Roof Structures and Lighting Concepts in Four Museums by Renzo Piano Building Workshop

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INTRODUCTION

Since the early 1980s Renzo Piano Building Workshop has conceived and realized several remarkable museums in the United States, France and Switzerland. This chain of museum projects was initiated by with the Menil Collection in Houston, Texas, designed and built between 1981 and 1986. Three other museums and exhibition spaces have followed: the Cy Twombly Pavilion, a single artist exhibition space which is part of the Menil Foundation in Houston; the Brancusi Workshop, a small, liberally interpreted reconstruction of the sculptor Constantin Brancusi's living, working and exhibition spaces in Paris, France; and the Beyeler Foundation, a museum in Basel, Switzerland that houses the private collection of Ernst and Hildy Beyeler. The designs of the Twombly Pavilion, Brancusi Workshop and Beyeler Foundation overlapped and these projects were mutually influential, though their dates of completion were staggered over a two-year period. All four museums, though considerably different in size, site situation, program and collection, demonstrate similar attitudes toward the display and viewing of art.

New technologies or reexamined existing technologies are used in Piano's work for their architectural potential. They can often aid in his research of the "immaterial" or what cannot actually be touched or seen in architecture, and in many cases "technology" is almost synonymous with "craft." The techniques called into play the most for his museum buildings are related to the various solutions for natural day lighting. All four buildings mentioned use predominantly horizontal glass roofs to bring light from above into the exhibition spaces; however, the filtering devices and layering systems of the roofs vary from project to project to assure a level and a quality of light that respect current museum demands and conservation standards, as well as each particular geographical setting. Other than the roof systems, the techniques, details and choice of materials employed in these buildings reflect the desire to assure a proper environment for viewing and conserving works of art or for integrating the building into its specific site. Though all four museums are naturally lit by means of a glass roof, it is important to be aware of certain particularities of each project, programmatically and architecturally, to appreciate its final design. Though Piano is convinced that the best condition for viewing art is by mastering daylight in naturally toplit spaces, there are few initial preconceptions about techniques, materials or the detailing to be employed. These design decisions evolve out of contacts with the client, consultants, situation, place, etc. The goal is to use materials and technologies, whether they be advanced or traditional, in an unselfconscious way to produce the best possible solution. *

THE MENIL COLLECTION

The idea of the "treasure house" of the Menil Collection was primordial in the development of the day lighting scheme for the building. Because of the abundance of artwork in the collection, and because the clients requested that the galleries be flooded with light, it was decided that all works would not be exhibited at the same time but would be rotated. From this came the idea of the treasure house: a perfectly controlled environment that seems to float above the main body of the building, where works can be stored in optimal conservation conditions. When exhibited to the public however, the works are in a brightly lighted space where light levels may reach as much as 1000 lux, over three times the amount of light normally accepted by curators and lighting specialists in exhibition spaces.

Fig. 1. The Menil Collection.

The roof of the Menil is composed of only two essential elements. The outside layer is made of slightly pitched, reflective glass roofing panels with stainless steel gutters between them. The inside layer is an intricate combination of the ferro-cement, light diffusing and reflecting panels called the "leaves" which are suspended from a threedimensional structural system in cast ductile iron. The fabrication of the leaves borrowed from techniques normally employed in the ship building industry while the design of the cast iron pieces reveals the experience Piano and the engineer, Peter Rice had acquired while working on the design of an experimental car for Fiat. The ferro-cement leaves are not operable. The amount of natural light in the exhibition space directly depends on the amount of light outside. Hence the importance of the concept of the treasure house and the rotation of works of art, considering the abundance of light in Houston.

THE CY TWOMBLY PAVILION

The Cy Twombly Pavilion is devoted uniquely to the work of that artist. This small building of approximately 10,000 square feet of gallery space is situated directly to the south of the original Menil Collection building. In plan the building is a nine square grid with each bay measuring approximately 30 x 30 feet. All gallery spaces are naturally lit except for the center gallery which is artificially lit at a much lower intensity as it contains more fragile pieces. The exterior masonry walls are finished in pre-cast, ochre-colored concrete slabs and support the light roof canopy above. Unlike those in the original Menil building, the works of art in the Twombly Pavilion are permanently exhibited and do not rotate. This necessitates a greater control in order to maintain light levels of approximately 300 lux instead of the 1000 lux permitted in the Menil.

