

Tango in Grass

2006/2007 International Bamboo Building Design Competition entry



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Preamble

This paper is the result of research conducted in the design of an entry into the 2006/2007 International Bamboo Building Design Competition. According to the competition's website it "... has been created to develop new award winning designs for bamboo buildings, raise awareness of the use of certified structural bamboo for building code approved structures, and introduce architects, designers and builders to working with bamboo as a structural material"¹. The rest of the material used to brief designers, is just that. While the competition is open to many building categories, in several places poor copywriting (as well as sponsorship by a company which manufacture's "off-the-shelf" bamboo housing) belies the aforementioned objectives.

My response to this supposed openness has been to focus on the material qualities of the one given aspect of the competition and to explore its latent potential - those that are inaccessible when constructing with other materials. My desire to reveal this potential is of prime concern; my research generated a proposal which follows a developmental logic where function followed form. With little criteria to comply with I have chosen to use bamboo to create a unique spatial condition and then to see what this form might accommodate. It is my interest to explore the material's capacity and to reveal special qualities in bamboo and its construction unique amongst building materials.

Bamboo

Traditionally, bamboo has been the material of choice for low cost single family homes in the tropical regions. It is venerated for its high strength to weight ratio, the ease of its workability and for the speed of its growth. Commonly referred to as the poor man's material, it is often grown, harvested and constructed by users themselves with little expertise or complex tools; the overhead costs are minimal. In these traditional domestic constructions, it is used in a



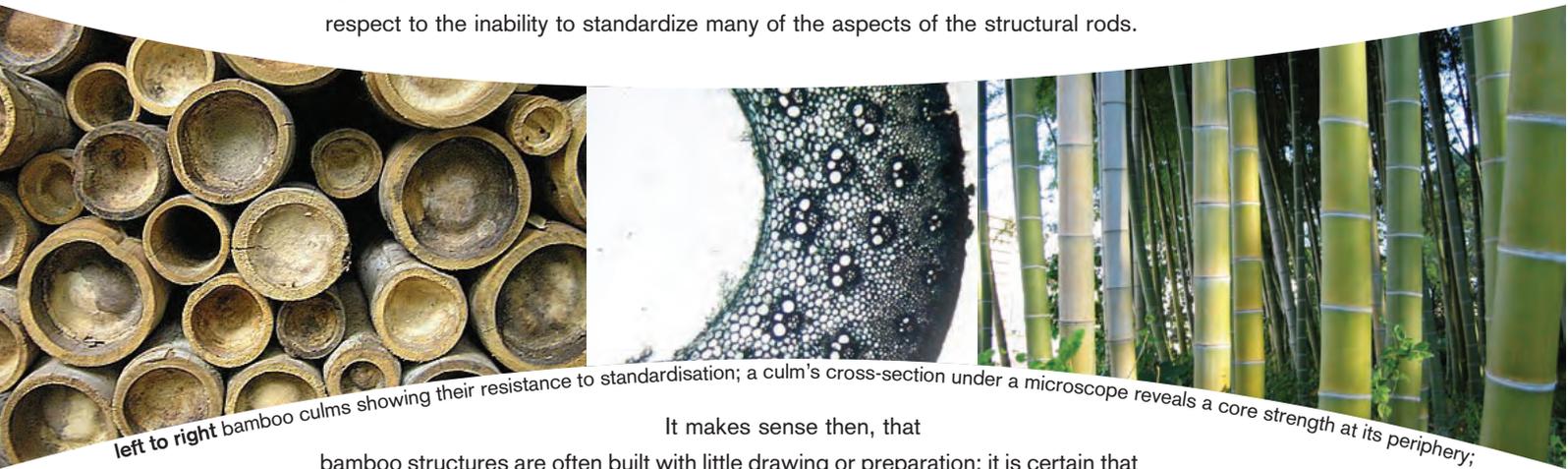
left to right bamboo used for scaffolding; a bamboo house prefabricated in a warehouse; the material of choice in poor and tropical regions

post and beam type configuration, hung with infill panels of lighter grade or split material to provide privacy, security, and spatial definition. It has seen the most use in tropical climates (where a significant portion of its habitat is) and consequently these constructions do not usually have to contend with the need for hermetically sealed interior environments.

