Flying Carpets: The Floating Roofs of Renzo Piano Building Workshop

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The buildings designed by Renzo Piano Building Workshop (RPBW) consistently demonstrate a clear efficiency of design. In fact, a major goal of Piano's design process is to make "one move to do many things"[1] as often as possible. In this way each element or system of construction provides many functions, both physical and conceptual. This is clearly evident in the design of the lightweight, seemingly hovering, flat roof assemblies that he refers to as "flying carpet" roofs. His fondness for this roof type is evident by its multiple replications in his projects over the years. Each flying carpet roof is an integral part (often the key part) of each building design and provides an array of functions to justify its complexity and expense. For one example, the flying carpet roof on the building in Milan for the Italian business newspaper Il Sole 24 Ore (Il Sole) provides many physical and conceptual functions at once. It is a major shading element for the top floor balconies, it provides railings to support the window washing equipment, it responds to the context by matching the height of surrounding buildings, it provides a structure light enough to be supported by the existing concrete frame, it defines the perimeter boundary of the building to conceptually tie the large complex together, it provides a clear capital to the tripartite order of the exterior and it helps blur the distinction between inside and outside space. All of RPBW's flying carpet roofs perform these multiple tasks in various ways depending on the use of the building. For this paper I analyze four buildings that utilize this type of roof: Il Sole, The Cy Twombly Gallery in Houston (Twombly), the Beyeler Foundation in Switzerland (Beyeler) and the Chicago Art Institute addition (Chicago) currently under construction. I compare their similarities and differences in 4 categories of Operational, Material, Compositional and Organizational.

OPERATIONAL - MODULATOR OF LIGHT

With each of the four roofs, the primary reason for their design, and therefore deserving of the most discussion, is the control and modulation of sunlight from above. This is especially important since the three museums have strict requirements on the amount of direct and indirect sunlight allowed into the galleries. "Many lighting trials have demonstrated, once again, that overhead light is the best way to give the works softer and more natural colors."[2] To allow abundant quantities of natural light without the accompanying ultraviolet damage and glare, Piano has created many distinct overlapping layers of sun-control elements that create a multi-layered sandwich of louvers, shades and screens to bounce and filter light. Although he has experimented with light control in roof design before, the real genesis of the multiple layer "flying carpet" roof was RPBW's de Menil Museum in Houston where "light was used consciously to dematerialize the space, creating the necessary concentration on the works of art."[3] While this roof performs in a similar way to the other roofs, it is not as compact and integrated as the others and therefore is does not fit the description of a flying carpet as well. The de Menil roof clearly displays all the sun shading, enclosure and structural systems in a thick band at the edge of the building. In this building the glass is the top layer, a structural truss is in the middle and light controlling lovers are suspended below. This ordering system of layers has been compared to Sverre Fenns's Venice Biennale Pavilion where a translucent skylight sits on overlapping concrete fins that perform both as structural beams and light reflecting louvers.[4] However, in the three other museums, only one thin band of a shading element is revealed at the building face thereby providing the roofs with their flying carpet im-

Fig. 1 de Menil Museum

agery. To achieve this, the ordering of layers is reversed from that of de Menil, with slight variations for each so that the louvers hover above the walls and the glass and much of the primary structure are hidden behind the walls. To get a better understanding of these complex details, I redrew a detailed, color-rendered section through each of the three museum roofs to delineate the specific materials and connections. (see appendix) Through this study I was able to identify the similar layering strategies.

The layering order follows this general pattern:
1. A top layer of fixed diffusing louvers, either in metal or translucent glass.
2. A middle layer of a sealed glass envelope used to keep out wind, rain and sun.
3. A bottom layer of a translucent ceiling of either stretched cloth or perforated metal used to diffuse the light to an even glow.

There are then variations between the museums. Twombly and Beyeler have an extra layer of mechanically controlled adjustable louvers located below the glass layer to add an additional level of light control. Beyeler also has an additional lower glass ceiling mainly used as an air cavity thermal buffer rather than a light control device. Chicago does not have an additional middle layer of louvers but this may be because the shape of the top louvers is far more complex than the simple bar grating of Twombly or the sloped glass panels of Beyeler. These both work effectively to control southern light but are less effective on east and west sunlight so the louvers at Chicago have incorporated a vertical fin on the back of the main louver to block low-angled light. The overhang of the top louver system at Chicago is also much deeper than at Twombly thereby protecting more of the skylight below. Twombly must compensate for this by adding extra sun protection to the glass itself. "Because the upper canopy of fixed louvers does not over sail the exterior walls, direct sun falls on the lower and outer edges of the glass. In these places it is fritted (at between 20 and 80 percent depending on location) to limit the amount of direct sun admitted."[5]

