FROM SEGREGATED TO INTEGRATED: The Evolution of Shading Designs in Marcel Breuer's Works

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Abstract: External sunshades, or brise-soleil in French, have played a significant role in the development of 20th century modern architecture history. An early promoter was Hungarian-American architect Marcel Breuer, who believed sun shading was a crucial architectural design motif. The sunshades in Breuer's early works were elaborately designed and attached to the glass wall façades. After 1960, they were no longer separated devices, but integrated to the new molded concrete façade system. Existing scholarship on Breuer is mainly focused on his furniture and housing designs produced during his early period and his aesthetic interest in the symbolic expression of prefabricated concrete structure. However, the evolution of Breuer's shading designs demonstrates a shift in his attitude from a segregated mode to an integrated one.

The interest of this paper is to review his development of sun shading designs, in order to argue how the concept of integration organizes Breuer's later façades. First, a study of the UNESCO headquarters secretary building demonstrates how a sun-shading design based on performance analysis fails to properly control the overall thermal environment of building. Then, a number of case studies attempt to unfold Breuer's integrated design process and various interrelationships between shading design and other architecture elements like structure, texture, mechanical systems, and architectural programs. The integrity in Breuer's design frees the façade from the modern concept of segregation, which is technically contradicted in nature, and leads to a more effective design process and a more meaningful architectural representation.

Keywords: Sunshade, segregated, integrated, Marcel Breuer

1. THE EMERGENCE OF MODERN SUN SHADES

1.1. SUNSHADES AS A SEGREGATED ARCHITECTURAL COMPONENT

The modern concept of the sunshade, called brise-soleil in French, is first proposed by the Swiss-French architect Le Corbusier. As Reyner Banham suggests, it was a remedy for Le Corbusier's transparent glass membrane, which was unable to exclude the excessive solar radiation (Banham 1969, 158). The emergence of the sunshade, as Aladar and Victor Olgyay point out, was a consequence of the separation of the wall into different elements playing distinctive roles after the rise of new structural possibilities (Olgyay 1957, 6). Compared to the multi-functional traditional walls, the modern ones were explicitly divided into skin (enclosure) and skeleton (structure). The former consisted of large panes of glass to be distinguished from the latter, and meanwhile generated a new spatiality of freedom. The problem of the glass wall was apparent. It introduced enjoyable light and view but also increased the heat load, making the interior inhabitable. At first, Le Corbusier introduced the concepts of la respiration exacte and le mur neutralisant to balance the air circulation, heat exchange and light between the architecture and the environment, manifesting an interior space thermostatically at 18°C all over the world. However, the ineffectiveness brought the sunshade design to the stage.

A segregation between the sunshade and the building structure is noticeable. On the one hand, such a division is submitted to the modern concept of the building system, where each element is treated and represented respectively. On the other hand, the segregation leads to a scientific design method focused on the sunshade individually at the risk of being isolated from the design process.

1.2. SUN SHADING AS A SEGREGATED DESIGN PROCESS

In the book Solar Control and Shading Devices, the Olgyays give a broad historical review of shading design. They argue that the correlation of human habitats with natural elements has a long history. The organization of architectural spaces often correspond to the movement of sun and solar control. Indian shelters, Louisiana villa verandas, and Tucuman country house colonnades are listed in the text as evidence (Olgyay 1957, 8).

However, as reviewed above, the modern sunshade is a remedy rather than an intention. Its main task is to effectively regulate heat, closely related to the exterior conditions like air temperature, solar altitude, and sun path, while little related to the inside. With the scientific method the Olgyays developed in the book, the geometrical feature of sunshade devices is emphasized by and related to shading efficiency. The shading mask was further developed to analyze a sunshade's geometrical parameters with a corresponding diagram, in order to establish direct visual connection with the diagram of a sun path. In such a way, a series of sunshade prototypes are classified and clearly represented by shading masks and section drawings. Case studies in Part 4 of the book are analyzed and displayed in the same way. Relationships with the building structure and interior space are hardly mentioned. As David Leatherbarrow and Richard Wesley observed,"Trimed and sized as they are, these photographs deprive the devices of specific relationships to the climate they modify and the interiors they protect." (Leatherbarrow and Wesley 2014, 174).

2. SUNSHADE DESIGN IN BREUER'S WORKS

Sun and shadow were significant design motifs of the Hungarian-American architect Marcel Breuer throughout his entire career. It informs the title of his first biography edited by Peter Blake (Blake 1956). In this book, Breuer showed his enthusiastic attitude on the wide openness provided by the new glass architecture. Hence, the sunshade was considered one of the basic architectural forms to control the heat and consequently a significant element on the building façade. Breuer even claimed that "[the sunshade] may develop into as characteristic a form as the Doric column" (Blake 1956, 117). The expression of the sunshade also endowed his buildings with a unique character.