The multi-layered steel and glass roofing system reflects the need for more precise light control and at the same time reduces air-conditioning loads. The outermost layer is made up of fixed louvers that are connected to the second layer, the structural steel canopy frame, by cast iron framing elements. The third layer, the skylight layer, is suspended from the structural frame and is made up of slightly sloped, double glazed units that include an ultraviolet filter. The glazing at the center of the roof is clear glass; however, at the perimeter of the building, as the glass becomes more exposed to low sun angles that are not blocked by the exterior louvers above, it is silk-screened at 80 percent in order to equalize the light transmission of the glazing layer. All roof glazing is heat strengthened and laminated. The fourth layer of the roof is a horizontal, electronically controlled, operable aluminum louver system with slats 3 1/2" wide. The operable louvers assure that even in the most extreme outside lighting conditions a satisfactory level of daylight can be maintained in the gallery spaces. The fifth and innermost layer is a fabric ceiling. The light transmission of the single sheet of cotton is roughly 45 percent. The fabric, with grommets every 5", is held in place by galvanized springs attached to an extruded aluminum track running around the perimeter of the upper part of each gallery space. Small holes in the fabric allow lighting fixtures mounted in light tracks above to descend below the ceiling to provide artificial lighting. The fabric serves as a light diffuser, but perhaps more importantly it serves architecturally to create a uniform ceiling and evoke a calm space. The interior walls are white plaster and the floor is natural oak. These two surface materials help to reflect the top lighting and create an atmosphere of generally diffused light.

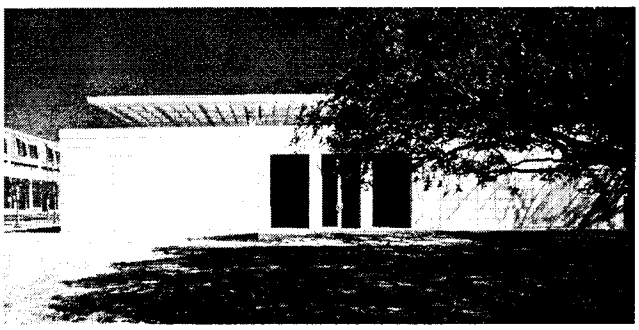

Fig. 2. The Cy Twombly Pavilion.

THE BRANCUSI WORKSHOP

The works of art and other objects in Constantin Brancusi's workshop were bequeathed by the artist to the French National Museum of Modern Art at his death in 1957. The workshop was much more than his place of work, it was also his living space, his exhibition space and, more importantly, a space where he experimented with the composition of his various works. As a young man Brancusi left his native Romania to go to Paris. He worked for a short time in the studio of Auguste Rodin but left to pursue his own work and is known today as one of the first abstract sculptors and as one of the most influential of the 20th century.

Brancusi concentrated on a limited number of themes in his work such as animal forms, birth, infinity, etc., that he often repeated while always searching for the essence of what he was abstracting. He worked extensively with the bases for his sculptures and would compose various pieces together with their bases making it impossible to know exactly what was base and what was sculpture. The way pieces touched the ground or touched the sky was of utmost importance to him. He hoped to do very large outdoor installations—land art of sorts—but had few opportunities to realize those kinds of projects. Over time his workshop became more and more important as a laboratory to explore the relationships or dialogue among the many different pieces and between the pieces and the space that contained them. At the time of his death his workshop was the best example of his attitude and reflections on sculpture, and considering the careful adjustments Brancusi made to the placements of his pieces, the workshop should be seen less as an accumulation of works than as one work of art in itself: a landscape of sculpture.

Brancusi hoped to keep this work of art intact, and when he bequeathed the contents of his workshop to the French government, it was with the stipulation that the works remain together in a space essentially identical to the one in which he worked. Brancusi was aware at the time of his death that his workshop in the Impasse Ronsin in the Montparnasse area of Paris would be destroyed to make way for a new hospital. Building materials of the original workshop were not saved since the workshop, in itself, was not architecturally significant; rather, it was the relationship between the works and the volume of the structure which was important. Brancusi possessed, in fact, five connected workshops in the Impasse Ronsin. Each measured approximately 12 x 24 feet. Three were devoted to the exhibition of his works and two were his living and working spaces. In section they had shed roofs with north facing clerestories.

