A Return to the Thick Space of the Wall

Genevieve Baudoin | Bruce A. Johnson
Kansas State University | Dual Ecologies

Abstract

This paper examines a return to the thick space of the masonry wall. The wall is where a building embraces its context and where humanity can physically experience this nexus. Contemporary technologies applied to masonry construction offer a return to both tactile solidity and the space of interaction between a building and its users. Precedents from Catalan vernacular to Herzog & de Meuron will be contrasted to offer a way of thinking through the spatial potential created through the modularity and specificity of blocks.

From that comparative study, the authors propose a design methodology using their own projects as case studies in distinct contexts. These case studies mine pattern and variation in unit masonry to generate a nuanced understanding of not only structure and systems within the wall but of the overall composition of the façade/wall itself.

From Thick to Thin

Stone, terracotta, and brick (fired and unfired), as unit masonry, offer shelter, security, and permanence. Masonry systems date to the origins of architecture. While it might seem obvious, these materials were load-bearing and available, workable, and lasted. Ornament was integrated into this system as the units were already custom shaped. While ancient Babylonian walls include images of fantastic creatures embedded in brick, this pictographic sensibility contains the seeds of the transformation of brick. They are not simply painted but sculptural, images molded as part of the thick space of the walls. (Fig. 1) As a cohesive part of the construction, the “ornament” became a cultural repository.

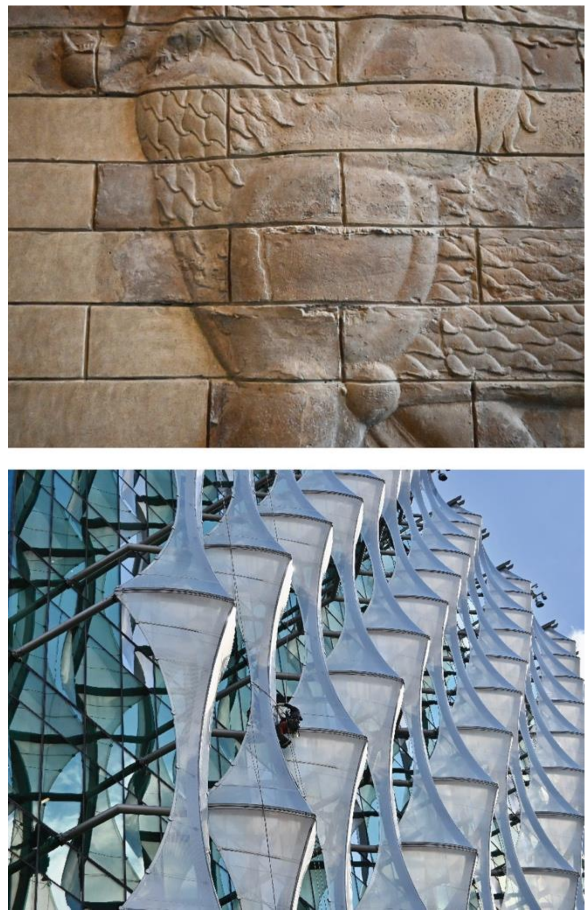

Fig. 1. Embedded ornament versus thin layers in Kieran Timberlake’s US Embassy. Photo credit: Bruce A. Johnson

The development of the steel frame in conjunction with theories like Le Corbusier’s Five Points ushered in the slow loss of the load-bearing facade. Ornament no longer needed to be unified with the load-bearing system of the building. The impact of this transition generated a critical loss in the expression of culture that was integral to a building’s construction. Numerous cultures had previously integrated ornament as part of the manufacturing of architecture; now this became something added on as decoration, if wanted at all. While there continues to be interest in studying ornament, architecture has furthered the disconnect between the building and the expression of cultural identity.

