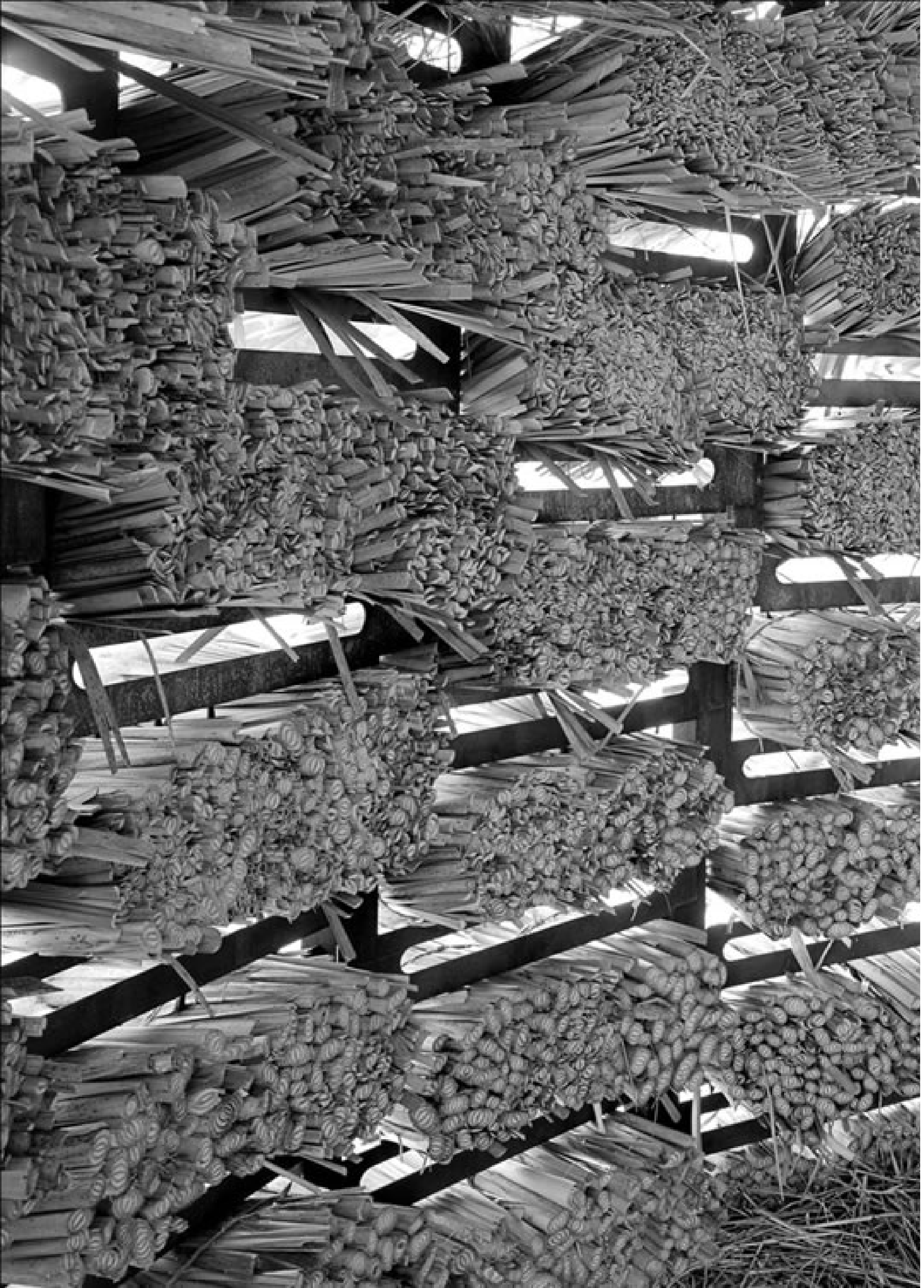
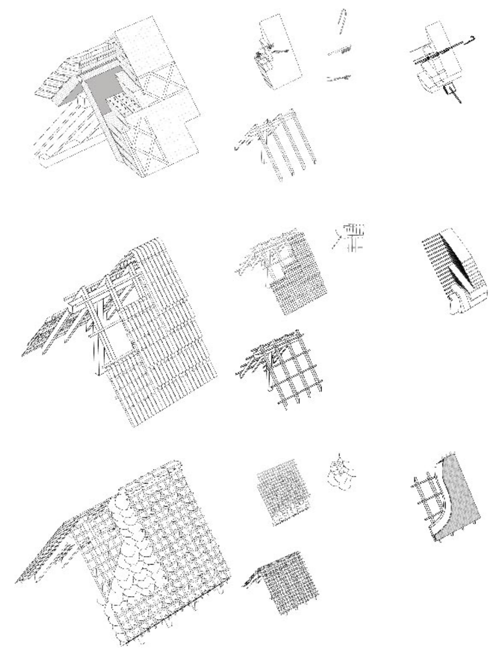




