ARCH 346: SuperSkyScrapers 2013 Bamboo Skyscraper Essay
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[Figure 17] Bamboo Skyscraper exterior view.

The 2013 SuperSkyScrapers competition asked us to design a conceptual skyscraper in Singapore that featured bamboo. The brief asked us to conceive of a design that has "a direct relationship with vertical development[1]", is an urban village[1], has to use bamboo as the dominant material[1], and the design should contribute to the sense of place of Singapore[1]. We looked at three projects that were designed as vertical villages: Paolo Soleri's Arcologies, Pinkcloud's Flip/City Shanghai proposal, and MVRDV's Peruri 88. We explored the potentials of bamboo in Vo Trong Nghia's Kontum Indochine café, bamboo scaffolding used all over Asia, and Vo Trong Nghia's Eco Resort Pavilion. Finally, we looked at three iconic projects in Singapore: the Gardens by the bay by Wilkenson Eyre, Marina Bay Sands by Moshe Safdie, and the indigenous Malay houses of the region.

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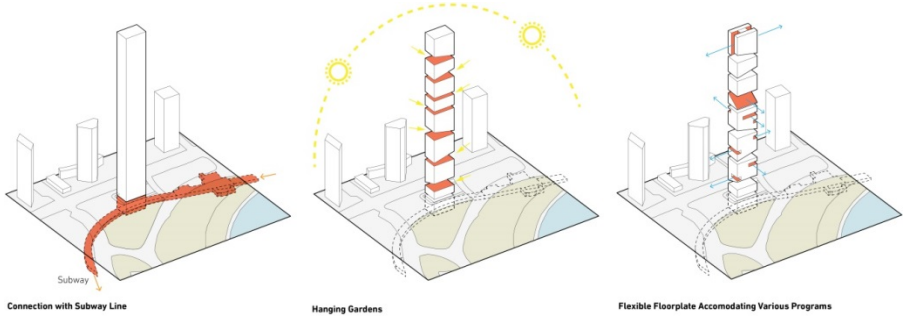
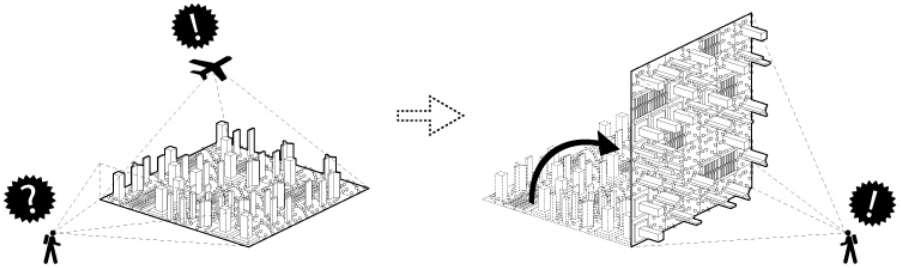
[1] "SuperSkyScrapers Singapore Bamboo Skyscraper 2013 Brief." *SuperSkyScrapers*, 2013.

The Arcologies of Poalo Soleri were more than large buildings; they were self-sustaining cities inside architecture. The paradox was that, although the Arcologies would be the largest single structures ever made, Soleri believed they would miniaturize the current cities overall and fight back against urban sprawl[2]. Soleri believed that cities could occupy a minimal footprint on the earth and liberate its surface[2]. We took the ideas of miniaturization and surface liberation into the massing design of our tower. The tower would have no podium and have an open ground level to sever its connection to the Earth and allow the existing forest to the south of the site to remain unaffected by the development [Figure1].



[Figure 1] Bamboo Skyscraper massing isometric diagram.



[Figure 2] Pink Cloud's Flip/City Shanghai concept diagram.

Pinkcloud expressed in their Flip/City Shanghai proposal that flipping the program of a city vertically would condense the city and catalyze synergy and a vivid community life[3] [Figure 2]. We took this idea one step further by creating six cuts in the tower that have five parks and one shopping promenade that serve as public outdoor mixing spaces between functional program blocks of the tower. The Flip/City proposal also had the idea of creating different block typologies based on different building typologies that exist in a city [Figure 3]. Similarly, in the design of our own tower, we thought we could employ the idea of creating functional typologies to design typological floor plates. The tectonics of each of our floor plates were designed to suit the different program requirements of a city [Figure 4].