The brevity with which it takes a bamboo plant to grow to maturation, makes it a potentially important resource in a world which is quickly depleting its natural resources. In fact, the ease with which bamboo can go from the field to its use in construction, makes for an approach with an extremely low embodied energy. There are uses for every last fibre of the plant finding its way into, in addition to its structural

application, use in finishes like flooring and veneers, roofing, and fencing as well as in the fabrication of utensils, baskets, bows, instruments and even for human consumption. It is often used with very little preparation and processing, and due to an outer skin that contains a high silica content², it is more resistant to insects and fire than ordinary lumber. There are techniques for curing and processing the bamboo poles, which bring them yet higher compressive strengths and further resistance to rot. Concurrent with its profusion in the tropical regions, it also performs very well in earthquake conditions due to its flexural strength.³

Bamboo has seen many proponents championing its benefits as a remedy to a culture of unsustainable consumption. It is remarkable, however, that for the most part the material has been used in a configuration that does not exploit its inherent flexural strength to achieve large spanning structures. It is predominantly used in short spanning structures with simple structural schema. In these scenarios, loads travel from largely straight roof rafters down to horizontal beams and finally to vertical posts which are often planted right in the earth. These structural components will generally consist of one bamboo pole, each with its own respective dimensions (these are inconsistent even within a single rod) and trueness. While connective details for straight-rod construction are proposed and documented by celebrated experts such as Oscar Hidalgo Lopez and Simôn Vélez, they, more often than not, seem counter-intuitive with respect to the inability to standardize many of the aspects of the structural rods.



left to right bamboo culms showing their resistance to standardisation; a culm's cross-section under a microscope reveals a core strength at its periphery;

It makes sense then, that

bamboo structures are often built with little drawing or preparation; it is certain that field conditions will prevail with such unpredictability. It is not possible to foresee or control the many of the properties of the rods including: the distance between nodes (the connective tissue that separates the internal chamber into compartments), the thickness of the walls of the bamboo pole, as well tendencies for poles to curve and grow thinner as they approach their end. Given these uncertainties, I have proposed an approach which does not abstract bamboo's material qualities but uses them to its advantage. Furthermore, the proposal seeks to exploit its capacity to bear bending loads and to yield its potential.

Bamboo's implicit inaccuracy of construction poses a dilemma for its use as a structural member in cold-climate modern construction. The inability to measure with precision, the very quality - of highly specific conditions dealt with on site - embraced by folk cultures of poorer regions, is problematic for a building culture founded on far smaller probable-error and highly engineered materials. Since awareness is the cause of this competition, it seems important to examine the potential of using bamboo in local construction, and contend with the implicit issues. What has been conceded in this process, is that the flexural performance, its resistance to standardization, and issues related to material's lifespan all prove to be formidable opponents to constructing permanent climatically controlled interior environments. While it is possible to construct

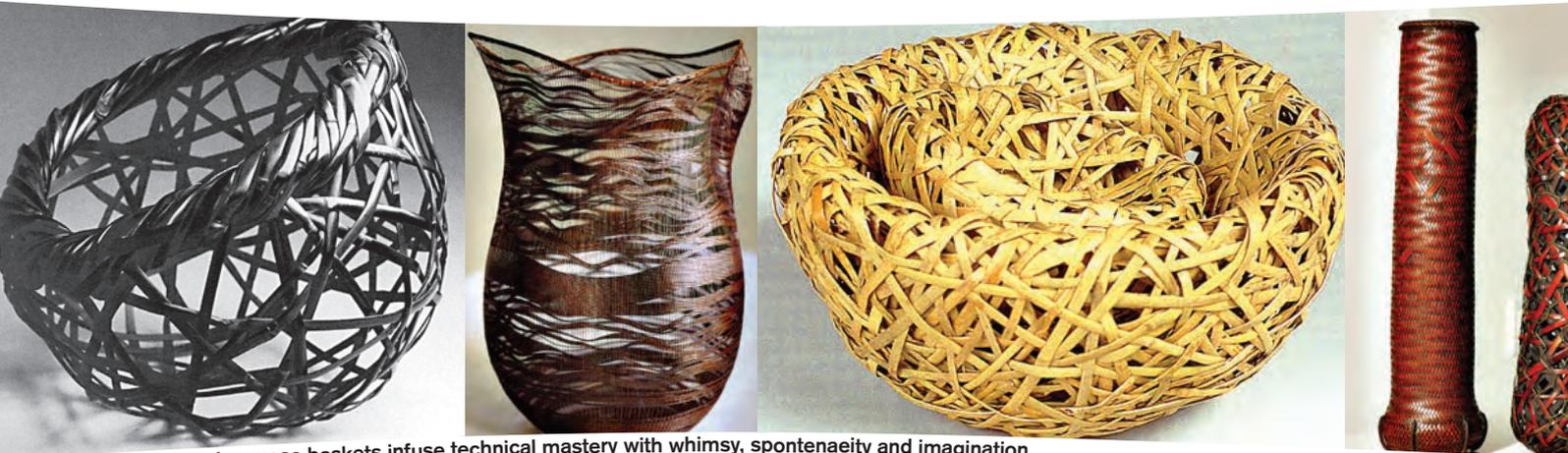
2 IL 31 pg. 31.

