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Le Corbusier – Plans
DVD N°7

Notice
“1940 - Studies in Sunlight (no place)”

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The theme of the sun is omnipresent in the Corbusian poetry which devotes the Ville radieuse, the brise-soleil, the 24 hour sun or even the dictatorship of the sun. Beyond these rhetorical effects, the question of the sun offers a grille of transversal reading of Le Corbusier's work. Three main periods can be identified. The first period stretches over until the end of the 1920s. The sun is to a large extent absent; the written works do not mention it, while the plans rarely showed the orientation of the projects. The shadows on the facades are designed following the academic canons (luminous rays at 45°) and have the main function of expressing the elements overflowing or hollow; no working drawing of sunshine is done during the period which seems more luminous than sunny. The glass panel is theorized and is built. When certain traditional devices for solar protection are picked up again in the projects; in the end it is more rhetorical than technical as for example the Pessac pergolas in 1925 or the roof parasol in the Baizeau villa in 1928.

The second period stretches over the beginning to the 1930s till the end of the 1940s. It is a period of research and solar experiments that articulate a double ambition; on one hand it is for Le Corbusier about satisfying the expectations of urban hygiene looking for maximum sunlight for each lodging of the Ville radieuse. The Charte d'Athènes illustrates this willingness but it above all the establishment of the heliothermal axis theory which witnesses this research. At the same time the thermal difficulties which the installation of the glass panel and the delicate establishment of the mechanical solutions of dropping the temperature and insulation, driving the architect to look for passive solar protection solutions. This approach will lead Le Corbusier into a deep mutation, which leads him to the “discovery”, the theorization, the experimentation and the generalization of the brise-soleil in his projects.

The third period finally is that which stretches to the end of the 1940s till the death of the architect. Le Corbusier with the aid of his exceptional collaborators finds the exact modalities of the establishment of the brise-soleil which becomes one of the fundamental elements of the plastic of projects. The plans, during this period make up an important part of the adjustment of these solar protection devices. At the same time the theme of the brise-soleil passes from the status of technical sketch to that of an icon of Corbusian imagery. Several drawings and paintings illustrate this principle with the same visual rhetoric: Unité d'habitation in the center of the composition faces the apparent course of the sun in winter and in summer. The summer curb passes above the Unity, symbolizing the obstacle the sun makes in the hot season while the winter curb penetrates into the apartment symbolizing the benevolent welcome of the sun in the cold season (1).

We are going to develop the elements concerning the second period, particularly the question of the heliothermal axis in the theory of the Ville radieuse, then the genesis of the brise-soleil, of the first projects for Algiers until the Marseille Unité d'habitation. The boardwalks recorded under the label of "Research through the solar path, studies of problems of sunshine (1940)" only witness these questions very partially. We thus cite different sketches and drawings belonging to the whole of the production during that period.

The sun in the Ville radieuse: Le Corbusier and the heliothermal axis

During the second half of the 19th century until the beginning of the 20th century, European cities are the theatre of a succession of epidemic illnesses. Men of science and philanthropists denounce the unhealthiness of the city housing which they suspect to be the source of infection. The medical discoveries (Pasteur, Koch) show the influence of the air and the light on the bacillus of tuberculosis and put forward the sunshine as a germ killer factor. From then on the habitation becomes one of the axis of the social prophylaxis of tuberculoses described as an illness of darkness (2). It is in this context that an ardent mobilization of the sun is going to become established in architecture and urbanism. The theories and the construction propositions terraced constructions of A. Sauvage, the open courts of A. Rey and H. Provensal or only the redent blocks building projects are in line with this aim. Le Corbusier, himself puts forward the necessity of the sun for all; he condemns the "architectural disaster" of the HBM (Low rent housing block) of the fortifications of Paris: "thousands of families are *encaved* in these brand new hovels. Thousands of families will never see the sun!!!" (The Ville Radieuse, p.90)

In 1928, A. Rey, J. Pidoux and C. Barde published *la Science des plans des villes (the Science of the plans of the cities)*, treated the architectural and hygienic urbanism (3). The heliothermal theory, which constitutes one of the foundations of the work based on the acknowledgement that the maximal temperature of the air (which the authors call "the thermal wave") is not strictly superimposed to the maximum of solar fluctuations. This discrepancy between the maximal irradiation and the maximal justifies temperature, according to the authors, the necessity to define a new unity of measurement, "the heliothermal value" times the duration of sunshine in a point by the average temperature of the air during this duration. The categorical way Rey, Pidoux, and Barde establish that in the name of heliothermal equality of the facades, the optimal orientation of buildings is more around 20° compared to the north-south axis (19° in Paris), the east facade being shifted towards the south and the west facade towards the north.