A Concern About Thinness

Contemporary concerns for climate control and economy have made exterior walls a series of separate thin layers. We build in increasingly less long-lasting, thinner materials, and the environmental controls we seek are ever more demanding. We continue generating advanced technology to monitor, control, and address the failings of these materials. The architects Kieran and Timberlake are strong advocates of thinness. They argue that "…the building's infrastructure, [is] now thin enough to be literally printed on a surface…"[1] In the US Embassy in London, the building is essentially a glass cube, in keeping with Mies' ideology of bureaucratic transparency in an institution that is typically opaque. Due to environmental requirements, layers are introduced through the ETFE-skinned shading devices with a thin film of photovoltaics embedded in them. While an effective and novel shading system that creates a thickened space, this depth differs from the presence of an opaque structure, particularly as this space is beyond the plane of habitation. (Fig. 1) The building leaves the impression of a shrink-wrapped cube, more reflective than transparent. The expression of the building, the moment where culture is manifest, is technology.

Ornament/pattern, which offer a cultural specificity and expression to buildings, has been increasingly lost in an age of thin pre-manufactured components and BIM integration. Now shackled to a world of BIM selection and globalized parts, depth is found in the lamination of materials that cloak a building, not the thick space of a masonry façade. Today's exteriors recreate depth through multiple shade systems, which provide a salvo to the environmental concerns of the all-glass building. But what of an essence of solidity, or a need for less transparency? The thick space of the wall offers a tangible space that the observer can experience and prompts the design to be both cohesive in its thinking and innovative in terms of the technology applied.

The Education of an Architect

As students increasingly utilize BIM modeling software with libraries of existing components, the ornamentation of the building often becomes an application of tiled images on renderings, not the design/refinement of an integral system. As the wall is seen as a series of panelized partitions, its value is often in what it looks like (as a perceived warmth/color/texture), not in what it is made of. While concerns for climate control and economy are critical to architectural education, they cannot subvert the integration of cultural expression. Such expression could be achieved with a return to masonry systems as they are an archetypal site for integrated ornament. Masonry systems can be brittle, heavy, and complex materials to understand without directed physical experience. This experience encourages students to engage with a materials' qualities/difficulties. Because of its challenges, masonry is constrained by subdivision - its optimization is only achieved through a deep understanding of its limits.

As a modular system of customizable parts, unit masonry can be massaged/coaxed into a spatial output, towards a thick space beyond the confines of a plane, whether ornamental, picto-spatial, fractured, parabolic or hinting at transparency. For students, the struggle to integrate ornament, pattern, material, and structure is critical in celebrating both history and technological innovation. It provides modularity that immediately offers human scale and hierarchy. As was the focus of Le Corbusier's *The Modulor*, it is a "working tool, a precision instrument: a keyboard shall we say a piano, a *tuned* piano. The piano has been tuned: it is up to you to play it well."[2] Le

Corbusier understood that modularity could provide a clear foundation for the making of architecture, but that it must be "played" well. Implicit in his statement is the notion that one must "practice" to be good.

A Technological Spark

Throughout history, masonry systems were common to most sedentary (non-nomadic) cultures. While one could write at length comparing the development of these construction systems, the focus of this paper is instead on how a relatively small technological innovation can move beyond its intended purpose given the right conditions. This technology is harnessed and proliferated into myriad forms that contribute to novel and complex space making as well as cultivating highly elaborate and integrated ornament.

Tile vaulting has existed since at least the 14th century[3] and was especially prominent in Barcelona. By employing thin terracotta bricks end to end, the Catalan or timbrel vault was a simple and revolutionary innovation that provided a fireproof spanning system without the weight of stone. Using fast-setting mortars, the vaults typically required no formwork, greatly speeding construction.[4] During the 1800s, the need for factories gave rise to tile vaulting's transition from more religious settings to secular, providing a simple technological shift. Access to stronger, quicker setting mortars became more available.[5] As the building culture in Barcelona using these tiles was prevalent, architects could quickly adapt and expand this small technological innovation.[6]

Buildings such as Rafael Guastavino's Batlló Factory and Josep Puig i Cadafalch's Casaramona Factory are both excellent examples of a proliferation of vaulting in support of a factory typology. The development of brick did not stop at the vault, utilizing an almost baroque application of exposed brickwork. The module of the terracotta tile that structures the roof becomes embedded in the façade, integrating ornament. The brick's thinness creates the possibility of corbeled stacking, archways, and colonnades. Even though factories are presumed to be austere – the use of this system provided detail and elaboration that was elegant and culturally meaningful.