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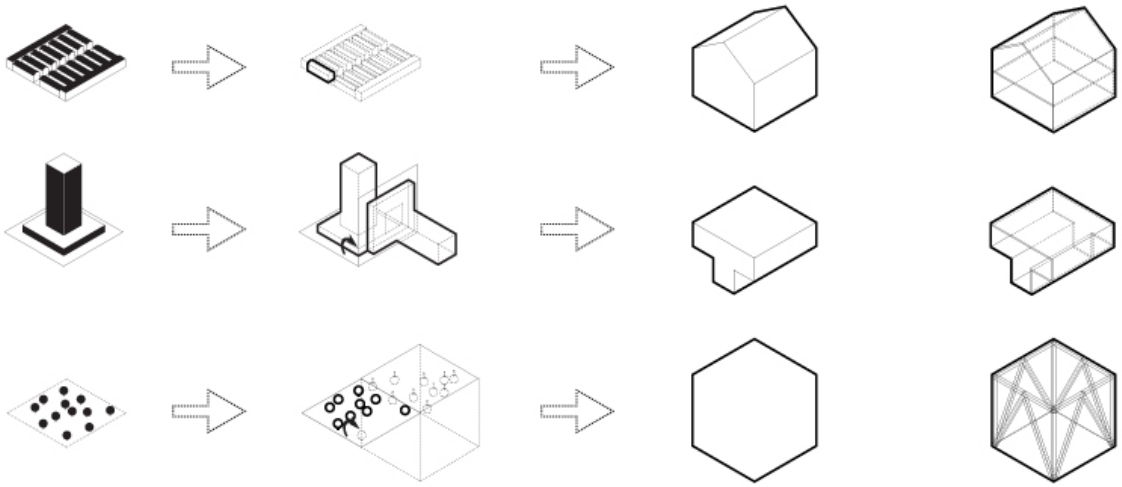
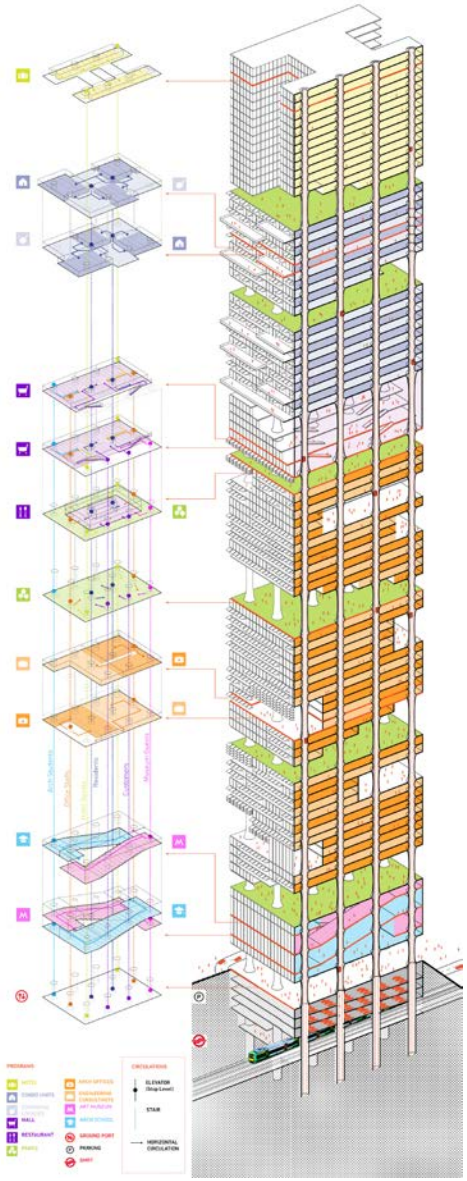
[2] Soleri, Paolo, Bable IIB. *Arcology: The City in the Image of Man*. 4th ed. Phoenix, Ariz.: Cosanti Press, 2006.

