

# Material Influence: Case Studies in Material as a Mechanism for Design

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## MATERIAL PRESENCE OF MAKING

The making of architecture is guided by a material's manufacturing process and construction techniques. These systems establish specific boundaries with the freedom to operate within their systems. Design is not simply ingenuity of form but rather a collaboration of poetry and rational systems. It is the balance of these two that produce architecture. Perhaps the most famous declaration from Vitruvius in *D'architectura* is: "Well building hath three conditions: firmness, commodity, and delight.<sup>1</sup>"

## TACTILITY + INTRINSIC NATURE OF MATERIAL

Material has tactility and an intrinsic nature. Its visual and emotional characteristics carry an interpretation. Its use, whether honest or applied, establishes an aura and a narrative. The aura comes from an emotive and experiential association whereas the narrative tells the story of its history, fabrication, and application.

The role between material and design has become disengaged. Historically there was a definitive relationship between material, place, and form. Technology (through both the diversity of materials currently available as well as the globalism of their availability) has divorced a material from form. Any structure can be associated with any shape and associated with any material. Such material application is evident throughout history, from Augustus' attitudes of structure to skin "I found Rome of clay; I leave it to you of marble<sup>2</sup>" to a more recent example of the Disney Concert Hall changing from stone to metal cladding without affecting the design or form.<sup>3</sup> Such separation

has removed material from the design process positioning it as a design finish. Material has lost its foundational premise turning it into a simulacrum. Cesar Pelli in fact states "architecture is the eight inches of the curtain wall<sup>4</sup>"

In opposition to this, the integration of the material with the design is intrinsically present in the works and writing of Louis Kahn: "Material should be the fountainhead of form.<sup>5</sup>" In educational curricula, Mies implemented such a premise as director of the Illinois Institute of Technology Architecture Program:

"In the second year the student learns simple construction in brick, wood and stone. He learns the properties of these materials and how they can be put together to make simple buildings.<sup>6</sup>"

The foundational premise of both is the expression of the material as collaboration between design and construction to result in Architecture.

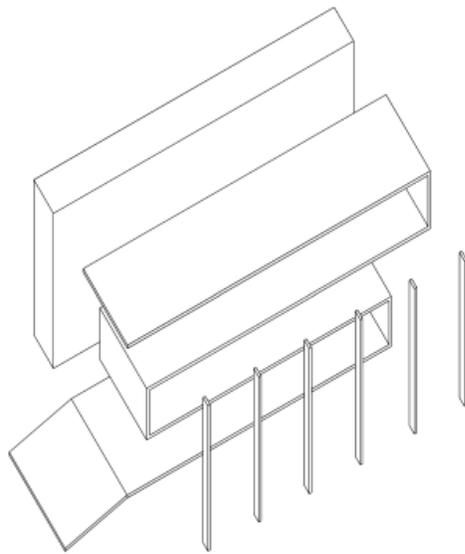
## PAPER METHOD

This paper will offer design applications as to how material and architecture can collaborate through two case study investigations. An exposition of the influence of material on the design process and execution will illustrate an architecture that emerges from a specific place, material, and application. Founded in two distinct locales, and authored by two varied architects, the principles of material expression and performance are shared. Their description will occur through parallel textual and visual description.

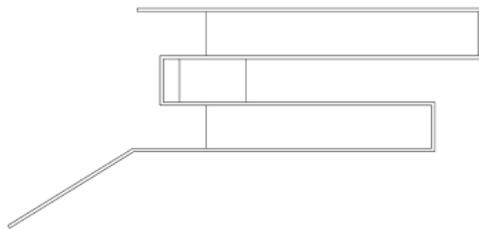
**CASE STUDIES:**

**Ellis House**

The Ellis House, located on the island of Windemere in the Bahamas, sits on a peninsula surrounded by the Atlantic Ocean on the east side and the Windermere Sound on the west side. Constructed out of locally manufactured concrete masonry and covered in stucco as per indigenous tradition, the form of the house emerges from the influence of the site, the local domestic typology, and the intrinsic characteristics of the material. Construction was limited in scope by the skill of the local labor and the availability of materials. The house intrinsically necessitated a vernacular sensibility of design and construction adopted and celebrated by the architects. The project required a limited level of complexity of detail to achieve fruition.