Fig. 2. Elaboration of tile/brick from from Puig I Cadafalch's Casaramona Factory (above) to Gaudi's Casa Mila (below). Photo credit: Bruce A. Johnson

Architects in Barcelona, including Antonio Gaudi, Domènech i Montaner, and Puig i Cadafalch, became the accelerant for this technology, where the fractal-like propagation of new forms and ornament in natural brick/terracotta erupted. (Fig. 2) These architects understood that building could also be a representation of Catalan identity, by the expression and integration of the terracotta tile, elevating it beyond function.[7] This can be seen particularly with Gaudi, who pushed the terracotta tile further through the incorporation of natural forms, from the snake bone-inspired roof structure in Casa Mila, (Fig. 2) to the implied awnings of Sagrada Familia's freestanding nursery. (Fig. 3) Again, the innovation of a quicker-set mortar and a thinner brick/tile generated an explosion of uses and reinvigorated formal exuberance.

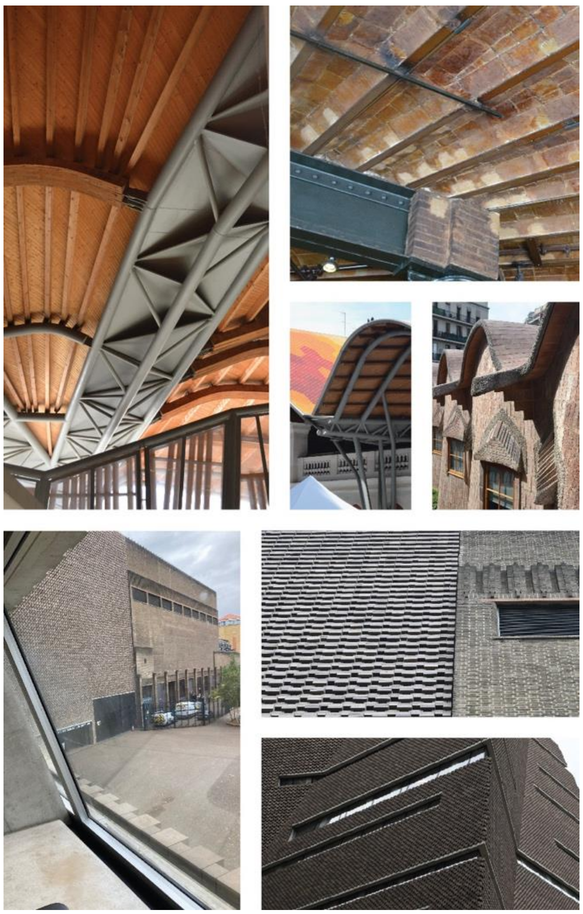

Fig. 3. Miralles' Santa Catarina Market (above) with traditional Catalan vaulting and Gaudi's nursery at Sagrada Familia versus Herzog de Meuron's brick veil at the Tate Modern (below). Photo credit: Bruce A. Johnson

Extending this argument, Enric Miralles understood the region's building methods as tied to Catalan culture and pushed terracotta tile outside of its material constraints. He saw construction like sketching, always transforming in response to the moment, "As if construction were not the final stage of the work process, but simply another of the unconnected instants that are always demanding a new response…. The same material asks to be shown in different forms, to bring the thinking up to date at every moment."[8] The Santa Catarina Market is clearly designed referencing the nursery of Sagrada Familia as well as traditional Catalan vaulting, but he chose to construct the roof in a combination of timber and steel, using ceramic as the outer skin instead. (Fig. 3) At the Igualada Cemetery, the tile is transformed into precast concrete, where the repeating block fronts of the niches become an ornamented tile, reading against the utility of the gabion wall. The history of terracotta tile in the region is inspiration, but precast block as a stand-in for tile creates the ordering system.