[3] Schalapps, Nico, and Fabian Busse. "Flip/City Shanghai." Pinkcloud. January 1, 2012. Accessed December 14, 2014. http://pinkcloud.dk/work/05/flipcity-shanghai



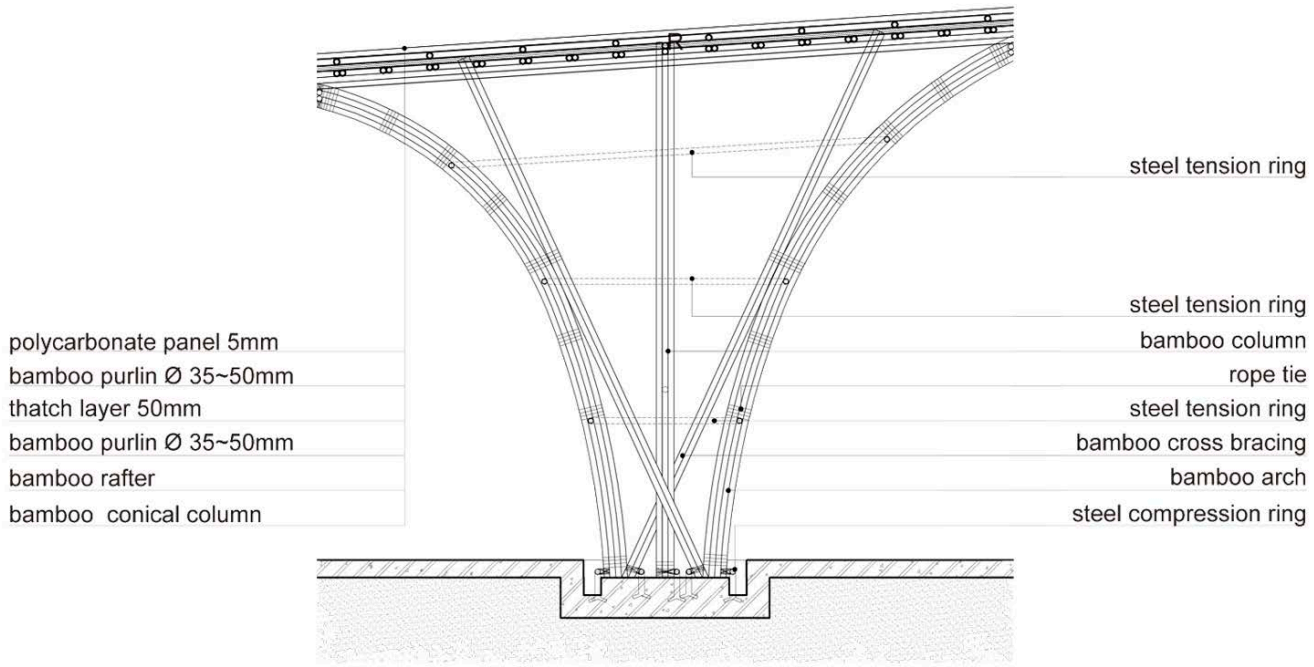
[Figure 3] Pink Cloud's Flip/City Shanghai typology diagram.



[Figure 4] Bamboo Skyscraper program and circulation section isometric.

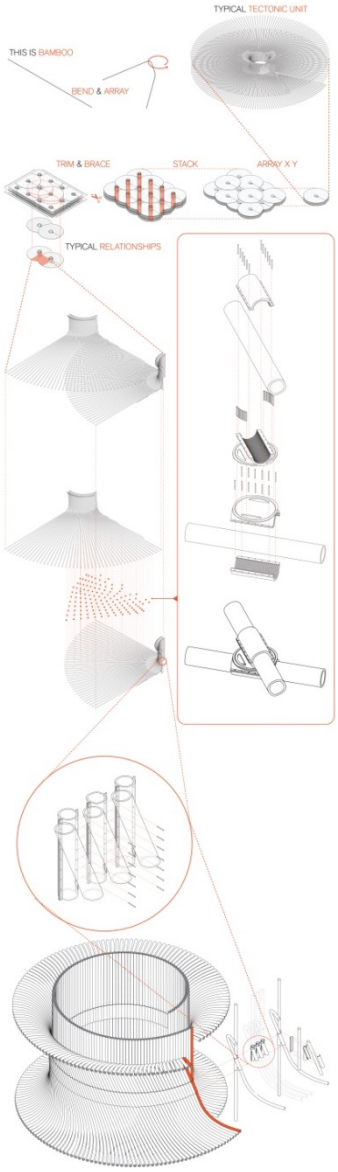
[Figure 5] MVRDV’s Peruri 88 sky park view.