2.1. SUNSHADE DESIGN BEFORE 1960

Various forms of sunshades were designed in Breuer's domestic projects during his early career before 1960, as he once claimed, "nearly every one of my works is an experiment in sun protection" (Hyman 2001). For example, canvas awnings were installed in the Doldertal Apartments in Zurich (1934), wooden slats were projected by cables in his own house in New Canaan (1947), and corrugated asbestos panels used in Dwight Ferry Jr. Cooperative house in Vassar College (1949). Breuer concluded two main technical principles in sun shading design: first, the sunshade should be made of slats rather than solid panels in order to let the heat that accumulates outside the window escape more easily. Second, sheets of "solar glass" that absorb heat and reduce glare were introduced as part of the sunshade device (Blake, 119).

Since solar glass would not interrupt the view and could be easily self-cleaned in the rain, it became a standard detail in Breuer's sunshade design after 1950 (Blake 119,123). The glass shade was first realized in the Smith House (1950), fixed by metal clips and cables to lessen its visual appearance, as the house

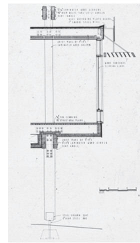


Figure 1: Wall section on the southeast of Starkey House. Source: (Syracuse University Library 1954-55)
Figure 2: East view of Starkey House. (Image by Ezra Stoller, from Robert McCarter, Breuer, 2016)

was located in a valley with beautiful scenery. In a later design, the Starkey house (1954-55), the sunshade on the southeast façade was a combination of solar glass and wooden louvers. Both were connected to the roof structure through steel pipes. The wooden louvers were at the same height of the top of sliding windows, providing shade for the area where people gathered near the windows. The solar glass in the upper part, may not have been intended for the view, and was probably set for the light to penetrate deeper into the house, with reduced glare and heat radiation (figures 1-2).

UNESCO headquarters secretary office building 1952-58

The sunshade design in the UNESCO headquarters secretary office building assembled all the characteristics in works of Breuer's prior to 1960. Nevertheless, it also amplified the problems existing in his previous works, to which he had not given enough attention.

The secretary building was designed in the shape of a Y, creating three curved surfaces which had six different oriented façades. Based on the data of the air temperatures and the intensity of direct solar radiation on each orientation, the SE, SSW, and WSW façade required additional sunshades (Howard 1959). As shown in the drawings, the shading system consisted of three layers (figure 3). The first was horizontal concrete louvers of 0.8m wide projecting from the floors, providing a primary shading. The slats were inclined to prevent any incident light and left space for hot air to rise and escape. The second layer was the vertical travertine panels, which mainly blocked light coming from sides and prevented the glare effect. The third was the heat-absorbing glass panes. The glass shade assisted in blocking the light from a relatively low incident angle (Fernandez 2011). The distance between the glass pane and the window was decided according to the orientation of façade, varying at 1.1m, 1.3m and 1.5m. The longer distance meant a better protection for lower angles of sunlight. According to the calculation, the shading efficiency of the whole system on SE façade was about 70% at 11 am, which was proposed as the time when the interior temperature reached its climax,

Figure 3: The sun shade of the Unesco House. (Syracuse University Library 1958)

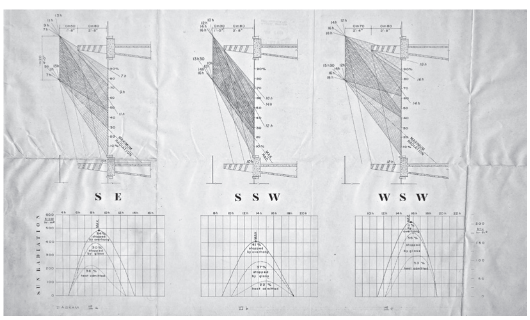


Figure 4: The study of placement of solar glass on three different overheated façade, and the diagram shows the percentage of heat stopped by concrete slats and solar glass. (Syracuse University Library 1955-58)

on August 1st (Fernandez 2011) (figure 4). The shading analysis was taken by the young Polish architect Piotr Kowalski, who had been working for the Olgyays at MIT, before graduation.

However, the real overall thermal performance of the building was far from satisfactory. The occupants complained about the overheating problems right after their first stay, during the summer of 1958. According to the report in 1959, the overheating interior during summer could be attributed to the following reasons: (Rapport sur la protection contre la chaleur des bureau du Palais de l'UNESCO 1959)

1. The inefficiency of the external shading system. The use of full-height glass panel walls was questioned as the lower part was left unprotected and easily introduced solar radiation during the afternoon. The heat-absorbing glass panel was questioned as well on its ability to block heat and was treated mainly as an anti-glare element.
2. The low thermal inertia of light construction. Partition walls were thin plaster plates glued to honeycomb papers. The ceiling material was very insulating, in order to keep the heat from being absorbed by the underside of the upper floors. Moreover, as Vanessa Fernandez mentions in her research, the concrete slabs were even thinner than traditional ones, further reducing the capacity for heat storage (Fernandez 2011). Hence, the heat was rapidly accumulated inside, leading to higher temperature than outside.
3. Lack of ventilation. Transoms were originally designed, and cross ventilation was factored into the sunshade studies (Howard 1959). Due to costs limits, they were cut out in construction and thus led to severe lack of air movement in actual use.

