LE CORBUSIER AND THE "MUR NEUTRALISANT:" AN EARLY EXPERIMENT IN DOUBLE ENVELOPE CONSTRUCTION

HARVEY J. BRYAN, Ph.D.
Graduate School of Design
Harvard University
48 Quincy Street
Cambridge, MA. 02178, USA

ABSTRACT. This paper presents a detailed discussion of Le Corbusier's concept of the "mur neutralisant" (neutralizing wall). It tracks the concept's development, from its first application in 1916 to its abandonment after it failed to gain acceptance for use in the United Nations Building in 1947. The paper concludes by discussing two completed and operating double-envelope buildings that have a number of similarities to Le Corbusier's concept.

1. THE EARLY EXPERIMENT

In 1916, Le Corbusier designed for the Swiss industrialist Anatole Schwob, a villa in La Chaux-de-Fonds. While the Villa Schwob is widely acknowledged for marking the transition between Le Corbusier's vernacular and modernist periods, it is also the first building to be completed since the development of the Domino concept (1914). The notion that Le Corbusier was most concerned with during this period was the use of reinforced concrete frame construction, which according to the Domino concept allows the wall to be liberated from its traditional structural role and thus becomes free to perform new functions. Le Corbusier began just such an exploration in the Villa Schwob by incorporating a thermal distribution function into the exterior walls. Le Corbusier would later term this strategy the "mur neutralisant" (neutralizing wall), which can be simply described as double wall construction with conditioned air being circulated in the cavity between the two walls.

This early version of the "mur neutralisant" incorporated heating pipes laid at the bottom of the cavity created by the double wall. Convection would heat the air within the cavity, raising the temperature of the surrounding wall surfaces. The temperature of the inner wall surface would be raised sufficiently to radiatively heat the adjoining space. Thus, by controlling the radiant fields, Le Corbusier introduced a level of comfort into this design that was unattainable by then current heating technology. While the Villa Schwob is thermally quite comfortable, this condition cannot be attributed only to the action of the "mur neutralisant" because there are other thermal phenomena at work.

S. Alvarez et al. (eds.), Architecture and Urban Space, 257–262.

Le Corbusier properly oriented the Villa Schwob to take maximum advantage of the sunny Alpine climate by placing its two-story living room and its large 5m x 6m window facing south; this, coupled with the thermal storage capacity of its building materials and the improved thermal resistance of the double wall construction, provides an excellent application of what we now term passive solar design (see Fig. 1).

2. THE EVOLUTION OF THE EXPERIMENT

Upon the completion of the Villa Schwob, Le Corbusier moved to Paris where he could engage in more challenging commissions. Over the next ten years his activities focused on theoretical writing, competitions and the design of several residences. The environmental concerns that he had begun to explore in the Villa Schwob, particularly the use of a south facing two-story glazed living room were present in a number of his designs of this period. In 1927, Le Corbusier brought together many of the ideas that he had been developing into the competition design for the League of Nations building. In this project the "mur neutralisant" evolved into an elaborate affair, with large mechanical ventilators blowing heated air into the cavity between the double glazed walls of the eight-story assembly hall. Le Corbusier spent considerable time on the technical aspects, working out many of the details of its design in consultation with physicist Gustave Lyon. From a historical standpoint this project is quite noteworthy because it is the first use of the hermetic glass curtain wall, which allows in light but not air, thus beginning the functional redefinition of the window.

Although Le Corbusier's design for the League of Nations building was never built, the notoriety he received began to attract larger commissions. In 1928 he was invited to Moscow to develop a design for the Centrosoyus building. In this design Le Corbusier re-used many of the features from the League of Nations design (see Fig. 2). However, the technical features that were proposed suggested an even more elaborate scheme than the one presented in the League of Nations design. Working again with Gustave Lyon, Le Corbusier introduced Lyon's scheme for mechanical ventilating the interior and the "mur neutralisant" for the perimeter of the building. These elaborate concepts caught the concern of the client, who requested additional information on its practicality. Hard pressed to find support, Le Corbusier turned to engineers at the American Blower Corporation, thinking that they would relish the idea of providing mechanical equipment for this innovative design. However, the American Blower Corporation could not find much support for his scheme. In a letter to Le Corbusier they state that their calculations showed that ". . . your proposal will demand approximately four times more steam and more than twice the fan energy to heat and ventilate the building than that which would be necessary with current methods employed in our country to heat and ventilate a building exposed to the same atmospheric conditions." (American Blower Corporation (1930). Lacking credible technical support and reliable cost data, the client chose to employ only a double glazed wall.

