

Where do the Twigs Go: Alternative Sustainable Practices

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The paper describes the theoretical framework, design and technical processes behind *Where do the Twigs Go?*, a temporary 3000 ft² spatial construct in Dubai, United Arab Emirates. The project is made primarily out of scavenged palm fronds, palm leaves and paper pulp from recycled paper.

The paper describes how the relationship between the theoretical framework, design and technical processes work to: 1. Integrate painterly attitudes and workflows into contemporary computational design methodologies and highly standardized modes of sustainable design production; 2. Rethink how ideologies and practices of Environmentalism impact architectural practice in the Middle East and North Africa.

The brief was to create five 500 ft² temporary exhibition spaces that operate as a public spatial landscape. Each of the five differentiated spaces is defined by highly textured exterior surfaces constructed through the layering of natural (i.e. Palm fronds and leaves) and synthetic materials (i.e. Paper pulp) to create conditions that challenges the visitors' assumptions about material, construction, and the environment. The textures recede in the interior spaces, giving primacy to the exhibition material. Ultimately, the spatial composition, materiality and curatorial framework create an activated public space.

Materially, the non-linear structuring of textured surfaces with natural and recyclable synthetic materials emerged by asking a child-like question: *Where do the twigs go?* The question emerged from an attempt at rethinking the life span of materials used in constructing temporary structures. Thus, the project explores the potential second life that plant matter can have between the time they are harvested, and the time they turn to compost? The answer presented here comes in the form a thickened yet porous structural wall.

The paper is structured in three parts. First, it describes the theoretical framework that drives the larger body of work. Second, the paper describes the design process and its relationship to the framework. The project developed through a digital/analogue workflow that moved between scavenging for natural material, 3D scanning, digital simulations,

and physical prototyping to produce painterly material systems. Third, the paper describes the construction process. Throughout, the paper maps the alternative modes of material sourcing that have to take place in such a project, and the industry relationships that facilitate these alternative sourcing processes.

At the end of its 7 days short life, all elements of the project have been composted or recycled.

INTRODUCTION

This paper describes the theoretical framework, design methodologies and fabrication processes involved in the making of a 3000 ft² temporary exhibition structure in the United Arab Emirates (UAE) titled *Where do the Twigs Go?*. This construct explores the architectural potential of an environmentally-friendly material system that integrates locally sourced and scavenged of palm fronds with sprayable and fibrous materials, specifically, paper pulp made from locally reclaimed newspapers.

As such, this paper is structured in three parts. First, it describes the theoretical framework and the goals that drive the larger body of work and research titled *Other Environmentalisms* that this project sits within. Second, the paper describes the design process, which was developed through a digital/analogue workflow that moved between scavenging for natural material, 3D scanning, digital simulations, and physical prototyping to produce painterly material systems, and its relationship to the theoretical framework. Finally, the paper describes the construction process, in which 5 discrete spaces were constructed, each space is composed of thickened wall surfaces that measure approximately 7 x 9.8 x 0.2 ft (Figure 2). Throughout, the paper will illuminate the alternative modes of material sourcing that have to take place in such a project, as well as the industry partnerships and relationships that help facilitate these alternative sourcing processes.

MAKING OTHER ENVIRONMENTALISMS

Where do the Twigs Go? represents one physical manifestation of a larger body of work that aims to advance an agenda *Other Environmentalisms*. This research agenda aims to activate Middle Eastern and North African (MENA) environmental attitudes and practices to drive innovative contemporary building solutions