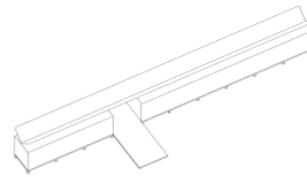
*Overall massing - bar figure defined in section by a continuous concrete surface*



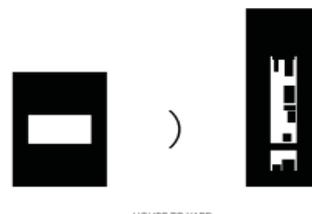
*Section of continuous concrete surface*

**Low Country Line House**

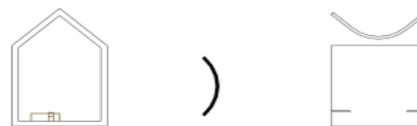
The Low Country Line House emerges from the cultural and climatic conditions of a rural North Georgia site. Desiring to have a limited impact on the landscape and be a self-sufficient building, the project sits lightly and responds formally and materially to environmental conditions. As an adjustable machine, the house operates to regulate use and performance.



*Overall massing - linear bar house with two pavilions linked by a dogtrot porch*



*Single figure transformed into articulated line with interior courtyards and passages*



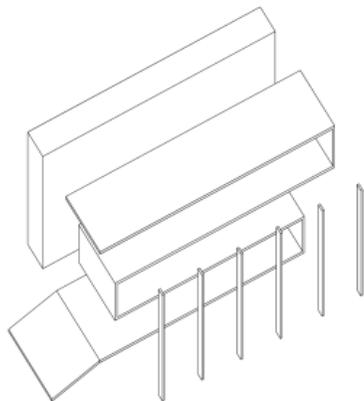
*Furniture as appendage converted to furniture as integrated with the architecture*

**THEMATIC ANALYSIS: CAUSE AND EFFECT**

**Ellis House**

In the Bahamas the primary means of construction is stucco clad reinforced concrete masonry. Brick and wood are in limited local supply requiring their import and subsequently a great expense and thus have limited use. A local concrete masonry plant provides the islands with an abundance of a singular material system. The stucco is employed to protect the block from the harsh salt air, high humidity, and hurricane force winds common to the region. Any additional materials need to be imported from the mainland US that greatly increases their cost and limits their availability. Embracing this limitation, The Ellis House uses a concrete block wall system as the primary method for enclosure. Incrementally infilling the cells of the block wall, the units are impregnated with 12'X8'X10' reinforced concrete frame. The masonry thus simultaneously defines the volume of enclosure and the structural cage. As a result the module of the material and the module of the structure are one and the same.

The secondary material used in the Ellis house is a locally quarried coral rock with high carbonate composition from mineral remains of marine invertebrates. The stone has a soft consistency that prevents it from being used in a structural capacity; it does however perform well as a cladding material. Due to the weight of the material, it is employed to clad the landscape walls of the house, grounding the composition visually and physically.



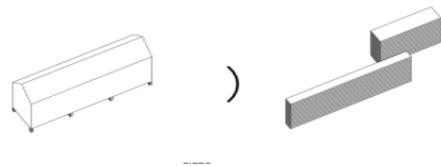
*Elements: massing wall - folded surface - column line*

**Low Country Line House**

In the Low Country Line House a combination of materials are chosen for their specific qualities and applications. Cast-in-place concrete is selected to provide a delicate cage frame lightly touching the site on a series of square pilotis. Steel is chosen for the efficiency of size, providing small members that simultaneously serve as the lattice framework for the structural cladding members and mechanical tracks for an operable skin of glass, wood, and perforated metal. Wood glue-laminate beams serve as the upper ribs for the rain catching vessel roof are used for their variable profile flexibility and their visually organic quality. Operable wood panels cloak the exterior blending the house with the surrounding woods. Each material is selected for form, performance, and perceptual reference.