The final solution ended up by adding wooden blinds outside the window, which was strongly rejected by Breuer himself. Critiques also arose from theorists like Lewis Mumford. He criticized the building for repeating the forms of modern technology, which had been proved inefficient already, and the largest misapplication was the use of an all-glass wall. The sunshades together with the Venetian blinds were neither technically nor esthetically satisfactory and left cleaning problems. As Mumford (1960) suggested, the sunshades in the UNESCO were symbolic rather than functional.

The above reasons illustrate that heat control could not count on the sunshade alone. The failure is a synthetic consequence of the entire building system. Each element is responsible. The lower glass serves little for the spatial openness, while it becomes the main culprit in introducing excessive solar radiation. The thin concrete structure, creatively designed by Nervi, supports effectively but loses the adequate capacity for heat storage.

Modern architecture tends to focus more on each element individually, like the structural efficiency of the framework, the openness of the glass wall, and the effectiveness of the sunshade systems, leading to a segregation of the design elements. Indeed, the sunshade design during the 1940s to 1960s is given excessive attention, and the shading effect is ensured by complicated multiple layers of slabs or louvers, which at the same time provide an expressive outlook. However, the openness that architects had originally aimed for vanished behind the mask of shades. The culture of the brise-soleil leads to a new aesthetic value in which buildings are faceless, covered by veils.

2.2. SUNSHADE INTEGRATED INTO THE MOLDED FACADE

After the failure of the UNESCO building, Breuer did not stick with his concept for an architecture of openness any longer and ceased to treat sunshades as the only element responsible for heat control. He was tired of the separation. Robert F. Gatje, one fundamental partner of Marcel Breuer & Associates, concluded in his memoir of Breuer that modern architecture glorified the separation of structure from envelope and Breuer, following Le Corbusier, had tried out every variation oin expressing the separation of structure, systems, and enclosure. But Breuer disliked separation, especially the column, which was freed from the façade but interrupted the inner space (Gatje 2000, 102). He began to reconsider the traditional masonry buildings where mechanical systems and pipes could be accommodated in their massive construction, which was relatively thermostatic. The "balloon frame" of the typical American house also found a renewed appreciation for its capability to house the ducts, wires, insulation, plumbing pipes (Gatje 2000, 102). It is clear that Breuer abandoned the separation concept of modern architecture and was seeking a new construction model, where all the functions which existed in traditional construction remained and within which modern technologies, like radiators and air-conditioners, could be integrated. The sunshade was also transformed from a segregated element to being merged into this new system.

In 1966, Breuer announced his new, prefabricated, thick concrete façade in the article "The Faceted, Molded Façade: Depth, Sun, and Shadow" in Architectural Record (Breuer 1966). It was comprised of thick concrete panels with a deep window protected in the strong shadow. In a comparison with the glass wall envelope, Breuer pointed out three major advantages of the new façade in the article: its integration with the periphery column which frees the interior space, its improved protection against sun radiance and climatic fluctuations, and its great accommodation for modern mechanical systems like air-conditioning. The last two points illustrate what Banham (1969) called the structural solution, and the power-operated solution, and both were combined in Breuer's new approach.

IBM Research Center, La Gaude, France, 1960-62

The concrete façade system first appeared in Breuer's competitive design for the tower office of One Charles Center in Baltimore, MD USA in 1960. The study drawings on the exterior wall containing elevation and section, respectively focused on the shading effect and the integration of air-conditioning within the façade structure. The concept of prefabrication was also shown in the dimensioned details. The design was not approved in the end, but it made a ready preparation for Breuer's following work in the IBM center in France.

The IBM Research center in Le Gaude, France, 1960-62, became the first realized project of Breuer's concrete molded façade (Gatje 2000, 102). The main building is in double-Y-shape with two-story laboratory elevated by tree shape concrete columns. Each unit module was 1.8m wide according to IBM's preference and 1.1m thick to make a column-free interior space (McCarter 2016, 270). The window glass was set 80cm inward from the external face of the vertical fin (figure 5). Drawing measurements indicate that the point of the spandrel and the top of the windowsill form an incident angle of 72 degrees. According to La Gaude's latitude N 43°43'22", the incident angle in the summer solstice is around 70 degrees;such a depth of window would offer adequate shading during summer. The Venetian blind was installed as well behind each window to provide additional protection when needed. The vertical concrete fin and horizontal angled panel provide passage for plumbing pipes. The air conditioning systems and ducts were located below concrete beams covered by suspended ceilings, which was little different from the One Charles Center.