This theory, founded on very contestable bases sparks off an important controversy in the scientific milieu. However, its reputation should have been without a doubt less if it had not been implemented in *the Ville Radieuse*. Le Corbusier continues in fact on his own the theory of the Science of city plan (without ever citing elsewhere the authors nor even explaining the principles to them) and to implement the heliothermal axis like the "armature of the urban layout" (La Ville Radieuse, p.159), established the thickness of the buildings (FLC 20352) and calculates the urban density resulting in function of the heliothermal values of the facades (FLC 20358 and FLC 20452, La Ville Radieuse, p.110). The architect explicitly or implicitly uses the heliothermal theory in several other urban projects of the 1930s. Mention of the plan for the right bank of the Escaut in Anvers is found in 1933 where the panels

of glass “are all oriented following the precise indications furnished by the heliothermal axis” (La Ville Radieuse, p.273) (4). The principle implicitly endures in his work until the beginning of the 1940s; it thus seems that the first object for the Unité d’habitation of Marseille in 1945, itself is oriented following the heliothermal axis (see the plan published in *Œuvre Complète 1938-1949*, p.173).

It must be pointed out that the Le Corbusier’s propositions largely extrapolate the hypotheses of the authors of *La Science des plans des villes* insofar as it is not the buildings in aligned bars on the heliothermal axis which are proposed in La Ville Radieuse, but the redent block configurations presenting diverse orientations. This organization induces effects of shading that did not consider the heliothermal theory. Research on these questions seems to have been done after the publication of the Ville Radieuse (FLC 30838, FLC 24862, and FLC 24863).

In 1939 the *Jeu de la Ville radieuse* is a pretext for the shadow drawings brought by the redent blocks at different times and seasons (boards FLC 24841 and following, FLC 24850 and FLC 24851).

It must also be noted that none of the facades of the redent blocks of *The Ville Radieuse* is not aligned on the heliothermal axis, even though this theory is supposed to be the basis of the plans. The heliothermal axis figured in his orientation theory for Paris at 19°, in *The Ville Radieuse* p.110 (FLC 24899) and on p.160, seem like a juxtaposed to the redent blocks, oriented following a general framework shifted by 26° compared to the North-South axis in the opposite direction of the heliothermal axis. This enigma finds an explanation on the board FLC 20356 (reproduced in FLC 20467 without the annotations which interest us). Diverse estimations are read regarding the insulation of the facades following the two orientations: in one case (on the left), the secondary axis of the redent blocks is aligned on that which is designed as “a P. Moscou heliothermal axis”; in the other case (on the right), it is the main axis of the redent blocks which follows the heliothermal axis. And yet, these boards include two errors: firstly, the axis says the heliothermal is oriented at 26° compared to the north- south axis and not about 20° as the theory would like (5); secondly, this axis is oriented in the opposite way of the one recommended in *La Science des Plans de Villes*, the west facades being turned towards the south and the east facades towards the north (6). These hesitations of orientation are perceptible in the sketch seen on the bottom of the board, where the direction north is seen and crossed out twice.

It seems that the published plan in *La Ville Radieuse* accurately continues the studies done on these incorrect bases in two ways (bad orientation and bad values). Only the heliothermal axis itself is rectified to be in compliance with the theory in the Science of the Plans of the City. This superimposition gives its strange character to the published plan and at the same time shows a great liberty that Le Corbusier matched with the scientific theories, were they as contestable as those of the heliothermal axis. Nevertheless, let us note that the redent blocks designed for Anvers, as they appear on the boards FLC 14923A comply with the theory.

From glass panel to the brise-soleil: the master of shadow

Le Corbusier’s rather discrete abandoning of the heliothermal theory (he does not explain it) can be interpreted in several ways. Firstly, the role of sunshine in the prevention of tuberculoses became

unimportant in the 1940s with the large scale use of penicillin. Secondly, A. Rey's theories were strongly contested at the beginning of the 1940s, especially by G. Bardet who felt that the principle of heliothermal value was physically empty in meaning, false and simplistic (7). Finally, and perhaps above all, Le Corbusier found himself then confronted with the question of an excess of heat behind the glass panel facades and asks himself how to master the solar fluctuations in a way to fight against the overheating summer.

