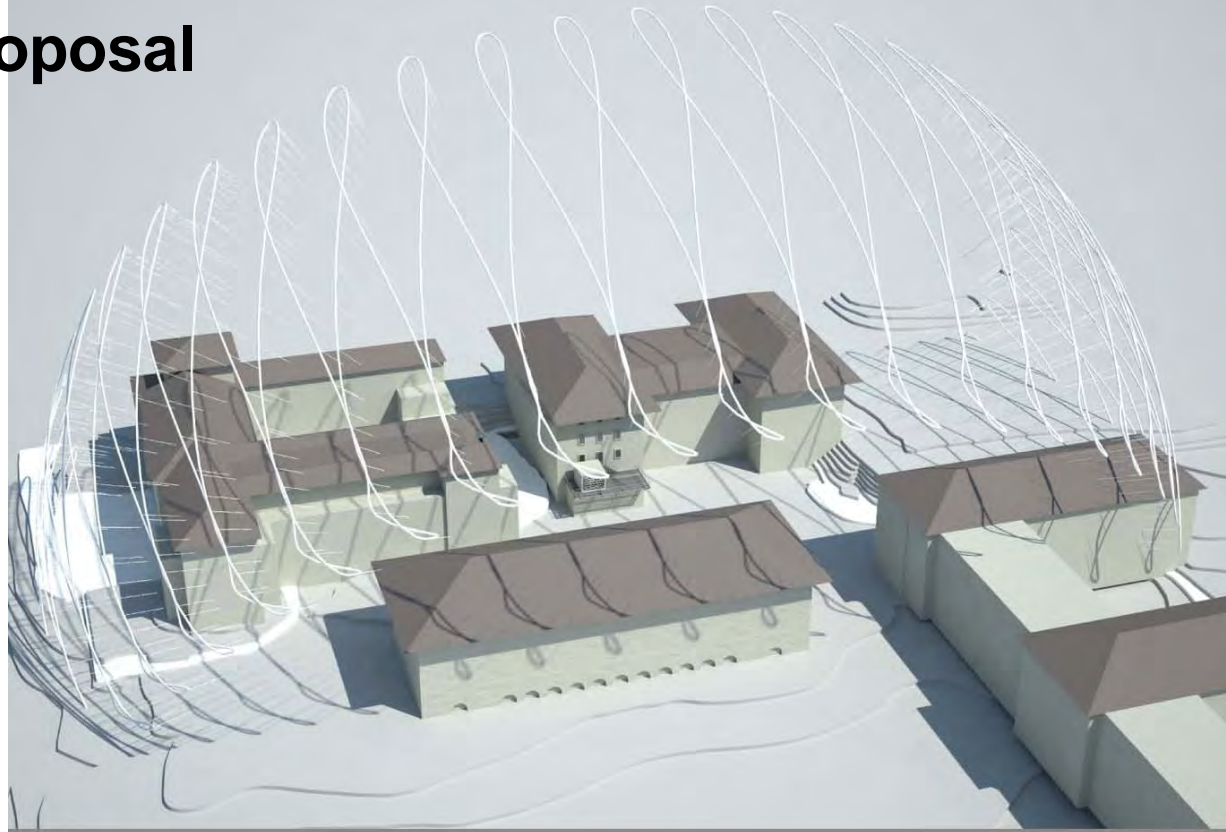


Director of Thermal Facade Lab: Matt Fajkus
Student Research and Proposal: Stefan Bader

Shading Structure Proposal

Informed Design Process

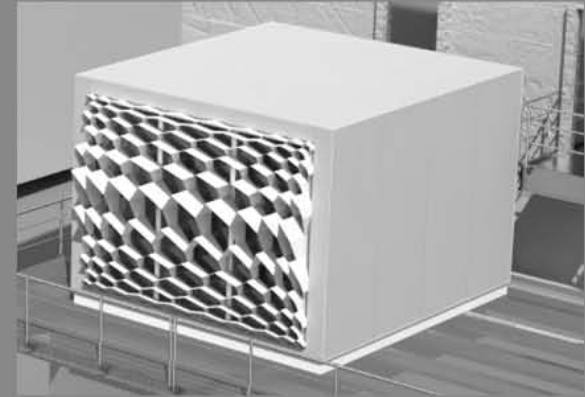
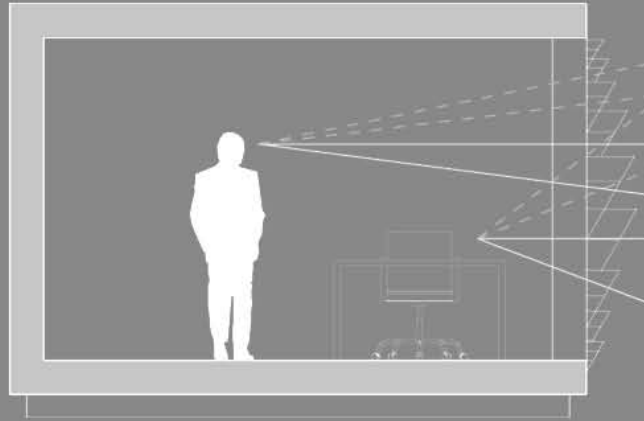
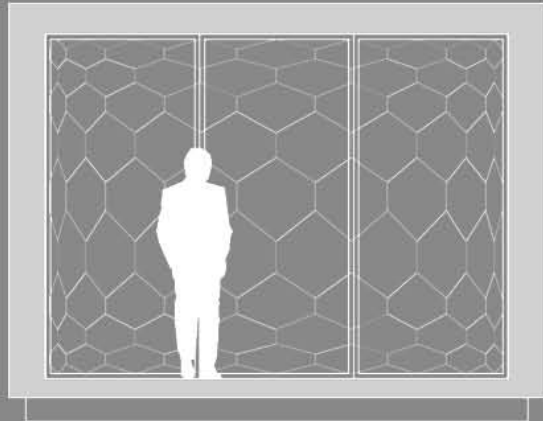
- Optimized Honeycomb Variant Form
 - Loosely Mimics the Daily Movement of the Sun



Shading Structure Proposal

Informed Design Process: Balancing Daylight

- Optimized Honeycomb Variant Form
 - Loosely Mimics the Daily Movement of the Sun
 - Structural Efficiency Via Triangulation
 - Stackable Module (Efficient Material Usage)



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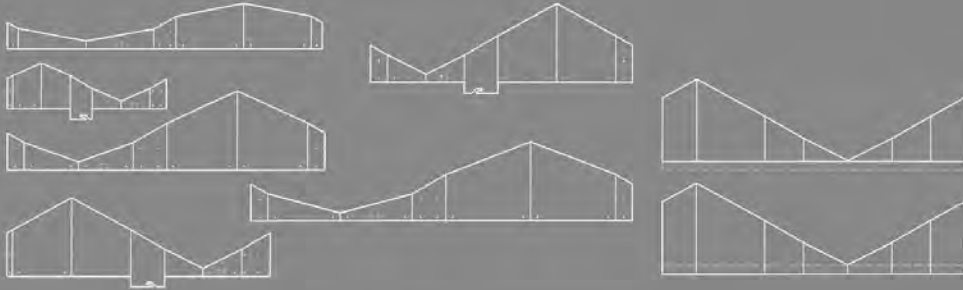
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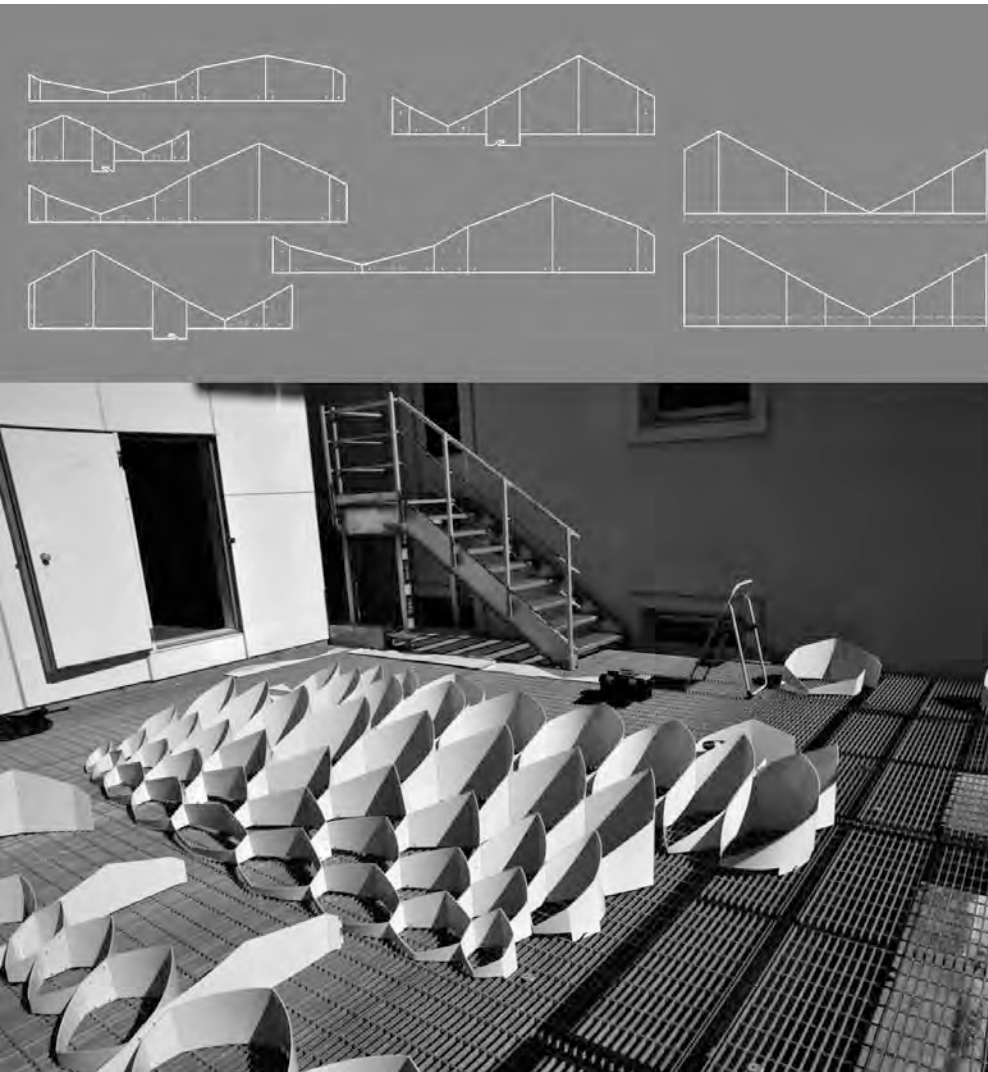
Shading Structure Proposal