*Layers: roof rain catcher - laminate roof structural ribs - building concrete frame - horizontal suspended floor plate*

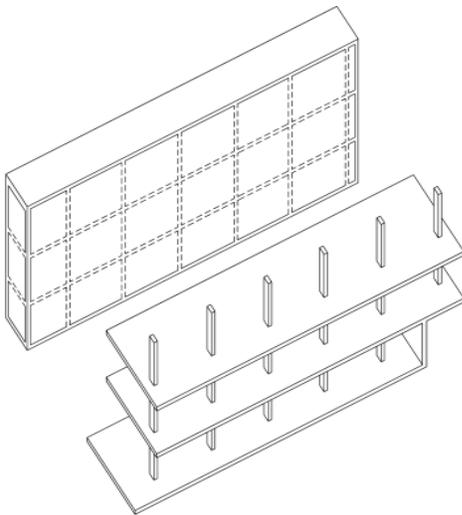


*Elevating piers transformed from incremental footings to large stone trombe wall piers for fireplaces and water retention vessels*

## MATERIAL MODULE/DIMENSION

### Ellis House

The Ellis House is based on the module of the 8"x8"x16" concrete block. Dimensions, both vertical and horizontal, are a module of the material. The stair core is constructed of concrete block with the remainder of the house being poured in place concrete. The cells of the stair core are filled with re-bar and concrete to produce a structural cage 12'X8'X10' on center that established the rhythm for the concrete frame and the remainder of the house. Interior walls are constructed of 4"x8"x16" concrete units. The walls use the free plan and always hold their ends from the column in the tradition of Le Corbusier. The geometry intrinsic to the material establishes the module and form of the Ellis House.



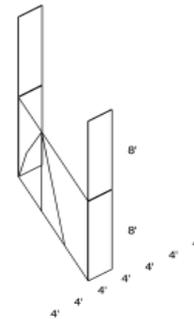
*Construction: block wall with concrete frame and cast-in-place reinforced concrete slabs with columns*

### Low Country Line House

The Low Country Line House begins with the module of the material. The skin, based on a double stacked 4'x8' plywood module establishes the primary rhythm of the linear composition. Two bays high in section [with an additional one half bay module above grade] the dimension is established by the 8' vertical of a standard sheet of plywood. The house crests at 20' [4' - 8' - 8']. Longitudinally the bay system is established by the 4' module. Running as two parallel lines, these edges estab-

lish wall boundaries allowing the house to infill as needed between them. The ends are treated as exterior partition walls aligned with a bay seam allowing for the floor plate to continue from inside to out while still bounded laterally by the two primary wall lines. The alignment of the two facades is essential to allow for the effectiveness of cross-ventilation and exposure control.

The concrete frame picks up on the twenty four foot module of the skin wall establishing the exposed cage of the primary structure. Six bays wide and twenty four feet across the frame hold the floor plate and roof plate [from which the side walls cantilever] and picks up the primary beams for the rain catcher.



*Material Module - operable skin defines ratio of length to width to height*

## MATERIAL CORNER/EDGE/SURFACE

Throughout the history of architecture, the language, material and construction technique can be traced through the articulation of the corner. As a seam between materials and surfaces, it illustrates the way buildings, their forms and their materials come together. As the most significant connection, the corner is illustrative of an attitude towards surface, volume and mass.

### Ellis House

In plan the Ellis House is bounded on the north side by a solid figure that tapers at each end thereby denying a traditional corner and terminating the walls by pinching them together. As a result an otherwise conventional core creates a boat-shape that makes reference to a local vernacular and funnels views out to the sound and the ocean. The opposing south face corners dissolve entirely. The

all glass walls become ephemeral with their transparency and pull back from the edges of the floor plates to deny any traditional reading of corner.

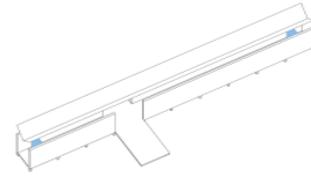
In the section of the Ellis House the floor plate is conceived of as a continuous surface that begins in the water and ends in the sky. Emerging from the sound as a series of steps ascending into the living room and continuing through the kitchen finally folding up to form the back retaining wall and ultimately the ceiling, the surface continues to loop as floor to wall to floor to wall, culminating in the flying ceiling of the master bedroom.