The four layers of light control may at first seem like overkill; but they are in direct response to strict illumination requests from the client. "The Cy Twombly gallery houses a permanent collec-

Fig. 2 Cy Twombly Gallery

tion so the works are much more vulnerable to damage by light. Consequently the level of illumination is lower and constant; 300 lux as opposed to 1000 in the (de Menil) museum."[6] While the layering is intricate and the technology complex, Piano does not try to draw attention to the roofs themselves. Instead he conceals most of the details behind the translucent ceiling and lets the roof do its job. "The air of modern technology, which the roof construction brings to the building, focuses on using natural light to illuminate the art objects below and is hardly perceived by the visitor."[7] By reversing the order of layers of de Menil, less sun penetrates the glass so cooling loads and ultraviolet damage are reduced and the roof takes on a more elegant role as a cap to the building; an idea to be further discussed later.

After noting these differences in each of the louver systems, it is important to trace their development over time. Starting with the de Menil and progressing through the Twombly, Beyeler and Chicago, there is an interesting cycle of development of the sun shading system. The de Menil had just the one large-scale concrete louver system. To better control the light in Twombly, a four layer system was created with metal louvers on top above fritted glass with a mechanical louver system and a stretched fabric ceiling system below. As was aforementioned, there was still a problem of low-angled light leaking in at the edges so for Beyeler, four layers of protection were again provided but with more protection at the edges from an overhanging eave. Similar to Twombly, the top layer is of large translucent glass louvers above a layer of fritted glass with mechanical louvers and a perforated metal ceiling below. For Chicago, RPBW has returned to a simpler shading system reminiscent of de Menil. If my research is correct (barring construction changes) and there is no fritting on the glass skylights, then there are only two means of shading in this building, a layer of metal louvers on top that can control light from all directions and a stretched fabric ceiling below. In this latest building the architects seem to have learned how to control light without the need for elaborate mechanically controlled systems thereby reinforcing their goal of making one system perform many functions.

Since Il Sole is an office building and not a museum, light control was not as critical. However by looking at sketches of the preliminary design, we can see how it still followed the same pattern of the museums. Originally there were more layers planned for the roof but got removed in budget cuts. A field of photovoltaic panels, arranged in a shed roof pattern similar to the top glass panels on the roof of the Beyeler, was to cover most of the roof. Beyond supplying a source of electrical power, they would have added another sun shading layer to the roof composition. Having less stringent shading requirements at Il Sole allows more light to filter through and therefore has the benefit of a pleasant light quality, like the dappled effect found under a tree, cast onto the balconies and courtyard below.

MATERIAL - WEIGHTLESSNESS

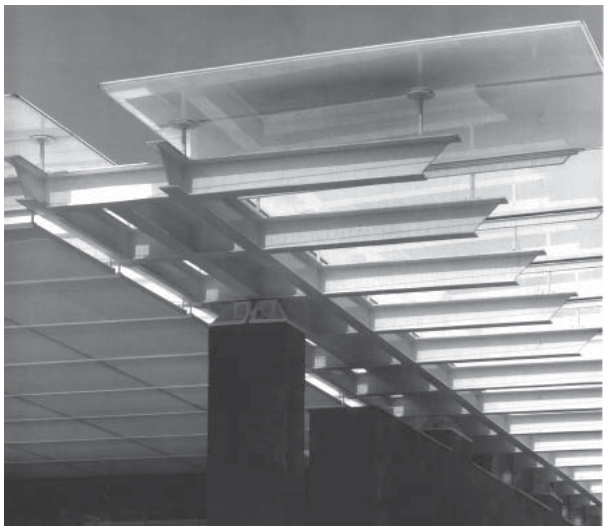


Fig. 3 Beyeler Museum

> "Anyone can build using a lot of material. If you make a wall a meter thick then it is going to stand up. Taking weight away from things, however, teaches you to make the shape of structure do the work, to understand the limits of the strength of components, and to replace rigidity with flexibility."[8] Renzo Piano

> *"When looking for lightness, you automatically find something that is precious, and that is very important on the plane of poetic language: transparency."*[9] *Renzo Piano*

Piano's long documented interest in transparency and lightness is evident in the lacy, delicate quality of the flying carpet roofs. The porous nature of the roof planes, that permit some but not all

light to penetrate, adds to the sense that the roofs are hovering or flying above the supports below. One of the first ways he emphasizes this sense is by contrasting the perforated roofs with a heavy base below. At Twombly the walls are unrelieved reconstituted stone that give a monumental feel and at Beyeler the walls are made of porphyry stone from Patagonia, the effect of which Piano has compared to a roman ruin. "The supporting structure is not visible from the galleries below, which creates a sense of lightness in clear and deliberate contrast to the rocklike solidity of the outside walls."[10] While some walls at the other 2 buildings are glass, both have significant areas of walls made of heavy compressive materials. Il Sole makes extensive use of yellow brick and Chicago has walls of stone veneer.