The facade was load-bearing and accommodated pipes systems spontaneously, which meant the grids of force and of pipes overlapped and needed special attention at the joints. It would be apparent from the

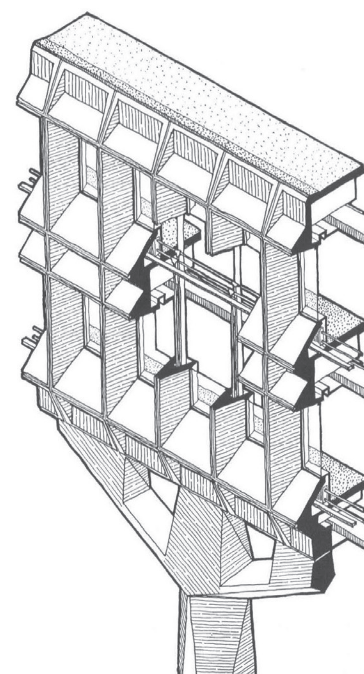


Figure 5: Axonometric of façade system in IBM research center, La Gaude, France, 1960-62. (F. Gatje, R. 2000)

SK drawings that the beams were at first located in the middle of the spandrel to give way to the vertical pipes (figure 6). However, such an arrangement was inconvenient when placing the interior partition walls. In the final construction, the beams were aligned to the vertical fins with a magnified beam head leaving an opening in the joint (figure 7). The façade was not intended to be precast at first. However, with the advice of the contractors, the concrete panels were precast by wooden formworks, which left the same parallel traces as those found on the concrete columns (McCarter 2016, 104).

Comparing the layered façade in the UNESCO building, the one in the IBM project shows a highly integrated design process and a synthetic result, in which every element is closely interrelated and engaged, while the UNESCO is an assembly of different elements that work toward different purposes. The sun shading is no longer an added element designed separately and attached to the façade afterwards. It merges into the envelope system. Moreover, as Tician Papachristou, one of the partners of Breuer, claimed, the precast units are the expression of functional demands (Hyman 2001, 156). The following cases illustrate different considerations relating to the form of Breuer's molded concrete sunshades.

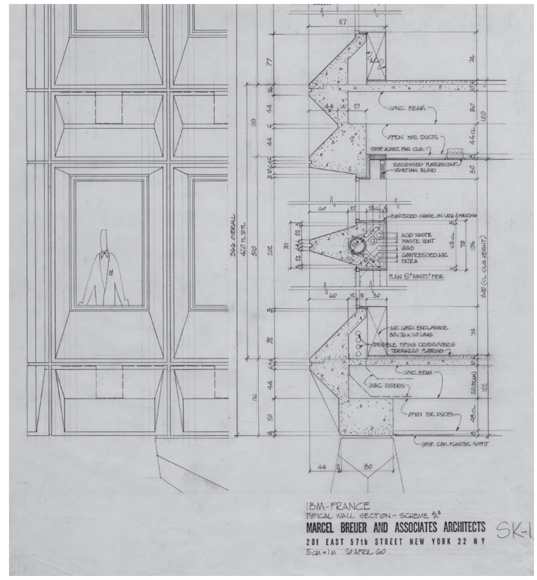


Figure 6: Exterior wall elevation and section, IBM Research Center, La Gaude, France, 1960-04-20. The outline of the beam on the elevation showed the beam's original location. (Syracuse University Library 1960)

2.2.1. TEXTURE AND WEATHERING

As an external element exposed to natural forces, sunshades confront dirt, water, and other weathering processes. This is a serious problem to Breuer, who claimed that one advantage of glass shading was its self-cleaning ability in the rain (Blake 156, 123), and it was also one of the reasons he strongly rejected external Venetian blinds in the post-occupancy design remedy of the UNESCO building.

Concrete, in Breuer's mind, was a material that aged well in nature (Hyman 2001, 157). In his early concrete practices, he preferred to leave traces of formwork on the surface of concrete, both for the precast and cast-in-place elements, like he did in the IBM center in France. However, Gatje said it did not weather well actually (Hyman 2001, 156). In the later projects, the prefabricated panels were usually sandblasted with acid washing to make a rough surface with slightly exposed aggregates. The rough texture has another function for shading efficiency and lighting condition, as it reduces the reflection of visible light into the interior space intensifying overheating and glare. Although it might have been a choice based merely on the aesthetic decision by Breuer, it coincided with good environmental performance, as other environmentalists, Baruch Givoni for example, researched during the 1960s.