*Thicken wall tapers to front and back edges questioning the thickness of mass*

### Low Country Line House

The Low Country Line House denies the corner by emphasizing the length of the linear surface. Focusing on a linear repetitive yet diversely operable surface, the house sets itself between the two lines of these primary parallel walls. Interior spaces and exterior rooms are generated between these walls. The turning of a space is disregarded for a more preferential interstitial bracketing. The role of the architecture then turns to the surface of enclosure: the two longitudinal operable walls aforementioned and the choreographed roofline, bending upward and downward between the two shells to vault the interior rooms, funnel wind, and collect water in the concave rain catcher. The connection of these elements comes through the space and the interaction of the user with these surface's diverse configurations.



*Recessed end walls denying corner to emphasizes extended flatness of linear operable side walls*

### MATERIAL COMPONENTS/MATERIAL APPLICATION

#### Ellis House

The Ellis House employs concrete block for walls and poured in place concrete for the floor plates and freestanding columns. Block is used as an indigenous material that naturally performs well as structural planes. When the plan opens to more free flowing spaces it transitions to the flexibility of cast-in-place concrete and non-load bearing concrete block walls as collaborative materials extending from the stair core. The concrete block walls and the cast-in-place columns are encased in a synthetic color impregnated stucco to protect the embedded re-bar from exposure to the high salt content air of the island.

As a textural foil to the roughness of the concrete block and cast-in-place concrete, the woodwork is all fabricated out of teak. As a material, teak is naturally resistant to rot and insect infestation. Common to the boat building industry prevalent in the islands, the material performs well in marine environments.

Color is essential. The desire was to have the concrete and stucco of the house as a neutral monochromatic grey highlighting the use of natural materials. The floors are a polished concrete. Walls and ceilings both inside and out are treated with the same grey stucco material and with the same installation technique and finish surface break down differentiation between the interior and exterior. The kitchens and bathrooms use refined materials in an honorific and color sensitive manner. White carrera marble is used as a highlight material on work surfaces including the kitchen counter and office floor. As a non-indigenous material, its use

is highlighted as foreign, celebrated and distinct. Every surface of the bathrooms is clad in a 1"x1" blue tile to provide a homogenous yet distinct surface. This condition is the only place that color is employed drawing a highlighted reference to the beach location and the color of the adjacent waters.

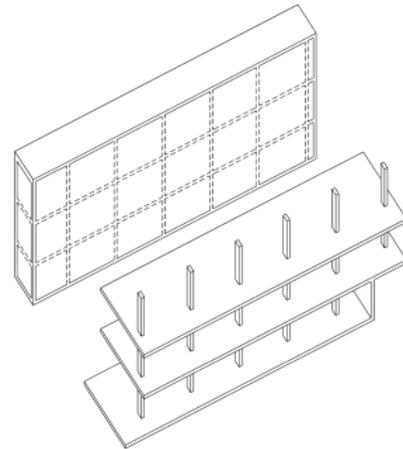
### Low Country Line House

The Low Country Line House has three primary materials – one for skin, one for structure, and one for the roof. Each component adopts the appropriate material based upon its performative necessities. **[1]** The structure is a cast-in-place reinforced concrete frame that establishes the primary spatial and programmatic module of the house. **[2]** The skin is a series of layered surfaces, operable to allow the house to breathe and adapt. The exterior layer is a resin impregnated plywood skin. Floating off the surface of the building it serves as a curtain for privacy, as the outer shell to deflect solar radiation, as a sun control surface, as a valve for the wind funnel roof surface, and as the outer shell for the thermal mass of the wall. Beneath this plywood surface is a metal panel bifurcated in elevation into an upper operable casement window and a lower screened and louvered panel. An inner plywood surface folds up to cover the lower louvers. When down it is flush with the wall, when up it serves as a table/work surface running the length of the house moving from indoors to outdoors. **[3]** The roof is formed by a series of glue laminated beams holding a thin shell shotcrete basin for rainwater catchment. The wood glue laminate beams of the rain catcher are each custom fabricated out of laminated pieces allowing for a variable section to the rain catcher based upon the program of the room below, the position of the roof vent and the quantity of airflow needing to be delivered. Varying in profile along the length of the house, the beams produce threshold profiles that the catchment basin morphs between from rib to rib. The variable profile allows for an expansion and contraction of the space between catchment basin and roof producing variable air flow intensities and roof vent positions directing air based upon the programmatic need and spatial organization below. Deeper beams allow for a tighter pinching of the airflow and thus an acceleration of available ventilation.