A counterpoint to the aggregation of tectonic/ technological innovation into ornament is seen in London at Herzog and de Meuron's addition to the Tate Modern (a previous adaptive use project by the same firm). London, like Barcelona, has a strong culture of masonry construction, and by hybridizing it with steel, monumentally sized industrial buildings could be constructed. In the original Switch House by Gilbert Scott, the use of brick is quite traditional, with masonry load-bearing walls and accent courses which form bands: here the brick is durable and relatively maintenance free. In Phase 2, the architects offer a similar color brick, calling it a "veil,"[9] but rely on a concrete frame so that the brick becomes a screen with perforations providing pattern and openings. The walls are a multi-layered system, where a vapor barrier is intended to keep moisture out. An interesting outcome of this elaborate play is that brick is only manifest on the interior when one looks through the aggressively patterned fenestrated openings or along the edge of the concrete frame, revealing it as a deliberate screen supporting only itself.

The Tate Modern Phase 2 appears to be masonry construction intended to work with the original brick structure,[10] and there is necessarily a dialogue between old and new due to their adjacency. However, the effect of the new brick as veil reads as pasted or adhered on, its use only a requirement due to color/scale. (Fig. 3) While the new building is masonry, it functions as a skin, but one of many thin layers that constitute the wall. What's lost is the sensibility of the brick, what it can do or how it can facilitate form on its own, and its ability to be read on the interior. Instead, it behaves as a shroud, and the spatial monumentality of the Turbine Hall, so valued in the original museum and where the technological innovation of the original construction is, becomes ignored in a translation seemingly aimed at denying the very weight of the brick.

In Barcelona, two things are at work: a climate (a kind of boiling point) and a small technological shift that sparks transformation. The climate manifests a building culture able to take advantage of that technological shift, which produces a ripple of after-effects that extend beyond a technology's original intent. What is critical in the examples from Barcelona is the way that technological innovation becomes the thread that spawns future diversions and deviations. This thread is not historicist but forward minded and can persist similarly to an atomic half-life – this can be seen in the work of Miralles. Projects in this vein of opportunity-supplied transformation depend on a modularity of human scale that shapes the form and formal play that becomes its celebration – its ornament.

Returning to Corbusier's modularity, great ancient buildings "…were all built according to precise measures…, a coherent system… which proclaimed an essential unity."[11] This unity develops from a kind of "block thinking." As part of the education of a "well-trained" architect, this block thinking is a system of measures tied to modularity as a three-dimensional system developed through material constraints that can be modified towards exuberance or celebration but must be understood to stand up to such modification.

A Design Methodology

In school, students test architectural ideas while learning the skills and knowledge needed to create a building. Direct experience with materials reveals their limitations, which must be understood to master them. When a material is too heavy, can't be cut, or can only work in certain ways, these attributes are often directly learned by doing rather than drawing. Fabrication research within studio teaches students to learn by failing. (Fig. 4) The fabrication process does not need to lead to a beautiful object that is structurally sound. Failures that come with misunderstanding a material are as important as a

Fig. 4. Direct experience as it translates to block thinking from Kansas State University studios 2018, 2022, and 2023.[12] Photo credit: Genevieve Baudoin

photogenic installation. "Block thinking" can be brought to the forefront of a project by understanding how the constraints inherently embed the scale of a human in their size, weight, etc. The challenges can then be used to organize a complete project/idea.

Block thinking is an abstract process where repeatability and scale is understood adjacent to material understanding. In his essay "Drawn Stone," Robin Evans writes that stereotomy, or "the cutting of solids," was, "…at the edge of mathematical geometry…at the edge of technical drawing…it flourished only were definitions blurred…the historical relationship between structure and ornament."[13] The block, as a repeating unit with thickness/poche, is subject to carving or subtraction. This stereotomic action can radically transform the felt space of the wall through how it repeats, stacks, and turns corners. Poche is an abstract space that is less used today in the manner of Palladio or Ledoux, largely due to the Modernist desire for thinness and the environmental performance we now require. But it is a critical tool that can encourage formal play and discovery and from which a "modulor" can be discovered. Through direct experience and block thinking, the architect is better prepared to take advantage of any technological shift to proliferate novel spaces, materials, and forms. Evans seems to predict the possibility of this transformative potential, writing: "Stone with the labor and weight wrung from it, could look almost like paper.… it demonstrated the victory of intelligence over material substance."[14]