HAIR, SPIKES, CATTAIL AND TURKEYFOOT

Vivian Lee

A decade into the popular use of digital fabrication in architectural design, one thing is certain: this [digital fabrication] will not kill that [the construction drawing].

Digital fabrication promises to transform architectural design from an allographic to an autographic art. In the digital fantasy the architect, like a sculptor, has total agency over the final form and is unimpeded by the translation of the construction drawing. In practice, however, these methods often require a new convention of construction documentation that speaks to the assembly of the coded, fabricated parts.

There are also extant construction methodologies that bypass the process of representational translation through the custom of oral tradition. One such methodology is thatch, which makes use of a material that is difficult to tame, and whose associated construction processes are contingent upon the its indeterminate attributes. It is this indeterminacy that has constrained documentation of the dwindling craft. By eliminating the need for representational translation, oral transfer of thatching knowledge can account for hard to describe labor practices and complicated sequences of operations.

Hair, Spikes, Cattail, and Turkeyfoot is an architectural project that seeks to discover new construction drawing conventions by exploring the techniques of thatching alongside the potentials of digital fabrication in the assembly of a pavilion. The design of this project has a twofold agenda: 1) to investigate, with the use of digital technology, the design and fabrication of strategic components that would bundle and organize soft organic matter into structure, and 2) to design a method of representation that redefines the construction set as a sequence of operations rather than an illustration of finished assemblies.

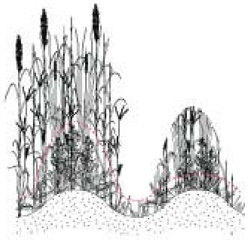
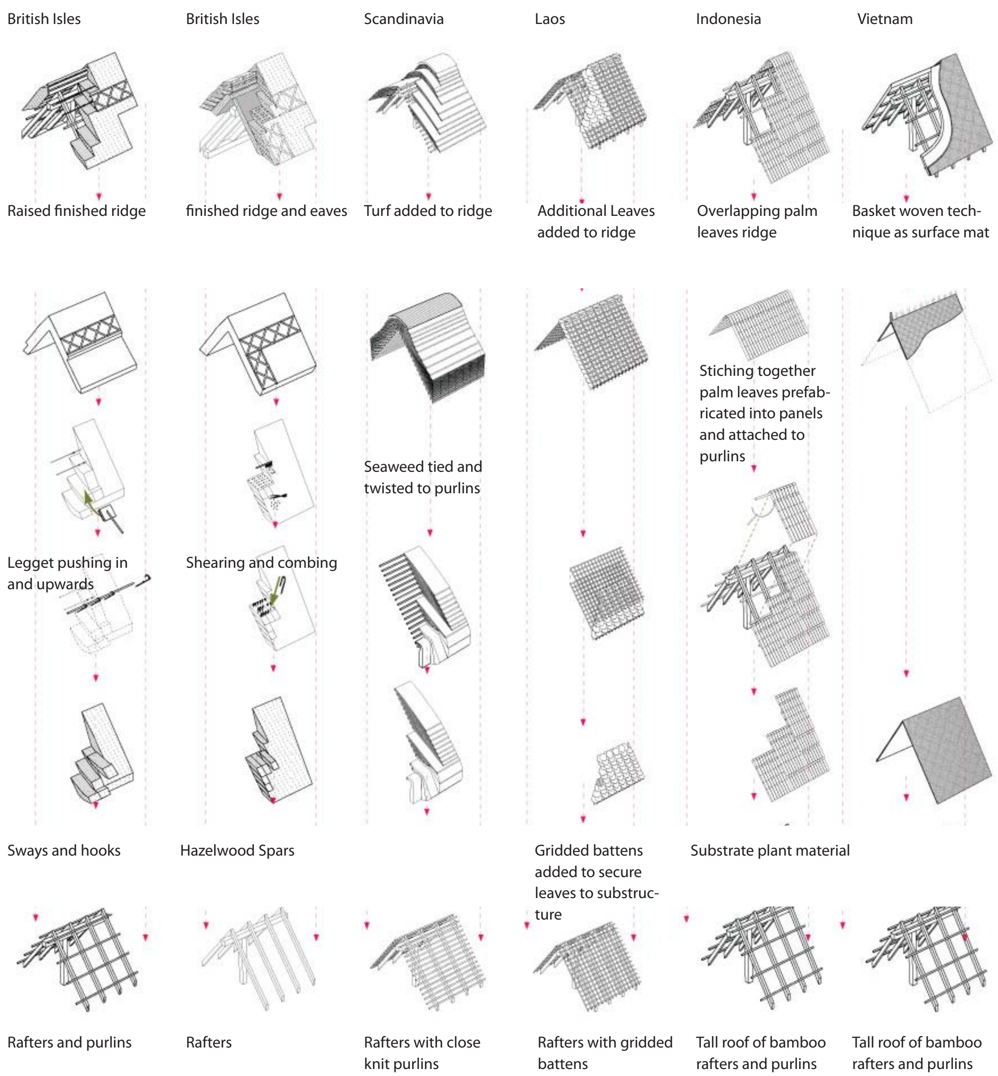
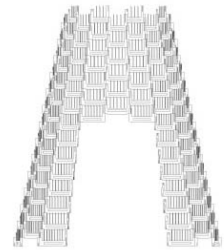