The most interesting aspect of MVRDV’s Peruri 88 proposal to us was the creation of open space high above grade. Furthermore, MVRDV showed that these spaces can be used collectively by the surrounding blocks of the tower, much like how a park would be used by the surrounding blocks of residence in a city [Figure 5]. Piggybacking on this idea, we thought that our sky parks could serve as the perfect dividers between programs in the tower. For instance, we placed a sky park between the office and university blocks. This park, shared by both groups, could become a place of informal connection between institution and industry [Figure 4].



[Figure 6] Vo Trong Nghia's Kontum Indochine café column detail.

The conical columns of Vo Trong Nghia's Kontum Indochine café express the beauty of bamboo structure. Vo Trong Nghia took advantage of bamboo's ability to be formed and bent to create a flowing structure that has an almost monolithic quality. The structure uses a combination of curved bamboo and tension rings to minimize the amount of material required to make such a large column [Figure 6]. We also appreciated how the taper of the large column looks like half of a section of a stalk of bamboo. Translating these ideas into our design, we created super columns out of many arrayed members of bamboo. To eliminate the need for internal structure, we nested a convex super column inside a concave super column, held together with steel tension rings [Figure 8]. These super columns work in concert to create a moment frame for the building, eliminating the need for a lateral support system. Symbolically, these columns are analogous to the sections in a stalk of bamboo, and the stacking of these sections creates the super stalks that support the tower.



[Figure 8] Bamboo Skyscraper structure evolution diagram

We looked into the *Design of Bamboo Scaffolds* by K.F. Chung and S.L. Chan to check the feasibility of our moment frame. Luckily for us, "It was established that the characteristic values of the mechanical properties of the bamboo were often superior to common structural timber, and probably also to concrete[4]." According to Chung and Chan, the main failure modes of bamboo in compression was buckling and splitting. The splitting was usually caused by moisture contents that were too high, and the buckling was caused by the slenderness of a stalk of bamboo. Although we could not design conceptually against the bamboo that is too moist, we could certainly account for buckling in our design. We used steel brackets to weave the bamboo together like a basket, so that the members would act as one large member as opposed to many smaller members to prevent buckling [Figure 8].

Vo trong Nghia was able to accomplish large spans in his Eco Resort Pavilion through the use of radial bamboo arches [Figure 16]. Inspired by this design, we sought to take advantage of bamboo's ability to form arches to achieve our great unsupported spans between super columns. By intersecting many radial arches between columns, we can create a fan vault. The ribs of the fan vault would be mechanically fastened together in a tight weave that is both functional and beautiful.

[Figure 16] Vo Trong Nghia's Eco Resort pavilion interior

[4] Chung, K. F., and S. L. Chan. *Design of Bamboo Scaffolds*. Hong Kong: Hong Kong Polytechnic University, 2002.

[Figure 9] Wilkenson Eyre's Supertrees.

[Figure 10] Bamboo Skyscraper's open ground plane.

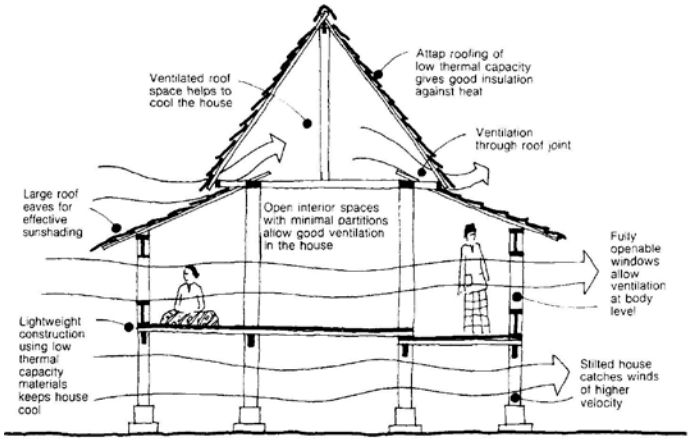
The Gardens by the bay by Wilkenson Eyre are one of the most iconic recent building projects in Singapore. These gardens serve as a tourist attraction and a landmark for Singapore. One of the iconic elements of the gardens are the Supertrees; tall tree like structures that house many species of plants [Figure 9]. In the words of the designers, the Supertrees "create height to balance the tall developments in the Marina Bay area[5]." We found our super columns ichnographically similar to the Supertrees, and that they also had the potential to create an intermediary scale between the tower and the rest of the site. By creating an open ground plane, the columns, much like the Supertrees, create an intermediary scale between the tower and the existing forest on the site [Figure 10 and Figure 11].