The pursuit of speculation may be needed when architecture is increasingly tied to regulated factory-like production. This limits the ability to propose and test new ideas that cannot be immediately profitable. There are firms like Foster + Partners and Renzo Piano Building Workshop that investigate topics related to material and product research, and they do so not so much for profit but to advance a larger tectonic thinking. Academia, on the other hand, can offer a means to pursue material and product research, but it can often become myopic, where the constraints of the scientific method slow a more immediate transfer of new technologies. Conversely, the academy, through the lens of design studio, remains a venue for testing ideas (whether concept, material, assembly, or community oriented) that largely remain unbuilt. These unbuilt projects test architectural ideas and should not be limited to the academy (either student or faculty). In the past, publishing theoretical projects was often the foundation for one's practice. Architects from Zaha Hadid to Steven Holl, Stan Allen, Bernard Tschumi, Rem Koolhaas, and more contributed to the discourse of architecture by writing on their own projects while learning directly from praxis what worked and what didn't. The projects that follow attempt a confirmation of this last vein of architectural inquiry – specifically where spatial possibilities are tethered to a material and tectonic investigation and where space is tied to the material and tectonic possibilities of a 3D printed masonry block.

A Theoretical Idea

With automation and cutting-edge printing technologies, the solid material qualities and malleability of clay/ceramics create a wellspring of potential in block systems. Traditionally the physical weight of clay/stone provided spatial thickness. Today, as Kahn stated in 1944, we can build with "hollow stones."[15] Within hollow stones we can embed utilities, ducts, services, etc. while potentially printing these stones directly on-site and reducing their embodied energy. So, can we utilize our technological sophistication to reshape the block and imagine the outcome?

Contemporary technologies applied to masonry construction offer a return to tactile solidity and the space of interaction between a building and its users. The following three proposals utilize a theoretical construction system, Woven Blocks,[16] as a modular ordering system to drive form that can be reshaped by the constraints of the individual sites. The blocks are intended to be manufactured through an on-site binder jet printing process. Structurally, the blocks act as a hollow stressed skin where a corrugated infill bonds an outer sinusoidal thickened surface to an inner flat thickened surface. This allows the weight of the block to be reduced while maintaining the stability of a deep section. Upon manufacture, the sinusoidal “active” surface is embedded with ornament/pattern. (Fig. 5)

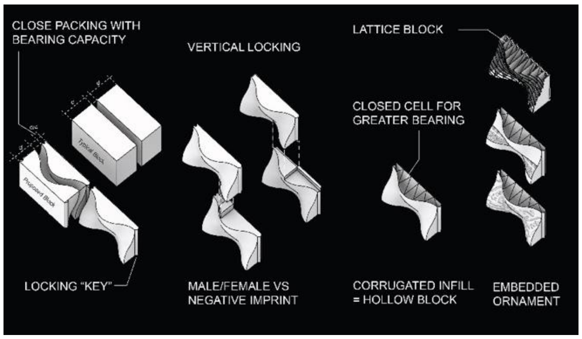

Fig. 5. Woven Block design evolution from basic pattern to ornamented block. Image credit: Dual Ecologies

Basic block dimensions for all three projects are 5.4’ x 4’ x 3’. Printers large enough to accommodate such dimensions exist in industry. These printers typically use highly uniform sands and phenolic resins as binder to create sand-cast molds for metal parts and would not be appropriate for building blocks. But if this printing technology could be made mobile, utilizing sands found on site that are bound by cementitious or biopolymer-based binders, the technology could shift to accommodate architectural block construction. The Woven Blocks design sits on the boundaries of a feasible block size to imagine the potential of 3D printing architectural scale building blocks. The following three proposals explore and test the potential of this hollow stone. Along with the formal specificities required at each site, each proposal derives an ornament/pattern from its regional culture (Incan Peru, Malian Africa, and the Angkor Wat region of Cambodia).

The first project, an Agricultural Center for Cuzco, (Fig. 6) is a study on the Incan terrace system. Here the terracing of the hill provides the basic ordering principle as it follows the flow of rainwater from an access road above and through the building enroute to storage in a sublevel of each terrace. Layers of heavy block walls that have been printed to match the curvature of the topography nestle and pull apart providing interior and exterior agricultural plots and building program. In this manner, the building program occasionally occupies a series of empty terraces where sparsely placed roof structures provide educational test plots above and shelter for classrooms below. Vertical movement is supplied by a secondary structural system of light steel. Where steel intersects the blocks, special building programs and select views are nested.

