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0/ FOREWORD
Towards a post tragic society

The famous interior designer Cornelius Gurlitt opens his chapter on windows of 1888 with a few cursory remarks on their most recent developments ,namely, the gradual increase in the size of the openings themselves as well as that of the individual panes of glass: "The last words of Johann Wolgang Goethe before he died, "More light", have penetrated our dwellings", he argued; and soon after, this statement soared upon the latter developments of Modern Twentieth Century Architecture.

Nowadays we are well aware of the fact that the excess in glazed surfaces does not provide thermal or daylighting advantages but it does prejudice the performance of the buildings through exponential increases in the conditioning loads (thermal, luminous and acoustic). These mechanical constraints demand uniformity to work adequately and thus we arrive at the result of total homogeneity in the architectural spaces.

At the same time, low-cost conditioning systems were produced (especially in the item of artificial lighting), and so the gothic-romantic obscurity is put on the spotlight whilst the environment is neglected and paradoxically the dependence on this same environment is almost total. As architect Luis Barragán pointed out, the majority of human activities were developed under excessive illumination. In the summit of this process the playwright and philosopher Jean Paul Sartre in one of his most important dramas "Huis Clos" depicts "Hell" as a windowless artificial place where electric lighting has no possible regulation nor variation. In the beginning it was darkness in the chambers of mankind, but mankind made a new light and feeling equal to the Gods mankind thought that it would last forever!

Today we feel astounded to see how much futility was dropped on these artificial systems weak against time winds and subsidiary of waning energies. Perchance there is no sadder tragedy than the one of those "glass-boxes" drifting with exhilerated air conditioning systems and forsaken in places near the Equator or the Poles, as the remaining satellites of an extinct planet. The same happens in Chandigarh, the town of automobiles where very few can afford even a bike.

Master Tanizaki in his famous book <u>In Praise of Shadows</u> reminds us of how "...our own imagination moves within a lacquer-black obscurity, whilst the people from the West confer a crystal transparency even to their ghosts..." "...we admire this faint glow, made of external light and misleading appearance, caught in the surface of dusk- coloured walls scarcely preserving the remains of life.

For us this brightness upon a wall, those shades, are worth a whole array of decoration and we are never tired of this vision..."

What do we propose? That the process of illumination and in a sense the whole environmental question have no meaning by themselves unless they interact with architectural surfaces; modulating, rebounding and regaining the "proximity" that Martin Heidegger thought it was missing. The same architectural form determines the measure of environmental exchanges.

We have continued on the research line abandoned by H. H. Higbie -who was perhaps unaware of the potential of his method- to define a "new method of configuration factors" (R) which is based on Helmholtz´s reciprocity law and Lambert´s corollary (1). It is however emotive to see by reading Higbie´s original papers how close he was to finding a solution and yet so far away from architectural aims.

Henceforth we will understand architecture as a system of filters (acoustic analogy) which, preserving the harmonic vectors of an environment, neutralize the discordant elements until they come to reinforce the original harmony.

What is then the role of the aforementioned systems of filters? The role is to generate transformations that relate outside environmental fields with the internal field (or human scale). While the outside field is considered of an infinite variation, the internal field is relatively constant as only the range of human comfort is tolerable; the function that regulates the transfer from one to the other is given by architecture itself.

The principle of identity lies in the fact that there may be sundry climate-responsive architectures, as much as transfer functions respond to the various external conditions, but the internal field from the comfort point of view tends to be identical.

What do we intend with simulation, the utmost form of knowledge? We try to build a bridge between architecture and virtual reality. We try to recognize every point of the space, to retrieve the lost "proximity" by opposing reality to scenography, avoiding the fashionable trend to see the environment exclusively in terms of prospective.