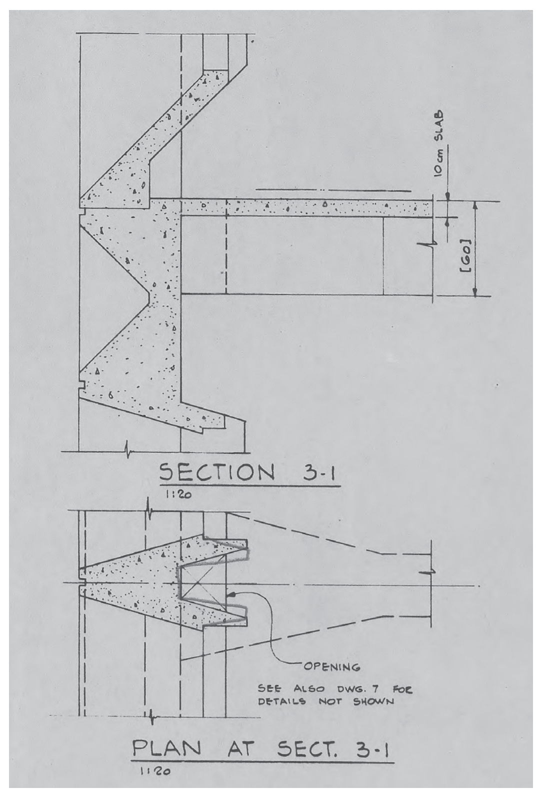


Figure 7: Joints of the beams and spandrels, IBM Research Center, La Gaude, France, 1960-07-18. The head of beam was thickened to leave openings for pipework. (Syracuse University Library 1960)

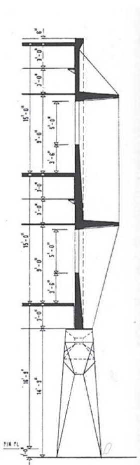
Scoring lines are also important to keep the concrete and even the window clean, as the two are connected in the molded concrete façade system. The detail was omitted in Breuer's IBM center in France, which was probably a reason for the bad weathering. The scoring line appeared in the Department of Housing and Urban Development (HUD) in Washington D.C. USA, 1965-68, however, the scoring line was right next to window and seemed like a final remedy which was not shown in the original constructional drawing. In the later project, scoring lines were usually located next to the outer edge of the bottom side of the sunshades, such as at the Armstrong Rubber Company in New Haven, CT USA, 1968-70 (figure 8).

Figure 8: Exterior view of the sandblasted concrete façade with scoring next to the outer edge. Armstrong Rubber company building, 1968-70. (Ben Schnall, Syracuse University Library 1965-1969)

2.2.2. STRUCTURE

As Breuer's façade is usually load-bearing, the form of the facade is closely involved with the entire structural system, and therefore leads to different shading patterns. In most cases, like the IBM research center in La Gaude, the façade is a thick grid with windows deeply folded inward. This appearance relates to the structural logic that each panel is one floor high and transfers the load from the upper floors. However, in a few cases, the sunshade is formed by vertical and horizontal fins projecting outward rather than the opening placed inward. Structural logic, instead of a pure aesthetic choice, lies behind the change of shading.

An example is the façade of the IBM laboratory building in Boca Raton, Florida (1968-72). Like the project in La Gaude, it was a three-story building, with the upper two stories elevated by concrete tree columns. With the advanced prefabrication industry in Florida, the structural engineer suggested that the two elevated stories be covered and supported by one single panel (Gatje 2000, 180). T-shape prefabricated beams cover the entire span between the facing facades to create a column-free interior space. Each concrete panel is 2.4m wide and 10m tall and the concrete beam is connected to the middle of the rear side of the panel (McCarter 2016, 388). This structural joint leads to an eccentric force, which creates an additional torsion to the façade structure, and thus a 1.5m deep vertical rib was added on the outside as a stiffener. The rib was centered on each panel, aligned with the T-shape beam supported behind and tapering to the top and bottom, which indicates the bending moment on the façade. Horizontal slabs are added, forming egg-crate sun shadings while the space between the slabs also helped the hot air to escape (figures 9-10).



