Addressing barriers for bamboo: techniques for altering cultural perception

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ABSTRACT: The potential benefits of bamboo as a rapidly-renewable, low-carbon, sustainable building material are well established, yet bamboo remains underutilized globally due to laborious manual evaluation and fabrication techniques and deeply-rooted aesthetic stigmas in western culture. Scholarship in this area has the potential to radically redefine the usage of bamboo as a cheap and sustainable material, but in practice the widespread implementation of bamboo is limited by its cultural perception. This paper examines cultural perceptions of bamboo as a cheap and informal or kitsch vernacular material, using existing scholarship and projects to analyze existing methods and attempts in practice to either elevate or transform perceptions of bamboo through built work and engineered materials. The paper posits how new research by the authors aimed at transforming the use of solid bamboo species can radically shift the way in which bamboo is perceived, transitioning from an irregular kitsch vernacular material to a refined material system that mimics accepted conventions or invents new vernaculars.

KEYWORDS: Bamboo, Construction, Cultural Perception, Sustainability, Biomaterial

INTRODUCTION

The benefits of bamboo construction in terms of structural performance and sustainability have been known within vernacular contexts for centuries, and recent decades have seen continued development of scholarship documenting, quantifying, and lauding these and other characteristics (Van Der Lugt 2017). As a structural member, bamboo draws its strength from the density of fibers around the perimeter of its cross section and performs well in bending (Fig. 1). The question then raised is why bamboo has not been more widely implemented as a structural building material in the global construction industry—the rapid rise in popularity of bamboo flooring certainly improves sustainability but does not utilize bamboo's impressive structural capabilities. Existing scholarship has outlined potential causes as the lack of reliable and established codes and standards for the grading of bamboo, which currently relies largely on know-how and visual grading (Trujillo and Jangra 2016), and the issues that arise from this lack of systematized documentation--architects are averse to specifying bamboo, meaning contractors do not work with it and companies producing bamboo for construction do not experience opportunities for large-scale growth (Opoku et al. 2016).

This paper describes recent work that attempts to address these issues through new approaches to structural bamboo construction. Across much of this work, the restraining factor is that the cultural perception of bamboo—particularly but not exclusively within western contexts—has not been directly addressed through the treatment of the material in a structural configuration.

The authors propose using digital means of measuring, optimizing, and routing bamboo in order to change the cultural perception of bamboo construction. The authors' work deals specifically wiith Dendrocalamus Strictus—known colloquially as Calcutta Bamboo, Iron Bamboo, or Tam Vong, a unique species of nearly solid bamboo grown in Asia, Indochina, and Latin America. The comparatively thick wall of the Calcutta Bamboo allows it to be faced on one or more sides to create a flat surface through stock reduction. This faced bamboo has the potential to be perceived as a hybrid between traditional bamboo and traditional milled lumber. Through this method, the project attempts to develop a structural and aesthetic language that

calibrates the relationship between the aesthetic stigma of “live edge” bamboo and the structural benefits it inherently contains. The fidelity of bamboo as a natural material is considered and manipulated throughout the process.



Figure 1: Uniform bending testing. Source: (Author 2019)

1.0 METHODS

This paper establishes the cultural stigma toward bamboo, as evidenced in recent research and the treatment of bamboo in various exhibitions and through popular media. Referencing past and current research, strategies to transform the perception of bamboo in structural applications are evaluated and categorized. This creates points of comparison for the author’s project to be differentiated in its unique strategy of navigating the perception of bamboo while maintaining its demonstrated structural benefits.

2.0. CULTURAL AESTHETIC STIGMA

Known colloquially as “poor man’s timber,” bamboo carries a longstanding cultural aesthetic stigma, particularly within a western context. The perception of bamboo as an informal or unrefined material results from a combination of racism, classism, imperialism, and a lack of investment in the development of its material possibilities.