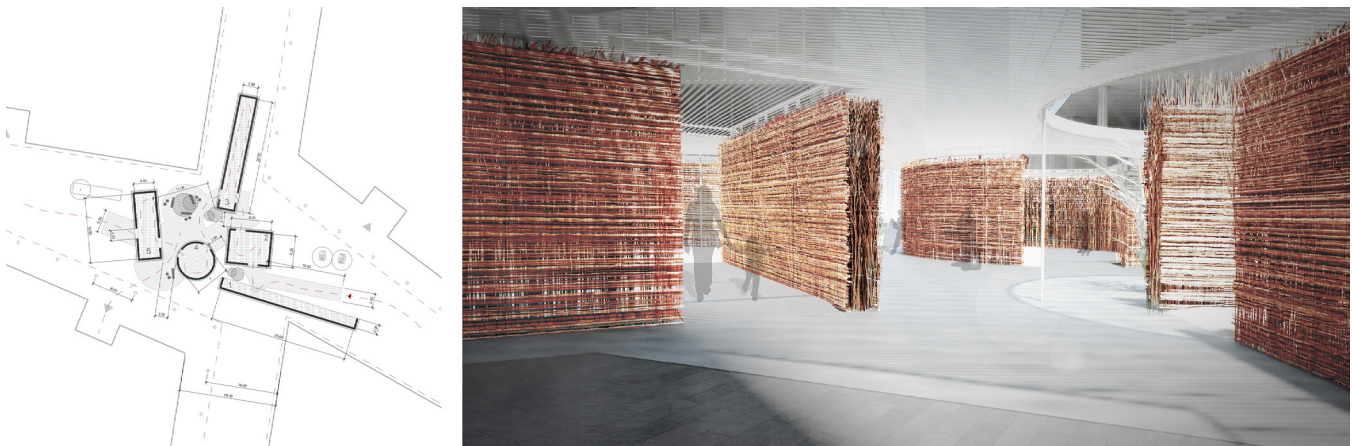


Figure 1. Plan diagram showing the 5 radically different pavilions as well as Spatial render showing an impression of how the walls work together to create a varied curatorial experience.

by exploring context-driven modes of production, alternative material systems, and the relationship between environmental and architectural imaginaries in a post-colonial condition.

Focusing on the material and the cultural aspects of the MENA environment, this agenda deploys environmental history methodologies and material research to generate architectural conditions that exhibit alternative attitudes to making and assembly to mainstream sustainable architectural production. The goal of this agenda is to challenge deterministic ideas about the MENA natural environment which limit architectural discourse and production in the MENA by introducing alternative narratives around environmental design within the MENA that destabilize imported Western notion of environmentalism.

As such, Other Environmentalisms critically examines and reimagines the production of contemporary architecture in the Middle East and North Africa (MENA) by interrogating the relationship between architecture and the environment. This has been developed within two ongoing challenges in the MENA: 1. The erasure of nuanced cultural specificities in the architectural imaginary due to highly techno-scientific trends operating within mainstream green building practices; and 2. Climate crisis.

A strong architectural current that runs through the Other Environmentalisms agenda is to look towards land art practices and to deploy painterly attitudes towards design and fabrication workflows in an effort to disrupt prevailing tendencies within mainstream sustainable design production that relies heavily on techno-scientific solutions.

PAINTERLY ATTITUDES TOWARDS DESIGN

In a seminal work published in 1915 titled *Principles of Art History: The Problem of the Development of Style in Later Art*, Swiss art historian Heinrich Wölfflin identifies a radical material shift in European representational art styles in the periods

between the Late-Renaissance and the Baroque in sixteenth and seventeenth centuries¹. Specifically, Wölfflin argues that what occurred was a shift from the linear to the painterly. Wölfflin defines the painterly as embodying limitlessness and merging, receding, open, and lacking in linear hierarchy. This represents an antagonistic and direct shift from clarity, tangibility and solidity of the linear style prevalent in Late Renaissance representational art. Architecturally, this paper argues that this reading refers to a proliferation of ambiguous part-to-whole relationships².

When looked at through a contemporary lens, it becomes apparent that the shift that from the linear to the painterly mirrors the shifts between still-prevailing Modernist attitudes to architectural production and emerging alternative modes of production that privilege redundancy over optimization. An example of this can be seen in *Rock Print*, a collaboration between Gramazio Kohler and Skylar Tibbits for the Chicago Architecture Biennial 2015, in which a column was constructed by “jamming” relatively small and untreated pieces of stone bound together by a continuous metal string. What results is a redefinition of traditional part-to-whole relationships³.

Rock Print and the project described in this paper, share a relationship with each other beyond their painterly attitude towards part-to-whole relationship; they are both forms of co-opting land art into architecture. While land art is typically understood as “art that is made directly in the landscape, sculpting the land itself into earthworks or making structures in the landscape using natural materials such as rocks or twigs... Land artists also made land art in the gallery by bringing in material from the landscape and using it to create installations.”⁴ Both projects, and most projects within the Other Environmentalisms agenda, co-opt material that is typically seen outside of mainstream construction processes into a structural and spatial condition.



Figure 2. View of the interior of a pavilion space showing the thickened wall in elevation.

