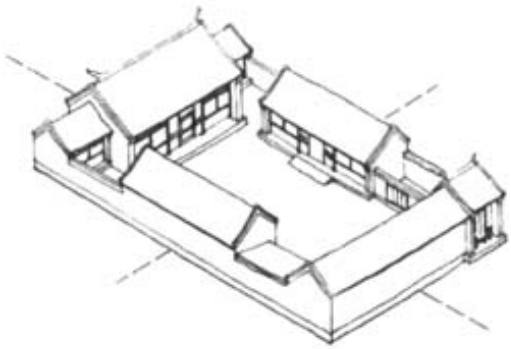
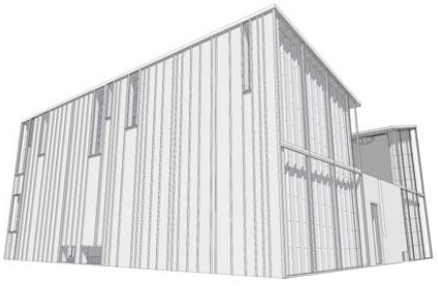
Bamboo: Modern Suburbia
June Tran

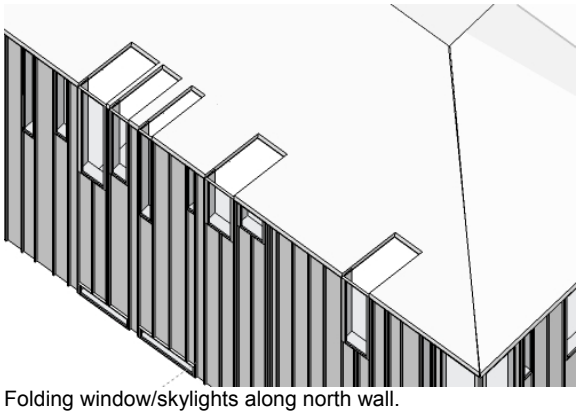
Archetypes and buildings from all over the world influenced this custom bamboo house, from schematic design to final structural detailing. We chose to design a bamboo building for suburban Vancouver, a non-tropical climate, which widened our influences to include precedents from both tropical and non-tropical climates. One may track these influences through schematic design, program, structure, and enclosure.


Bamboo Wall House by Kengo Kuma and Associates


Chinese courtyard house

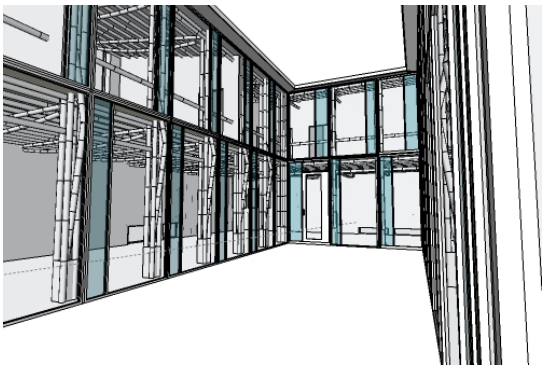
Our initial idea came from the Bamboo Wall House by Kengo Kuma and Associates. Kuma emphasized verticality and enhanced visual perspective with repeated bamboo canes. With this idea in mind, we came up with the idea of a long courtyard building with bamboo verticals along the inner courtyard. We modeled the enclosure around a typical Chinese courtyard house with many openings towards the courtyard and a relatively opaque exterior.


Southwest corner showing shed roof


Folding window/skylights along north wall.

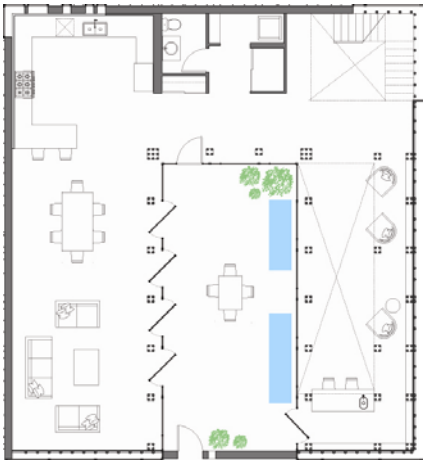
Chinese courtyard houses typically have gable roofs, but we chose to use a shed roof sloping towards the courtyard. This gives the appearance of a clean line flat roof on the exterior, but preserves a practical slope to shed Vancouver rains. We conceived the exterior wall as a solid surface which would fold over the structure to form the roof, in a similar manner to many of Ian McDonald's buildings. Some of the windows along the exterior wall continue on the roof as skylights to create this effect.