To resolve these problems, Le Corbusier follows two parallel ways. In the first phase, he imagines the mechanical solutions of the "neutralizing wall" and the exact air. The solutions are progressively theorized and even patented. However, the physical knowledge and the average materials seem to lack the devices needed for construction. The questionnaire to the physicists in 1930 shows the worth of Le Corbusier's uncertainties to continue in the mechanization way of comfort (8). In addition, the additional costs that induce the projected devices hinder the implementation of the works which could have demonstrated it, like that of the Cite de Refuge de l'Armée du Salut. At the same time Le Corbusier is looking for architectural methods to master the shading on the glass panel. The question of control of the quantity of light given by the glass panel is asked in 1929. "Your glass panel, your vertical windows are all prepared to be adjusted at will. You leave your light wherever you want. Your glass panel will be made of clear glass, or special glass(...) which will have a thermally insulated value on a thick wall and which will stop the solar rays" (Précisions, pages 132-133). If the imagined devices still remain rather unclear, the ambition of "stopping" the solar rays is clearly expressed; the word here is dropped, the brise-soleil is in gestation.

Formally Le Corbusier places the invention of the brise-soleil at the moment of his moving to Rue Nungesser and Coli in 1934 (10). In reality the problem consisting of reconciling the benefits of the sun in the winter and those of shade in the summer is questioned starting in 1932, in the lot project in Algeria published in *The Ville Radieuse* (p.292): the personified sun emits two rays which intercept a system of floors cantilevered with the mention of "winter sun / summer shade". Between 1932 and 1945 the brise-soleil device conceals very diverse forms: it is a system of pivoting jalousies (venetian blinds) in the projects for Barcelona (1933, FLC 13179, FLC 13185), an assembly of racks hung South and West with sections of glass for the projects of Algiers (1933, FLC 29873), slanting blades and vertical partitions in Rio (1936, FLC 19242). The fusion between the principle of the hanging garden in villas in the 1920s and the one of the brise-soleil together producing the device of the brise-soleil loggia appear in the projects for Algiers at the end of the 1930s (palais de justice 1938, FLC 14154) and under a very different climate in the project of the biological station by Roscoff, 1939 (FLC 24444). In 1943 these different possibilities are mentioned in that which A. Wogenscky thus calls "the regulating of the sunshine" (11).

From 1945, Le Corbusier becomes the promoter of the brise-soleil for which he self proclaims to be the inventor. He announces in July 1945 at a conference on urbanism and sunshine in the habitations and consecrates a chapter of volume 2 of *Œuvre Complète* to the "problems of sunshine": I showed you the sequel of successive small discoveries which have permitted me to become and to remain a friend of the sun and to bring, even in certain countries like Brazil and under the tropical sun, solutions which are the first to let the modern live flourish in all liberty (...); moreover the word used here – the brise-soleil – stipulates that one has become master of an element." (12) Except for the particular case of Rio, this

research regarding the brise-soleil finds its first concrete application in the Claude and Duval factory in Saint-Dié. However, the emblematic project of this new device is obviously that from Marseille. The brise-soleil loggia appears on the first rough sketches of the facades of 1945 in a rather disorganized assembly. From 1946 to 1948 several variants of brise-soleil loggias are drawn: with an intermediary tablet (existing situation), without a tablet (situation of unity constructed later in Berlin) and with two intermediary tablets. This last version continues to be in the plans until May 1947; it will not be abandoned following J. Dourgnon's studies on the clarity of the apartment (see this after).

It must be underlined that the paradoxical character of this loggia, from the fact of the existing contradiction between the organization of crosswise apartments, oriented towards from East to West and the device(system) of the horizontal brise-soleil in which the efficiency is confirmed for the close orientations from the south (in the northern hemisphere). The device must allow *"the sun to give its full effect in winter and to be curbed in the summer, in the heat wave seasons"* as Le Corbusier explains (13). But in reality, the brise-soleil turns out to be mediocre in the apartment type of structure; June 21st, after 3pm sun-time, the loggia only protects half of the West facade exposing the other half to the hottest night rays.