Mock-Up Fabrication Process



Shading Structure Proposal

Mock-Up Fabrication Process + Installation



Shading Structure Proposal

Physical Performance Analysis

- Granulated Daylight Measurements
- Variable vs. Control Comparison
- Climatic Variance Consideration

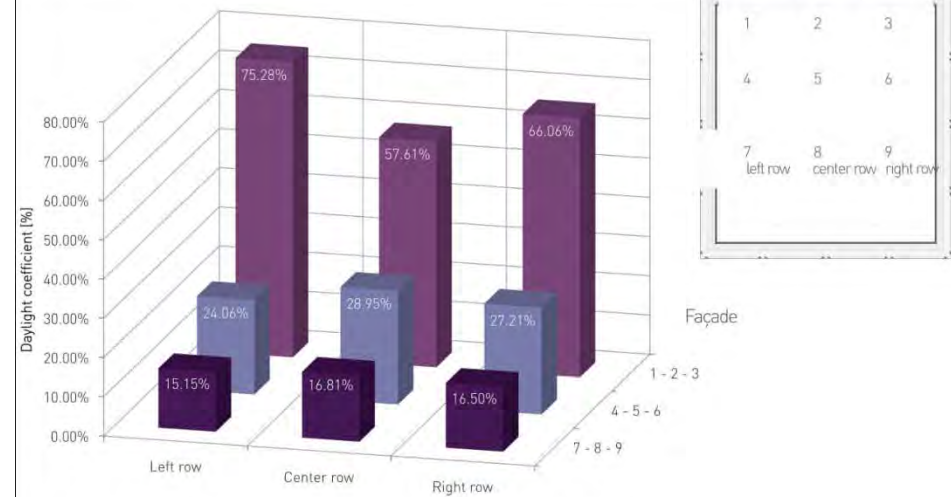


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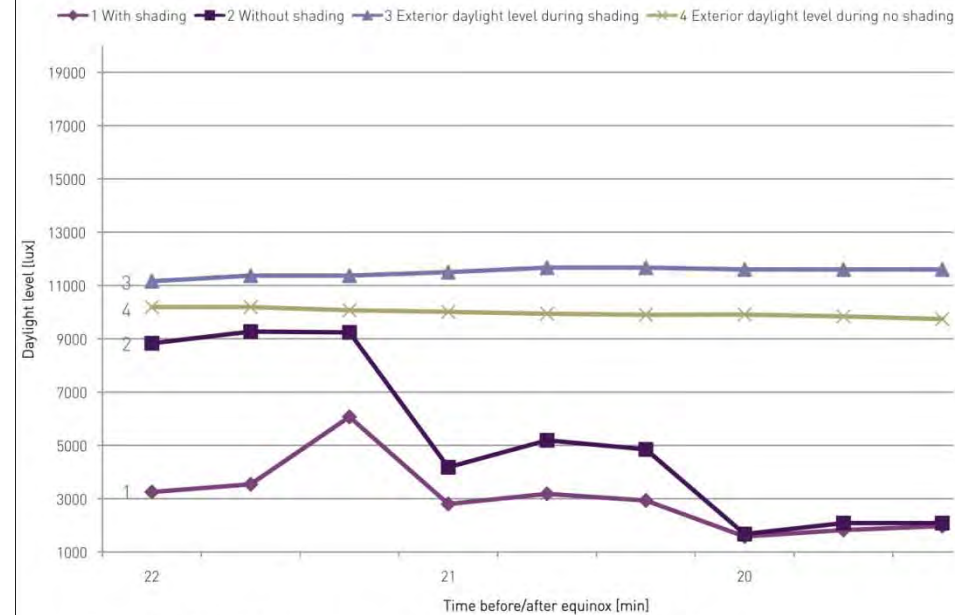
Shading Structure Proposal

Physical Performance Analysis

- Granulated Daylight Measurements
- Variable vs. Control Comparison
- Climatic Variance Consideration



Distribution of daylight coefficients in the Thermal Lab with shading - test 02

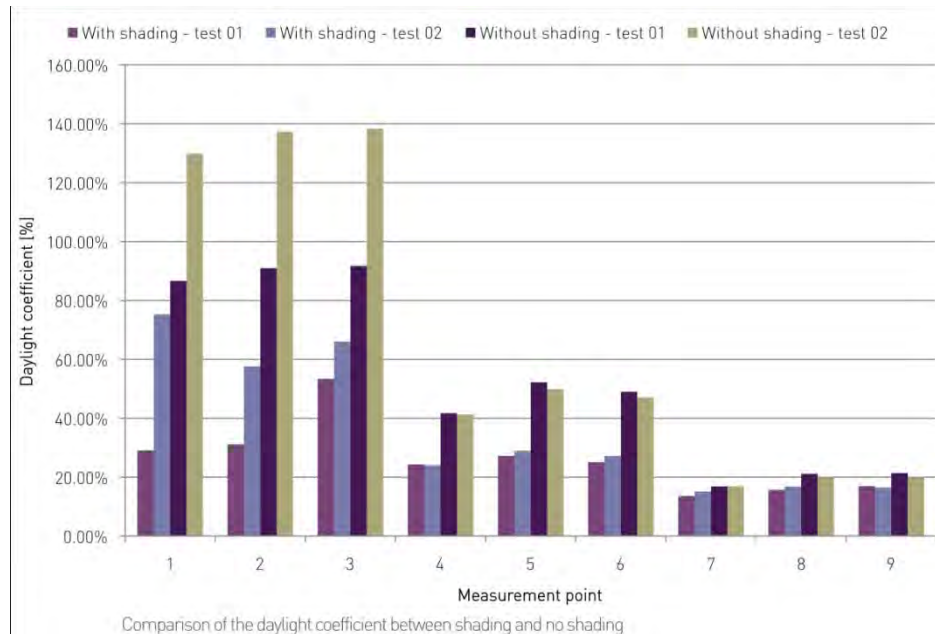
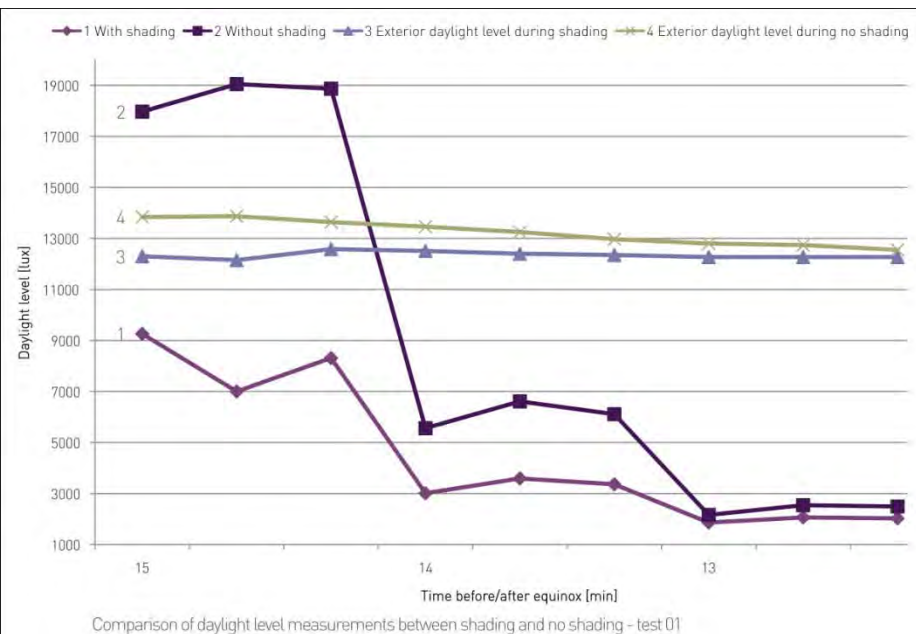


Comparison of daylight level measurements between shading and no shading - test 01

Shading Structure Proposal

Physical Performance Analysis

- Comparative Result Analysis For Optimized Honeycomb Variant Structure
 - Similar Daylight and Thermal Performance as Shading Structure Precedents
 - Provides More Views Than Shading Structure Precedents
 - Uses Less Material Than Shading Structure Precedents







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universal framing system
varying frame sections create
an internal domestic topography

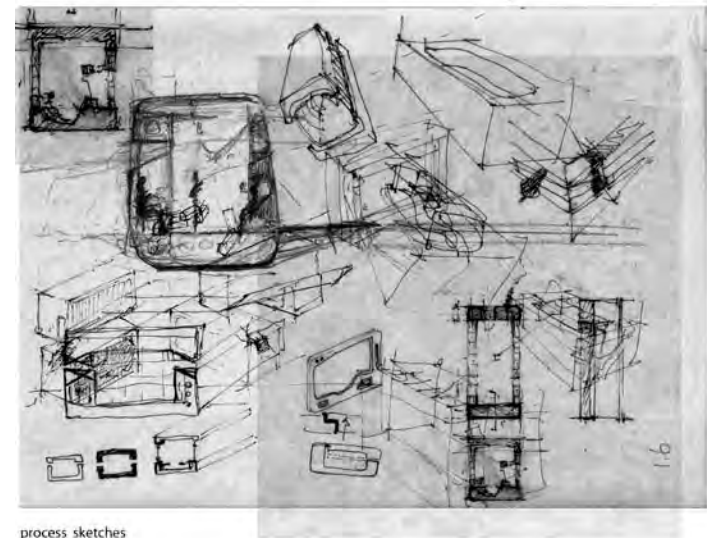
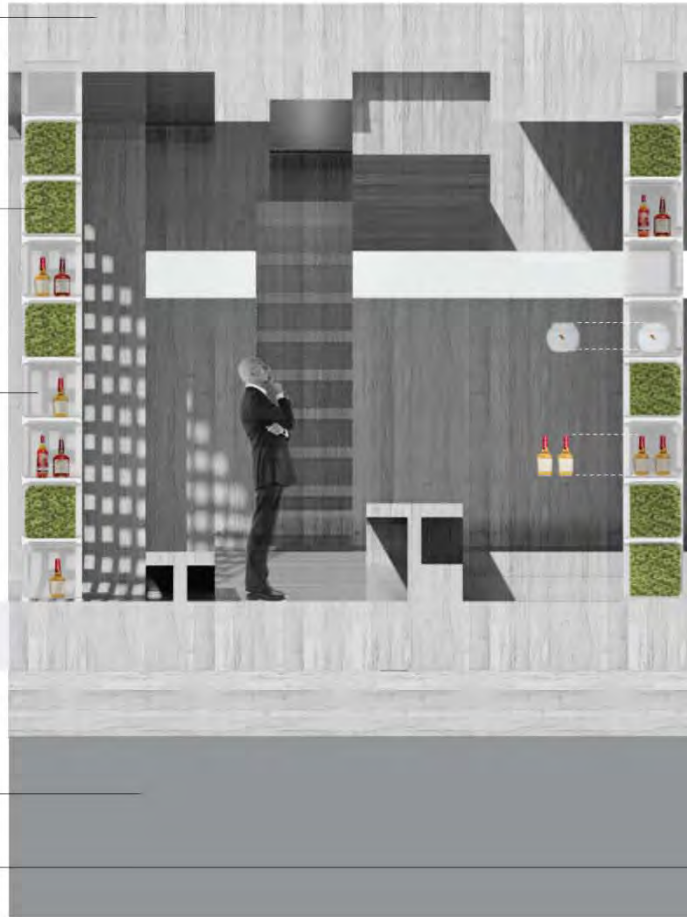
"plug-in" modules type 1
regional materials:
sustainable sourcing providing
regional character
diffuse daylight and thermal management