The reference to bamboo as “poor man’s timber” or “poor man’s wood” was made almost two decades ago in *Grow Your Own House*, in which the authors also make the claim that “...bamboo has liberated itself from this stigma as the downsides to Western culture have emerged and people are increasingly turning toward regional, sustainable technologies” (Vegesack and Kries 2000, 9). While there has been a substantial growth in interest toward sustainable technologies, to have made the claim in 2000 that bamboo had been freed of all cultural stigmas seems naive—Susanne Lucas of the World Bamboo Organization discusses the ramifications of the same “poor man’s timber” term over a decade later in her 2013 book, *Bamboo* (Lucas 2013, 16).

The stigma toward bamboo as an informal or low-brow material is evidenced in popular media representations of bamboo construction—ranging from depictions of primitive and uncivilized huts to the mystical healing powers of zen gardens and spa therapy. The shelter constructed by the marooned visitors of Gilligan's Island is defined by its striping of bamboo poles in the popular sitcom aired from 1964 to 1967. Nearly every convenience of contemporary western life is recreated in bamboo, from a pool table to a pedal-powered taxi cab (Gilligan's Island, 1964) (Fig. 2). Tiki themed restaurants, summer apparel, and poolside accessories abundant in contemporary society only reinforce such depictions. Similarly, Disneyland's Swiss Family Treehouse was built as an ad-hoc collection of bamboo poles nested around a giant tree—and later was adapted to become and remains to this day Tarzan's Treehouse—while the sign for the park's Adventureland is framed in imprecisely joined bamboo members with a primitive mask mounted overhead (Fig. 3). These depictions are not always overtly negative but do work to undermine the idea of bamboo construction as anything other than temporary or a condition of circumstance—in both Gilligan's Island and Swiss Family Robinson, the world is constructed in bamboo not by choice but by necessity given no other available materials, meaning the material of bamboo itself becomes a symbol of the protagonist's plight. The hospitality industry likewise plays into the bamboo aesthetic, advertising beach vacations in bamboo cabins set above the water. The result of such imaging is a reading of bamboo as a shorthand for vacation, in the same way that a Swiss chalet conjures memories of a ski vacation or a log cabin implies camping in the woods away from the comforts and commodities of everyday life. The composite effect of such imagery effectively disassociates bamboo from incorporation into contemporary society.



Figure 2: Still from episode "Home Sweet Hut." Source: (Gilligan's Island 1964)

The stigma toward bamboo is also documented in recent research. In a survey on perceptions of the use of bamboo in construction in Ghana in 2016, it was found that after lack of specification by architects, lack of bamboo processing companies, and insufficient government cooperation, the fourth highest barrier to the use of bamboo is the "Problem of social acceptability (bamboo is considered for the poor)" (Opoku et al. 2016, 86). This concern was

listed well above such items as the lack of availability of the material or the lack of knowledge and skill in how to detail and implement bamboo structures.



Figure 3: Crude bamboo sign for Disney's Adventureland "Home Sweet Hut." Source: (Flickr 2018)

3.0. ATTEMPTS TO TRANSFORM THE PERCEPTION OF BAMBOO

In recent years, several strategies have been implemented with varying levels of success aimed at transforming bamboo into a contemporary structural building material. These strategies can be grouped into several categories: macro-scale assemblies, unique composite joinery, elevation of material, concealment of material, and material transformation of the bamboo pole.

3.1. Macro-scale assemblies

Macro-scale assemblies have been attempted with various techniques of aggregating bamboo poles into large unique forms including crisscrossing, lashing, and fish-mouth assemblies. The resulting forms tend toward fluid geometries that demonstrate the capacities of new construction systems through the display of novel aesthetic qualities.

The ZCB Bamboo Pavilion constructed in 2015 in Hong Kong displays such qualities, consisting of large bamboo poles that are tied together in a traditional method (Kristof and Fingrut 2016). However, the scale of the construction is so great that the form and luminous quality of the pavilion eclipse the reading of the bamboo pole, bypassing the aesthetic quality of the bamboo and allowing it to be read simply as a set of aggregated linear members that might just as easily be made from steel or aluminum pipe.