3 IL 31, pg. 42.

in cold climate despite these setbacks (with either full rods or engineered glulam products) it seems to be contrary bamboo's natural properties.

Basket-weaving

The primary source from which I have drawn inspiration are Japanese baskets from the end of the 19th century up until the present. With roots in utilitarian objects stemming from 10 000 BCE, the designs of bamboo baskets have evolved into sculptural, expressive and unique works of art which reveal a deep respect for the material's intrinsic properties. 20th Century master basket makers, such as Sekijima,



modern japanese baskets infuse technical mastery with whimsy, spontaneity and imagination

Nagakura and Yonezawa Jiro, have moved beyond the anonymous craftsman who produce repeatable designs. They have all had the formal training of the traditional craftspeople but have infused their technical mastery with imagination⁴. These baskets exhibit a whimsy, and spontaneity that shrouds their disciplined execution. The works engage a balancing act in order to locate a position that is ordered in a natural, casual way that defies traditional notions of visual structure. It is this quality – a position which respects the higher omniscient power of nature - that the proposed structure seeks to conjure .

The master basket weavers of Japan go through rigorous training that starts with a slow examination of the material and its procurement, leading to proper methods of processing and cutting. An apprenticeship can easily take ten years and even still rarely do these craftsmen produce more than one basket a year. For the purposes of this study, the focus has been on transposing qualities of baskets – of a woven framework of natural material whose constituents work in unison, of complex curves and surfaces that span large distances, of a surface which makes distinctions between structure and infill indistinguishable - onto a garden pavilion constructed out of bamboo.

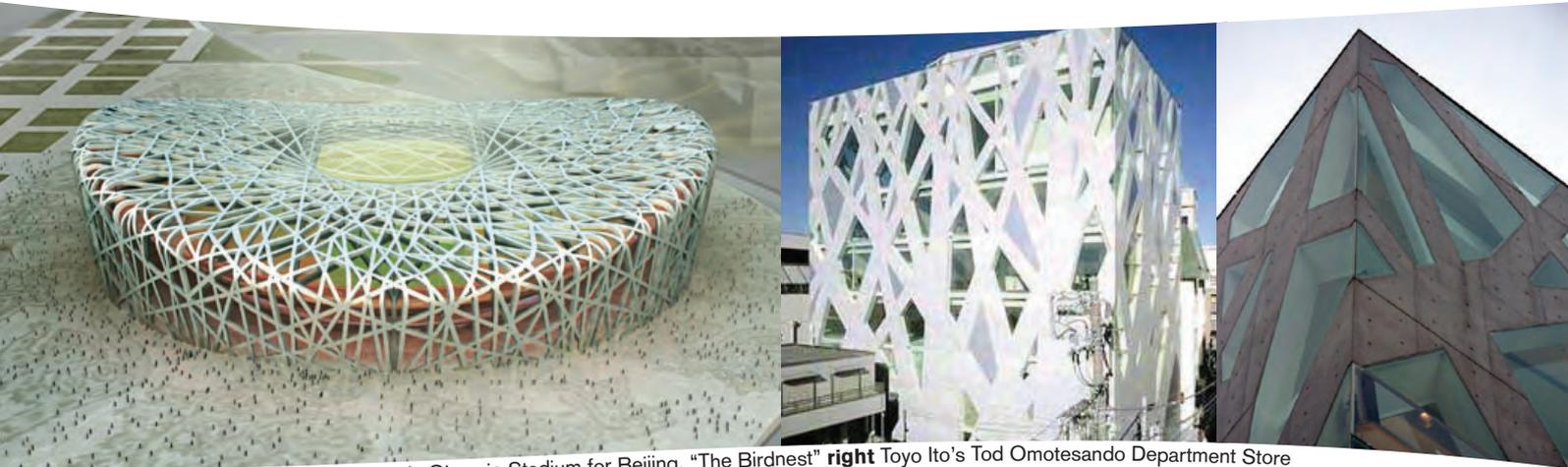
What I have produced is an open-air pavilion of an open weave of structural members arranged in a density that describes a contiguous surface. Within each surface full bamboo rods are arranged to work in tandem, and within the pavilion each surface operates in tandem.