The next technique to impart lightness common to all four buildings is the elevation of the roof plane clear of the supports below. At Beyeler the roofs are suspended on pointed columns capitals above the walls to increase the feeling of separation. "You notice that the white fittings not only help unify the glass and steel, but also that its pattern and the slight slopes of the glass add a visual rhythmic energy that helps the roof fly free of the earthbound walls."[11] At the other three buildings, the roof is raised an average of about ten feet above the walls below creating a clear reveal of space between wall and roof. At Chicago, this effect is the most dramatic. Not only is the roof raised the greatest distance above the walls below, it also extends out the farthest from the building perimeter as it "hovers over the building like a ships rigging".[12] This requires the roof edge to be supported on columns isolated from the perimeter wall. Because the roof is perforated and has little live load from snow or wind, the columns can be especially slender. The overall effect is one where the roof seems to be physically disconnected from the building while conceptually holding it all together.

RPBW also achieves a sense of weightlessness through a practice of structural gymnastics. To increase a sense of disbelief about how the roof is supported, they stretch the structural strength of steel and glass close to their maximum efficiency with little unnecessary material wasted. Where possible, such as at Il Sole and Beyeler, he extends the edge panels out past the last supporting beams to increase the sense of lightness as the roof seems to dissolve at its end. "Above you see the oversailing roof float out to embrace its surroundings, supported on the crisp white steel grid and the glazing bars propped from this and stopping short of the ends of the glass sheets which reach out unconstrained by frames."[13] For the deep cantilevered roof over the interior courtyard at Il Sole, the main beams thicken upward as they get closer to the support point rather than downward as is typical for a cantilevered beam. In this way the heaviness of the beams is screened and partially hidden from view from below thereby adding to the sense of structural curiosity and excitement as to how the roof is able to span so far. Again, the minimum live load requirements of perforated louvers allows the structure to achieve a minimum thickness and thereby a greater sense of lightness.

COMPOSITIONAL - ROOF AS CAPITAL

The lightness and perforated quality of the flying carpet roofs begs the question, do they belong more to the earth or the sky? Probably a little of both. Like a cloud hovering over the facade below, they crown each building to provide a graceful transition from wall to sky. The classical tripartite order of base, shaft and capital has proven itself to work on both modern and traditional buildings. Piano understands this and takes advantage of it in these designs by using the roof to create a strong capital to each edifice. While the Beyeler has been compared to a Roman temple, I also see a comparison to another Italian building type, the renaissance palazzo with an open loggia on the top floor. This is especially evident at Il Sole where, like at the palazzo, the top floor balcony recesses from the face to create a deep reveal and a lightweight roof cantilevers far out and around the corner of the heavy base below. Both create an aesthetically pleasing completion to the elevation and transition to the sky.

Another way the roofs act as a capital is through the use of intricate details created by the multiple layers of construction. The overlapping layers of louvers and glass mullions create intricate patterns that draw the eye upwards to the rich detail as the tryglyphs and metopes of a classical temple pediment might do. However Piano's details are more honestly arrived at (by Modern architecture