"plug-in" modules type 2
personal objects:
collection display to provide
individual character.
direct daylight and view management

interlocking deck

water

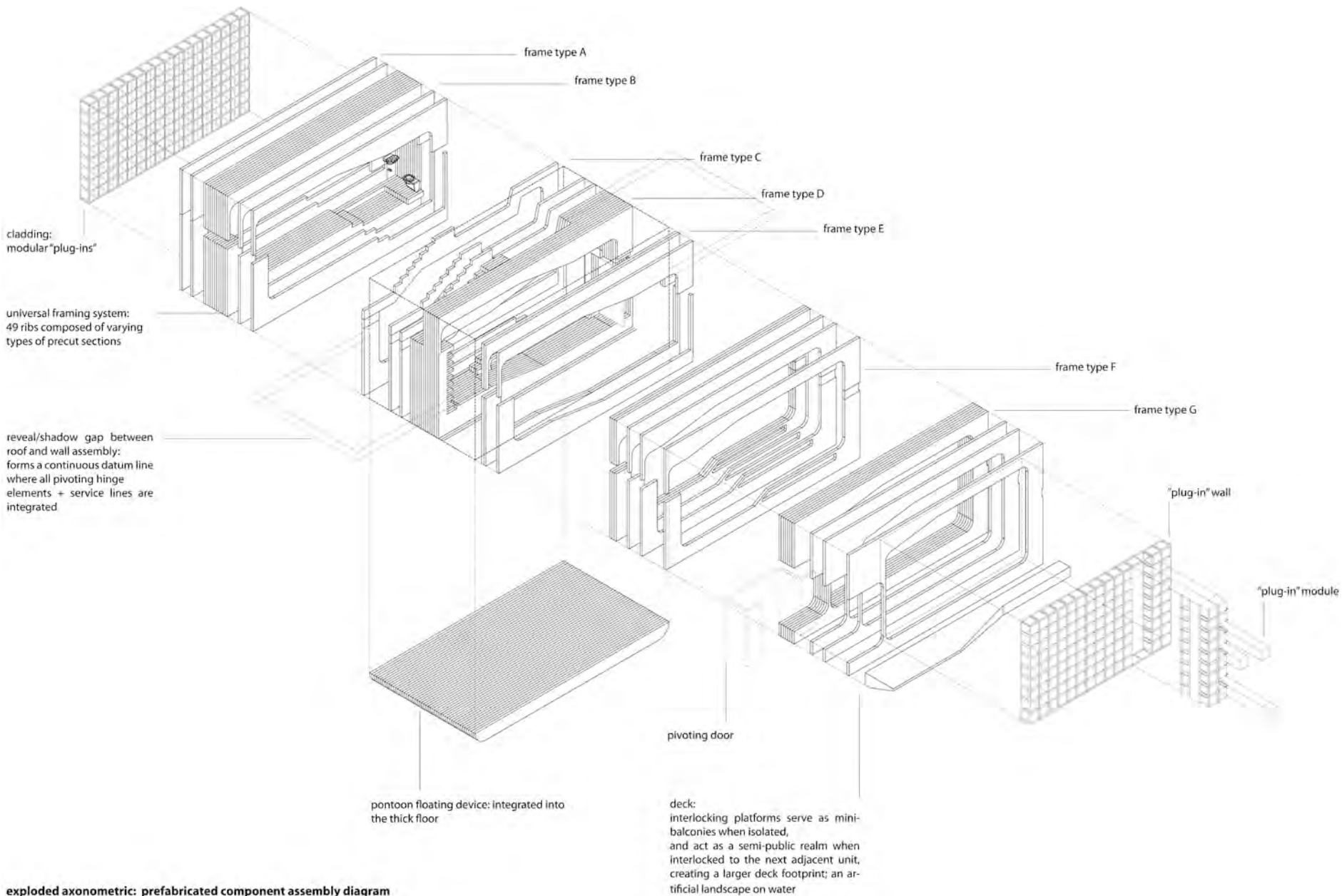
contextualism:
interchangeable
block-cell units



process sketches



section diagram: "plug-in" module system





universal framing system
varying frame sections create
an internal domestic topography

"plug-in" modules type 1
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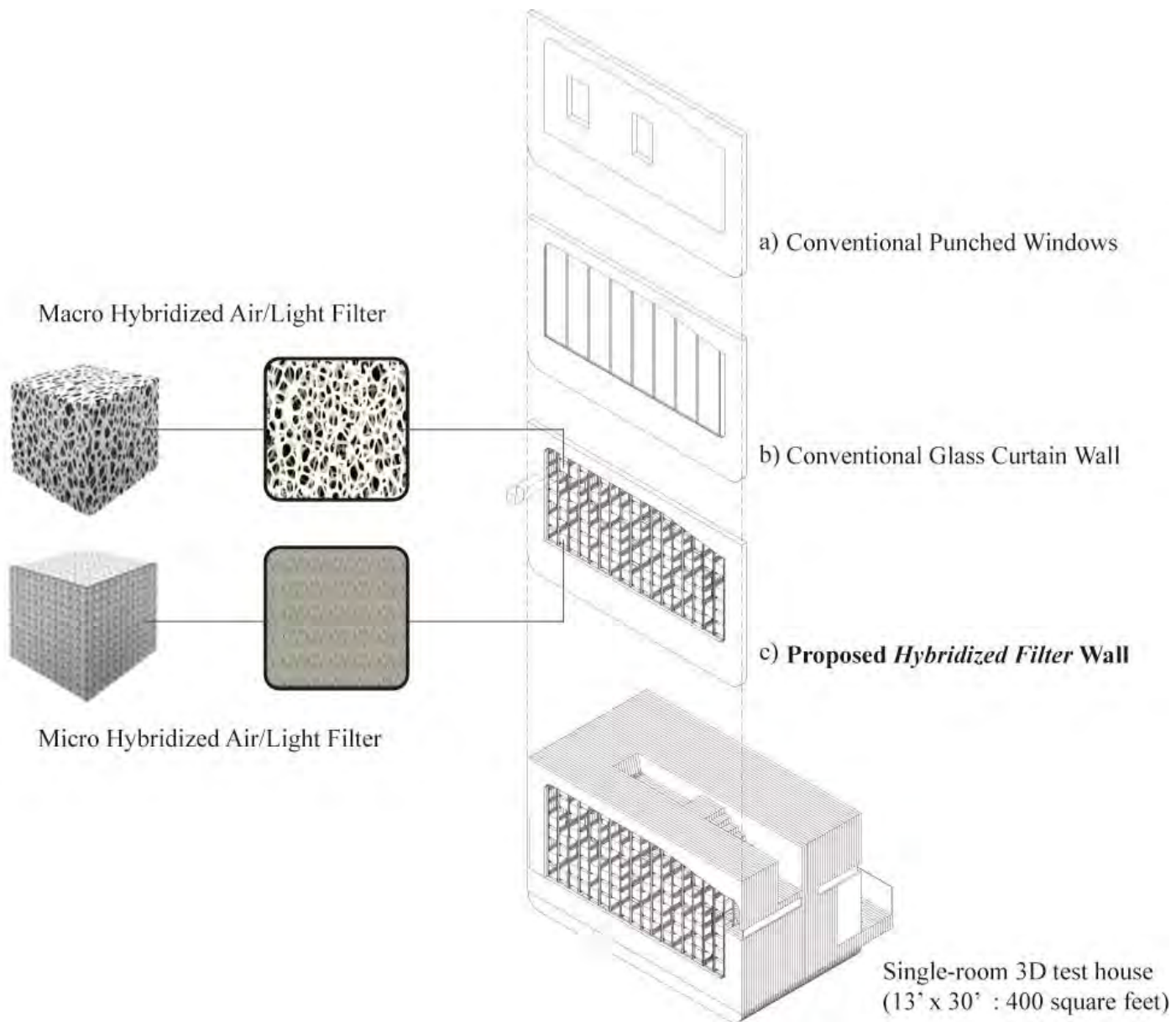
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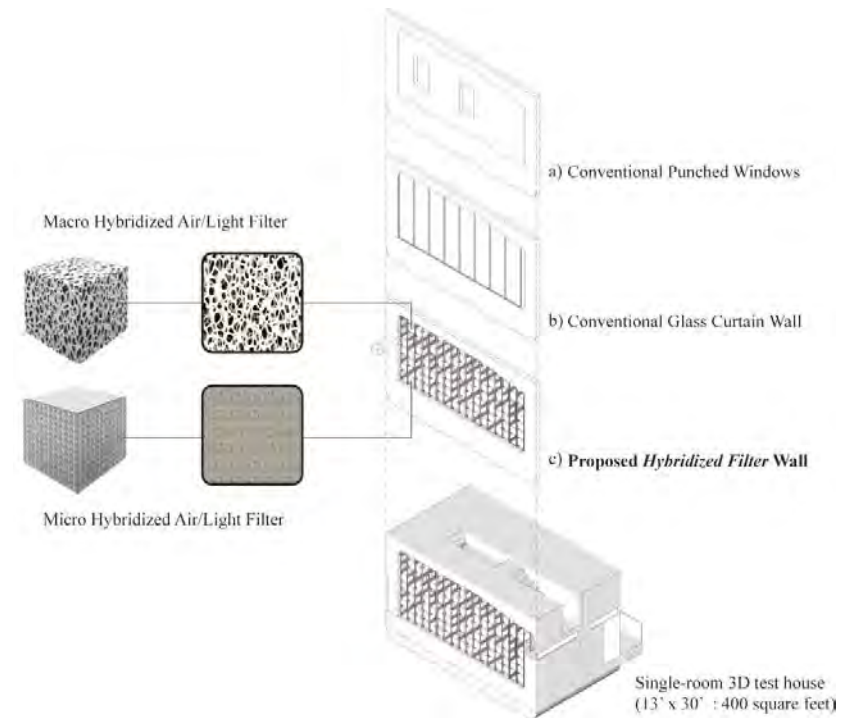
section diagram: "plug-in" module system