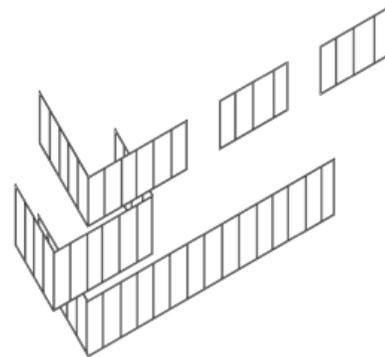
Each material establishes the associative form

of each component emerging from the physical capabilities and limitations of the material while addressing the specific functional requirements of its usage.

### Ellis House

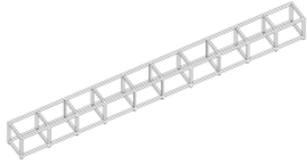


*Concrete frame with block infill - Reinforced concrete slab and columns*

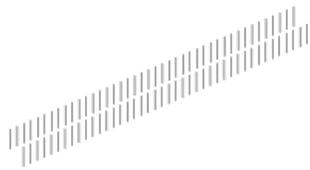


*Operable glass panels*

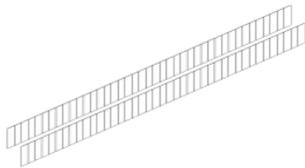
**Low Country Line House**



*Concrete frame*



*Steel mullions as tracks*



*Operable panel wall*

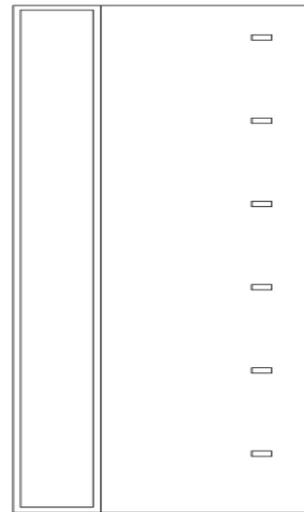


*Glue laminate rain catcher roof ribs*

**Material Weight / Force Lines / Structural Legibility / Performance**

**Ellis House**

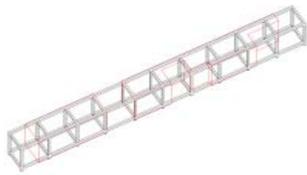
In the Ellis House the weight is evident in the density of the opaque core and the rhythm of the opposing line of columns. The glass beyond the columns reinforces that meter of the columns by reiterating them in the mullion and secondary structural system. A top-mounted beam that provides the necessary structure while preserving the continuity of the surface below achieves the cantilever over the master bedroom. The house consistently exposes its materials and structural systems to provide a clear and honest reading of the building.



*Wall to column relationship*

### Low Country Line House

In the Low Country Line House, the primary structure and weight is felt through the cage of the cast-in-place concrete frame. Holding the floor plate and roof plate, the frame is articulated in a different material to express its individual nature from the other material systems used in the house. The wall surfaces use the meter of the verticals as both structural tracks for the panels expressing the force and motion lines of the skin walls. The columnar grid carries through the structure expressed as pilotis feet [the only connection of the building to the ground other than the fireplace piers] and the extension fingers that touch the rain catcher. This structural frame is exposed through the house maintaining its prismatic character running consistently from inside to out along the length of the house.