Surface and Structure

Like the modern Japanese baskets, there is a recent trend in architecture that collapses the long-standing divide between surface and structure. Gottfried Semper argued

for an architecture whose ornamentation and structure would be perceived of as a whole. In his "Four Elements of Architecture" he proposes that architecture's origins coincided with textile construction. The very first enclosures that humans created for themselves were constructed of woven walls hung from a secondary structure. The significance of this is that it was the surface of the fabric, and not the structure, that provided for spatial qualities that these early peoples sought. In a re-examination of this polemic, several recent constructions collapse the division between surface and structure, giving them equal levels of import.⁵

For Toyo Ito Tod's Omotesando building, the exterior concrete shell of its



left Herzog & de Meuron's Olympic Stadium for Beijing, "The Bird's Nest" **right** Toyo Ito's Tod Omotesando Department Store

regular volumes, is punctured with a density of openings, reducing the structural plane down to diagonal lines resembling the branches of a tree. These openings, glazed flush with the concrete surface, play a game of figure/ground which produce an ornamental patterning from structural arrangement. The concrete structure then provides the frame for views in and out of the store as well as a casual organic graphical motif which plays off of the otherwise regular and unarticulated arrangement. Like the bamboo baskets, an order, has been imposed on the structural frame favouring ornamentation over efficiency; this contrary to the modern aversion towards redundancies and superfluous detail. If, as Semper argues, "architecture comes to be defined in its essence as an ornamental activity"⁶ than this order of logic proves to be lucid.

Herzog and de Meuron's Olympic Stadium for Beijing, which has been coined the "Bird's Nest"⁷ by the Chinese, also typifies a strategy which positions its structure in a way that defies traditional Modern logic. Its structure is composed of sections of steel where consistent widths of steel criss-cross each other in an apparently random pattern, describing a volume of complex curvature. The project puts its support at the service of ornamentation, setting up a relationship where the two are inextricably linked. What results is a soothing cohesive unifications between chaos and order and form that is both culturally significant for the Chinese people and an innovation in the course of architectural history.

Like the aforementioned precedents, my proposal for the competition posits a construction that is simultaneously ornamental and structural. It is composed of an open weave of elements whose resultant patterning is inextricably linked to its ability to stand up.

5 Scott Rimmer. The Symbolic Form Of Architecture: An investigation into its philosophical foundations and a discussion on the development of the perception of architectural form by modern theoreticians and symbolist architects University of Virginia <http://scholar.lib.vt.edu/theses/available/etd-494114149741201/>

6 Semper, Gottfried. The Four Elements of Architecture and Other Writings. (Cambridge, England: Cambridge University Press, 1989). pg 29.

7 The New York Times. May 21, 2006. The China Syndrome. Arthur Lubow. <http://www.nytimes.com/2006/05/21/magazine/21beijing.html?ex=1305864000&en=5c744f242881f682&ei=5088&partner=rssnyt&emc=rss>

Grid Shells

Linked even more closely to my proposal are two projects, constructed of bamboo, which achieve large open spans and whose spatial envelope describe surfaces of complex curvature using relatively minimal amounts of material. Whereas an office like Frank Gehry's produces designs featuring billowing curves that require highly technical equipment and resources, these projects employ more efficient means to this end by exploiting the flexural strength of bamboo.

At the Naiju Community Centre, Shuei Yoh employed a grid shell of interwoven bamboo rods to render a singular roof covering. This spatial outline reads like a limp planar element that is lifted from its centre; at several points along its perimeter ripples in the wave provide access to its interior. It has a casual "wabi-sabi" feeling, as if one out of an infinite number of configurations has been frozen in time. It is



this sense of a restless body that is in the process of seeking equilibrium that I have attempted to emulate in the garden pavilion that has been proposed.