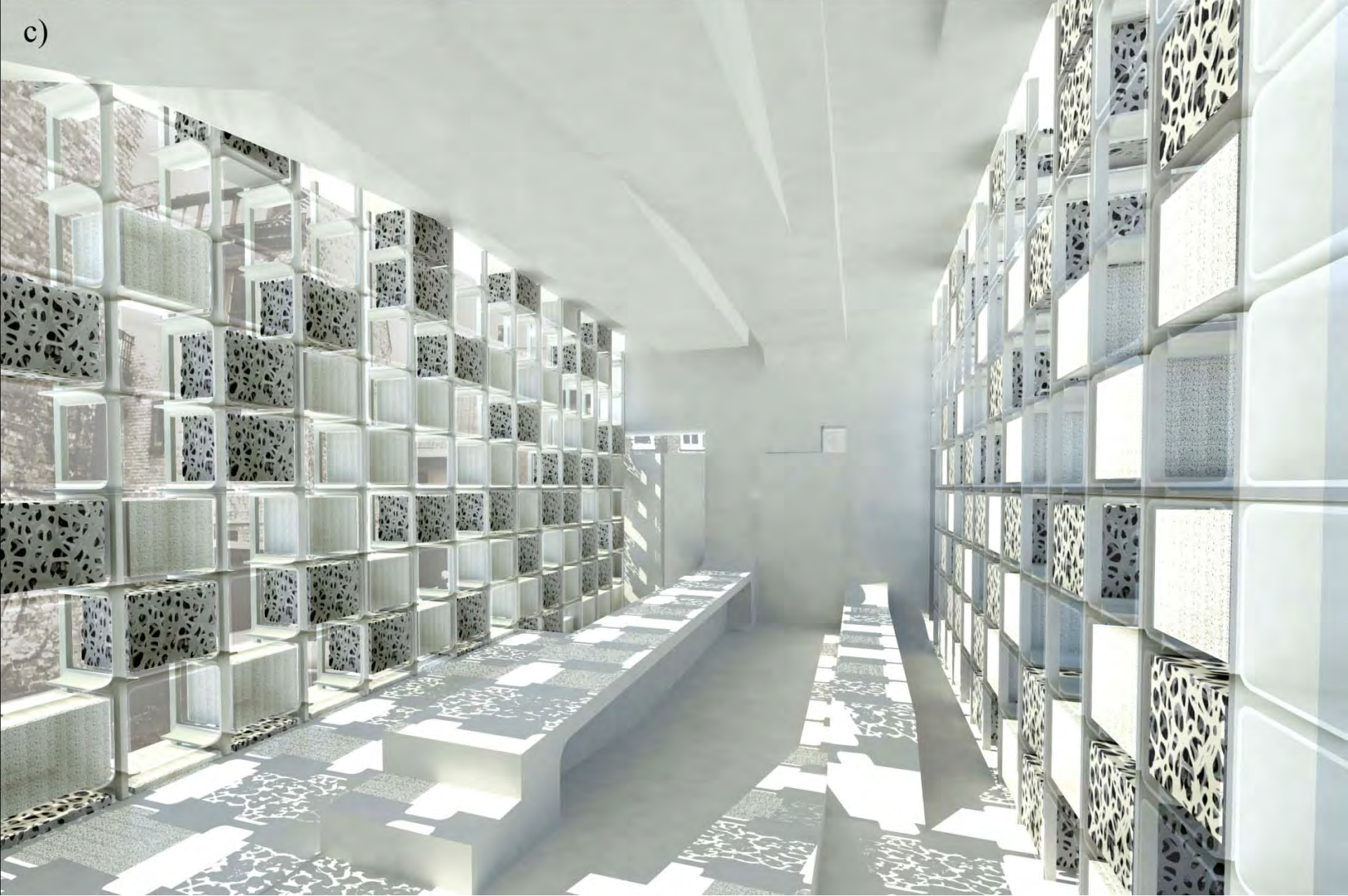


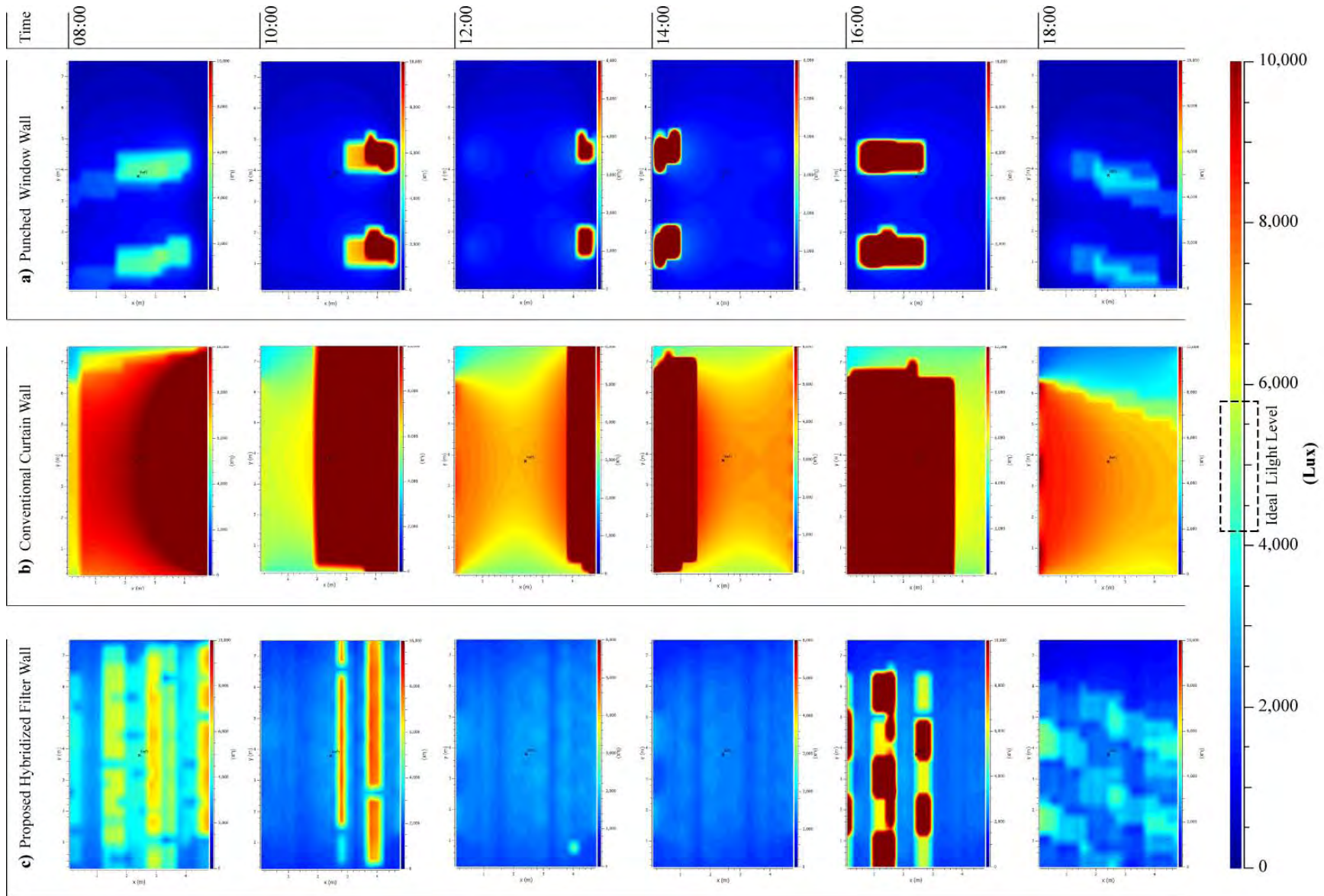
interior view 01: view from entrance: plug-in modular walls manage daylight and structural frames suggest functional zones





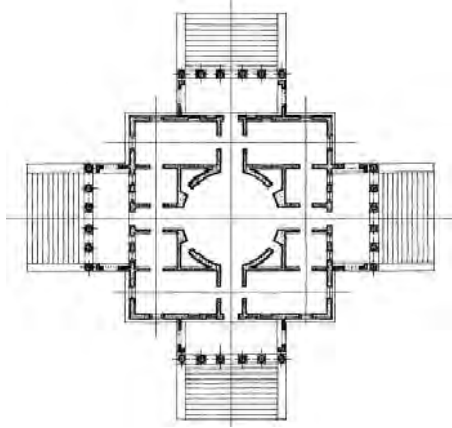
c)





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Villa Rotunda, Palladio



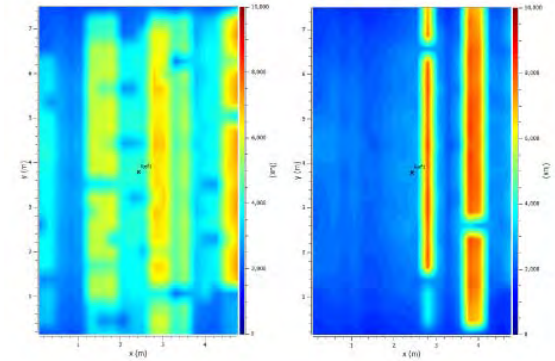
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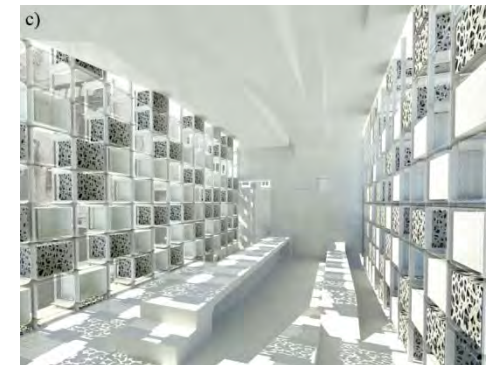
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Symmetry as Standard



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Asymmetry as Standard



Light/Energy > Function > Form

No Universal Formal Standard



interior view 02: view to entrance: plug-in modular walls manage daylight and structural frames suggest functional zones



interior view 01: view from entrance: plug-in modular walls manage daylight and structural frames suggest functional zones

Can one designer make a difference in large-scale sustainability?