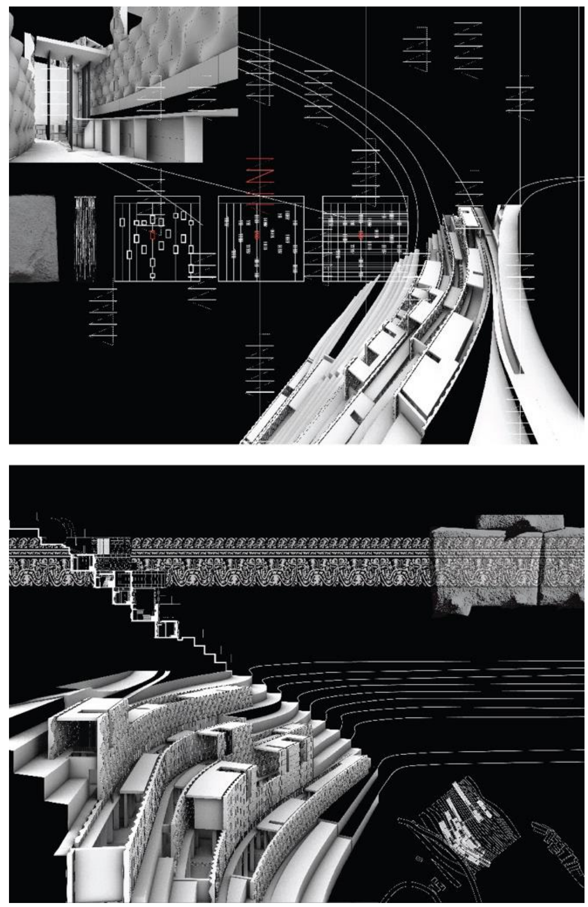

Fig. 6. Two composite drawings to illustrate the proposal for an Agricultural Center at Cuzco. Image credit: Dual Ecologies

The Siem Reep River House (Fig. 7) straddles the river that feeds the Angkor Wat Temple complex in Cambodia. A perimeter site wall ensures the legibility of the overlap between house and river and allows for water storage during the dry season as a series of reflecting ponds. The domestic program is layered into subgrade strata constructed of plain-faced heavy block. The ceremonial program of the house grows from these strata into three vertical towers. The towers are inverted hollow pyramids clad in heavily patterned blocks. Each tower relies on a repetitive light steel frame to support a perceptually heavy hollow block skin. In the tower the walls tilt away as one processes upward, and the light steel provides an anchor back to gravity and the program below.

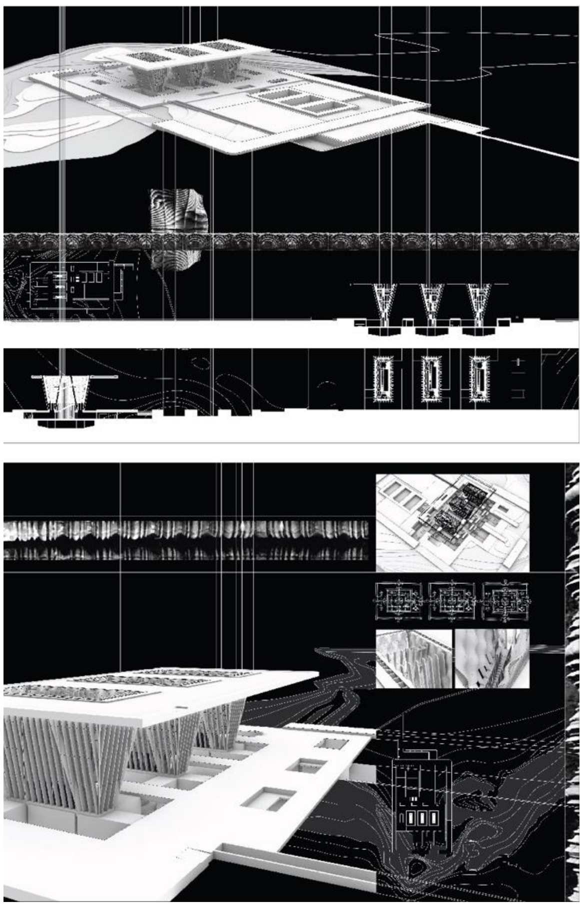

Fig. 7. Two composite drawings to illustrate the proposal for a River House on the Siem Reep. Image credit: Dual Ecologies