In 2004 nArchitects constructed a temporary installation for PS1's courtyard in the form of a canopy. Composed of a singular system of interwoven bamboo members, the continuous structural surface was deformed to produce local conditions with different shadow densities and spatial atmospheres. Fixed steel rings at grade anchor the bamboo rods as they rise upwards and are bent into the surface, and woven in with each other.⁸

The Proposal

The proposed design illustrates bamboo's ability to produce large spanning collective spaces without the need for intensive engineering or specialized tools. This proposal emanates from an exploration of the material's capacity, and an examination of its limitations and potentials for use in the Canadian climate. The scheme presents a realistic prototype for a pavilion in a park setting that could be constructed by the members of a local community. Conceived as an open latticework of bamboo rods, it is a construction that is forgiving of irregularities in its members. It is also a form, since it is an assembly of curved forms composed asymmetrically, which is tolerant of de-formations that might accrue due to site conditions, the accumulation of rod irregularities, and the specific needs of the community. Thus it can never be no-less perfect.

The structural system is made up of the bending of single bamboo rods fixed rigidly to a continuous concrete foundation. The individual members are woven into a curved plane where they are made to engage with entire surface. These grid shells share moments of tangency and engage each others flexural capacity. They describe two levels of spatial envelope: an inner vaulted space that defines a place of

assembly, a place for worship, celebration, performance and ritual, and an outer shell, composed of four inflected vertical planes and a roof plane, defining the outer limits of adjacent spaces in the landscape. Through its contrapuntal resistance, the outer shell intensifies the flexural capacity of the shell, as well as providing for both buffer and framing of adjacent spaces. Like Semper's concept for the origins of architecture, it draws from textile construction and bridges the divide that modern architecture has created between structure and surface.

The roof and outermost walls provide an armature for cloth. The openings between members might also be woven with a finer grade of material to provide more permanent variations on openness.

The buffer zone between the two shells is where technical and support spaces are located. These include but are not limited to: washrooms, kitchen, storage, a/v control centre, stairway up to a mezzanine or technical level. In a scheme which might require lighting and sound equipment, the space created above the spring-point for the vaults provides a suitable plenum and service conduit.

This pavilion locates its program in the tradition of a garden gazebo, a space open to the public (and the elements) to be appropriated for various functions. Amongst the uses I have envisioned it supporting are: wedding celebrations, religious ceremonies, and dancing. With minimal modifications to the envelope the same basic form could provide a proscenium stage for theatrical performances or even for musical concerts.

The form and construction of the garden pavilion takes its cue from modern Japanese basket design. It is an object whose woven, complexly-curved, surfaces collect and define a space, yet with a porous envelope. It stems from an idealized form and like the handcrafted baskets, its built form defers to the qualities and specificities of the material, the localized conditions of the site and the temperament of the craftsmen. Like a fleeting moment frozen in a fixed material state, the pavilion posits an enclosure with an elastic tension. It displays a restless dynamic posture that is emblematic of bamboo's character.

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- Semper, Gottfried. *The Four Elements of Architecture.*

Internet Resources

General

- <http://www.americanbamboo.org>
- <http://www-users.rwth-aachen.de/Christoph.Toenges/index.html>
- <http://www.bambootechnologies.com/bambooresearch/researchindex.htm>
- <http://www.deboerarchitects.com/BambooThoughts.html>
- <http://bambus.rwth-aachen.de/eng/index.html>
- <http://www7.ocn.ne.jp/~bwc/bwc-e/uses32-e.html>

Construction and Products

- <http://www.conbam.de/>
- <http://www.koolbamboo.com/>
- <http://www.bamboonursery.com/>

Connection Techniques

- http://www.bambu-tec.de/index_e.html
- <http://www.in-duo.de/index.php?bereich=system>