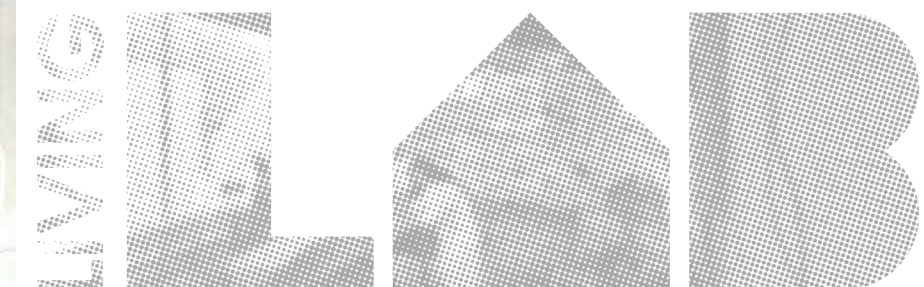
“Consumption is a matter of needs and needs depend on design. Your need for gas depends on the design of your car, and your need for a car in turn depends on how the city you live in is designed. So, if you can change the design of your city, you can change your needs, and in the end your consumption.”

-Stephan Behling

(Foster + Partners)

Can one designer make a difference in large-scale sustainability?





PIKE POWERS *single-family housing* category size **2530 sf**
LIVING LABORATORY *may 2011 completion* location **austin, texas**

PIKE POWERS LIVING LABORATORY

DESIGN TEAM: MATT FAJKUS, AIA, ULI DANGEL, TAMIE GLASS + [AUDREY MCKEE]



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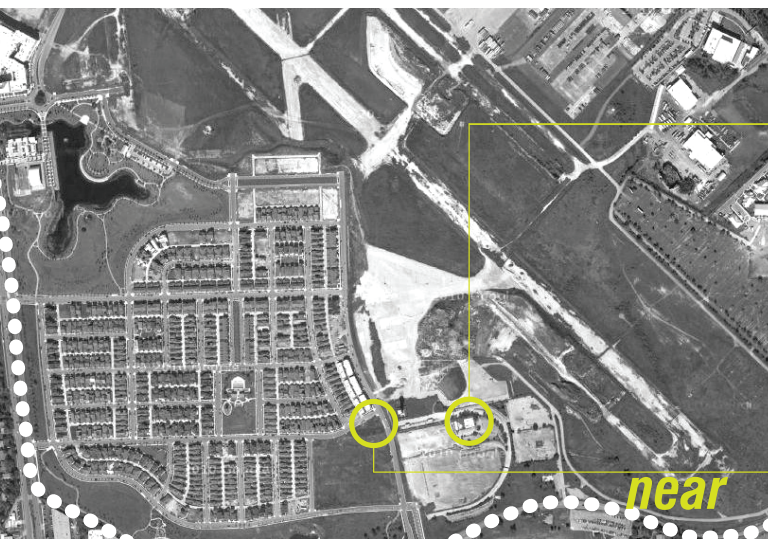


mueller development :
repurposed airport site

university of texas

downtown austin

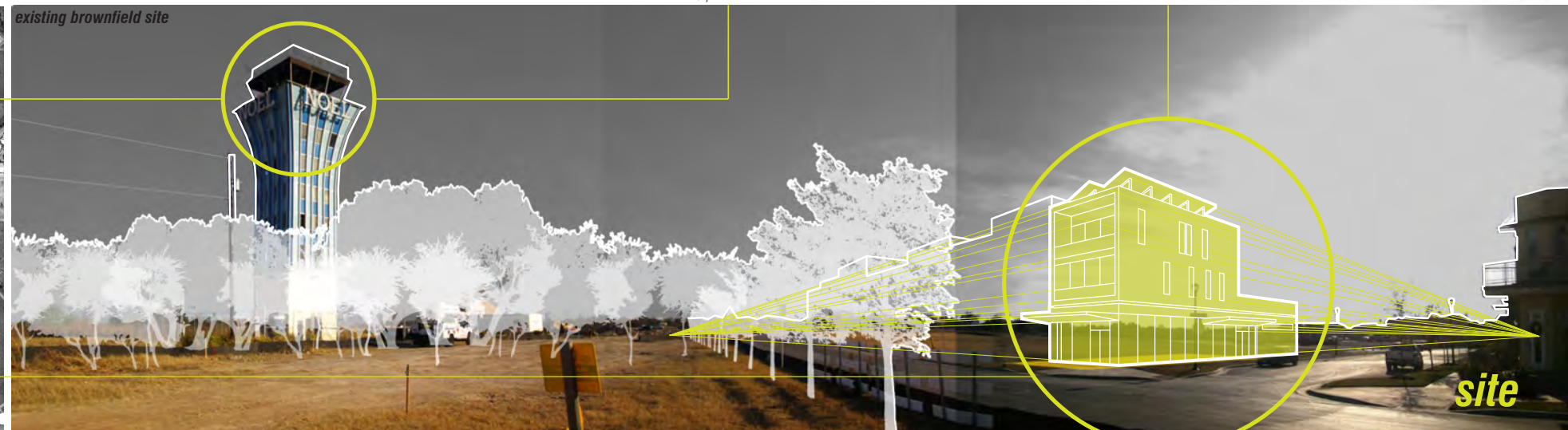
far



existing brownfield site

living lab lot

near



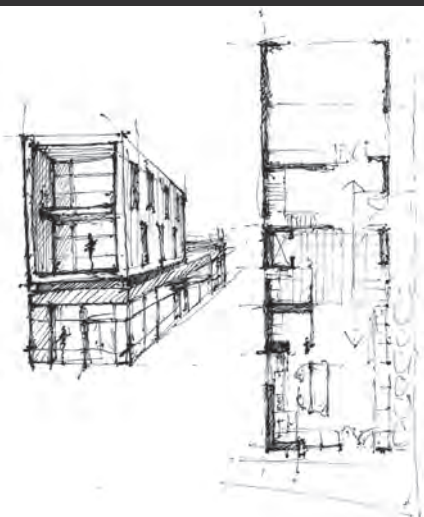
CONTEXT far near

The Pecan Street Living Lab exists as part of the *Pecan Street Project Energy Internet Demonstration* endeavor and will be located at the **Mueller Development in Austin, Texas**. This brownfield site has origins and remains from the decommissioned airport and is being reclaimed as a sustainable live/work community. Minutes away from downtown Austin and the University of Texas, this site offers a unique opportunity to combine dense urban living with vast green spaces around the former airport control tower. This site takes advantage of existing and planned mass transit routes as well as nearby cultural amenities.

The **prototypical Living Lab** will sit within this context as a two-volume structure. The primary laboratory testing room will be located on the lowest level to be separate from the domestic living lab zone on the two upper levels. These Live/Lab zones will not only interact and influence one another, they will **interact with the larger context** by teaching and promoting research through activated street level facades and as demonstration spaces for other homes in the community.

mueller control tower :
decommissioned from former airport

live
live
live



site

PIKE POWERS LIVING LABORATORY

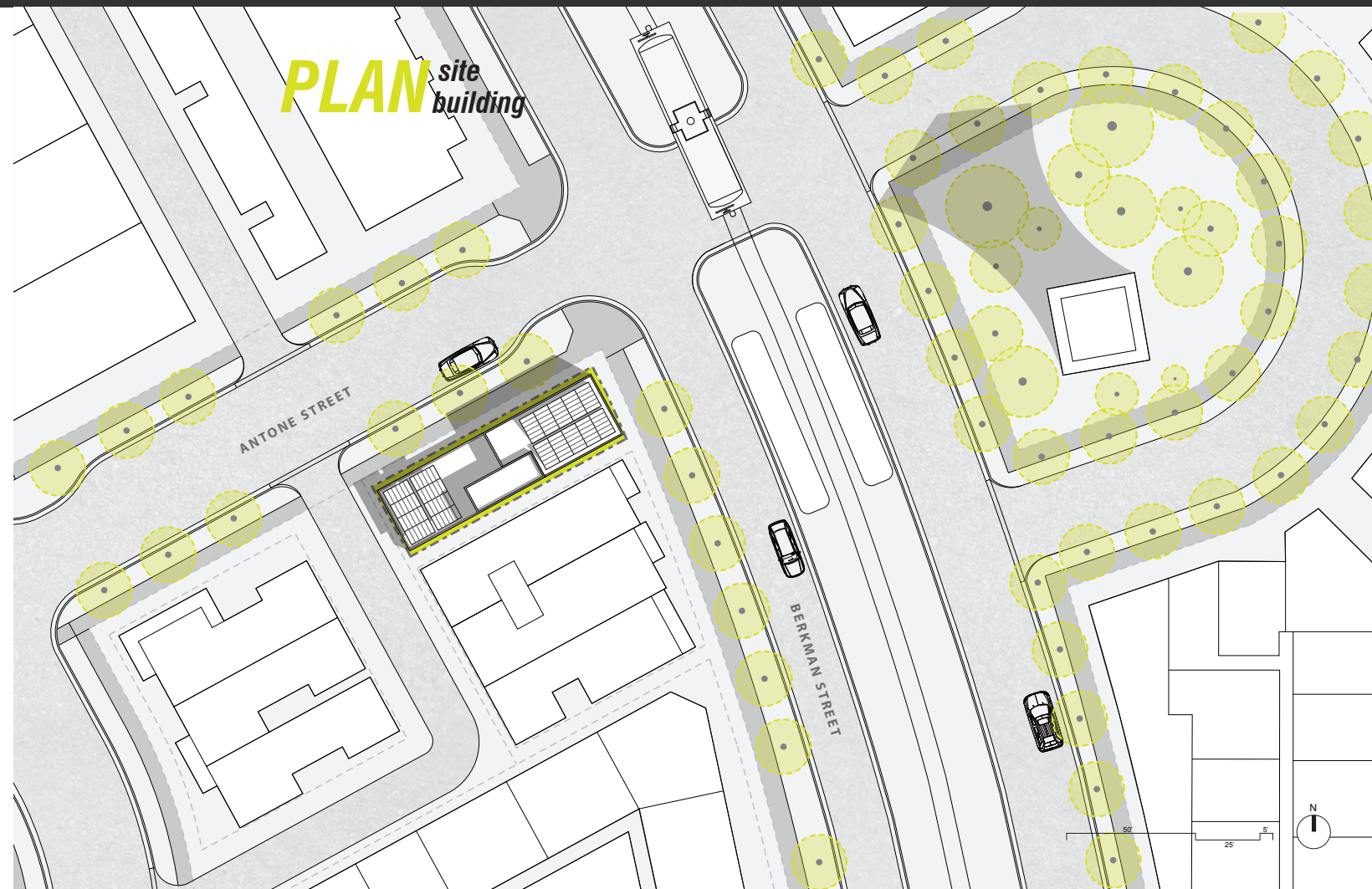
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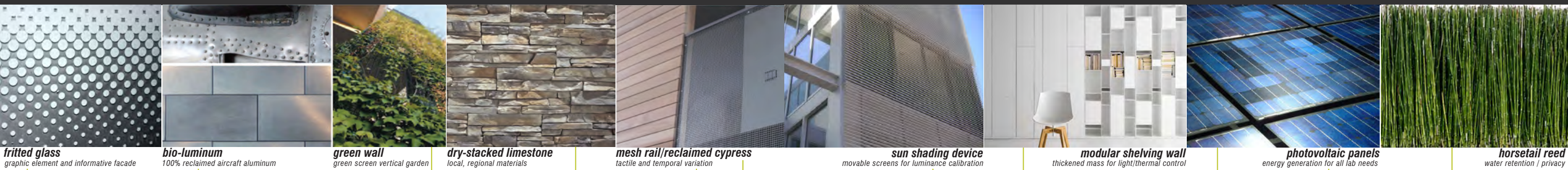
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EXPERIENCE material
spatial