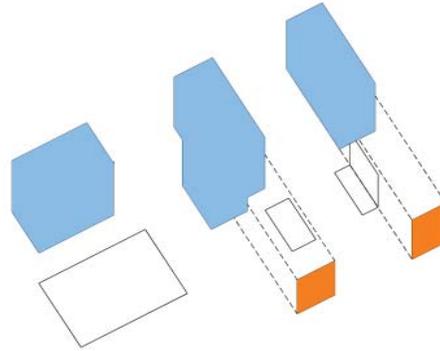


*Structural concrete cage with programmatic volumes*

#### MATERIAL EXPERIENCE: SPACE + LIGHT

##### Ellis House

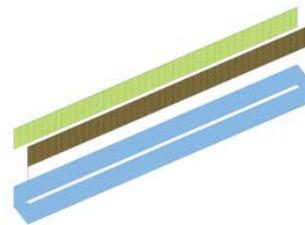
Spatially the Ellis house deals with the contrast of the cave like space of the stair hall to the light filled space of the living room and the bedrooms. These two spaces are continually intertwined in experience as one moves through the house, passing back and forth across this threshold. Additionally this passage is experienced by the view of the water to the south. The overhang along the south side protects the interior from the summer heat while the windows in the stair hall allow for natural cross ventilation. The experience of the break down between interior and exterior is important in both the light quality and spatial readings of the house. The engagement of the picture plane with the surrounding landscape allows the perimeter to dissolve visually erasing any boundary between interior and exterior. This visual effect is contrasted by the punched window beyond the office [that frames a distant island] and its twin in the east bedroom [that frames the ocean].



*Color - blue bathroom, white of marble, and orange of shower curtains*

##### Low Country Line House

The Low Country Line House is about the experience of place, the climate, the specifics of the natural surroundings, and their consistent relationship with the space and function of the interior rooms. The building, as a machine for viewing, engaging, and collaborating with the environment allows the inhabitant to operate its skin to create variable conditions. Light, view, programmatic need, and ventilation are all orchestrated through the physical and adaptable engagement with the building. Operable skins and roof vents allow for wall to become furniture and the skin to dissolve – expanding and contracting as necessary to respond to environmental conditions. The sequence of spaces centers along a dog-trot porch that zones the house between guest and daily living and studded by large stone fireplace piers anchoring to the site through their extension beyond the walls and into the untouched surrounding landscape. The house through its ability to moderate its environment is a collaboration and integration of site and architecture.

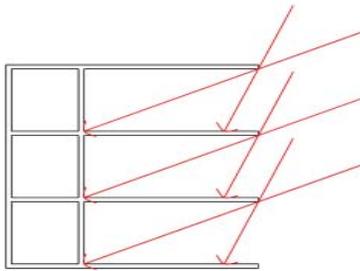


*Color - transparency of glass perimeter with overlaid louvers and etched operable plywood panels*

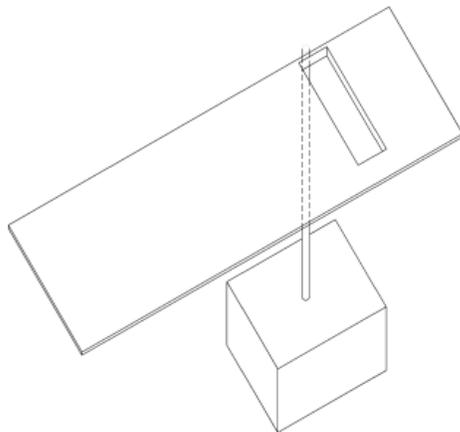
**MATERIAL, ECOLOGICAL AND SUSTAINABLE IMPACT: CLIMATE / ORIENTATION / WIND / SUN / WATER / SITE**

**Ellis House**

The Ellis House attempts to utilize the omnipresent wind on the island as a passive cooling device. All the windows are operable allowing for the sea breezes to flow through the building. The overhangs on the south side block the sun during the summer months and allow more solar gain during the winter months. Curtains in the house also aid in this aspect. The roof is designed to collect rainwater that is then stored in a large underground cistern. Other water is also collected through a well that is next to the house. Exterior spaces are located at the corners of the building where the air speed will be at its greatest. The house has been designed in a way that the natural aspects of the island, the water, sun and wind can work in collaboration with the architecture.