Woodsworth College Residence by architectsAlliance

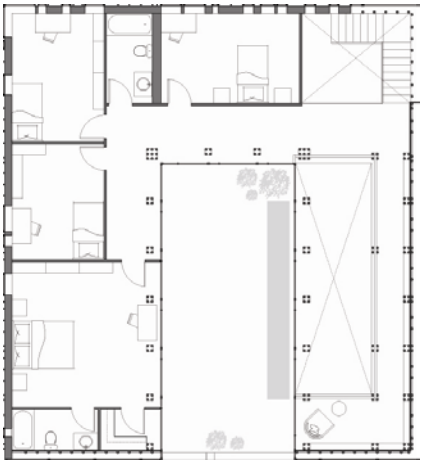


Courtyard view

The courtyard needed more transparency, so glass was a natural choice. architectsAlliance often uses staggered window patterns, which inspired us to do the same in the courtyard, for the visual interest and play of light on the bamboo columns.



Ground floor plan



Second floor plan

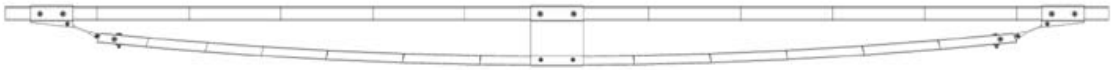
Programming and plans developed based on the central courtyard space. The program started with the typical North American suburban home for a family of four, including a living/dining area, kitchen, three bedrooms and guestroom, along with various service spaces. However, we wanted a double height space where we could showcase the bamboo structure. We chose a library because of the opportunities for multiple stories of book storage and incorporating bamboo into the shelving structure.

Trinity College Library, Dublin

Library view

After finalizing the program, we arranged the public and entertaining spaces on the ground floor, and private spaces upstairs, typical to most North American suburban homes. Placing public spaces on the ground floor created an opportunity for entertaining in the courtyard. The wall between the courtyard and living/dining area needed to be flexible for this, allowing the two areas to connect or separate. Pivoting doors allow for this flexibility, without interrupting the staggered mullion pattern.

While North American suburbia influenced the program, the structure took influence from many different countries. For the entire structure we used *Bambusa Stenostachya*, the recommended species by competition jurors. At the roof and floor, we chose to support bamboo joists over short spans with prefabricated bamboo trusses to reduce deflection. Prefabrication would ensure quality control and consistency in the trusses, and speed up construction on-site.



Bamboo floor truss

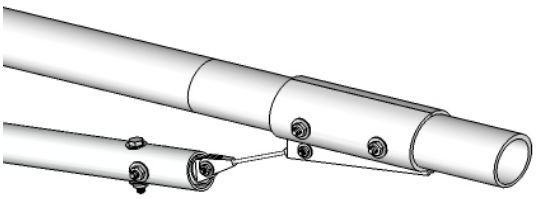
Bridge in Pereira by Jörg Stamm

Jackson Triggs Winery by KPMB

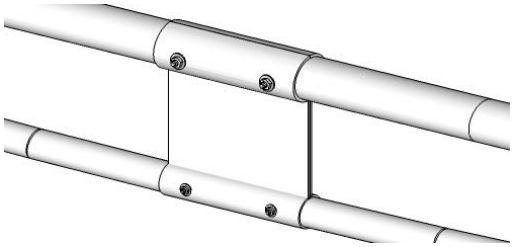
Jörg Stamm's bamboo bridge inspired the curved shape, and KPMB's trusses at Jackson Triggs Winery inspired the idea to articulate the bottom chord as purely tensile. The final design takes advantage of bamboo's tensile and curving capabilities in the bottom chord, and articulates the trusses' internal forces through its connections. At the ends, a tensile steel connection transfers forces from the bottom chord to the top. The design of this was inspired by Shoei Yoh's bolted bamboo joint, and Calatrava's clean tensile connections.