A spiraling processional ramp provides order to the Manuscript Library at Timbuktu (Fig. 8). The ramp is held by a series of heavy block bents that frame side aisle repositories. The bents begin solid and erode vertically, becoming finger-like and comingling with the filtered light from the sheltering roof above. Two internal ventilation chimneys provide air flow from ground source tunnels connected to towers nested in the city beyond. Inspired by the introverted and climatically responsive buildings in Mali, the internal central chimneys subdivide the winding ramp system into private zones that abut the public circulation. Light steel structure punctuates the heaviness of the introverted heavy block ensemble supporting the ramp when it detours into the primary public zone of the building. Here, the ramp breaks away from its primary role as an unwound and continuous library stack.

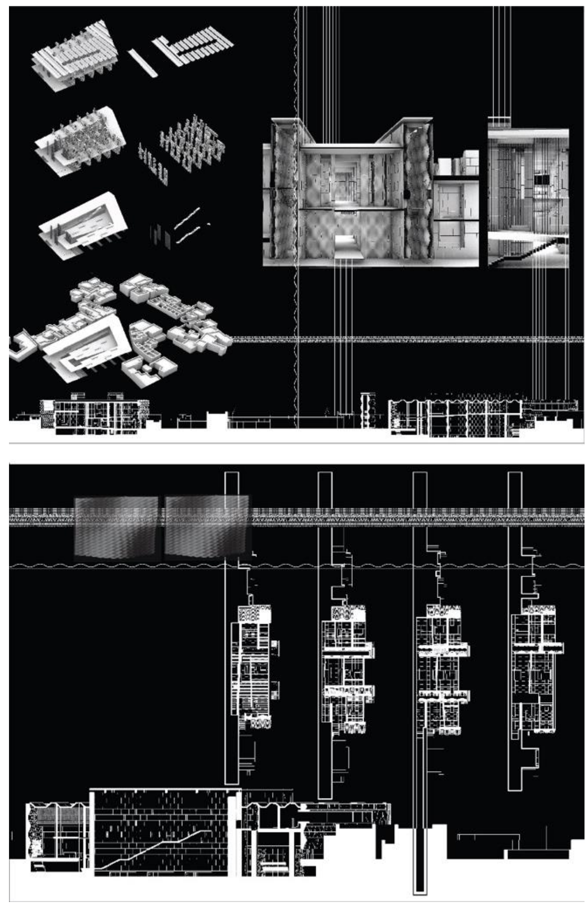

Fig. 8. Two composite drawings to illustrate the proposal for a Manuscript Library at Timbuktu. Image credit: Dual Ecologies

Conclusions

The goals of the preceding projects are multifold. First, these proposals intentionally utilize the type of block thinking that both provides a coherence to an individual project as well as a thread between them. The blocks drive the wall heights and character of the spaces. As the walls turn corners, these conditions are dealt with differently depending on context. They are treated as an absence at Angkor Wat, as an extension at Cuzco, and as an additive change at Timbuktu. The blocks are not solely beholden to themselves and intentionally rely on the balance of an additional tectonic system when needed for tensile support or as a balance to the perceived heaviness of the blocks. This provides hierarchy to the blocks.

Second, the block, because it is a printed object, can be made to adapt to a range of sites. While more investigation into the material properties and the block's environmental, thermal, and structural performance would be necessary as these projects develop, for Cuzco, the blocks are subtly curved to match the topography. At Angkor Wat, the blocks must step out at an angle and can be printed to allow that geometry. In the Timbuktu proposal, the bents and chimneys require trimming and individual sizing of the blocks to create the perceived lightness as one moves up the ramp. While this can be seen as a naivety that is enabled by the digital process, this is also the potential of the mass customization that 3D printing offers.