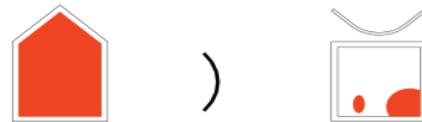
*Sun - shallow penetration in summer and deep penetration in winter*



*Water - Roof collection with cistern storage*

**Low Country Line House**

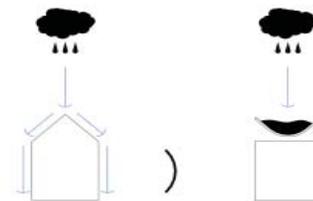
The Low Country Line House steps lightly on the landscape. Catching rainwater for irrigation and grey water usage within the house, opening and closing to catch, funnel and harness prevailing winds, retracting and exposing surfaces to shield or gather sun, orienting itself toward micro and macro climatic conditions to optimize what is there, the house is a machine for the processes of providing lightly. Self-sustaining due to philosophical as well as practical conditions, the remote condition of its location and associated siting sets the practicalities of the surrounding "natural" as the responsive and collaborative context for the house.



*Task heating - not space that is controlled but body*



*Light access and control through both wall and clere-story roof*

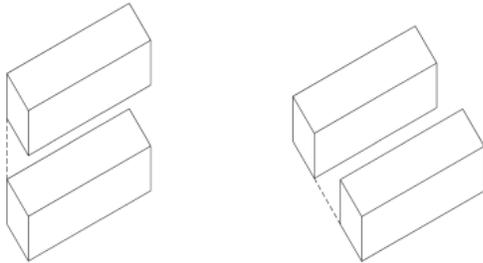


*Inverted roof for rain collection*

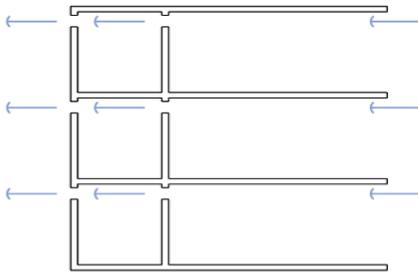
**MATERIAL PRECEDENT – VERNACULAR TYPOLOGY**

**Ellis House**

The Ellis house uses the center hall house scheme as its starting point. This typology is very common to the Bahamas. In fact the original designs for the Ellis house were actually center hall schemes. Due to other factors, mainly the client’s desire for all the inhabitants to have views of the ocean, the center hall scheme was essentially transformed into a vertical version. The public side of the scheme is placed at the bottom near the ocean and pool, whereas the private portion of the house is placed in the air. The middle level or car port is the vestige of the center hall.



*Center hall house transformed into sectional organization*

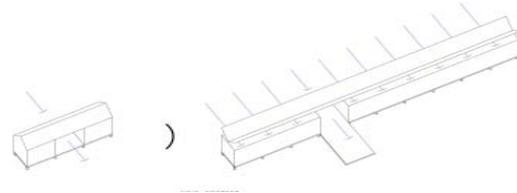


*Wind - operable glass façade with clerestory vents*

**Low Country Line House**

Beginning with the typology of the dog trot house, the Low Country Line House sets the central porch on an asymmetrical bi-furcating axis. The result is a severing of the house into two distinct formal and programmatic pieces zones by use and duration. The small component housing the guest quarters and office space while the large portion houses the remainder of the housing functions.

The porch extends past the two defining walls of the Low Country Line House to create a suspended table extending into the landscape. The elevation of the inhabitant off the ground plane and the re-establishment of an artificial datum for occupation objectify and formalize movement from the house to the landscape. The connection is light but noticed.



*Dogtrot house with distended wings and subtracted inner courtyards - inverted roof to funnel and accelerate existing wind conditions*

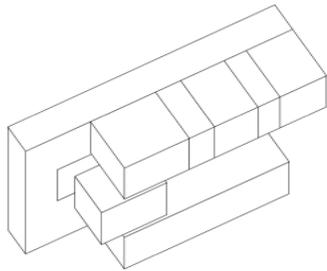


*Traditional house form inverted and made operable and porous for light, wind, and water control*

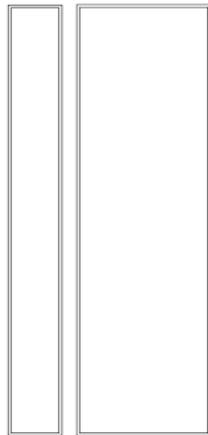
**MATERIAL PROGRAM – SPACE/USE/MATERIAL**