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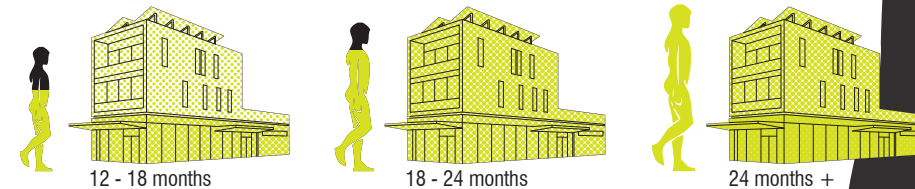
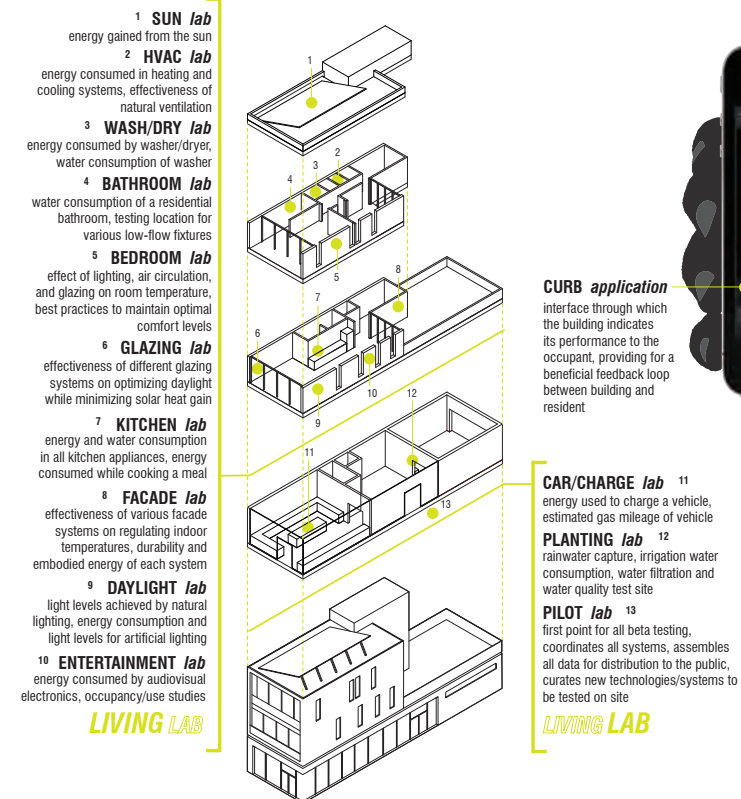
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if these walls could talk ...

smart building > smart occupant > smarter building > smarter occupant

Three entities will participate in a mutually beneficial feedback loop. In the beginning, the lab component contains knowledge of sustainable technologies. Over time, the 'labs' within the home will reveal data about real-time energy and water consumption, which will in turn educate the user about how to live more responsibly in the home. Once the user better understands the home, the lab will also benefit from this knowledge, which provides it the opportunity to offer further suggestions for improving the home, which then educates the user further. All three entities engage in a virtuous cyclical dialogue.



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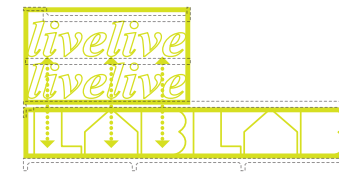


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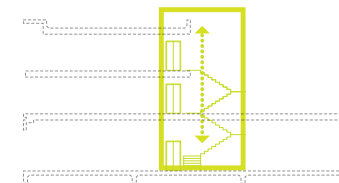
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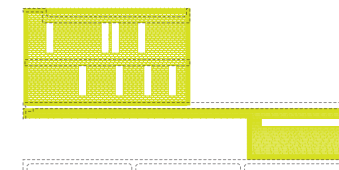
ACTIVE *didactic presence*



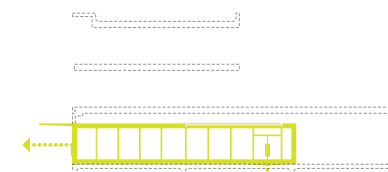
BLUR *living / lab*



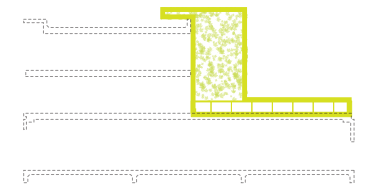
ASCEND *elevator / stair*



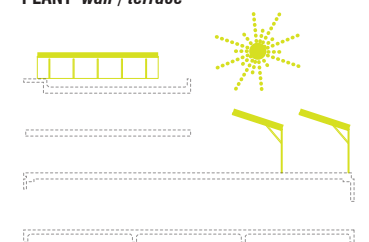
CLAD *local / recycled*



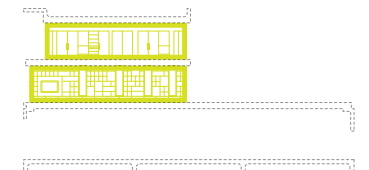
INVITE *entry / exposure*



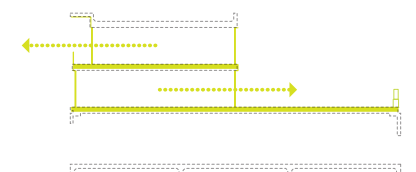
PLANT *wall / terrace*



HARVEST *solar / power*



STORE *modular / shelving*



VIEW *balcony / terrace*

performance-enhancing formal moves ... **STRATEGIES**

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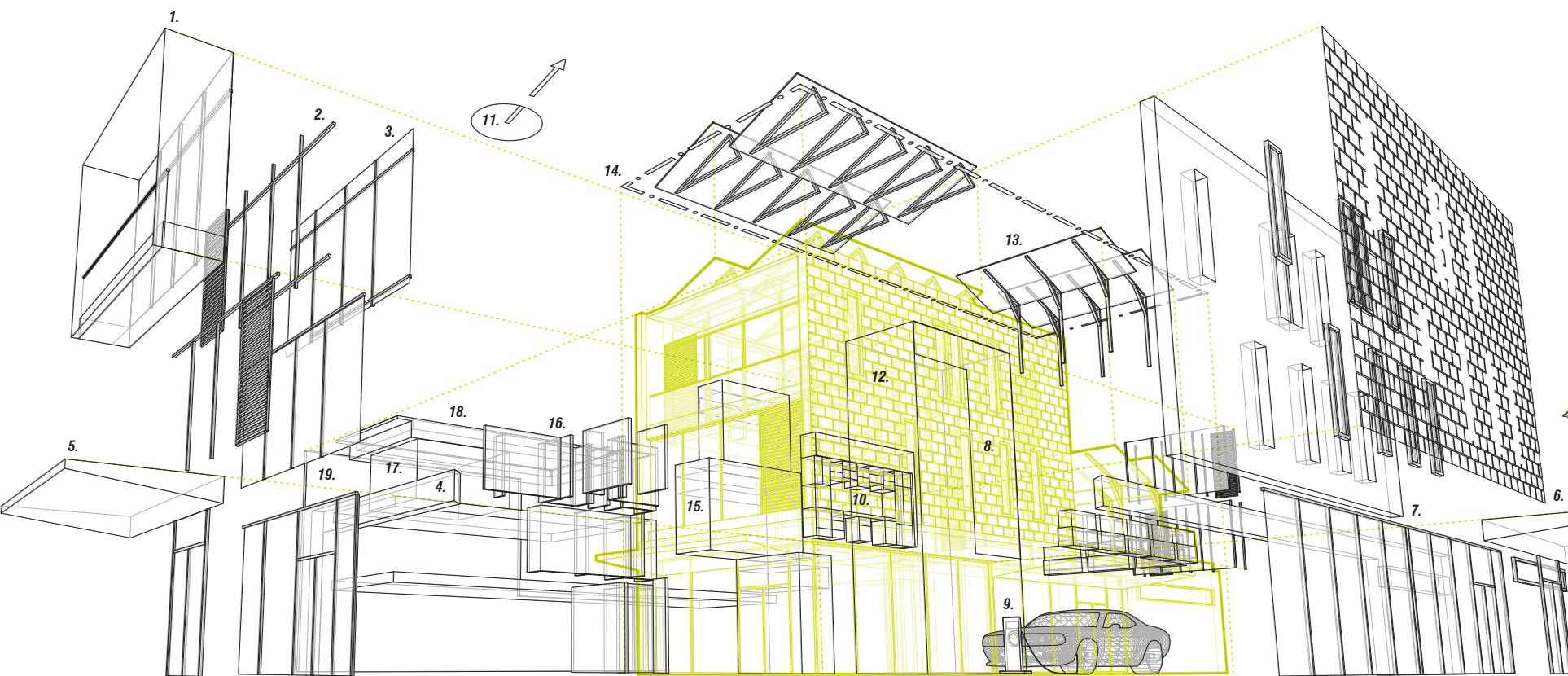
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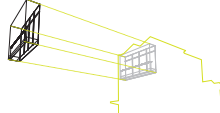
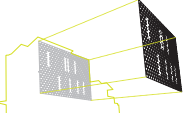
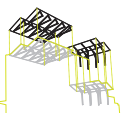
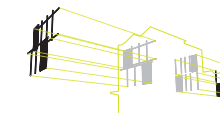