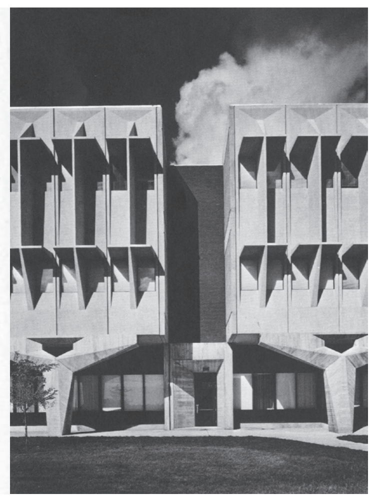


Figure 9: The exterior wall section, IBM administrative office, Boca Raton, FL USA. Source: (Process: Architecture 32, 1982)
Figure 10: View of the façade, IBM administrative office, Boca Raton, FL USA. Process: Architecture 32, 1982)

Similar structure solutions in Breuer's works could be classified into two categories. The first is the large factory building, where the rib is essential for stabilizing the tall exterior wall, such as at the Torin factory in Nivelles, Belgium (1963). The second is the multiple-story building, where each panel covers more than one floor. The torsion arising from the connections behind the panel make a vertical rib necessary, such as at the Strom Thurmond Federal Office Building in Columbia, SC (1975-82), where vertical ribs and horizontal shades were shown on the facades (figure 11).

Robert McCarter commented on the IBM Boca Raton that:

> Even though the sun shades are only partially effective…yet the fact that the precast wall panels are building envelope, window frame, and vertical structure, in addition to sunshades for the windows, and the parallel fact that none of these functions can be removed without diminishing the effectiveness of the others, together assure both the constructional integrity and formal consistency of expression of the building. (McCarter 2016, 388)

Different choice of structure does not sacrifice the existence of sunshades, but instead results in a new expression with structural logic, representation, aesthetic value, and environment performance. This avoids a technology-determined result and instead presents an interesting tension between structural and environmental devices.

2.2.3. ARCHITECTURAL PROGRAMS

As an environmental mediator, Breuer's sunshade varies to create different relationships between exterior and interior, according to the related architectural program. The position of windows and ratio of the void to solid creates different degrees of openness, indicating hidden functions and activities. For office and factory buildings, the façade shading pattern is usually identical and repetitive. When it comes to a multi-function complex, shading variations are created to correspond to the specific programs.

The project for the Campus Center at the University of Massachusetts in 1965-1970 is an explicit example. The project consisted of a large, elevated plaza containing rooms and auditoriums, which did not require natural light, and a nine-story block standing on it. The block was a multifunction complex with the mechanic rooms on the ground floor, campus hotel from the second to the fifth floors, office section on the sixth and seventh floors, and restaurants on the top two. An additional penthouse for machines lies on the roof (figure 12).

The varying shading patterns on the south façade illustrated a closed relationship with the programs inside. The panel for the hotel section is thirteen feet wide each, corresponding to one ordinary suite. Based on a higher level of privacy, there was only one opening of five foot square on one side of each panel, which faced directly to the entrance of the suite. The bathroom and sleeping area were enclosed by the solid section. The office section was covered by a concrete panel of the same width, but further divided by an additional mullion in the middle to create a pair of windows. The taller openings introduce more light for office working inside. The top restaurant became even more open without being enclosed by the molded concrete panels. The whole two-story volume was stretching outwards, containing a 3'6" wide balcony on each floor protected by precast-concrete grilles. The separation between balcony and restaurant was a full height glass wall with sliding doors, providing maximum visibility to the view outside (figure 13).

This campus center represented different characteristics from the UNESCO office. In the latter, an extreme degree of openness was expected with a severe sacrifice of climatic management, while the UMass center exhibited a much more flexible approach to façade design, which highly integrated sun protection, view, light, privacy and resulted in a ddiverse architectural expression.

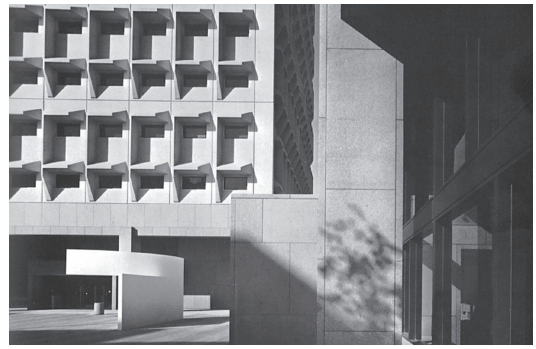


Figure 11: The east view of Strom Thurmond Federal Office building in Columbia, SC USA, 1975-82, most vertical ribs cover double stories and some triple. (Herbert Beckhard 1991)

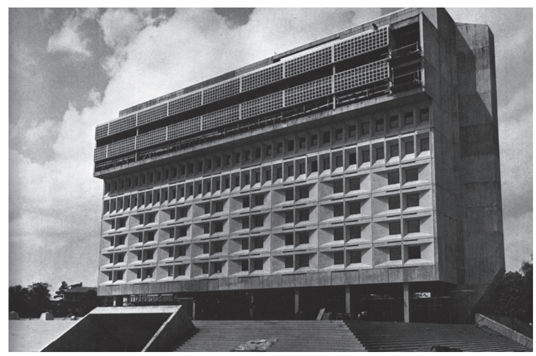


Figure 12: The south façade of the campus center in the University of Massachusetts, Amherst, MA USA 1965-70. (Neil Dohorty, Tician Papachristou, 1970)