In Archi-Union's parametrically designed Mobius-strip pavilion entitled In Bamboo, (Chen 2018) the design blurs historic and contemporary—the form is a daring combination of two vernacular circular forms merged into a single figure eight. While the construction process engaged digital fabrication for the shaping of the glulam beams, the pavilion's bamboo façade

is a hand hewn traditional woven bamboo screen, therefore embracing rather than challenging the traditional reading of bamboo.

3.2. Unique composite joinery

Projects implementing unique composite joinery display novel ways of creating connections for bamboo members, often utilizing a modern material such as steel or aluminum to create nodes between bamboo poles. These projects display the structural capacities of bamboo in modern construction, but display raw bamboo pole without treatment or modification without attempting to challenge its cultural perception. Instead, this strategy is often an unapologetic approach deploying modern joints and forms while the bamboo poles themselves are used as linear structural members in a relatively traditional way.

In the German-Chinese Pavilion for the 2010 Shanghai Expo, machined stainless steel nodes are juxtaposed with raw bamboo compressive members (Bamboo Pavilion 2010). The bamboo poles are read as pipes, albeit in a slightly more organic milieu. Countless other projects employ this technique, from studies by Renzo Piano for multi-axis building joints to bicycles by companies such as Boo Bikes and Calfee Designs. These bicycles similarly employ raw bamboo poles with joints made in a modern material, in this case resin-reinforced carbon fiber. In all cases, the cultural perception is largely unchanged despite the celebration of the structural performance because of the expression of the raw bamboo pole.

3.3. Elevation of material

Many widely publicized bamboo projects in the last decade have advanced the expression of the material, often using traditional construction techniques and connections but marketing and presenting the projects as high-class design. These examples typically lean heavily into the bamboo resort culture exemplified in Gilligan's Island and Disneyland's Swiss Family Treehouse while simultaneously embracing the fluid formal language developed during the Digital Turn.

The Green School and Green Village in Bali which began construction in 2008 is a leading voice in applying contemporary design to bamboo construction, and has been widely publicized globally, bringing new attention to bamboo as a sustainable and dynamic construction material. The work does not however address the cultural stigma of bamboo within most typological applications, instead aligning itself with glamping and resort cultural archetype of the sophisticated hut. This categorization leaves the material stranded within a specific cultural association, making it difficult to transplant it to both an everyday context and a different cultural context.

Kengo Kuma's Great (Bamboo) Wall is a house employing bamboo walls and screens with an overtly high-design sensibility (*House near Badaling* 2003) (Fig. 4). The project aims for a Miesian sense of space, plane, surface, and transparency, elevating the status of the material and certainly celebrating it. However, the bamboo is not meant to be understood as anything other than raw bamboo—the poles are used as-is and remain trapped within their cultural associations.

3.4. Concealment of material

In his 2016 TEDx talk, David Trujillo, chair of the Bamboo Construction Task Force at the International Network for Bamboo and Rattan, discusses the implementation of bamboo in housing and other similar structures (Trujillo 2016). After laying out clear arguments for the sustainable and structural capacities of bamboo, the example he provides as the bamboo house that global society will welcome—labelled as "Villa Diana Carolina, Ricaurte, Colombia"—has no visible bamboo at all. A label placed over the image calls out that bamboo is "concealed in the wall and roof." This strategy sidesteps cultural perceptions entirely by removing them from sight.



Figure 4: Kengo Kuma's Great (Bamboo) Wall house. Source: (Wikimedia Commons 2005)

3.5. Material transformation

Recent and ongoing research projects are aimed at abstracting the bamboo pole at a variety of scales through different processes while retaining the structural integrity of the material. These techniques range from flattening, unwrapping or bending the poles, to weaving, laminating or compositing boards into new shapes and forms. Some of these methods are now commonplace, such as the composited strips seen in the contemporary hardwood-replacement bamboo flooring sold worldwide, while others are less known, such as the structural composite laminated beams known as Bamboo N-finity used to create a solar carport frame by BMW South Africa (Pablo van der Lugt 2017, 54-5). In these applications, the material transcends the connotation of "poor man's timber," but risks exchanging this stigma for another cultural perception of cheap engineered lumber.