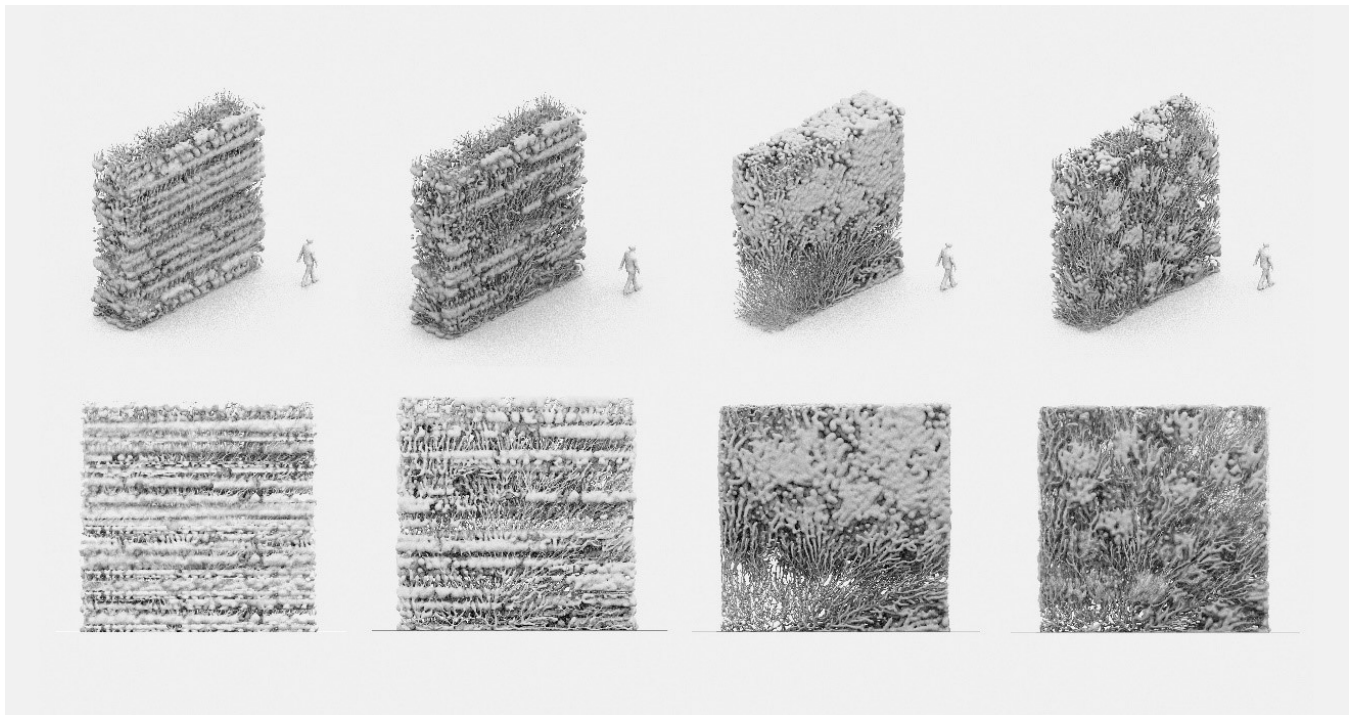


Figure 3. Versions of digitally produced twigs and digitally simulated paper pulp showing striated and gradient patterning.

Thus, *Where do the Twigs Go?* situates itself within a contemporary shift between the linear and the painterly. In essence, it deploys painterly methods of assembly to create an architectural condition that puts into question traditional part-to-whole relationships. The project explores the potential of deploying painterly attitudes within the context of contemporary computational design methodologies and digital fabrication techniques by introducing material scavenging into an analog/digital workflow that includes scavenging, 3D scanning, digital simulations, and physical prototyping. Specifically, *Where do the Twigs Go?* explores the potential of deploying a relatively large number of self-similar scavenged natural material, to the point of redundancy, to create composite wall surfaces devoid of any mechanical connections. The result is an open and limitless material system that blurs part-to-whole relationships in favor of ambiguous material hierarchies through the use of locally sourced and scavenged of palm fronds with sprayable and fibrous materials, specifically, paper pulp made from locally reclaimed newspapers.