Figure 1. Harvest: A scythe is used to harvest the thatch material. The harvester must be aware of the topography of the land so as to collect equal lengths of grass. A special slip knot secures the collected thatch from the harvest through the jamming process.

Figure 2. Bundle: A special slip knot helps secure the collected thatch from the harvest through the jamming process.

Figure 3





Cut The harvested bundles are segmented based on the sectional design of the pavilion. Cattail, which has the thickest, sturdiest stalk, is used at the base. Turkeyfoot fronds are used to decorate the oculus. Longer lengths of phragmites, denser and more rigid, are used as a post-tensing system to resist the forces of the inner structural core.

Research

Thatch is a method of construction commonly used for roof applications in vernacular architectures in both tropical and temperate climates. Known for its water shedding and insulating qualities, widespread use of thatch is also attributed to the access of rapidly renewable resources (grasses) and their ease of assembly and economy. Despite these advantages, knowledge of thatch work has declined in the last half century to only a few masters and fewer apprentices.

While vernacular thatch structures are well documented, there is a lack of information pertaining to their process of assembly. One of the initial goals of the research was to create a representation that compares the layers of structure, substrate, and aggregation in a variety of thatch practices. This drawing of thatch roofs provides a taxonomic understanding of the varied assemblies that emerge from a diversity of locations, vegetation types, and methodologies (fig.3). What remained unclear during our research was the processes by which the tools and fasteners were used, both to bundle the individual stalks of vegetation into a unit and then to secure that unit to the structure.

Thatch is a craft-based process. For this project, the process required physical demonstration and instruction by William Cahill, one of the few master thatchers in the United States. Cahill shared his knowledge of the harvest, treatment, and assembly techniques used in thatching. A cattail-congested pond on the site provided the primary supply of thatch. Harvesting entailed "getting to know the grass" in order to collect just the right growth and grain. Each stem of the plant was cut equidistant from the topography of the land (fig. 1), and a detailed slip-knot diagram provided instructions on how to properly bundle the plant for ease of transport and in anticipation of the drying and threshing process (fig. 2). As harvesting was concurrent with the design of the pavilion, we calculated through digital modeling the quantity necessary to be collected of each plant type. Further computer estimation determined where each thatch bundle was to be segmented along its length relative to the desired sectional design of the structure.