Undeterred by the second failure to employ the "mur neutralisant,"

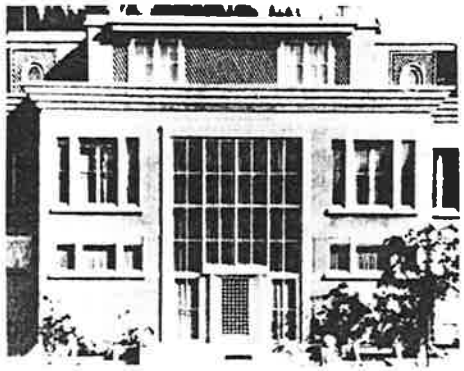

Fig 1. Villa Schwob - South Facade

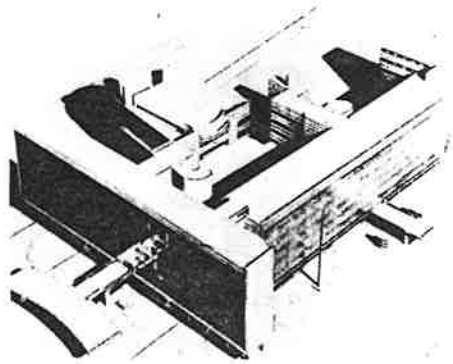

Fig 2. Centrosoyus - Perspective

Le Corbusier went on to propose the concept of "respiration exacte" (exact breathing), which was a closed fan driven heating, ventilating and air-conditioning system that was largely based on Gustave Lyon's ventilation work (Le Corbusier (1930). Like the "mur neutralisant" the "respiration exacte" is an important concept because it is the forerunner of today's hermetically sealed, air-conditioned buildings.

Le Corbusier lost no time applying these concepts to projects like the Cite de Refuge in Paris (1930) and the Palace of the Soviets in Moscow (1931). The Cite de Refuge, a multistory hostel for the Salvatio Army, is the more interesting because it was actually built (see Fig. 3 Like in the previous building, the client was concerned about the concepts that Le Corbusier was proposing and wanted to see technical support. This time Le Corbusier approached Saint Gobain, the French glass company, to see if they would test the "mur neutralisant." Saint Gobain, intrigued by the idea, not only agreed to undertake testing but also to involve Gustave Lyon in establishing the testing procedure. An insulated 4m x 2m x 3m(high) test-chamber was built to house a 1.5m x 2.5m double glazed window that allowed hot air to circulate between the panes (see Fig. 4). This window divided the test-chamber into two small rooms; in the first outdoor temperature was simulated, and in the secon the resulting indoor temperature. Tests were performed by placing dry ice in the first room and then measuring the change in temperature of the second as well as the energy used by the heater and fan. Performanc was determined by comparing the above tests to a window that used a non "mur neutralisant" design. The resulting report was not very flattering to Le Corbusier's concept. While it did acknowledge that the warmer glass surfaces would improve comfort, it did so at a tremendous expense in terms of thermal and fan energy (Saint Gobain Glass Company (1932), thus confirming what the American Blower Corporation had told Le Corbusier two years earlier. This report and the high cost estimates that the client received for the "mur neutralisant" necessitated its rejection. What the client did agree to was a 1,100m^2 sealed single pane curtain wall on the south facade and the heating and ventilation but not the air-conditioning component of the "respiration exacte."