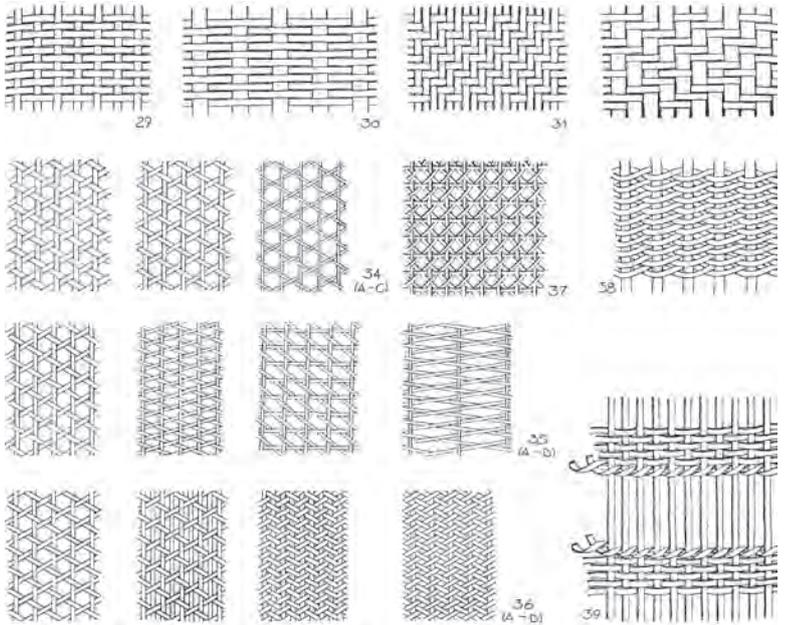
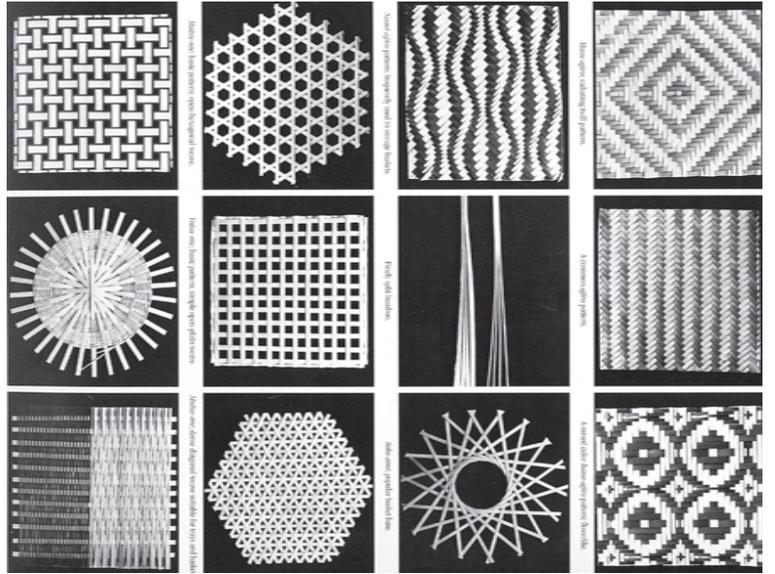
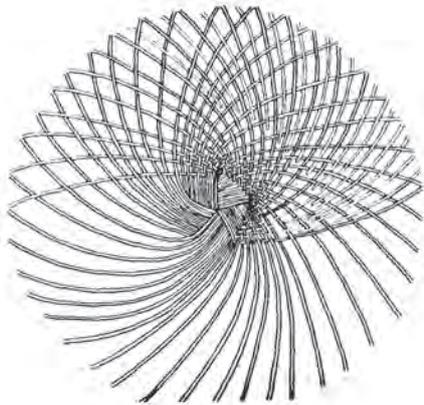
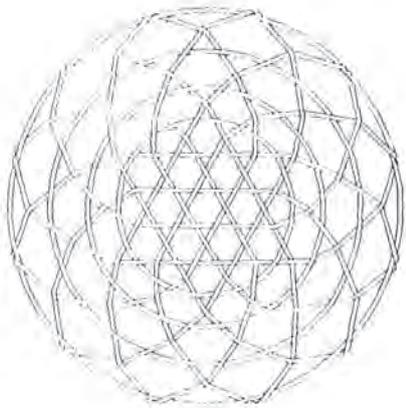
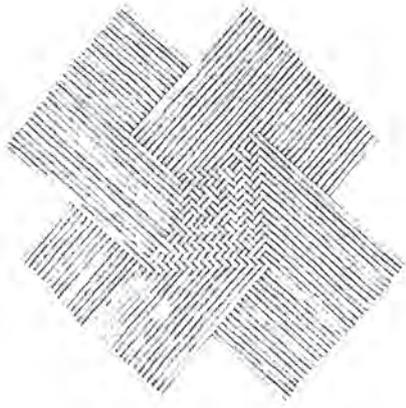
Bamboo Basketry

- <http://www.basketmakers.org/topics/bymaterial/bamboo/>
- <http://www.asiasociety.org/arts/baskets/index.html>
- http://www.nmai.si.edu/exhibitions/baskets/subpage.cfm?subpage=tech_tech