On the contrary in the winter, more than half the facade is in the shade of the loggia all afternoon. If Le Corbusier claims authorship of the device, the layout *"according to the sun dictatorship"* (14), it seems that nevertheless he did not hesitate to falsify certain documents in order that the constructed situation seem to comply with the theory. So the working drawing of sunshine published in the magazine *Le Point* consecrated to the Marseille Project in 1950 (15) are manifestly false, lest admit that the crossing apartment can show two opposing sides, both being oriented South...it is not difficult to show that Le Corbusier was aware of these arrangements; firstly because the unpublished working drawings of sunshine show the phenomenon well (FLC 26386 for example) ; secondly because Le Corbusier himself in 1933 gave the solution of the slanting vertical brise-soleil for the expositions to the West (16).

Another period for the "scientific" justification of the brise-soleil of Marseille must be reported; it is about a sun and light study ordered by Le Corbusier for J. Dourgnon (FLC 26381, FLC 26382, FLC 26386) and published in 1947 in *l'Homme et Architecture* (Man and Architecture) (17). *"We will see that the scientific study for this question, done by an authorized specialist confirms the results foreseen by Le Corbusier."* The architect very pleased with himself (18). In reality while J. Dourgnon stipulates in his conclusions that the East and West facades are *"perfectly unusable, because the apartments there are sunny at least 2 to 3 hours on the most unfavorable day"*, he does not validate the system itself of the brise-soleil loggia but he responds indirectly to the prewar hygienist theories for those which the principle criteria was the length of exposition to the sun to the interior of the housing, as we have shown with the question regarding the heliothermal orientation (19). In addition, J. Dourgnon already puts to work that *"in the summer and for these two facades, the brise-soleil must be completed by a screen, an awning or jalousies (slatted blinds) to intercept the rays very close to the horizontal."*

In Marseille, Le Corbusier finds himself in reality confronted with a complex and paradoxical situation: to have to demonstrate the well-founded solution of the brise-soleil (necessary demonstration taking into account the bad experiences of the glass panel), in the orientations where the brise-soleil is least effective. Like the theory of the heliothermal axis, the stakes of this demonstration are well worth,

without a doubt, some distortions to the scientific mind. It is rather significant to ascertain in addition that Le Corbusier thus looked to install brise-soleil on the facades of emblematic buildings of the 1930s as Le Pavillon Suisse, (FLC 15592) or *la Cité de Refuge de l'Armée du Salut*, (FLC 10925, FLC 10926) show his willingness to correct the errors of the glass panel. Two drawings of the period leave one to even think that the architect envisaged adding a brise-soleil to the west facade of his own apartment on rue Nungesser and Coli. So the plan FLC 13745 of the 24NC series shows a device of a horizontal brise-soleil, shaped from an Eternit curbed sheet metal recovered in smooth concrete. This project dated June 1950 echoes a sketch of August 1948 (FLC 13854A), where one seen the same device of the rolled brise-soleil fastened to bind to the west facade, rue de la Tourelle. This brise-soleil was not done and as we know from then on, it would have been not very efficient. Nevertheless, the existence of the project indicates the force with which Le Corbusier ends his solar experiments at the end of the 1940s in this building built following the hygienist precepts of the 1930s and in which he declares himself to have invented the brise-soleil.

Notes

(1) This figure is engraved on the foundation stone of the Unity of Marseille Habitation, (FLC 27162), taken up in the Poem of the Right Angle and notably on the door of the High Court of Chandigarh (FLC 6816).

(2) See P. MORY, "Architecture and hygiene in Paris at the beginning of the 20th century. The architect between the medical knowledge and the political power", in P. Bourdelais (dir): *The Hygienists. Stakes, Models and Practices*, Paris Belin, 2001. For an analysis of this question under an historical angle of medicine, see notably T.C. MEDICI, "Tuberculosis and the ideal modern habitat", *Medicine and Hygiene* 2448, September 2003.

(3) A-A REY, J. PIDOUX, C. BARDE, *The science of city plans, its applications in construction, to extension, to hygiene and to the beauty of cities, solar orientation of habitations*, Lausanne, Payot and Co, Paris, Dunod, 1928.

(4) Le Corbusier in addition explains that this heliothermal "was conjugated with an axis eminently architectural: the Avenue of the Cathedral", *La Ville Radieuse*, p.283.