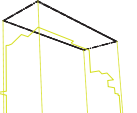



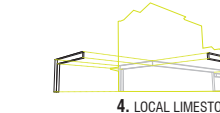
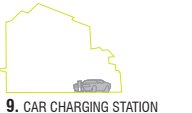




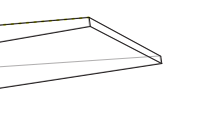



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PERFORMANCE *building human*

Active and passive sustainable systems. This building is far more than just a series of technological interventions. It is instead a collection of existing systems and technologies that provides the framework within which feedback loops may occur. Once this infrastructure is laid in place, the user may engage and learn about these systems as he fine-tunes his lifestyle, and ultimately, the building's performance...



a collection of LIVING LAB's sustainable component parts ... **CATALOG**

- | | | |
|---|---|---|
|  |  |  |
| 1. WINDOW OVERHANGS | 6. BIO-LUMINUM FACADE | 13. PHOTOVOLTAIC ARRAY |
|  |  |  |
| 2. PASSIVE VENTILATION | 7. OPTIMIZED WINDOW SIZE/ LOCATION | 14. NO LOT LINES |
|  |  |  |
| 3. LOW EMITTANCE GLAZING | 8. XERISCAPED ROOF TERRACE | 15. DUCTLESS HVAC |
|  |  |  |
| 4. LOCAL LIMESTONE | 9. CAR CHARGING STATION | 16. RECYCLED INDOOR MATERIALS |
|  |  |  |
| 5. INVITING COMMUNITY | 10. MODULAR KITCHEN | 17. FLEXIBLE BEDROOM/ CLASSROOM |
|  |  |  |
| 11. OPTIMIZED SITE ORIENTATION | 18. OPTIMIZED FLOOR THICKNESS | 19. SOLID, ROBUST CONSTRUCTION |
-  PARTS :: ASSEMBLED

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RESEARCH live lab



Living, Lab, and user work together in a virtuous cycle of knowledge. This building is an alternative to the PASSIVE house standard, and is instead an ACTIVE organism that communicates with its user, providing him with the opportunity to improve the building's performance via small daily changes. The pilot lab organizes device testing and compiles resultant data, while the residential labs feature in-situ sustainable device testing, allowing the home to operate as an instrument that may be continually fine-tuned. Ultimately the loop goes as such : smart building makes for a smart user, which leads to a smarter building and a smarter user still...



LIVING LAB



LIVING LAB

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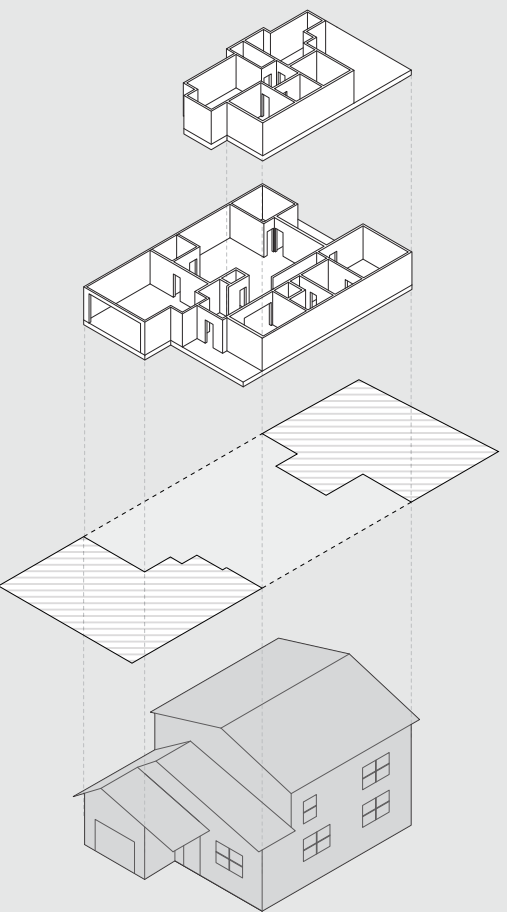
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TRANSFORM program typology

Spatial + Systematic Optimization. Spaces within the home are redefined as labs which create a new framework for an experimental lifestyle. A typical single-family detached home is distilled into its component parts in order to better understand both the use of space and efficiency of systems. This is a commentary on American resource consumption, and illustrates that with a few simple moves, we can begin to reimagine a typical house that performs more intelligently...

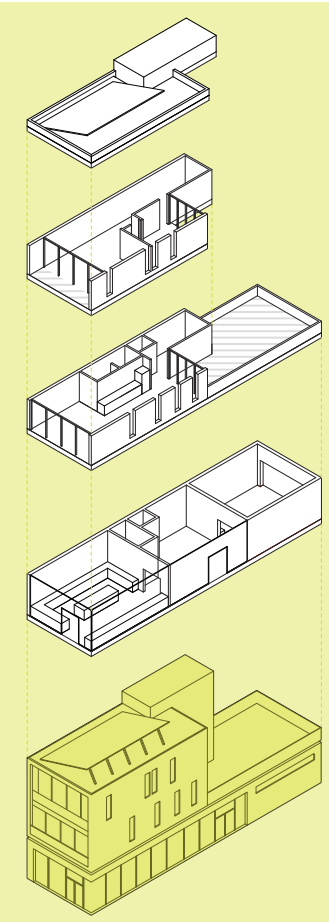


TYPICAL single family home 12,244 kW/h = \$1,464.26 per year



<p>LIVE space</p> <p>ENERGY = 5081 kW/h INDOOR AIR QUALITY = >500 chemicals</p> <p>NARROW FOOTPRINT = maximizes potential of daylighting strategies and savings ORIENTATION + FREE PLAN = natural cross ventilation (saving 30% on energy costs) FREE PLAN = efficient use of space ENERGY = 1860 kW/h</p> <p>STORE space</p> <p>ENERGY = 2761 kW/h</p> <p>SMART PHONE / LIVING LAB TECHNOLOGY = allows user to monitor energy use, water use, mean temperature, air quality, and daylight levels in the home ENERGY = 1634 kW/h</p> <p>OUTDOOR space</p> <p>GROUND LEVEL = inefficient land consumption TRADITIONAL LAWN = irrigation water consumption WATER USE = 250 gallons per day</p> <p>LARGE SHARED LAWN = outdoor space for the community XERISCAPE = less water use, native plants ELEVATED = maximum lot use / less land use</p> <p>WORK space</p> <p>TRADITIONAL COMMUTE = increased gas consumption and carbon emissions</p> <p>OPEN FLOOR PLAN = requires less energy / construction waste for future adaptations MIXED USE = potential to work from or near home NON-COMMUTE = less gas consumption and carbon emissions</p> <p>SLEEP space</p> <p>ENERGY = 2084 kW/h WATER USE = 75 gallons per day</p> <p>HEATING LOAD = 3% savings for each degree decreased COOLING LOAD = 6% savings for each degree increased WATER USE = 45 gallons per day (35% savings) ENERGY = 1214 kW/h</p> <p>CIRCULATE space</p> <p>TRADITIONAL HALLWAYS = wasted conditioned space within the home</p> <p>CONSOLIDATED CORE = allows for more efficient room layout SIPS PANELS = 60% energy savings DAYLIGHTING STRATEGIES = reduces lighting energy costs by 80%</p>
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7,531 kW/h = \$903.76 per year **neo-typical LIVING LAB**

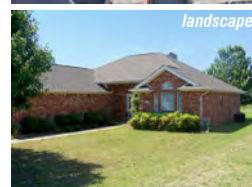
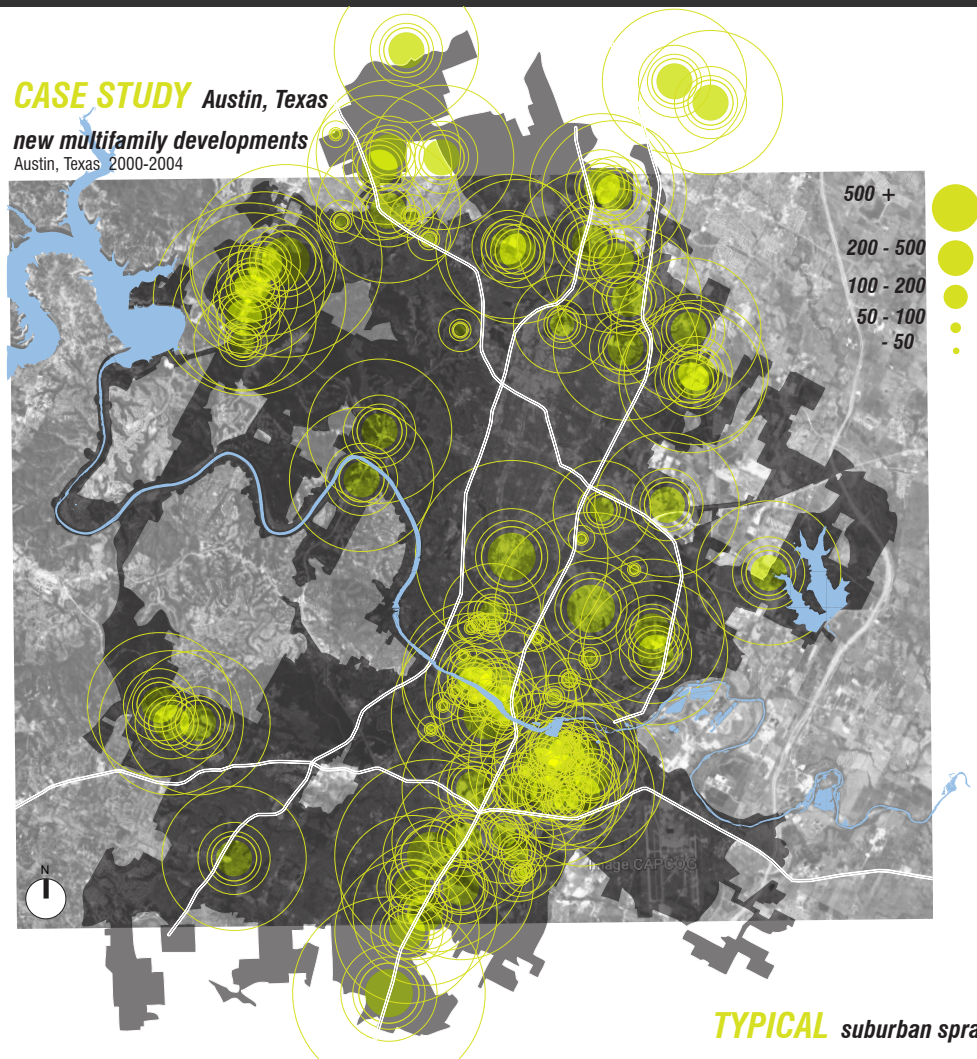