The first reconstruction of Brancusi's workshop was in the Museum of Modern Art when it was located in the Palais de Tokyo in the western part of Paris. This reconstruction was inside the building at basement level and had no natural lighting. The second reconstruction was realized in the late 1970's at the northwest corner of the site of the Georges Pompidou Center as part of the National Museum of Modern Art. The building long seemed insufficient for the extraordinary works of art that it contained and in the early 1990's it was decided to demolish it and to realize the third reconstruction of Brancusi's workshop as part of a general plan of renovation of the urban areas around the Pompidou Center. The problem of the reconstruction was atypical. The building could not simply become a museum, nor could it be the reconstruction of the "living" spaces of an artist who had died 40 years before. The project evolved into a serene and dignified exhibition space in order to best show the numerous works that it houses.

The reconstructed Brancusi Workshop is more or less identical in plan and in section to the building Brancusi inhabited. The form that corresponds to the original workshop is now the core of a new "museum" building. Visitors no longer enter the workshop but view the works of art from a gallery space that surrounds it

Glass partitions separate the gallery from the workshop and provide greater security for the many fragile works as well as a perfect climatically controlled environment for them. The structure of the "core" is in laminated wood, echoing the wooden structure of the original building. The new, reconstructed museum is essentially composed of three major elements: the first, the core with its wooden structure that projects out to rest on the second element, the masonry walls which are made of local Parisian stone and protect this intimate building from the busy and lively urban area that surrounds it. The spaces created between the workshop and the walls become the viewing galleries, temporary exhibition spaces and the entry space. These spaces as well as the small exterior garden created by the walls

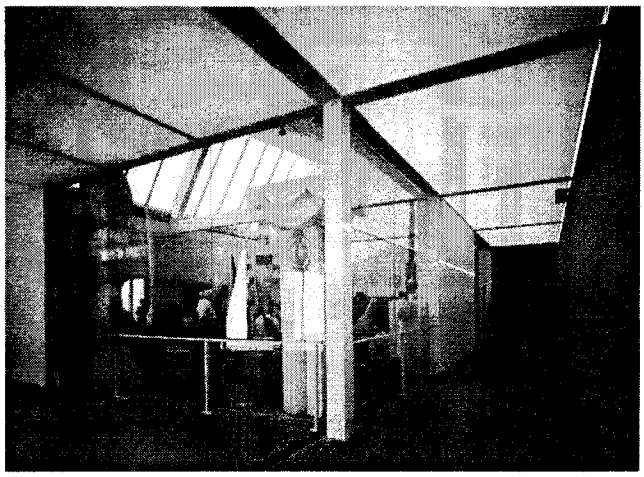

Fig. 3. The Brancusi Workshop interior.

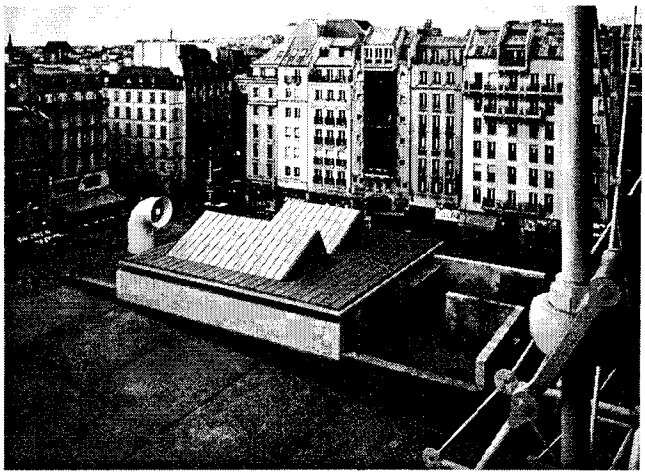

Fig. 4. The Brancusi Workshop seen from the Pompidou Center.

that project beyond the building are reminiscent of the spaces surrounding Brancusi's original workshop in the Impasse Ronsin. The third element is the roof which is poised on the wooden structure and stone walls.