Bamboo joint by Shoei Yoh

Tensile joint by Santiago Calatrava



Truss end connection

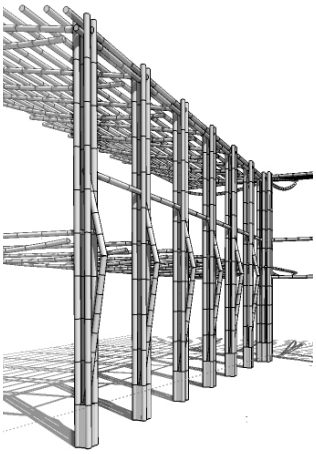


Truss middle connection

The bolts prevent bamboo splitting, while the cable connection emphasizes tensile force in the bottom chord. At the middle connection a steel shear panel transfers compressive force from the top chord downward. The metal sleeves and bolted connections prevent the bamboo from splitting. The heaviness of this middle connection compared to the end articulates the difference of forces being transferred.

Trusses would need support from both the outer wall and inner courtyard wall. The courtyard needed to be transparent and permeable, so we used a series of bamboo columns to support the trusses. These are spaced far enough apart for doors and generously uninterrupted glazing, but close enough for joists to span between trusses.

Restaurant in Colombia by Jörg Stamm

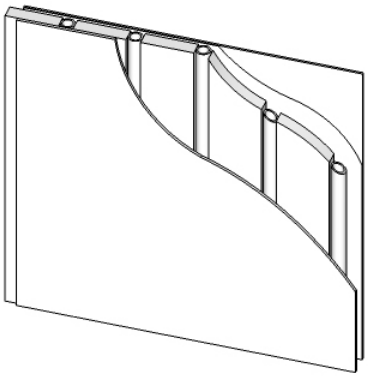


Courtyard columns

Jörg Stamm's restaurant design supplied inspiration for the columns. The bamboo is set in a concrete foundation and base for a strong moment connection. The four-cane arrangement also allowed for multiple connections in different directions, giving flexibility with the framing arrangement.

The outer wall did not require such transparency, so we used a denser structure. North American stud walls and bamboo walls with plaster infill inspired a hybrid wall with bamboo replacing wood studs.

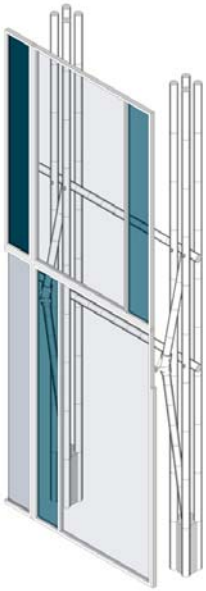
Wood stud wall with plywood shear panels


Bamboo stud wall with plywood shear panels

Here the plywood is nailed directly to the bamboo studs, using *Bambusa Stenostachya's* ability to be nailed without splitting. Plywood creates moment resistance, while bamboo provides vertical support and a cavity for insulation. We designed this structure and the others with the ability to support a wall enclosure appropriate to Vancouver.

Almost all examples of bamboo buildings available to us were located in tropical areas, which presented a huge challenge for designing the enclosure. Buildings in such areas often support simple enclosures of plaster infill or woven reeds, and often no enclosure at all. Vancouver has a temperate climate, but a building there would still require insulation and moisture protection which these enclosures do not provide. So, we took precedents from both tropical and non-tropical regions to design the enclosures. We used three different wall assemblies to articulate the exterior.

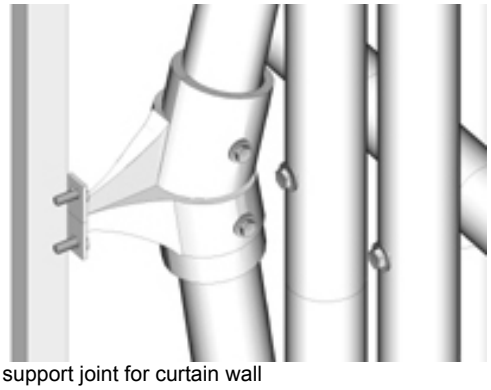

BCE Place by Santiago Calatrava


Bamboo columns supporting glass curtain wall

At the courtyard we wanted transparency and permeability, so we chose a curtain wall system to allow for large windows and doors. We wanted the bamboo columns and glass wall articulated as distinct elements so the bamboo structure would stand out on its own. For inspiration, we looked at the BCE place by Calatrava. Calatrava separates glass

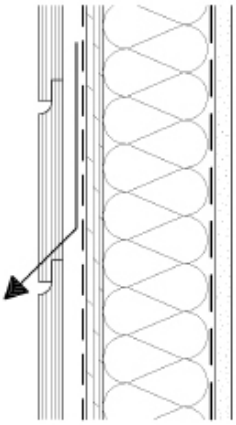
from structure by leaning the structure inwards and supporting the glass with struts off the columns. With straight columns, we decided to extend struts outwards to support the curtain wall.