PIKE POWERS LIVING LABORATORY
 DESIGN TEAM: MATT FAJKUS, AIA, ULI DANGEL, TAMIE GLASS + [AUDREY MCKEE]

CASE STUDY Austin, Texas

new multifamily developments

Austin, Texas 2000-2004



SPREAD THE WORD...

smarter buildings > smarter occupants > smarter neighbors > smarter cities

new single family detached developments

Austin, Texas 2008-2011

1 person icon = 50 lots

2008

24 person icons = 1202 lots

2009

6 person icons = 316 lots

2010

15 person icons = 760 lots

2011

17 person icons = 867 lots

total : 3145 lots

A TYPICAL SINGLE FAMILY DETACHED HOME consumes 12,244 kW/h of energy per year, costing \$1464.26

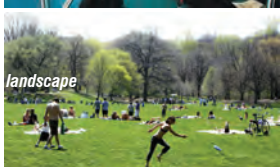
THE LIVING LAB estimates using 7,000 kW/h of energy in its first year [and lower consumption every year after that], costing approximately \$840.00

IF 1 out of every 50 lots were a living lab, the result [for those 50 lots] over ten years would be a savings of 62,440 kW/h, enough to power the living lab for another 10 years or invest \$7492.80 in sustainable technology research. Through these savings, the living lab helps to educate the community/city/nation about growth in America :: reimagined.

In the case of Austin, Texas, over the past four years a total of 3145 single family detached lots have been built, an average of 786 per year.

IF 1 out of every 50 lots were a living lab, this would result in a savings of 98,156 kW/h per year throughout Austin, Texas. This could power another 14 Living Labs throughout the city to continue spreading awareness, or give \$11,778 back to the community.

POSSIBLE urban growth



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COMMUNITY social responsible



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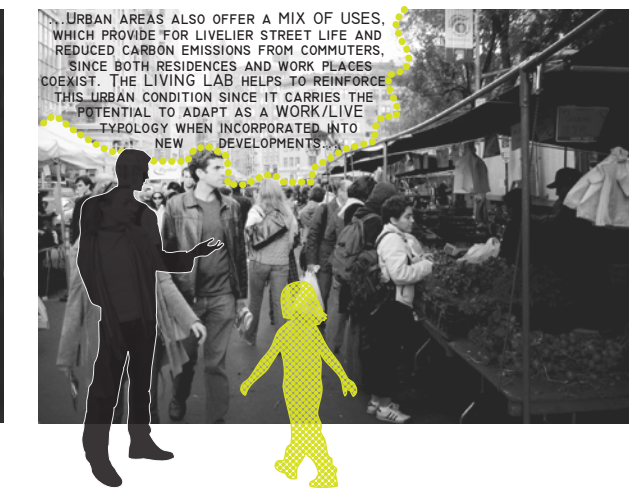
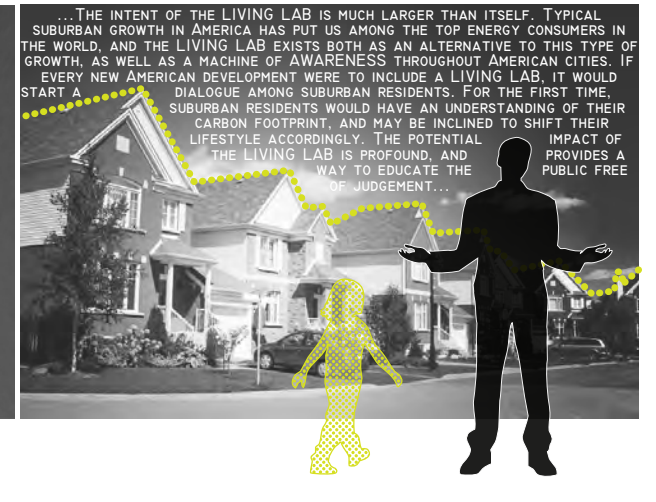
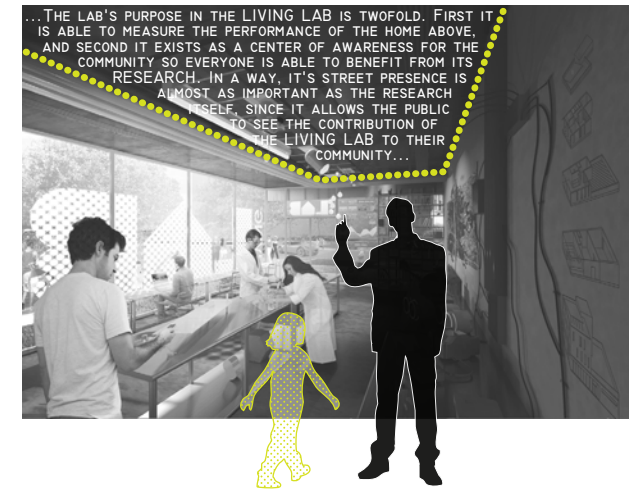
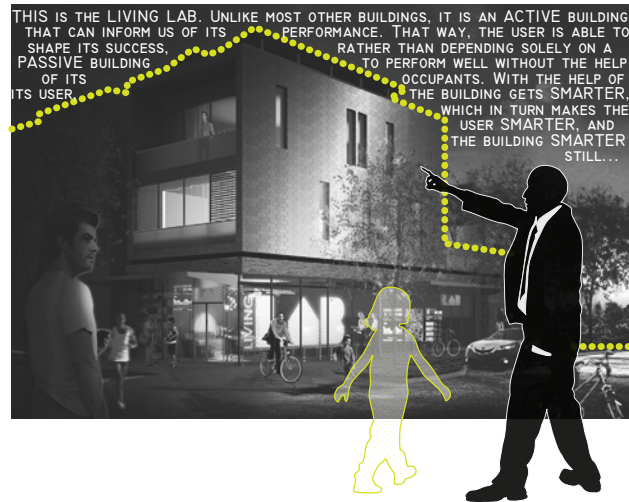
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The Living Lab exists as part of the **Pecan Street Smart Grid Demonstration Project**, a research effort under the direction of Pecan Street Inc. Supported by a grant from the Department of Energy, a team of researchers from The University of Texas at Austin, the National Renewable Energy Laboratory and the Environmental Defense Fund are working to **develop and test an integrated clean energy smart grid** of the future in the homes of today. The test bed for this sustainable demonstration project is the Mueller Development in Austin, Texas; and within this framework, the Living Lab will play a key role. Sited within a row of shop houses, the structure will provide the opportunity to function both as a **sustainable smart model home as well as an active lab for sustainable technology experimentation**. Both elements will act as a showplace for technologies and serve as an educational center where researchers, utility providers and the public can see the systems at work and test new approaches in a real world, carefully controlled setting.

The Living Lab aims to achieve a high degree of holistic sustainability on multiple levels, including low-tech strategies such as optimized solar orientation for passive daylighting, as well as high-tech strategies such as cutting edge photovoltaic panels to generate electricity. The integration of architectural strategies and innovative technologies into the design will not only ensure **optimum levels of energy efficiency and renewable energy**, but also demonstrate the highest feasible levels of resource efficiency, water conservation, construction waste management, and use of locally and regionally sourced materials. Specifications for finishes and furnishings are based on a life cycle and environmental impact assessment. Furthermore, services and systems will be consolidated on the floor plate to **maximize flexibility and versatility**,

allowing for modification over time as the end users' needs change. The flexible, open plan will also promote the principles of universal design with the goal to create an environment that is inclusive of all, regardless of physical ability.

In recent years, researchers have found that **LEED buildings are not performing** as well as expected. Although many LEED buildings are energy modeled prior to construction, experts have found these energy models to be inaccurate, and the energy consumption of many LEED buildings to be greater than expected. We posit that LEED buildings aren't performing well because their **occupants aren't performing** well, and it is this problem that we address in the Living Lab.

As a solution, we propose shifting both the construct of the house and the construct of living in a house. We imagine **living as an experiment**; living as an opportunity to learn and to improve your surroundings as a result of that knowledge. Consequently, the house is **not a static machine that serves** for its occupants, but rather it is **a living organism that grows** in its relationship with its occupant.

Most importantly, the Living Lab will stand apart as a typology because of its **honesty about environmental performance**. For the first time, a building will no longer operate passively and independently from its occupants, but will instead **communicate actively with its users**. Today's readily available technology integrates this concept easily into the occupants' daily lives, providing them with the opportunity to be responsive to a building's performance rather than merely measuring and monitoring it. This feedback loop is continually cyclical, resulting in **greater performance and greater knowledge** of both building and user alike.

ACTIVE community presence

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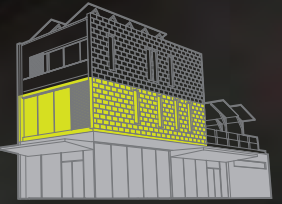
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LIVING LAB
LIVING LAB

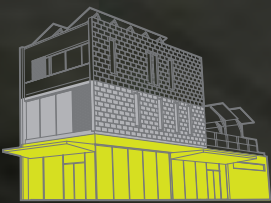


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Skin Deep? Building Envelopes + Spaces

Sustainable architectural design approaches at multiple scales

by **Matt Fajkus**, AIA, LEED AP, Assistant Professor of Architecture, The University of Texas at Austin