The Brancusi Workshop measures approximately 5000 square feet. It is the smallest of the museums discussed yet it has two distinct roof types. After much study and debate concerning the form of the roof that covers the original five bays of the workshop it became clear that the original asymmetrical form of the sheds was the correct solution. In the final scheme the sheds emerge out of the horizontal roof plane that surrounds them. Materials are identical for the shed roof and the horizontal roof; however, light control is quite different. The lighting problem in this project was not one of quantity, since the sculptures are not vulnerable to light as paintings are, but rather a search for the proper balance of light between the space that is viewed—the five bays of the workshop—and the gallery space around it where the viewers are. Visitors to the original workshop in the Impasse Ronsin commented on the impression of whiteness of Brancusi's space. Because of this it was even more important to have a strong light in the workshop in order to direct the view of the visitor as well as to allude to the atmosphere of the original space. It was also important in order to minimize reflection in the extra white glass panels which define the workshop space.

Brancusi had greatly appreciated the changing light in his workspace and often photographed his pieces under different conditions. The visitor to the reconstructed workshop has an impression much like that of the original workshop where the natural light changed with the time of day, the weather, and the season. A constant, uniform, highly controlled light was not desired.

The glass of the north facing sheds is laminated double glazing. A translucent white film as well as ultraviolet protection is integrated into the glazing to diffuse the light and again to evoke a certain calmness in the space by avoiding views out through the shed clerestories. The workshop is artificially lit by halogen spots on light tracks. They highlight certain pieces during the day and they are the unique source of light at night when the workshop takes on a very different atmosphere.

The roof system over the viewing galleries is much more like that of the Twombly Pavilion. It has three layers, but no operable shading devices. The outermost layer is composed of perforated 2'-6" x 6'-0" stainless steel panels. These panels create a roof plane that functions in several different ways. Architecturally, the roof is perhaps the most important facade of the building since it is seen from the upper floors of the Pompidou Center, particularly while descending the escalators on its west facade. The metal panels are also an architectural link to the typical zinc, standing seam roofs of traditional Parisian buildings and they also function to filter the sun, making them essential for thermal and lighting purposes. The panels are perforated at 50 percent. This ratio was derived from lighting and architectural considerations as well as from the necessity to maintain enough material to be able to walk on them. They are reinforced by parallel stainless steel stiffeners every 4" and all panels can be opened to allow access to the glass roof below. (insert Figure 4 here)

The structure of the glazed roof is related to the 12' x 24' bay of the workshop and is composed of "H" shaped beams of welded flat steel sections that are insulated and lined with a stainless steel gutter. For aesthetic reasons the gutter system is horizontal and the number of down pipes was increased to assure proper evacuation of rainwater. T-section aluminum arcs span 6 feet between the beams and support the glazing, as well as short stainless steel legs that hold the perforated panels above. The 2'-6" x 6'-0" glass panels are curved to assure water run off but also to avoid another line in the roof as would have been the case had two straight pieces of glass with a ridge piece been used. The glazing is very similar to that of the shed and is composed of 12 mm clear glass at the exterior, a 12 mm airspace and two 6 mm laminated layers at the interior. A translucent film in the lamination works as an excellent light diffuser, has good thermal properties and minimizes the visual effect of dust and dirt on the outside of the glass. All of the glass is extra white which gives the glazing complex a crisp white color rather than the green tint of normal glass. Light transmission of the glazing is approximately 50 percent.

Fig. 5. The Brancusi Workshop: glazed roof under construction.

A fabric ceiling aligned with the bottom surface of the wooden beams is the innermost layer of the light diffusing complex. The fabric is stretched onto a rectangular 6' x 12' aluminum frame and attached to it by Velcro strips. The fabric is synthetic, fire resistant and has a light transmission of approximately 50 percent as well. The density was chosen for its light transmission but also for its visual translucency in that it allows a screened view of the structure above it. The ceiling panels are connected to the wooden structure by pivots and can be opened to allow access to the light fixtures above. Artificial lighting above the fabric gives greater transparency to the ceiling at night thereby giving a greater sense of depth to the roof structure and to the space itself. In the temporary exhibition space a system of manually operated louvers was installed above the fabric ceiling to better control the lighting when fragile photos, paintings, or other objects are displayed. Light tracks are placed between ceiling panels for exhibition lighting. The total natural light transmission through the three layers of the horizontal roof complex is approximately 10 percent of available outside light.

THE BEYELER FOUNDATION

Ernst Beyeler is among the most important art dealers in Europe. He began his career as a bookseller but went on to open an art gallery in Basel, Switzerland, in 1951. From the early 1970's he began to seriously build a collection of paintings by modern masters and of tribal art. In the mid-1990s he asked Renzo Piano to design a museum for his personal collection in Riehen just outside of Basel on a relatively open site where the project would become a synthesis of art, nature and architecture. The building is in the park of the Villa Berower, a 19th century historical monument. Because of its site, preliminary schemes for the project somewhat resembled a large greenhouse in the villa's park. The glass roof canopy was maintained from this initial idea.