2.2.4. EQUIPMENT

A unique feature of Breuer's sunshade design, as compared to others during the 1960-70s, is its active integration with modern mechanical devices. Taking air-conditioning as an example, Banham pointed out that the architectural design had a very close relationship with the air-conditioning system at the beginning, however, as air conditioning developed to a simple box which could be easily installed anywhere, its relationship with the structure had vanished and meanwhile brought about conflicts with the façades (Banham 1969, 187-91). The Kips Bay Apartments by I.M.Pei was a typical negative example illustrated in Banham's book. In Breuer's work, the depth and thickness of the façade was fully exploited to integrate mechanical equipment like air conditioning units.

The campus center in the University of Massachusetts, mentioned in the last paragraph, is a typical example. The air conditioning systems were installed in each unit, under the window of both the hotel and the office, and the narrow horizontal slot clearly indicates the machine behind (figure 14). The detail enriches the façade shading patterns and moreover

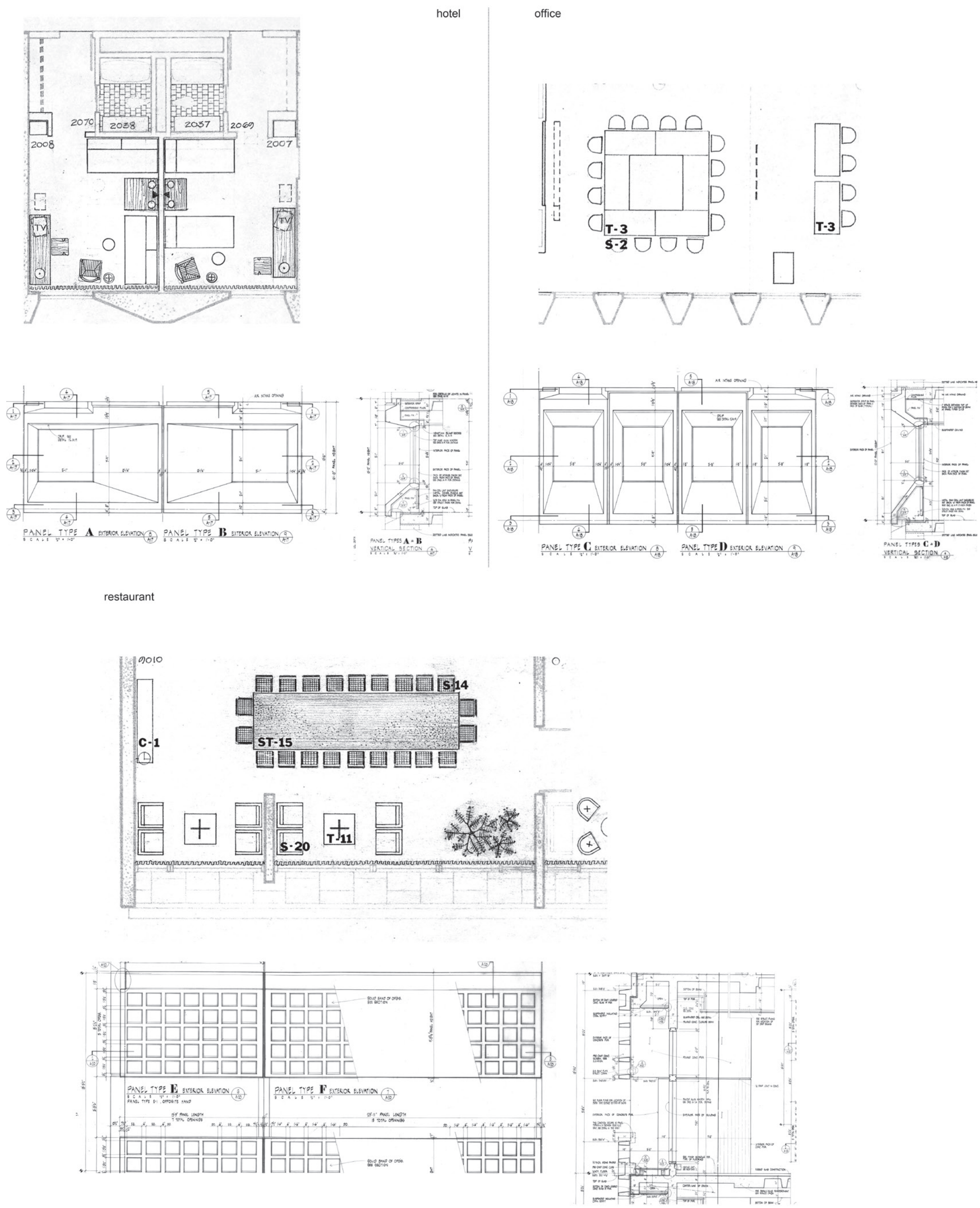


Figure 13: A comparison of plan, elevation, and section of the hotel, office and restaurant, Center Campus of UMass, Amherst, MA USA 1965-70. (Syracuse University Library 1969)