Third, because this is a printed masonry system, ornament can be embedded into the manufacturing process. Ornament is a means to provide cultural expression and spatial enhancement that has been lost in today's architecture, where it fell out of fashion with the rise of the idioms of Modernity and the methods by which to embed it. Ultimately without ornament we are left with the expression of the technology, which is increasingly divorced from the humanity of a given work. Utilizing printing over hand craft is not intended to supplant artisanal labor on a given site, but to revive an ornament that is all but lost either because the craft no longer exists or is too labor intensive to produce today.

Fourth, these projects look to deliberately employ a perceptually solid structure adjacent to culturally loaded sites that already utilize heavy/thick load-bearing masonry to test the relationship of the old and the new. As in Barcelona and London, the locales of Peru, Mali, and Cambodia have a building culture that is rich. These proposals are a way to test whether a small technological shift in the printing process can be applied to an environment that might seem alien to the technology but could spark further formal exuberance in the search for the spatial implications of the thick wall. This type of study is critical in schools of architecture as well as in praxis, where the richness of a building culture can be intensified to spawn not just a one-off novelty building but a generation (or more) of architects with more intensity and sophistication than before.

Notes:

1 Kim Tanzer and Rafael Longoria, *The Green Braid: Towards an Architecture of Ecology, Economy and Equity* (Routledge Press, 2007), 196.

2 Le Corbusier, *The Modulor,* trans. Peter de Francia and Anna Bostock (Faber and Faber, 1954), 130-131.

3 John Oschendorf, *Guastavino Vaulting: The Art of Structural Tile* (Princeton Architectural Press, 2010), 20.

5 E. Murphy, T. Michiels, and D. Trelstad, "Forging the Link Among Shape, Formwork, and Mortar Assemblies in Guastavino Vaulting," in *History of Construction Cultures Volume 1: Proceedings of the 7th International Congress on Construction History (7ICCH 2021), July 12-16, 2021, Lisbon, Portugal*, eds. João Mascarenhas-Mateus and Ana Paula Pires (Taylor & Francis, 2023) 149-153, doi.org/10.1201/9781003173359-20

6 Salvador Torragó, "Considerations on Guastavino's work in Catalonia," in *Guastavino Co (1885-1962): Catalogue of Works in Catalonia and America*, Salvador Torragó ed. (Actar + Col-legi d'Arquitectes de Catalunya, 2002), 7-8.

7 Jeremy Roe, *Antonio Gaudí* (Parkstone International, 2012) 20-21.

8 Enric Miralles, Richard C. Levene, Fernando Márquez Cecilia, and Carme Pinós, *Enric Miralles, 1983-2000: mental maps and social landscapes = mapas mentales y paisajes sociales* (El Croquis, 2002), 78.

9 “Herzog and De Meuron: The New Tate Modern,” *GA Document* 138 (August 2016), 45.

10 Alexandra Casto, “The Modelling Process of the Tate Modern Brick Façade by Herzog & de Meuron,” *Nexus Network Journal: Architecture and Mathematics* 23 (2021), 1045-1046, https://doi.org/10.1007/s00004-021-00572-x.

11 Le Corbusier, *The Modulor: A Harmonious Measure to the Human Scale Universally Applicable to Architecture and Mechanics*, trans. Peter de Francia and Anna Bostock (Faber and Faber, 1954), 11.

12 Students’ work included: Colton Parmley, Cordell Robinson, Riley Counts (2023); Ryne Roemer, Tim Ahn, Hannah Fowler, Simon DeGrace, Natalie Roberts, Enrique Alvarado, Nathan Alford (2022); Tim Struemph, Dylan Schoenfeldt, Mitchell Culbertson, Guiliana Fustagno, Andrew Mallinson, Jared Shelton (2018)

13 Robin Evans, *The Projective Cast: Architecture and Its Three Geometries* (MIT Press, 1995), 179-180.

14 Evans, *The Projective Cast*, 205.

15 Louis I. Kahn, “Toward a Plan for Midtown Philadelphia,” *Perspecta: The Yale Architectural Journal* 2 (1953): 23.

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