Other research projects transform bamboo in even more drastic ways, such as the Truss Me furniture system designed and produced in India by Sandeep Sangaru in which the bamboo is partially spit and reassembled by lamination to construct space frames with solid natural nodes and laminated braces in between. Designer Stefan Diez's Soba bamboo furniture leaves the poles largely intact but creates innovative joints through the removal of long sections of the pole, reducing it to a belt-like dimension and allowing it to wrap around other poles to create structural connections. These approaches have also been developed through architectural research in which bamboo poles are partly split and laminated together to create space frame-like aggregations that use the natural nodes of the material as structural connections (Sonpal 2015). These projects display significant tectonic shifts in bamboo construction, suggesting entirely new vernaculars for bamboo.

4.0. APPLICATION AND CONCLUSION

Given the demonstrated benefits of bamboo construction but the drawbacks of its ingrained cultural perception, we are developing techniques to change its vernacular—either by adopting the vernaculars of wood construction or more promisingly, inventing new vernaculars that leverage the specific qualities of bamboo. Our ongoing research projects seek to advance bamboo construction via the specialized use of Calcutta Bamboo, a species with a very high wall thickness and very small hollow cavity at the center of the pole. By surfacing or facing the Calcutta Bamboo, flat surfaces are created, and the bamboo fibers take on an aesthetic quality that closely resembles some species of hardwood lumber (Fig. 5).

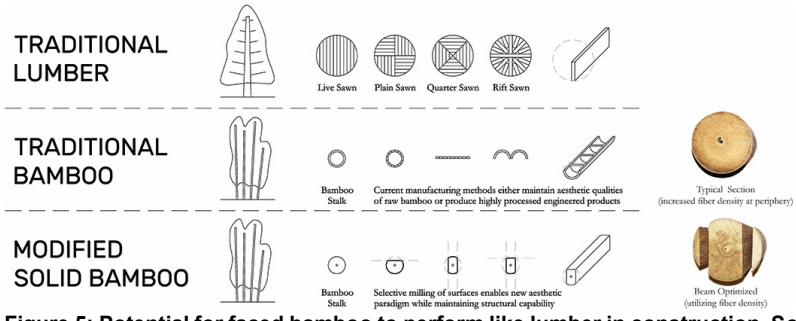


Figure 5: Potential for faced bamboo to perform like lumber in construction. Source: (Author 2018)

We are developing a material strategy and an intelligent parametric system that will enable the bamboo to be manipulated and used in this way. The system consists of several components that first evaluate the material to determine its specific geometry and qualities, then mill surfaces and specific joints in a custom 4-axis CNC mill (Fig. 6 and 7). The aim is to create an intelligent system that uses feedback from visual, noninvasive scanning to determine which piece of material is used for each specific part of a designed structure. The opportunity also exists for the designed structure to be informed and adapted by the structural and formal capabilities of the available material.

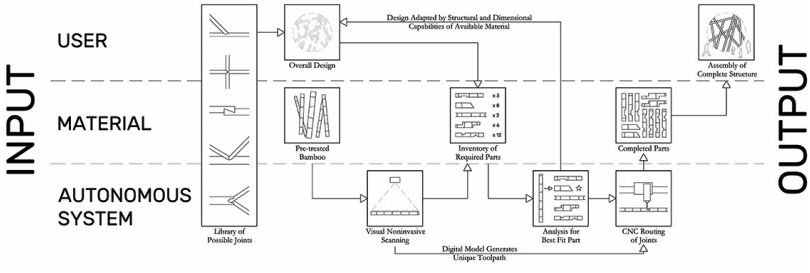


Figure 6: Integrated scanning, parametric part selection, and CNC routing machine for bamboo pole construction. Source: (Author 2019)