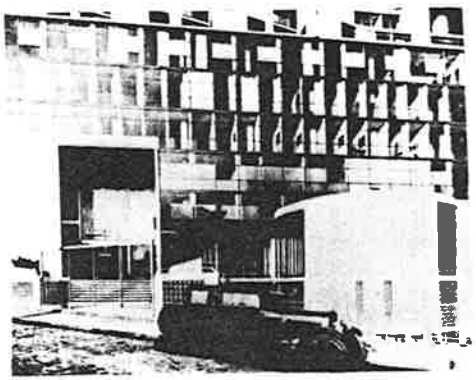

Fig 3. Cite de Refuge - South Facade

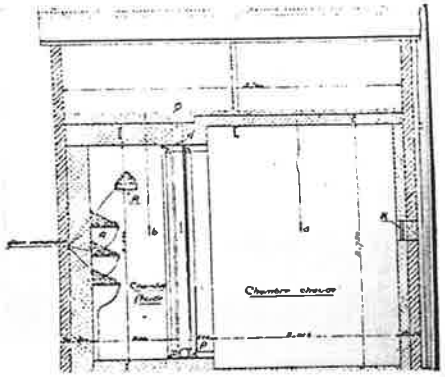

Fig 4. Saint Gobain's Test Chamber

On December 7, 1933, the Cite de Refuge opened with considerable attention being paid to its architect. However, within a few months the client was complaining about severe winter underheating and summer overheating, and proposed the installation of operable windows in the south facade to correct the overheating problems. Le Corbusier countered by strongly arguing against such a change, suggesting instead that the money would be better spent purchasing the air-conditioning equipment in order to complete the "respiration exacte" concept. The controversy continued until the summer of 1935 when Parisian officials threatened to condemn the building unless operable windows were installed (Taylor (1987). While the operable windows remedied much of the overheating, problems persisted until 1952, when a major alteration (suggested and partially executed by Le Corbusier) introduced sunscreens, opaque panels and additional operable windows to the south facade.

It was not until 1947, during the design of the United Nations Building, that Le Corbusier again proposed the "mur neutralisant." As the dominant member of a 10 member Board of Design, Le Corbusier found his design ideas being enthusiastically received by his colleagues on the Board (see Fig. 5), while his technical suggestions received little attention. This was particularly the case with his insistance that for this building to work from a comfort standpoint that it had to incorporate the "mur neutralisant." Late in 1947, as the "mur neutralisant" began to lose out to a single pane curtain wall and a state-of-the-art air-conditioning solution, Le Corbusier became bitter and wrote to U.S. Senator Warren Austin, President of the U.N. Building Commission, complaining that his ideas were not being given proper consideration (Le Corbusier (1947). His letter did not change matters and soon after he disassociated himself from the building (see Fig. 6).

What is interesting about Le Corbusier's proposal for the U.N. Building is that it marked an important transition in his thinking about the design of the building envelope. He never again would attempt to use the "mur neutralisant" and his subsequent designs started to rely less on mechanical devices and more on passive strategies such as the "brise-soleil" and natural ventilation through the use of clever

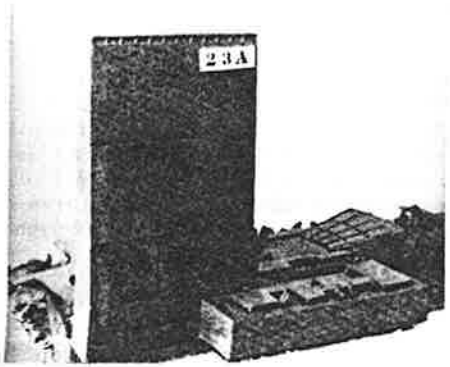

Fig 5. Le Corbusier's Model for the United Nations Building

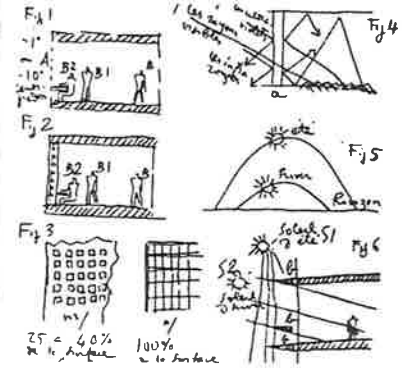

Fig 6. Drawings from Le Corbusier's Letter to Senator Austin

building cross-sections and operable windows.