Fig. 4 Pallazzo and Il Sole

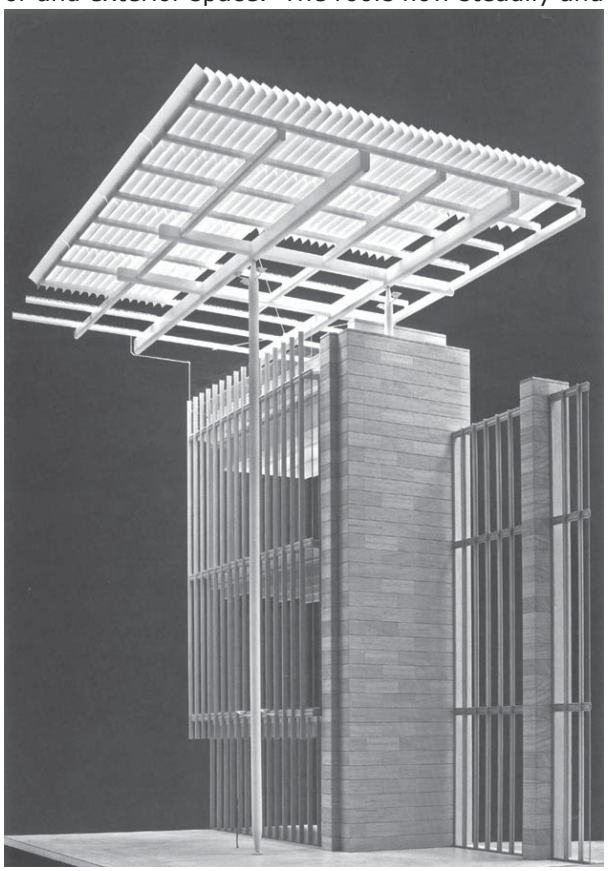
standards) as they are functional elements and not merely representatives of former construction materials and methods as in the classical temple. Piano has written that he is interested in reintroducing the theme of ornament, not decoration, to architecture. He writes; "I believe that architecture has to be given back its richness. It should show the mark of the person who made it, what Peter Rice calls the 'trace of the hand.' The quality of the building is also expressed through the quality of the detail."[14] Architects of modern buildings have long been wary of providing too much embellishment to their buildings as they feared being labeled traditionalists adding extraneous ornament. However, the flying carpet roofs run little risk of being labeled extraneous as they have such clear and important functions of structure and climate control. These precise instruments clearly reveal their function while simultaneously providing some visual interest for the viewer; another example of Piano's objective to achieve multiple goals within one design.

ORGANIZATIONAL – THE SHELTERING ROOF

A fourth commonality of the flying carpet roofs is the use of the roof as an overall unifying architectural enclosure that serves as an organizing datum for the spaces below. This 'mother hen' effect is most clearly demonstrated at Il Sole and Chicago where the roof is used to clearly demarcate the main body and underlying order of the buildings. The strict geometry of the roof steadfastly maintains the order of the project while allowing the walls below to move to accommodate programmatic functions. At Chicago the perfect square plan of the roof is supported regally on slender columns while the building below extends inward and outward, to varying degrees, from the line of the roof perimeter. Yet the strong square shape of the roof implies invisible boundary walls to hold the building together. Since the project is yet another addition to the museum, there was a strong need for hierarchy, order and clarity for this new entrance, which the clear geometry and prominence of the roof helps provide.

Fig. 5 Chicago Art Institute

The sheltering roof also blurs boundaries of interior and exterior space. The roofs flow steadily and



continuously, almost disregarding what is happening below. For example at Il Sole, the roof soars over exterior balconies and courtyards, interior atriums, spaces between buildings and solid roofs without much change. This creates some special 'in-between' spaces that feel like both interior and exterior spaces. The quality of light created by the perforated nature of the roof greatly aids this

effect which would have been less so under an opaque floating roof. At Beyeler the roof is decidedly directional but as it extends over the north and south sides and dissolves into garden, it soars past the glass curtain walls and over the water garden below with only slight modifications in its materials. As such, the space below feels like it belongs to both the interior and exterior.

CONCLUSION

While initially created as practical mechanisms for the strict control of sunlight, Piano has developed the flying roofs into powerful design elements in their own right that have proven to be adaptable to many cultures and locations. While their number of layers and degree of enclosure vary with the demands of each project, the general pattern of the flying carpet roofs remains consistent. Because the engineering of the roofs is not clearly visible, their role as sun screens is often overshadowed (no pun intended) by the strength of their sculptural form. However one is not more important than the other as the roof systems incorporate operational, material, compositional and organizational aspects into a truly integrated design. As they fulfill Piano's goal of making "one move to do many things", they are excellent examples that demonstrate the inseparable relationship between technology and design, something we are constantly striving to impart in our students today.