The project is a three-aisle building with parallel walls approximately 350 feet long. Gallery spaces are a minimum of 24 feet wide and are calm and serene. The galleries are introverted and serve as a backdrop for the art. The exterior walls are clad in stone similar to the local red colored sand stone and seem to be carved from the earth. For conservation reasons light levels in the Beyeler Foundation do not exceed approximately 300 lux. The entire collection, which is comprised primarily of paintings, is permanently displayed.

Fig. 6. The Beyeler Foundation.

Together with the London engineering firm of Ove Arup, who was also the consultant for the Menil and the Twombly, the Building Workshop created what is perhaps its most elaborate roof system to date. The roof is conceived to provide enough natural lighting in the gallery spaces throughout the year except for certain cloudy winter days when artificial light is necessary to maintain desired lighting levels. Lighting calculations and the design process for the Beyeler building were typical of the methods used for all of the museum projects by the Building Workshop. Computer modeling and calculations were done in coordination with thermal calculations. Light transmission and thermal performance information for proposed materials was collected. Large scale models representing building materials were made by the in-house model making shop and tested outdoors using hand-held light meters. Finally, a full scale prototype of one gallery space that accurately represented all interior and exterior materials was constructed on the site of the future building for final verifications.

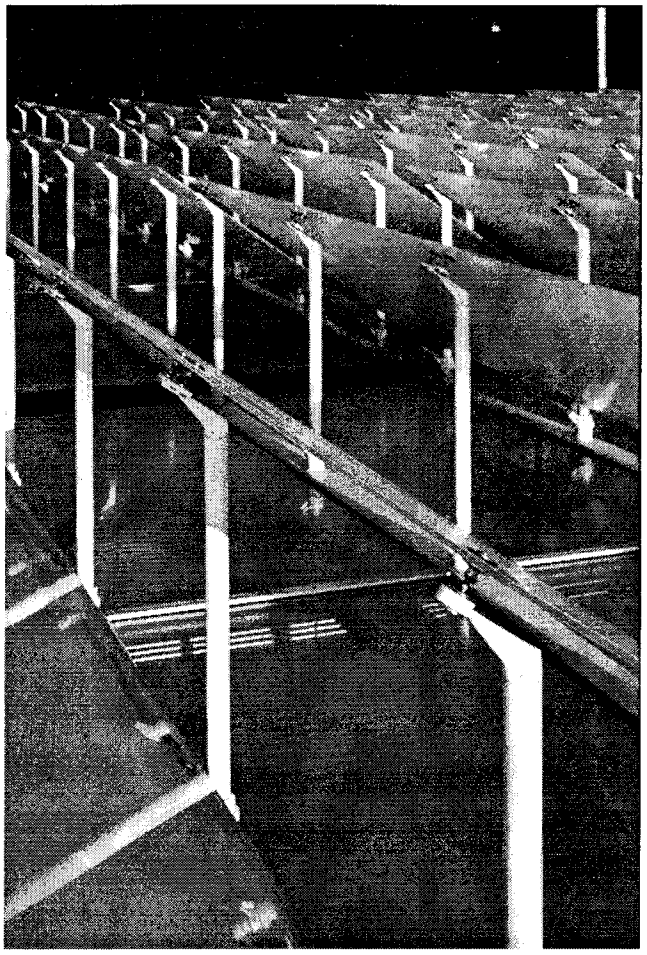

Fig. 7. The Beyeler Foundation: glass roof panels.

The glass covering of the Beyeler Foundation seems to be independent of the thick walls of the building. Seen from the exterior the repetitive white glass planes appear to hover in space.