Working intimately with the vegetation informed the design of the pavilion. It was important to draw out the formal potentials of each of the thatch species for their aesthetic, functional, and structural properties. In the end, we used three types of thatch in the structure. Cattail (Typha) is a common Native American thatch material where the base of its stalk is sponge-like with insulating properties. Cattail stems drastically taper from root to tip, offering an aesthetic opportunity in a gradient of thatch textures. Local Turkeyfoot (Andropogon gerardii, Big Bluestem), was chosen for its water shedding qualities and located near the top of the pavilion. Turkeyfoot also has very distinctive, non-molting fronds, which were used in the design as a halo near the oculus. Phragmites (Phragmites australis), a heavy structural reed, was used in a post-tension ring at the mid-section of the structure to counterbalance the eleven-foot tall conic form (fig 6).

Figure 4

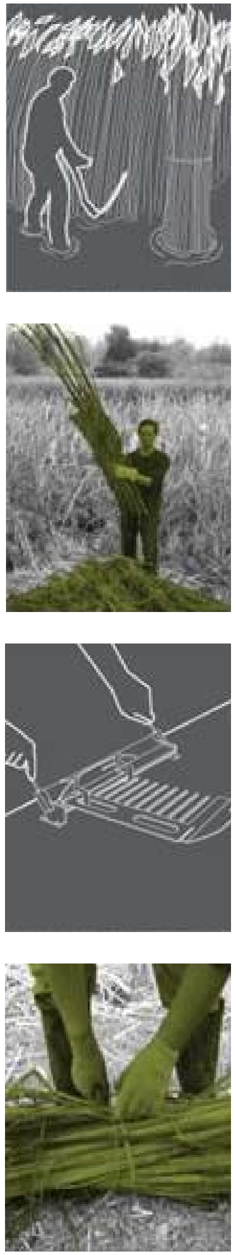
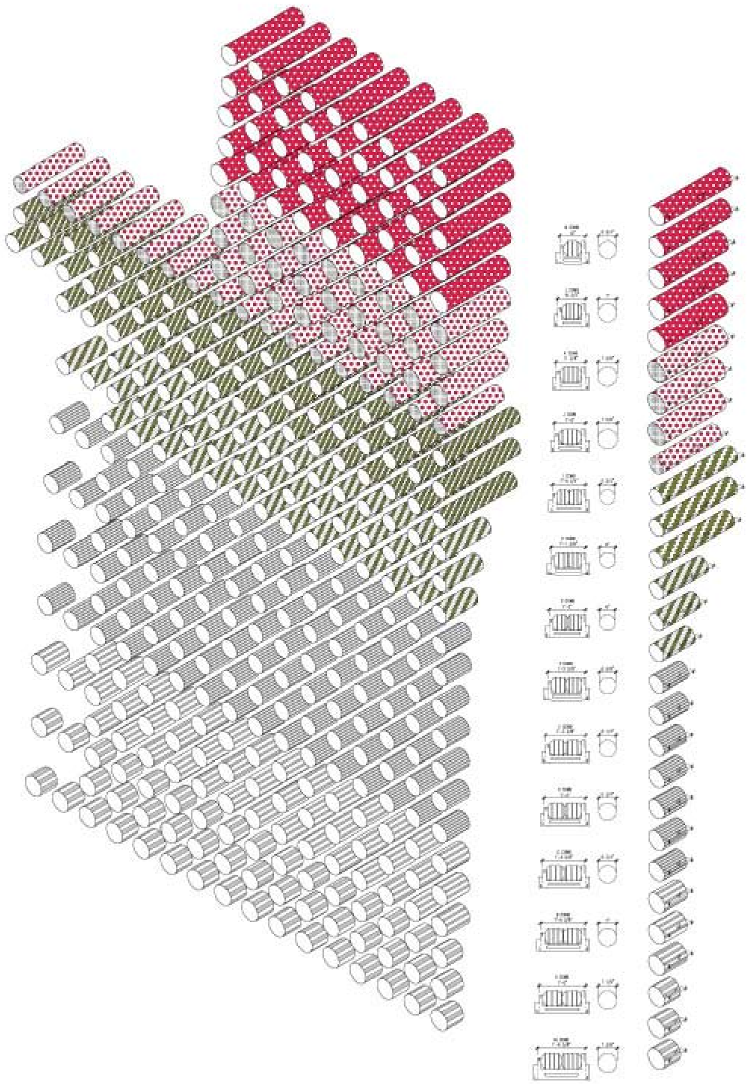


Figure 5 Jamming Each bundled unit of thatch is jammed into the comb with strict dimensional requirements as indicated in the coding system. The coding tag denotes the comb used, the overall length of thatch, where the bundle should jam into the comb, what type and segment of thatch to employ, and what jig to use. After the thatch blocks are stacked, the thatch is trimmed with the guidance of the jigs.