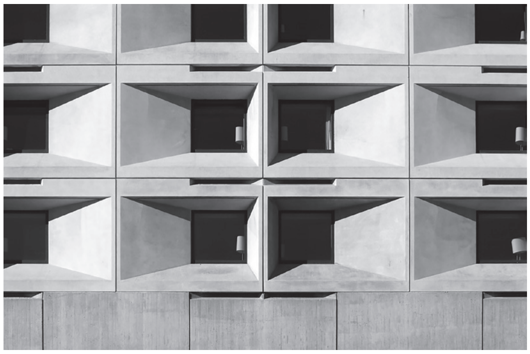


Figure 14: Exterior view of the façade. Campus Center of the University of Massachusetts, Amherst, MA USA, 1965-70. (Bruce M Coleman 2011)

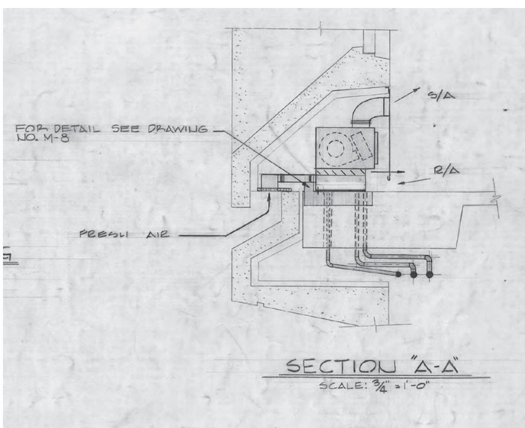


Figure 15: The façade detail of hotel section. The Campus Center of the University of Massachusetts, Amherst, MA USA, 1965-70. (Syracuse University Library 1967)

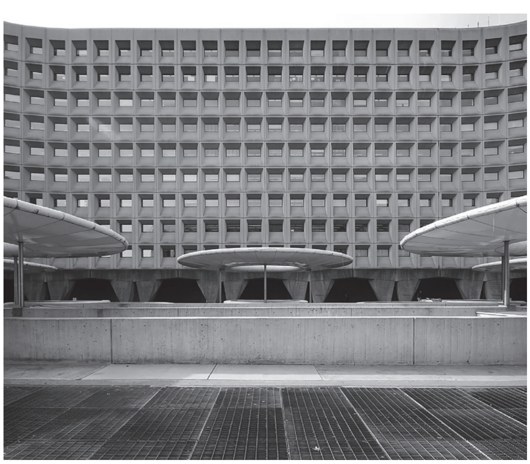


Figure 16: The west façade, HUD, Washington D.C. USA, 1965-68. (Patt Trevor 2018)

shows a close collaboration between the architectural design and engineering requirements. As Robert F. Gatje mentioned, Breuer was careful to coordinate between the architectural drawings and mechanical demands, to ensure the whole façade system was practical technically and aesthetically (Gatje 2000, 130) (figure 15).

The equipment logic expressed on the façade could also be found in the project for the Headquarters of the Department of Housing and Urban Development (HUD) in Washington D.C. USA, 1956-68. The façade was Breuer's typical molded concrete grid, integrating shading and plumbing pipes. The ten story building, with nine of them elevated from the ground, was fed fresh air from both the top and ground level, the vertical columns of the middle four floors were designed thinner than the bottom three and upper two, according to the dimension of ducts. This subtle variation gave the façade a more dynamic expression in its veiled exhibition of the mechanical system (figure 16).

CONCLUSION

Alan Colquhoun summarized that "The brise-solei was more than a technical device, it introduced a new architectural element in the form of a thick, permeable wall…" (Colquhoun 1989, 187). The care for sun protection, and climatic resistance leads Breuer to his molded concrete façade. Nevertheless, Breuer went a step further to integrate modern mechanical devices and pipes in his envelope system and showed a close relationship with other fundamental architectural elements. He also exemplified a combination of Banham's structural and power-operated solutions, which was unfortunately missed in Banham's texts.

A high integrity of design result is always backed up by a highly integrated working process. Architectural, interior and mechanical design run parallel in Breuer's work, in order to create a building like the UMass campus center, where the program, façade, and mechanical systems are all coordinated in a simple architectural expression. It predicts the future of an integrated cross-disciplinary design approach, which prevails nowadays.

Although there are still a number of projects showing Breuer's pure aesthetic interest in various forms in sun and shadow, the projects shown in this research should not be overlooked and the integrated thinking and details still inspire in today's architecture design.

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