(5) The heliothermal axis is shifted 19° for the latitude of Paris. The authors of *La Science des plans de villes* specifies that the value "varies only a little with the latitude and the climate of the place that we consider", without giving value to the latitude of Moscow.

(6) It must be said that the confusion is easy insofar as the authors of the Science of the city plans generally show the diagrams where the South points towards up and the North points towards down.

(7) G. BARDET, "Le facteur soleil en urbanisme" (The sun factor in urbanism), *Techniques et architecture*, July-August 1943, p.205. See also B. Barraqué, "Soleil-lumière, soleil-chaueur, deux conceptions du confort?" (Sun-light, sun-heat, two concepts of comfort?) in J-P GOUBERT, *Du luxe au confort*, Paris, Belin, 1988.

(8) In witnessing for example the question: "If one admits that, through radiation, the solar rays provoke an important warming of the interior air of locations, could the methods neutralizing the effects of this radiation be indicated (concerns the big windows in the summer)?", *La Ville Radieuse*, p.50.

(9) Cf. B.B. TAYLOR, *Le Corbusier. La Cité de Refuge. Paris 1929-1933*, Paris, L'Equerre, 1980.

(10) "It is in a temperate country, in Paris, that I felt the unfriendly effects of the sun in certain seasons (summer) behind the glass panel. This kind of glass which is adorable for ten months becomes an enemy of the heat wave. It was then necessary to invent something. It is in my private atelier on Nungesser and Coli Street where I suffered in silence (for reason!) that I opened an eye on the brise-soleil, that I imagined them, that I baptized them in this term today became universal: the brise-soleil (sun-braker)." (*Œuvre Complète 1952-1957*, p.114). In the other versions, Le Corbusier traces the birth of the brise-soleil to the villa project in Carthage for L. Baizeau in 1928. However, these shade load bearing boards of the Baizeau villa owe more to the client than to Le Corbusier himself who proposes a glass panel on the south-east facade, composed on the three levels of the living room without solar protection...Cf. T. BENTON, "La villa Baizeau et le brise-soleil", in *Le Corbusier et la Méditerranée*, Marseille, Ed. Parentheses, 1987; D. SIRET, "Généalogie du brise-soleil dans l'oeuvre de Le Corbusier : Carthage, Marseille, Chandigarh", in *Cahiers thématiques*, n.4, October 2004, Paris, J-M Place, pp.169-181.

(11) A. Wogenscky, "Réglage de l'ensoleillement", in *Techniques et Architecture*, n.7-8 "Le soleil", 1943, p.207-211.

(12) *Œuvre Complète 1938-1946*, p.103.

(13) *Œuvre Complète 1938-1946*, p.109.

(14) *Œuvre Complète 1946-1952*, p.90.

(15) Le Corbusier. *L'Unité d'habitation de Marseille*, *Le Point* (Literary and Artistic Magazine), XXXVIII, November 1950, p.46. Several boards can be considered as rough sketches of these working drawings of the sun: cf. FLC 7994, FLC 29638, FLC 29645, and FLC 29646 among others.

(16) Regarding the first projects for Algiers in 1933, Le Corbusier notes: "*The difficulty resides in the west since the time of sunset is the most difficult because it projects its luminous rays horizontally; our brise-soleil proves to be inefficient and this time should be replaced by vertical blades arranged perpendicularly or diagonally on the facade, while being adjusted by the orientation of the facade.*" (Complete Work 1938-1946, p. 103) These vertical diagonal brise-soleil will be effectively used for the Marseille Gallery, there where the loggias are not necessary.

(17) *L'Homme et l'Architecture*, n.11-12-13-14, 1947. Jean Dourgnon is one of the pioneers of lighting in France. Cf. B. Barraqué, "the lighting is science and art: Jean Dourgnon 1901-1985", in F. CARDOT, *L'électricité et ses consommateurs*, Coll. Histoire de l'électricité, Paris, PUF, 1987.

(18) Le Corbusier, in *L'Homme et l'Architecture*, op.cit., p.77.

(19) It is quite normal that in 1947 Le Corbusier respects the rules that he imposed with so much vehemence in the Athens Charter, in which article 26 specifies: "*the sun must penetrate several hours per day in each house, even during the least favorable season. (...) It must be expected that the constructors of a working drawing demonstrate that the sun of the winter solstice penetrate in each house at least two hours pr day. Otherwise, the authorization to build will be refused.*"