We intend to abolish the metaphysical link that our Western society has always set between body and soul, the cause and the effect, the agent and the actor, Destiny and the Man, God and the creature. If the whole operation is not hidden, why or how should we make something divine out of this? the puppet is not held by threads. No thread, and no metaphor, no Destiny; as the puppet does not imitate the creature, man is no longer a puppet between the hands of God, the inside does not reign over the outside, on the contrary, for the first time in architecture the outside reigns over the inside. As Joseph Rykwert could have argued, the new letter of the alphabet is Daleth: the cosmic door towards a compassionate architecture.

A/ ANTECEDENTS

Having studied the existing structure and the solar exposure of the Plaza de America Pavilion with the intention of adapting it for the Faculty of Engineering, we propose to improve the environmental conditions of the cited building and its annexed laboratories of new construction through arcitectural design.

A necessary consequence of this process will be a reduction in annual energy consumption (which will become, according to our calculations, a reduction from 3 million frigories per hour to 1.6 million) to which we must add a reduction in the demand rate schedule. In addition, it will benefit the users' comfort with the clear advantage in improved working conditions.

On the other hand, these types of architectural modifications will provide solutions from a building point of view to pressing environmental problems. Consequently, via this operation, rather than introducing complications to the project we are guaranteeing its future value for generations to come.

In order to complete these objectives, we have elaborated a series of strategies which are outlined in the following paragraphs.

B/ BUILDING SYSTEMS

1. NATURAL ILLUMINATION AS A PASSIVE COOLING SOURCE

The dominant concern in the climate where the Plaza of America is situated is excessive heat in conventional buildings (2). Outside temperatures in excess of 40° C have been recorded between May and September.

Nevertheless, in the months between November and February, although statistically it is rarely below 0° C, it is necessary to provide some form of heating to maintain ideal comfort conditions. Experiments completed by SAB (3) demonstrate that it is possible to obtain most of this heating by completely natural means, i.e. passive systems.

The initial concern we find is that although theoretically it is possible to limit solar gains through insulated walls and roofs, in practice this rarely occurs as a certain level of illumination is necessary in order to inhabit the space. Assuming then that the heat generating by occupants and machines is low, our main objective will be to provide adequate task lighting with minimal solar gains.

The source presenting the optimal light-heat ratio (up to 160 lm/watt) is daylighting, especially beam daylighthing. Let us consider that the most evolved mercury vapor lights, with their poor color rendering, only achieves 80 lm/watt. Therefore, spatial illumination should be accomplished primarily by solar illumination, resulting in considerable psychological and ecological advantages.

Nonetheless this type of illumination has two drawbacks -its directionality and its high intensity. To avoid these drawbacks, it is necessary to consider systems of light diffusion.
These systems, although not designed to totally eliminate the disadvantages, can be utilized to our benefit (in other words, it is possible to appreciate the variety of sun positions and intensities and at the same time obtaining a balanced and regular luminous environment). The general strategy will be to create geometrical conditions in which direct and indirect lighting will complement one another.

In the building under consideration, if the façades were to be maintained without shading devices (especially on the south and west) in winter, although natural illumination would be acceptable at a meter from the window, four meters from the same window the illumination would be less than 120 lux and six meters away the illumination, of 60 lux, would be insufficient. Having in mind the building's large halls, the aforementioned illuminance values reveal that only ten percent of the considered spaces would have some guarantee of sufficient daylighting. However, it must also be cited that all of these spaces would not be totally habitable next to the glass because of the inevitable thermal problems.

In summer, if solar control was not present, the illumination values would rise disproportionately. One meter away from the window we would find a level of 5.000 lux and six meters away 500 lux, creating overheating and glare, resulting in either seasonal adjustment or supression of natural source with the necessity to use electric lighting and its subsequent problems. On other hand, in the rooms with northern orientation, the illumination would be insufficient, similar to winter conditions.
By the means of solar control in the form of fins, brise-soleil or lightshelves, we would diminish the intensity of light right next to the window and increase daylighting, through reflection, away from the window, and at the same time avoiding the problems of glare and overheating. According to our calculations, with our proposed design, 80% of the spaces would be guaranteed sufficient natural illumination with the subsequent important energy savings in cooling, heating and electric lighting.