**Ellis House**

The Ellis house is programmed so that all the private and public spaces have their own exterior spaces. This boundary is continually questioned by the large operating glass doors that comprise the south elevation. A series of balconies join all of the spaces on all three floors and they are all focused towards the ocean. The vertical core of the building houses primarily the stairs, but also the library, a gallery, the pantry and a small bathroom on the bottom floor. This core also operates as a single loaded corridor horizontally. Each bathroom in the house has both an interior and exterior shower allowing the user the option of viewing the sea even as they wash. The finish on the building, smooth stucco, is identical both on the interior and exterior. This detail serves as another way of breaking down the barriers between the inside and outside.



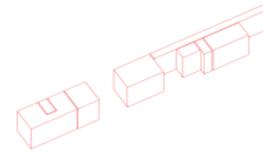
*Program - service core with public below and private above*



*Service and Served*

**Low Country Line House**

The Low Country Line House is formally and programmatically compartmentalized within the two defining walls of the overarching form. Sectioned with every interior space having an associated exterior space, the boundary between out and in is constantly dissolved. The house contains two bedrooms each with a private bath. Each bedroom has positions for both summer and winter sleeping relative to the climatic and site conditions of the position and season. The main living space is consolidated into a single great room for living, dining cooking that abuts the large central porch. Opposite this space is the office space buffering the guest quarters from the rest of the house. Organized primarily as a single loaded corridor that flips sides of the house at the dogtrot porch, the skein of the houses expands and contract to respond to each of the adjacent spaces climatically and functionally to provide work and display surfaces.



*Program - public to private*



*Automobile integrated at end of house nestled between the line walls of the house*



*Guest quarters extracted from body of house and articulated*

**CONCLUSION**

Material is the media of architecture. It is a physical expression of context and culture. Its intrinsic qualities and limitations determine the approach to design and form. It has the ability to define architecture. With specific dimension, weight, and technical qualities, a material directs a design process. As the foundational premise of making, material influences all else. These projects illustrate how a vernacular material and building construction influences design. Examining the influence of: form, cost, methods of construction, fabrication of product, installation of materials, structural and aesthetic performance, ecological and sustainable impact, and spatial/light/visual impact these projects provide an analytical process for the implementation of the potential of a material. These projects emerge from a sensibility founded in material celebration. They work within the guidelines of a material's performance, modularity, structural capabilities, formal presence and emotive power to produce an architecture that is of a material. As case studies they represent a material methodology founded in architecture of material influence.

**ENDNOTES**

1. This quote is taken from Sir Henry Wotton's version of 1624, and is a plain and accurate translation of the passage in Vitruvius (I.iii.2): 2. Haec autem ita fieri debent ut habeatur ratio firmitatis utilitatis venustatis. firmitatis erit habita ratio, cum fuerit fundamentorum ad solidum depressio et quaque e materia copiarum sine avaritia diligens electio, utilitatis autem, cum emendata est sine inpeditione usus locorum dispositio et ad regiones sui cuiusque generis apta est commoda distributio, venustatis vero cum fuerit operis species grata et elegans membrorumque commensus iustas habeat symmetriarum ratiocinationes.

2. Caesar Augustus from Cassius Dio 56.30.3 - At his death-bed

3. "However, construction of the concert hall itself stalled from 1994 to 1996 due to lack of fundraising. Additional funds were required since the construction cost of the final project far exceeded the original budget. Plans were revised, and in a cost saving move the originally designed stone exterior was replaced with a less costly metal skin. The needed fundraising restarted in earnest in 1996 - after the real estate depression passed - headed up by Eli Broad and then-mayor Richard Riordan and groundbreaking for the hall was held in December 1999."

Gehry, F. *Symphony: Frank Gehry's Walt Disney Concert Hall*. Harry N. Abrams: 2003.

4. Caesar Pelli

5. Louis Kahn

6. A Curriculum of Ideas, Reginald F. Malcolmson, *Journal of Architectural Education (1947-1974)*, Vol. 14, No. 2, ACSA-AIA Seminar: The Teaching of Architecture (Autumn, 1959), pp. 41-43