They change color with the time of day and the weather. They create a system of north facing sheds that function as the first layer that modifies the light entering the building. The panels are made of 12 mm tempered, extra white glass panels, silk-screened at 100 percent. The glass panels are bolted to cast steel pieces that connect to vertical steel tubes that are themselves connected to the primary, steel roof structure below. The glass roof is actually over five feet thick and it becomes a loft of sorts or an oversized double glazing in order to meet strict thermal performance requirements in Switzerland. The outside layer is a double glazing of tempered and laminated glass and is slightly sloped towards gutters that are situated above the thick walls. The inside layer is a 20 mm thick laminated

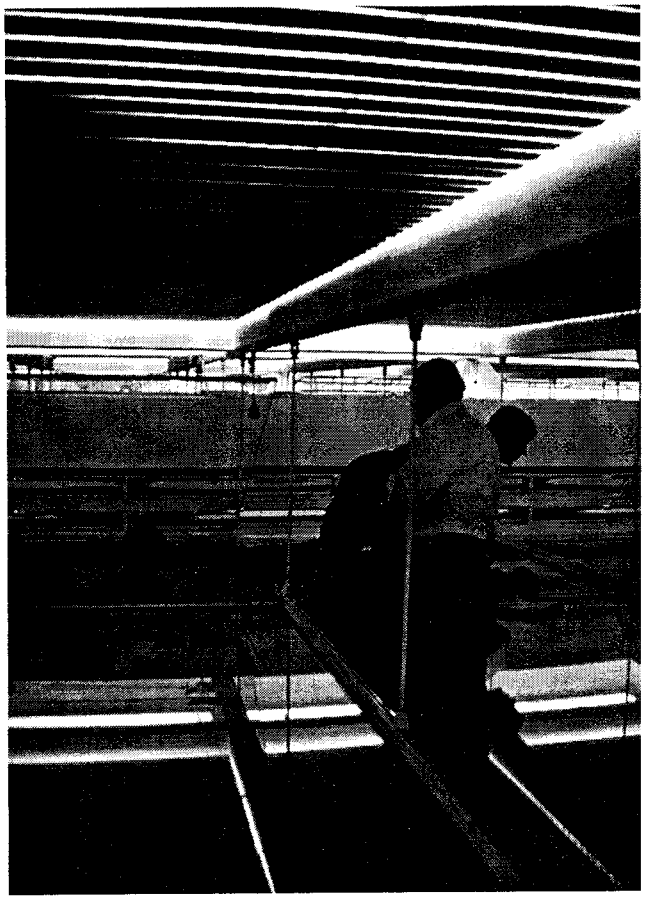

Fig. 8. The Beyeler Foundation: loft under construction.

glass which is horizontal. Within the loft are operable louvers similar to those in the Twombly Pavilion. Their movement is controlled by a computer that is linked to light sensors on the roof.

Inside the building, a suspended ceiling is made of 2'-6" x 5'6" aluminum panels perforated at 70 percent. Again, all panels can be opened to allow access above. The panels create a virtual ceiling plane with nothing suspended below; however, visitors are quite aware of the structure and layers above and can sometimes catch glimpses out to the sky. Artificial lighting is fluorescent and is situated above the ceiling. Fluorescent lighting was used to minimize heat gain, minimize energy consumption and because of the long life of the bulbs. Two bulbs with different light temperatures were used in each fixture to obtain an acceptable color of light. The fixtures above the ceiling panels bathe the walls of the galleries. Another concealed fluorescent lighting system in the loft provides a general light for the space at night and lights the layers above the ceiling thereby expanding the gallery spaces upwards. It also lights the white glass panels that hover above, and makes them glow.

CONCLUSION

Naturally toplit spaces are essential in the museums designed by the Building Workshop to create exhibition spaces with the best light quality for viewing art in a calm and serene space. Toplighting participates in creating exhibition spaces that are a backdrop for the works rather than spaces in competition with the art. The layered, repetitive, modular roof structures are strong architectural elements, yet from within the gallery spaces they seem to recede as material objects and become instruments that allow subtle changes in light that best reveal the qualities of the works.

The four buildings that have been presented show that, for what may seem very similar programs, Renzo Piano Building Workshop seeks to find what is specific to each. It is one of Piano's preoccupations to explore what is local and what is universal in each individual project. Transparency, lightness and light and repetition of elements that implies infinite space are among the themes that reoccur in his projects. His use of materials, techniques and technologies do not show a quest for originality, flamboyance, or even a desire to be noticed. Rather his taste for research always pushes towards synthesis and integration.

NOTES

* This paper presents a firsthand analysis as I was a collaborator in the Paris office of Renzo Piano Building Workshop for 12 years and served as project architect of the Brancusi Workshop and participated in the Beyeler Foundation project. All four museums are published in Renzo Piano Building Workshop Complete Works by Peter Buchanan as well as Renzo Piano's Logbook.