[Figure 11] Aerial photo of the site of the Bamboo Skyscraper.

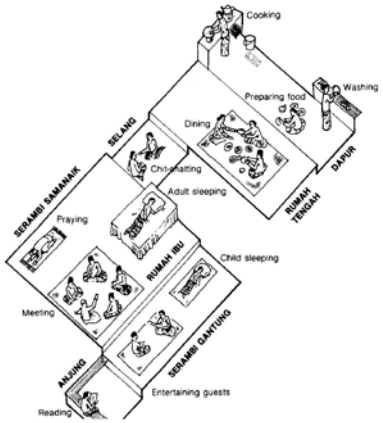
[5] "Supertree Grove." Gardens by the bay. Accessed December 15, 2014. http://www.gardensbythebay.com.sg/en/the-gardens/attractions/supertree-grove.html#!/overview

[Figure 12] Moshe Safdie’s Marina Bay Sands resort sky park.

Another iconic new project in Singapore is the Marina Bay Sands resort, which features a sky park on its roof [Figure 12]. This park is a vertical extension of public open space that takes advantage of the tropical climate of Singapore. We thought that the parks in our project would be equally successful in Singapore because the existing sky park is well enjoyed.

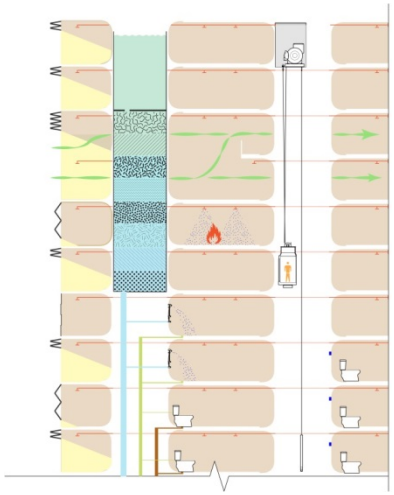


[Figure 13] Traditional Malay house cross section.



[Figure 14] Traditional Malay house plan axonometric.

The traditional architecture of Singapore is the Malay house. The Malay house is a vernacular typology found throughout the Malay Peninsula. To keep cool without electricity in the hot humid climate, the house is raised up on stilts to maximize surface area for ventilation [Figure 13]. The interior of the Malay house does not use partition walls to separate different programmatic spaces. Instead, the house has many different levels of grade to define different rooms [Figure 14]. We also wanted to incorporate cross ventilation into our tower, so we substituted curtain wall with operable bamboo screen cladding that would allow the wind to permeate and naturally cool down the building [Figure 15]. Much like the traditional Malay floor plan, we tried to create programmatic separation in our floor plate typology, rather than levels like in a traditional skyscraper.



[Figure 15] Bamboo Skyscraper environmental technologies diagram.

Each project we looked at gave us ideas that played into our final design. The Arcologies by Soleri, Flip/City Shanghai by Pink Cloud, and Peruri 88 by MVRDV were all projects which challenged the idea of what a skyscraper could be. Similarly, the Kontum Indochine Café by Vo Trong Nghia, Bamboo scaffolding, and the Eco Resort Pavillion by Vo Trong Nghia were projects that showed us what bamboo could do. Finally, the Gardens by the Bay by Wilkenson Eyre, Marina Bay Sands by Moshe Safadi, and the Malay houses were projects that were iconic of Singapore. Although looking at many precedents helped us to conceive of our concept, it was only through countless iterations and discussion were we able to integrate all these ideas into a cohesive project. Personally, I think the role of precedents in any architectural project is like a launch pad to help a project depart from a blank sheet.

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[Figure 2]

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[Figure 3]

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[Figure 4]

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[Figure 7]

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[Figure 6]

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[Figure 7]

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[Figure 9]

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[Figure 16]

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