Retool and Assemble

Despite the variety of vernacular thatch applications, one of the most ubiquitous tools developed to thresh and dress thatch is the comb. The design involved redefining the comb to serve not only as a tool, but also as a fastener, a transporting device, and the structural basis for the pavilion.

Given the opportunity to digitally fabricate any shape, we set out to design a comb that implicitly describes the assembly sequence while serving as a leave-in guide for the arrangement of the thatch into a unitized, stackable, comb-as-wall component. We arrived at a comb design that integrates several features: the sharp prongs thresh and hold the bundles in place, the handles facilitate transport and serve as apertures, the slot joints indicate an assembly logic, and the bent wings delineate the overall radius of the conic massing. These tacit programs built into the digitally designed component are at once a tool and a key to the overall design.

The construction documentation consisted of corresponding instructions for both the water-jet machine and the thatcher, supplemented with diagrams describing the sequence of assembly. Each horizontal comb course diminishes in width consistent with the structural massing and the tapering sections of the thatch bundles (fig. 5). A catalogue of components illustrates the thatch bundle counterpart to each comb course (fig. 5). Color and pattern coding delineate thatch type, mixture, diameter, and length along the section of the pavilion. Together these drawings prepare the parts – that of comb and thatch – to be assembled on-site. The comprehensive sequence drawing instructs assembly and is the resolution to the catalogue representation (fig. 4). The representation of labor sequences – harvest, bundle, fabricate, thresh, sort, jam, stack, trim – produced a seamless process of assembly that made the construction of the pavilion possible in under eight hours.

Conclusion

Oral traditions often involve intricate techniques that are difficult to represent and are therefore seldom documented. Digitally fabricated designs catalog an array of produced parts but require thorough explanation of component assembly. This project combines two methods of construction – digital and oral – to explore the role of sequence-based drawings in current architectural practice. The result of these processes is a structure that looks forward in its use of digital fabrication without losing sight of the notion of assembly. The final product does not come fully formed off the bed of the water-jet cutter; it must be worked and processed to conform to the contingencies of the organic material.

The indeterminate "fuzziness" in both the material and craft of thatch necessitated the guidance of an expert, the retooling of the role of digital fabrication, and subsequently the rethinking of representational conventions. These drawings of a new thatching methodology serve not only as an artifact of construction, but as a testimony to the labor and movements required.

Stacking The comb-tools are designed to stack and provide structure through a strategically placed joint. When stacked, the joints create a seam through which compressive loads are carried to the ground. To account for lateral loads, anchor points are integrated into the joints. Each comb has four anchor points – simple half-inch steel brackets – that provide additional connections to unify the entire structure. Each course of the combs secures the stalks of the ones below, creating a mutually dependant structure of stalks and combs.

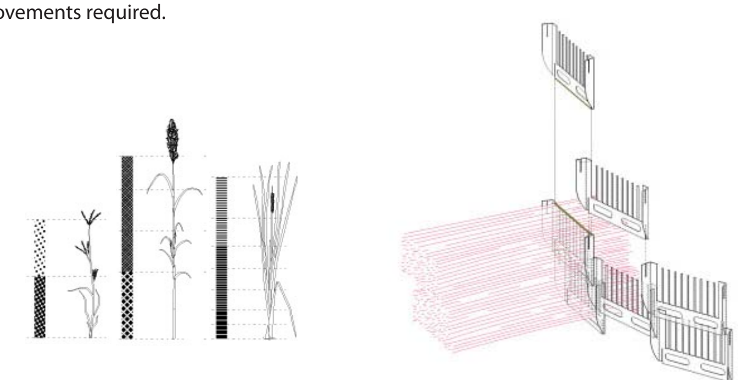


Figure 6

TURKEY FOOT
TURKEY FOOT
PHRAGMITIES
CATTAIL
CATTAIL
ROOF
10'-8"
DOOR
6'-2"
SEATING
1'-3"
GROUND
0'-0"