In the classrooms, daylighting varies gradually from 1.800 to 800 lux at distances up to 20 meters, providing balanced lighting through most of the rooms, an effect unattainable with conventional fenestration, whose maximum effective light penetration is only 5 meters. The subsequent cooling load due to heat transfer ought to be as low as 10 W/m² while electric lighting would create a load equivalent of 65 W/m², which is to say the load reduction is 85%.

The SAB has employed other systems with success to improve daylighting, such as south oriented monitors (whose typology approximates sawtooth skylights with the difference being that they are usually incorrectly oriented to the north, (see S.G. Ramaswamy (4)). In order to utilizate them, they ought to be situated, logically on the building's roof, but if one wishes to use them to light lower levels, they have to be connected with patios, the so called Mediterranean atrium, of ample proportions to create a friendly, interior space.

Following this idea, the central space of the existing building has been converted into a library, transforming a great glazed vault that receives undesired solar gains from all parts of the sky dome into two south-facing, conoidal monitors.

At the same time the monitors are provided with large diffusing elements or baffles to regularize light distribution without impeding its entry and the dynamic qualities produced by daylighting.

Observing the graphic results of the natural illumination calculations, we can study the example of July, when the new systems create lighting levels that reach the range of 700 lux and therefore loads in the area of 6 W/m², while with the old vault the lighting values were over 20.000 lux, unacceptable levels for visual comfort besides creating a thermal load of 160 W/m², that is to say a load increase of 2.600% and a predictable raise of annual expenses solely for this concept of 10.000 ECU.

On other hand, in January, the illumination and solar gain levels derived from the old system are lower than those gained by the new one ---1.200 lux in the existing and up to 3.000 in the proposed- for sunny days (65% of January days).

It is also necessary to note that the aesthetics and perception of the spaces has been improved with the introduction of new illumination rythms, patterns that have been elaborated in architecture in the same way that music is composed with a phrase or scale, controlling the tone and duration of sensations and producing for the outside world cadences, cycles and seasons in eternal succesion.

The same concept is followed for the retrofitting of parabolic vaults of the side patios, with the difference being that the previously noted geometric conditions give rise to parabolic conoids, also aesthetically suggestive and of great structural resistence.

The complement of natural illumination with artificial for special situations or for nightime use is extremely important. In the first place, this source of illumination is as similar as possible to natural through adequately placed and distributed luminaires of good color rendering (more than 5.000K). In the second place, systems of light regulation, such as dimmers and luxmeters, will be used according to the availability of daylighting, always finding the best possible balance.

At the same time, the integration of cooling and ventilation systems was considered as well as sprinkler and smoke detection systems. Remember that the analysis of natural illumination has been studied in all cases with the flux transfer method, a novel version that includes both overcast and beam daylighting conditions has been developped by SAB.

2. PASSIVE COOLING

2A.- SOLAR PROTECTION

Once the problem of natural illumination is addressed, as shown an essential point for optimal cooling, we can apply the strategies that lead to temperature reduction in interior spaces and the additions of the projected building.

In the first place, there is the need to protect spaces from excessive solar gains. A classic problem arises here given that the times of maximum temperature in Seville's climate, that is late July and early August, are not symmetrical with respect to June 21st. Therefore, fixed solar protection for the overheated period limits sun penetration in early spring when it is desirable for passive heating.

2B.- SOLAR COORDINATES

We find on the southern façade that protection of 60 degrees is sufficient (after 60°, the sun rays would not enter). To the contrary, the west faç ade is most unfavorable and even an angle of 30 degrees leaves part of the thermal patch without cover, although within an acceptable range. With the east façade, a nominal protection of 65 degrees is enough. Protection is not needed on the north façade.