Another condition within the project that connects the painterly attitude described above, as well as the land, with the broader cultural goals of the Other Environmentalisms agenda, is its attempt at challenging deterministic ideas about the MENA natural environment which continues to limit architectural discourse and production, is the material and assembly's relationship with vernacular houses in the UAE and the wider region, that remained in use well into the middle of the 20th century, and were made almost solely from palm fronds (These were locally known as *Areesh* houses). In ways that are very much similar to

the contemporary *Rock Print* project mentioned above, these structures eschewed part-to-whole readings in favor of. While this was the result of a tactical move, given the relative scarcity of building materials, allowing for the redundancy of palm fronds to become both structure and enclosure, rather than an overall design agenda, this project recognizes these practices as an influential material culture reference.

PAINTERLY SPATIAL ORGANIZATIONS

The project brief asked for five discrete yet spatially connected exhibition spaces, each providing approximately 500 ft² of uninterrupted exhibition space, with the overall exhibition theme and content independently curated by a single curator. Moreover, the client required that the exhibition spaces be connected to a unified external public space.

Given these requirements and conditions, a painterly approach was deployed at a master-planning scale. Specifically, the overall spatial organization of the project was conceived through the positioning of discrete painterly assembled walls of different lengths that work off of each other spatially to create an interplay between semi-enclosed exhibition space, circulation and public spaces. Ultimately, the dynamic composition, and the resulting relationship between the walls allows for a non-linear, yet coherent, curatorial narrative to emerge both in the interior, as well as on the exterior (Figure 1).

SCAVENGING AND DIGITAL ASSEMBLY

The overall development of the project relied on a feedback loop between an integrated analogue/digital workflow that



Figure 4. Prototypes showing scavenged twigs and sprayed paper pulp binder.

adapted to the different scales of the design process, from initial physical and digital prototypes to large scale wall surfaces. This workflow oscillated between scavenging for natural materials that afford particular architectural qualities such as redundancy and density through repetition; 3D scanning to better understand and deploy the materials chosen; digital simulations to create variable design iterations of wall types to achieve a workable technical and design solution, 3D printing of digital prototypes for assessment, and physical prototyping to produce painterly material systems that challenge traditional part-to-whole logics.

DEVELOPING A PAINTERLY ASSEMBLY

Given the previously described conceptual agenda, as well as limited project budget, early decisions were made to explore the architectural potential of creating a composite material system made completely from reused elements that would typically find their way into a waste management facility, either permanently within a landfill or in transit on the way to recycling or being incinerated.

Thus, after a series of site visits which build on a previous working relationship with Bee'ah, a leading integrated environmental, recycling and waste management company in the UAE, as well as initial prototypes (Figure 4), the decision was made to explore the architectural potential of creating wall surfaces that integrate natural plant material (a design feature that exists within other iterations of the overall conceptual agenda) and binding them with a sprayable fibrous material in the form of paper pulp made from locally reclaimed newspapers.

The first steps included identifying a type of natural plant material that is abundantly available through ongoing and non-seasonal cutting. This material also needed to exhibit particular volumetric density once aggregated, so that it can receive sprayed paper pulp, so that it can transform into a painterly material assembly. While, previous design projects within the agenda relied heavily on fallen timber members, the square area of wall surfaces required for this project immediately ruled that out. Thus, the choice fell on a finer type of plant material that allows for a higher resolution surface to emerge through its redundancy. Specifically, the choice was for particular type of plant material that comes from date palm trees, an abundant tree in the UAE. The branches used typically carry dates, and once the dates are picked, they get cut to allow for a new batch to grow. This condition, along with its inherent density given its filigree nature, made it an ideal candidate.

At first, this material was being scavenged from refuse and home gardens, but eventually, an abundant source was made available from Bee'ah which has an existing collection, sorting and reuse infrastructure in place that the project was strategically able to tap into.

Given the relatively non-mainstream nature of the material sourcing, the unusual nature of the materials and composite material system that was developed, the limited time constraints (The project timeline was approximately 4 months from initial client meetings to disassembly), the severely limited budget for a project of this size, the project was conceived of, designed, and constructed to a large degree through a design-build model. These circumstances enabled an opportunity for an integrated relationship between the designer and the contractor. Thus, the development of the material system occurred in parallel with fabricating the final construct, resulting in a number of subtle differences across different wall panels of the final construct.