Bamboo Growth/Cultivation

- <http://www.lewisbamboo.com/habits.html>

Appended Research Images





Millenium Park, Chicago, Frank Gehry



Pavilion used as stage for concert

Jewish Wedding Canopy "Chuppa"



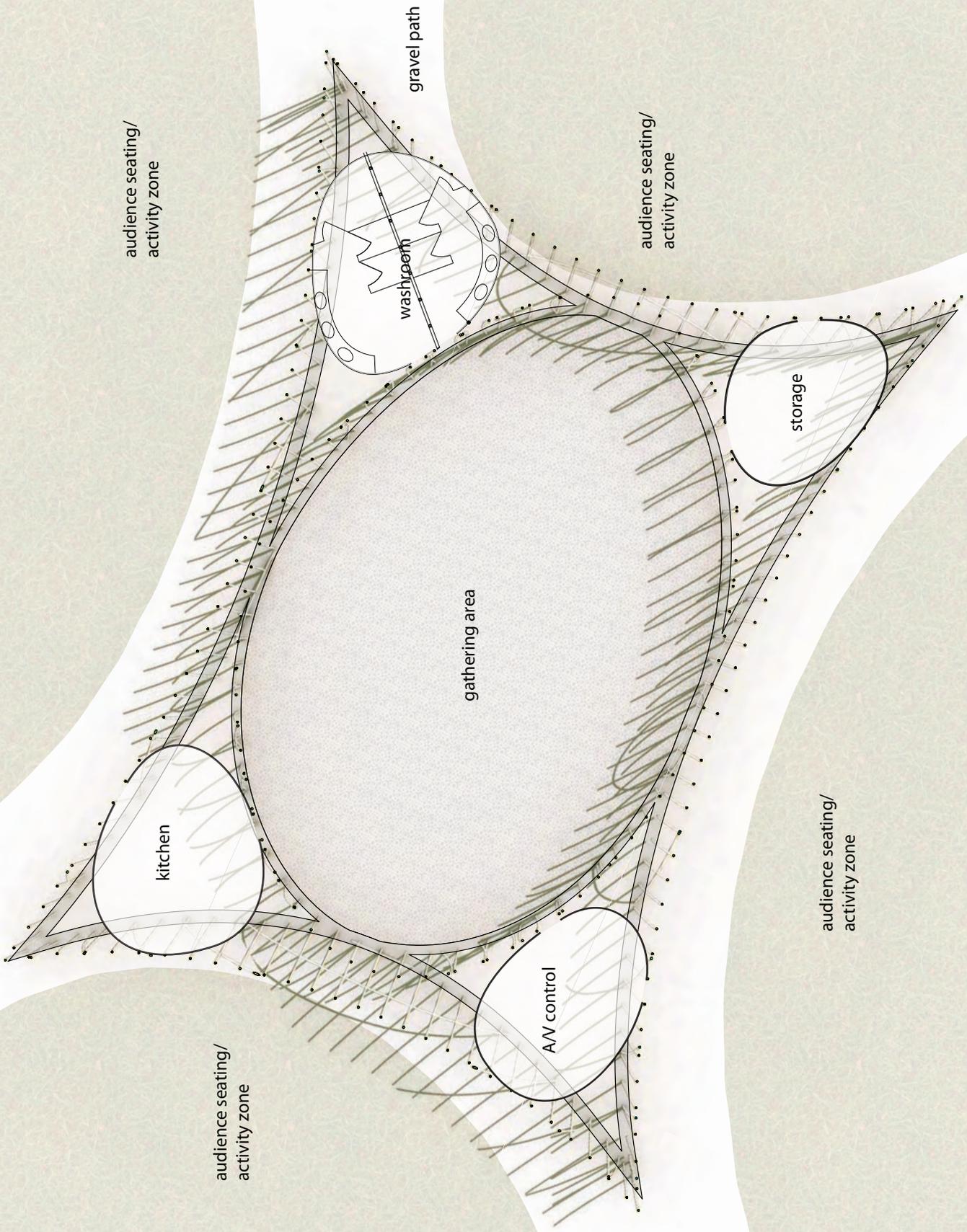
Wedding Ceremony Outdoors

Appended Drawings

Ground Level Plan

Section Perspective

Exterior Perspective



Ground Level Plan



Section Perspective



Exterior