Sketch by Santiago Calatrava

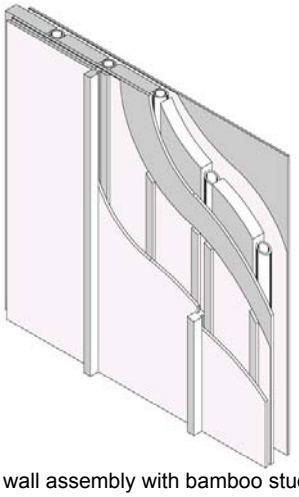


Steel support joint for curtain wall

Calatrava's more whimsical drawings inspired the steel joint between the strut and window mullion. We designed the joint in two pieces to be bolted together, which allows for quick and simple assembly on site.



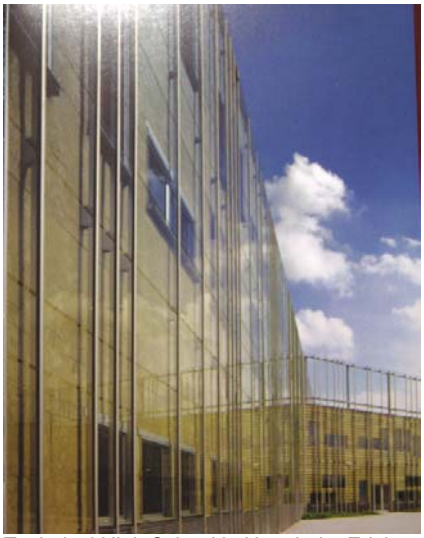
Cavity wall assembly with wood studs and siding



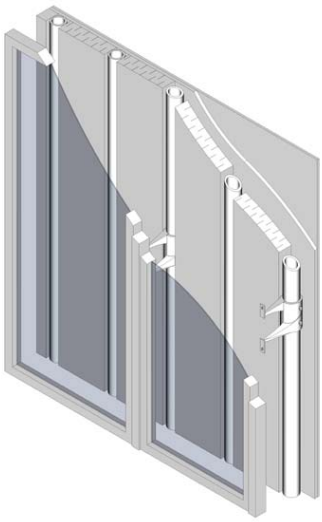
Cavity wall assembly with bamboo studs and plywood finish

We used a hybrid bamboo stud wall assembly along the bedroom and living room walls where more privacy is required. Bamboo canes take the place of wood studs here in a cavity wall enclosure system, which is used extensively in Canadian suburban homes. Stained exterior grade plywood serves as a finish, with vertical fins to hint at the bamboo structure beneath. Purlins create a cavity between the exterior finish and plywood shear panel for rain drainage, protecting the bamboo structure from damage. This assembly is opaque, so we placed windows where necessary.

The walls at the library and front gate have no windows to create visual interest. To create such interest we wanted the wall assembly to reveal at least part of the bamboo structure to the exterior, but without exposing it to the elements, and without the same transparency as the courtyard. Erick van Egeraat's Technical High School in Utrecht uses a curtain wall to protect the structure, and exposing mineral wool as a finish material. We liked the idea of revealing both structure and insulation for architectural honesty, so we adapted the assembly for a bamboo structure.



Technical High School in Utrecht by Erick van Egeraat



Bamboo studs supporting glass curtain wall

In this assembly plywood attaches to the interior of bamboo studs for moment resistance. Similar to the courtyard, the bamboo canes support a curtain wall system that provides moisture protection. Mineral wool insulation between the canes improves thermal resistance of the assembly, and gives an interesting finish appearance. The steel connection between stud and curtain wall was again inspired by Calatrava and designed for bolted assembly on site.

One cannot design without being influenced by the works of the past whether consciously or subconsciously. From schematic design to final structural detailing, archetypes and existing buildings had an impact on this bamboo house. These influences show through the schematic design, program, structure, and enclosure. One can entertain the illusion of designing in a vacuum, but forming a conscious appreciation of these influences leads to a greater understanding of how one designs.

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