2C.- VENTILATION

After establishing the apropriate levels of insulation, with which one can achieve important favorable changes with respect to the exterior temperature (it is necessary to note that if the proposed design is not executed, the building will have an impoverished interior environment -as we have often noted in conventional buildings, an environment less habitable than exterior conditions) the following step would be to establish the ventilation conditions, especially nightime ventilation through adequate orientation of openings that do not prejuice the environment. We can utilize simple windows or elements that emphasize the so called "stack effect", a phenomenon whereby air may also be filtered of contaminants in order to return pure air to the building.

This means that the south and west façades will have a good level of ventilation, but for this it is necessary that at least 50% of the faç ades glazing will have to be operable in order to attain the desired effects. In the opposed façades, to achieve cross-ventilation, at least 30% of the glazing must be operable, but for reasons of maintenance, we will continue with 50% operable glazing.

The former reference to the nightime component, result from the fact that night is really the best time to take advantage of the effect produced by ventilation. It is necessary to realize that during the day, temperatures are too high to obtain appreciable results. In effect, during summer nights, temperatures are less than 25° C (the lower temperature limit established in HVAC norms) and it is then adequate to produce "free cooling". This cooling acts in principle over the thermal masses -slabs and partitions- of the edifice, being stored, for later use to reduce the temperatures of the following day.

Having in mind the aforementioned, and the thermal mass and aperature sizes, according to formulas of Givoni and Evans, developped experimentally by SAB, we will have reductions of maximum interior daily temperatures of 3°C to 4° C in July and August, and 2 to 3°C in June and September. That is to say, that if the maximum daily indoor temperature is 31°C in July, with these steps we can obtain values less than 28° C with its consequent reduction in cooling load and subsequent energy consumption. This reduction, we can calculate at 20%.

A further recourse is mechanical ventilation -either simple fans or using the air-conditioning in a ventilation mode. The cost of these means is irrelevant compared with the reduction in energy consumption. However, in all ways natural ventilation in this building is perfectly viable, covering the case of mechanical failure or malfunctioning.

3. PASSIVE HEATING

Once the main climatic problem in Seville is analyzed, cooling, it remains to comment on heating systems that, although of less importance, have a considerable effect on the comfort of occupants.

Given the normal temperatures and realizing the solar gains achieved through the glazed openings, sufficient energy can be obtained and stored in the thermal mass and later re-radiated to obtain thermal comfort without energy consumption. To achieve this, it is necessary to recognize the zones of energy loss -primarily glazing- and insulate them thermally or cover them in winter nights with protection or venetian blinds. Where this is not possible, special low transmission glass should be used, like in the north façades.

Finally, in the definitive project, there are circumstances that oblige us to use conventional heating and cooling systems, then these systems will always complement the passive ones, never eliminating or negating their effect. However, with those strategies, we have demonstrated a saving more than 45% over current energy use.

4. ACOUSTICS

Except for the spaces destined for lectures, the requeriments will be insulation against outside noises and absorption of interior noises.

For the outsides, noises, the walls have standards of heat and acoustic insulation, as already commented, and their mass should be sufficient, achieving a value above 50 A decibels according to calculations and experiments.

To absorb interior noises, surfaces of mineral fiber or cork are utilized. Other materials used are vermiculite or perlite. Reverberation times in classrooms are:

T (250) =1.20 seg.
T (500) =0.88 seg.
T (1000) =0.72 seg.
T (2000) =0.53 seg.
T (4000) =0.51 seg.

For offices, the reverberation time will be less than one second, in meeting halls less than point eight seconds and common areas up to one point three seconds.

The halls with special acoustic requeriments should be studied independently, but the existing auditorium is considered adequate.

C/ MONITORING

To prove the aforementioned statements, the degree of each system's efficiency, level of energy use and possible improvements, some monitoring systems must be implemented.
Some important points of the monitoring procedure will be discussed.

D/ URBAN SYSTEMS

As an addition to improve garden and patio areas of the project, we introduce brief notes on vegetation from a climatic viewpoint.

Vegetation
An objective is to increase the use of vegetation in outdoor spaces and building surfaces, especially roof areas. Vegetation in underground spaces is also considered through the use of reflectors and light conductors.

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