The specific structural diagram of bamboo is such that the outside perimeter of the pole is also the part with the greatest fiber density and strength (Van Der Lugt 2017, 38-9). This means that if all faces are removed to produce a fully squared piece of material—thereby making it fully recognizable to a western sensibility most familiar with lumber—the portion of the material granting the greatest structural performance is lost (Fig. 8 and 9). Rather than sacrificing the strength of perimeter, our current research aims to balance performance and aesthetics through selective facing or planking, leaving a mix of live edge and planed faces. This research is developing a set of documentation on the structural performance of Calcutta Bamboo in various combinations of faced and un-faced states. By making known the structural qualities of faced bamboo, we will be able to validate the possibility of addressing concerns of cultural perception while allowing for its implementation as a structural system. It is our goal that such activities will advance new ways of thinking and building that utilize an outstanding renewable natural material in such a way that it can be accepted and utilized globally through its perception and future acceptance into a wide array of societal and cultural contexts.

5.0. FUTURE WORK

This paper establishes the presence of tainted cultural perceptions of bamboo in various cultures globally and examines several strategies for changing the perception of the material, while proposing particular techniques for preparing and assembling the material to specifically change these perceptions. However, future research will need to gather data to substantiate the claims that these strategies will in fact change the cultural perception of the material in a predictable way. This will be done through future surveys and other methods.



Figure 7: Integrated scanning, parametric part selection, and CNC routing machine for bamboo pole construction. Source: (Author 2019)

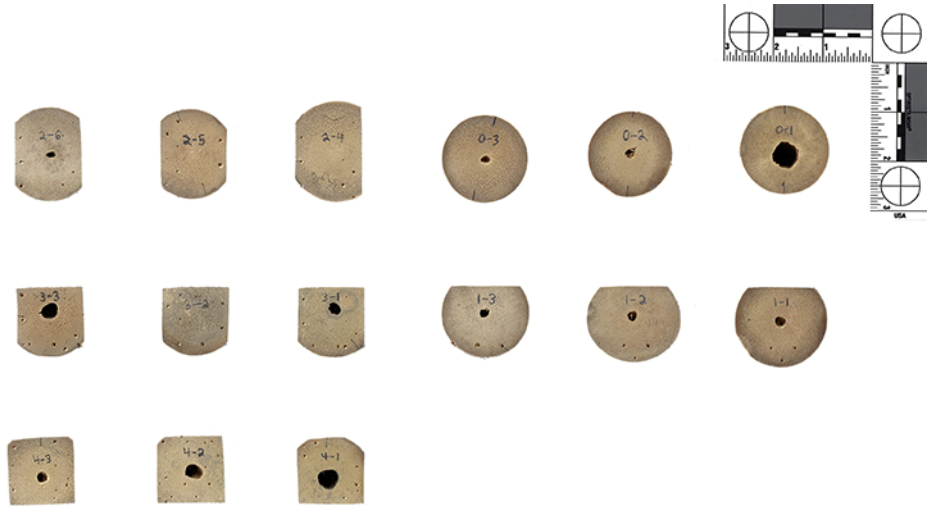


Figure 8: Cross sections of faced Calcutta Bamboo. Source: (Author 2019)

Further limitations do exist in the current species of investigation. Calcutta Bamboo is a tropical species and is not currently grown in the temperate climates of America. While having a very solid cross-section, it grows to a maximum diameter of 2-3 inches. Additionally, the bamboo is very solid at the base of the plant but becomes progressively more hollow towards the top of the pole. Future development of our fabrication and material system will attempt to utilize both the more hollow and less hollow sections of the pole in order to minimize material waste. Further research will also examine and test several other species of structural bamboo that

are similarly thick-walled but grow to much larger diameters. We also plan to develop hybrid material strategies that combine ideas of faced poles with engineered laminated beams, trusses, and structural panels.

	Unfaced/ omnidirectional
	Faced 1 side/ down
	Faced 2 sides / left & right
	Faced 2 sides/ top & bottom
	Faced 1 side/ up
	faced 3 side/ left/ right/ down
	faced 4 sides/ omnidirectional
	faced 3 side/ left/ right/ up

Figure 9: Cross sections of faced Calcutta Bamboo. Source: (Author 2019)

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