While the plant choices were being made, two other activities were taking place. First was the development of a sprayable fibrous material mixture and delivery method (i.e. How to spray it). Thus, a paper pulp mixture was developed and tested at incrementally increasing scales (Figure 4), with a view to minimize chemical adhesives that would otherwise accelerating the drying times. The paper pulp mixture was physically tested and observed for four key characteristics: 1. Compressive strength; 2. Tensile strength; 3. Density and consistency to enable spraying using a simple air compressor that was rigged to becoming a paper pulp sprayer; and 4. Water resistance (given the potential of rainfall at the time the project was up). Finally, the mixture was tested with different natural pigments to explore the role of color in the pavilion.

DEVELOPING PAINTERLY COMPUTATIONAL METHODS

A simultaneous computational methodology was developed to create a circular feedback loop that better informs the design decisions regarding plant layouts and spraying densities and

orientations. This process was also highly beneficial for pre-fabrication purposes, as it became an efficient way of producing imagery to communicate design intent with the contractor given that traditional shop drawings were not realistically going to communicate well in this project. Thus, the images produced digitally became alternative types of instructions.

This computational methodology included 3D scanning plant material and sprayed plant material to be able to digitally simulate design iterations of wall surfaces at a human scale (Figure 3). This process allowed for a diverse array of design choices to emerge. For example, Figure 3 clearly shows an iterative study of variable spraying densities and orientations, such as walls that exhibit striated effects, derived a steady and linear spraying motion, and others that exhibited a gradient effect, derived from a wider and surface driven spraying motion. Throughout this exercise, 3D printed prototypes at various scaled were also used as a prototyping and communication tools with both the client and the contractor.

CONSTRUCTING THE WALLS

The construction of the wall surfaces was broken down into a series of repeated prefabricated uniform parts. Each part measured 7 x 9.8 x 0.2 ft and were assembled linearly to create longer wall surfaces and resulting spatial conditions. The wall surfaces were all prefabricated offsite and erected on site in two days. Each prefabricated part was made up of 4 parts: 1. Scavenged palm fronds; 2. Paper pulp; 3. White-wood frame; 4. Metal wire mesh. The wire mesh stretched over the wood frame, after which the plant material was entangled into the mesh. No mechanical connections exist between the plants and the metal mesh as the paper pulp acted as the binder.

Each wall panel consisted of two different types of surfaces, corresponding to an interior and exterior surface. As show in Figure 5, the external wall surface was finished with a rust colored paper pulp mixture binding the plant material, while the interior texture was composed of paper pulp sprayed directly on top of wire mesh. This interior condition was designed to allow for the displayed work in the interior of the pavilion space to be the center of attention, while the wall surfaces recede.

CONCLUSION AND FUTURE ITERATIONS

A major lesson learned within this project was the disconnect that can occur within an analogue/digital circular workflow due to the nature of the two different conditions. For example, Figure 4 shows a number a striated condition that simulates a linear spraying motion at a controlled speed, paper pulp density and nozzle size. However, given a number of factors both environmental and mechanical, these exact conditions were difficult to replicate at a larger scale. This was because the initial simulations were based on physical and scanned prototypes at a much smaller scale (Figure 3). Thus, future work will include further development of the paper pulp mixture as well as a more robust and robotically controlled spraying mechanism

that can achieve results that are closer to a digital simulation to close the circular design process.

Finally, at the end of its 7 days short life, all elements of the project have been composted or recycled.

ENDNOTES

1. Heinrich Wölfflin, *Principles of Art History: The Problem of the Development of Style in Later Art* (PP: Dover, 1950).
2. A version of this paragraph was written in a previous paper coauthored with another individual. Full credits will be given upon acceptance.
3. "Gramazio Kohler and Skylar Tibbitts' 'Rock Print' Is a Gravity-Defying Pile of Stones," *ArchDaily*, October 14, 2015, <https://www.archdaily.com/775343/gramazio-kohler-and-skylar-tibbitts-rock-print-pushes-the-limits-of-stone-structures-at-chicago-architecture-biennial>.
4. "Land Art – Art Term," Tate, accessed October 16, 2019, <https://www.tate.org.uk/art/art-terms/l/land-art>.

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Figure 5. Pavilion image showing thickened free-standing wall, skylight, roof, entry and the white surfaces of the interior space. Interior surfaces alternated between white, (exterior) red and black depending on interior exhibits, as well as conditions where visitors interact with the project. (Top photo credit: The Cartel; Bottom right photo credit: Jalal Abuthina)