ENDNOTES

1. Conversation with Mauricio Cardenas, former employee of RPBW and team member of Il Sole project

2. Piano, Renzo, *The Renzo Piano Logbook*, Thames and Hudson, London, 1997

3. Piano

4. Foundation Beyeler, Editor, *Renzo Piano–Foundation Beyeler, A Home for Art*, Birkhauser, Basel, 1998

5. Buchanon, Peter, *Renzo Piano Building Workshop, Complete Works Volume 3*, Phaidon Press Limited, London, 1997

6. Piano

7. Beyeler

8. Piano

9. Piano

10. Piano

11. Beyeler

12. Cuno, James & Thorne, Martha, *Zero Gravity*, The Art Institute of Chicago, Chicago, 2005

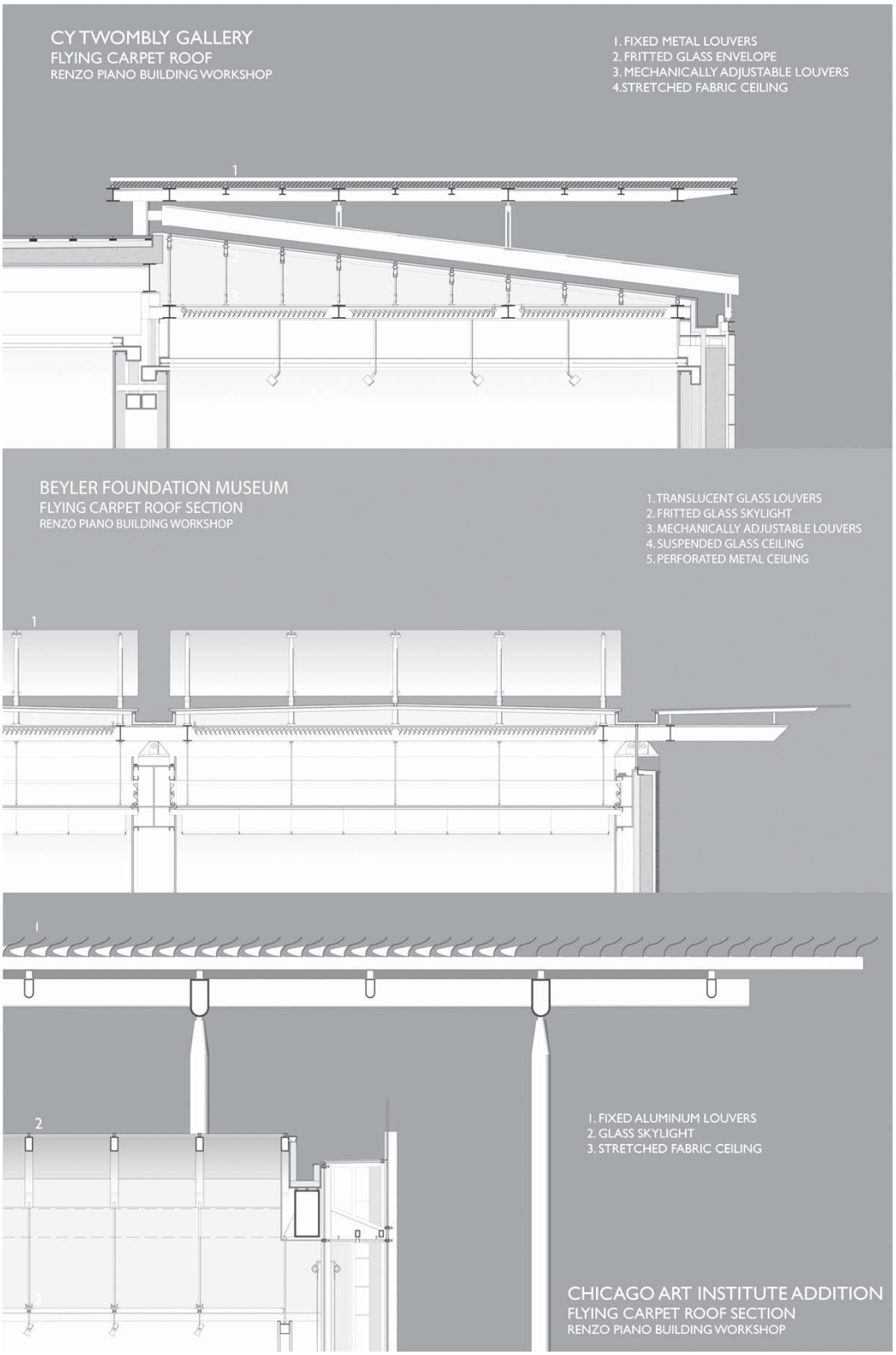
13. Beyeler

14. Piano

REFERENCES

Buchanon, Peter, *Renzo Piano Building Workshop, Complete Works Volume* 4, Phaidon Press Limited, London, 2000

Poletti, Raffaella, *Renzo Piano Building Workshop-Nuovo Sede Per Il Sole 24 Ore*, Il Sole 24 ORE, Milano, 2004



(Fig. 6 Appendix – Wall Section Renderings)