3. THE VALUE OF THE EXPERIMENT

While historians such as Reyer Banham have dismissed the "mur neutralisant" as an "unreal and unworkable" concept (Banham (1969), I do find merit in the concept. I say this even in light of the negative evaluations done by both the American Blower Corporation and Saint Gobain because both of these studies neglected to take into consideration the solar contribution, just as Le Corbusier failed to understand how it was working for him in the Villa Schwob. If Le Corbusier had taken the sun into account he would have discovered that the issue was not how to blow hot air into the double glazed cavity but rather how to use the solar energy that became trapped within the cavity. Such a version of the "mur neutralisant" would utilize a double glazed wall with operable louvers at the top and bottom and a horizontal grate at each floor which also work as a sun shading device as well as allow air to move vertically. In the winter, this wall would work by reducing the building's heat loss by having both vents closed, thus trapping within the cavity the solar radiation comming through the outer pane. In the summer, both vents would be open and the shading devices would prevent solar radiation from striking the inner pane. The radiation coming through the outer pane would cause expansion of the air and rapid exiting out the upper vent which would result in cooler outside air being drawn into the cavity.

Additional evidence as to the feasibility of a modified version of the "mur neutralisant" is the fact that there have been several window prototypes as well as buildings completed over the last decade which utilize such a strategy. The window prototypes range from the "air-flow window" which is beginning to see application in Scandinavia to the "return-air window" recently used in The Lloyd's of London Building. The buildings can all be classified as having double envelopes and

range anywhere in size from small institutional to large commercial office buildings. While there are a number of these buildings in operation, space limits the mention of only two.

The first is the Equitable Life Assurance Society Building in Charlotte, N.C. (1977). The envelope of this building utilizes several horizontal glass plenums called "solar belts" that surround the perimeter and act as the neutralizing cavity as well as form the route by which solar heated air moves around the building in winter and from which interior exhaust is vented in summer. While the building performs well, considerable energy is needed to move the air horizontally through the solar belts.

The other is the Occidential Chemical Building in Niagara Falls, N.Y. (1981). The entire envelope that surrounds this building is comprised of two glass curtain walls which create a 1.5m x 9-story neutralizing cavity on each of its four orientations. Open louvers at the top and bottom of the 9-story cavity and grates at each floor allow solar heated air to vent via the chimney effect in summer, while closing the louvers traps the warm air in winter. Although the building is performing better than design estimates had predicted, the building's cube-shape and identical treatment of each facade suggests a building that is insensitive to orientation.

4. CONCLUSION

While Le Corbusier misunderstood the physical principles that were at work in the "mur neutralisant," he at least was a protagonist in the technological debate. He was not content, like so many present-day architects, to let the consultants or manufacturers solve the technical problems for him. The two recently completed double-envelope buildings are cited not as a validation of the "mur neutralisant," but rather to suggest that the questions concerning double-envelope wall construction with which Le Corbusier was so concerned are still with us and need to be investigated further.

5. REFERENCES

American Blower Corporation, (1930) Letter to Le Corbusier dated January 24, Foundation Le Corbusier, Paris.

Banham, R. (1969) The Architecture of the Well-Temperated Environment, University of Chicago Press, pp. 159.

Le Corbusier, (1930) Precision, Paris, pp. 64.

Le Corbusier, (1947) Letter to Senator Warren Autin dated December 4, reprinted in Architectural Record, July 1950, pp. 69-71.

Saint Gobain Glass Company, (1932) Verres et Glaces, Aug/Sept.

Taylor, B. (1987) Le Corbusier, The City of Refuge, Paris 1929-1933, University of Chicago Press, pp. 115.