# Climate and culture as design material: The government houses of Chandigarh by Pierre Jeanneret, a contemporary solution

## *Clima y cultura como material de diseño: Las casas gubernamentales en Chandigarh de Pierre Jeanneret, una solución contemporánea*

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### Abstract

The crises affecting contemporary global society underline the need for a design reflection. The study presents an interpretation of the work of the architect Pierre Jeanneret for the government houses in Chandigarh. These, raised with the function of welcoming many people from various social classes, are the focus of the dissertation, in which, starting from the scale of the neighbourhood, a series of projects have translated climate and culture into tools and materials of the project. Therefore, through the presentation of the individual solutions, the relationships between composition, use of local materials, technique and tradition will be highlighted, outlining a systematic and attentive approach to the specific site, interpreting the place in a modern perspective. Finally, the research presents a reflection on how Pierre Jeanneret's project for domestic spaces can display a potential actualised approach, in which the needs related to climate and humanitarian crisis can be translated into opportunities for the project. This emphasizes the current difficulty in presenting a systematic design response, for which the development of a design sensitivity such as that presented by Pierre Jeanneret is instead hoped for.

***Key words:*** *Pierre Jeanneret; Chandigarh; Climate; Housing; Fragility.*

### Resumen

Las crisis que afectan a la sociedad global contemporánea subrayan la necesidad de una reflexión sobre el diseño. El estudio presenta una interpretación de la obra del arquitecto Pierre Jeanneret para las casas gubernamentales de Chandigarh. Éstas, levantadas con la función de acoger a muchas personas de diversas clases sociales, son el centro de la disertación, en la que, partiendo de la escala del barrio, una serie de proyectos han traducido el clima y la cultura en herramientas y materiales del proyecto. Por lo tanto, a través de la presentación de las soluciones individuales, se pondrán de relieve las relaciones entre la composición, el uso de materiales locales, la técnica y la tradición, esbozando un enfoque sistemático y atento al sitio específico, interpretando el lugar en una perspectiva moderna. Por último, la investigación presenta una reflexión sobre cómo el proyecto de Pierre Jeanneret para los espacios domésticos puede mostrar un enfoque potencialmente actualizado, en el que las necesidades relacionadas con la crisis climática y humanitaria pueden traducirse en oportunidades para el proyecto. Esto pone de relieve la dificultad actual de presentar una respuesta de diseño sistemática, para la que se espera, en cambio, el desarrollo de una sensibilidad de diseño como la que presenta Pierre Jeanneret.

***Palabras clave:*** *Pierre Jeanneret; Chandigarh; Clima; Vivienda; Fragilidad.*

*The problem of modern housing is, above all, architectural, despite its technical and economic aspects.*
*It is a complex planning problem. And can only be solved with creative thinking, not with calculation or organization.*

Mies van der Rohe[1]

## Introduction

The current systemic crisis, in which overlap of fragility and change seems to define the main characteristics of contemporaneity,[2] sees the accentuation of numerous conflicts and the increase of disparities within the global scale.

This mutation seems to stress the centrality of climate change[3] as the main factor in the stability alteration of various kinds —spatial, political, economic— in which an increasingly frequent presence of crises and states of emergency does not seem to find a certain and lasting answer. In this context, the design of space at various scales seems to struggle to construct an adequate response, recalling a recurring need for a transition of the project towards new forms of response[4] to crisis.

With respect to this theme, Buckminster Fuller exposed how the presence of systemic crises was not directly attributable to resource scarcity, but instead to a lack of design.[5] And this is how, a decade later, Tomás Maldonado identifies design hope as a necessity, not only for the figure of the architect but more generally for the role of the project.[6] This implies the awareness that designing, therefore, means taking on the responsibility of transforming and modify[7] the reality, where the concept of crisis could be a fertile opportunity for a design transformation.

To exemplify these arguments, the article proposes a reflection on the project of some dwellings designed by Pierre Jeanneret in Chandigarh, in which the result is a clear interpretation of how the difficulties have been interpreted as an opportunity by the architect, as Josep Quetglas expresses: in architecture, we should use disadvantages and imbalances to our advantage in order to transform them into project opportunities.[8]

Here, the project is precise to address specific needs and criticalities, translating some locals instances into a modern language. Specifically, in the face of problems related to migratory pressure, deriving from a socio-political change, the project shows a spatial response to primary needs, such as those of housing. Furthermore, climatic and local distribution issues are assumed as an opportunity to transform the modern project, reflecting on design solution, usage of local materials and reinterpretation of traditional forms and architectural elements thus, rediscovering the specificity of architecture.

Thus, the final objective of the discussion is the identification of an interpretative key for Pierre Jeanneret's projects, where to highlight the topicality of the design process, in which a specific reflection, and above all, design ones, has resulted from broader problems.Ultimately, this approach is associated with nowadays problems linked to migrant flows, often caused by the climatic crisis, and the need for a more in-depth reflection on the spatial design of so-called refugee camps, where the design response is often latent.

1 Mies Van Der Rohe, *Escritos diálogos y discursos*, (Murcia: Colección de Arquitectura, 1981), 19.

2 In the book "Risk and resilience", Alessandro Balducci underlines the process of "*loss of the state of stability*" that has occurred globally since the 60s / 70s. From that decades on, transversal and recurrent crises have affected nations and opposite parts of the planet, highlighting a chain of events such as the growing presence of climate disasters, the onset of localized and world pandemics, the advent of terrorist phenomena, the succession of humanitarian crises, etc. All this has produced a growing instability which has influenced the definition of society, economies and spaces.

3 Ashley Dawson, Extreme Cities. *The peril and promise of urban life in the climate change*, (Edinburgh: Verso, 2019).

4 It refers to a growing presence of the theme of design transition in the scientific literature and seminars. Such as: Harriet Bulkeley, Andres Luque-Ayala, Simon Marvin, *Rethinking Urban Transitions: Politics in the Low Carbon City*, (London: Routledge, 2018); Berkers, M., De Boer, H., Hinterleitner, J. (Eds.). *The City of the Future. Making city in times of major transitions. Ten design strategies for five locations*, (BNA Onderzoek, 2019); Ilaria Valente, Marco Bovati, Emilia Corradi, Fabrizia Berlingieri, Cassandra Cozza (curated by), *Design Actions in Urban Transitions. Architectural and Urban Design for Shifting Conditions*, International Seminar, Politecnico di Milano, 30 October 2019.

5 Buckminster Fuller and John McHale, *Inventory of world resources human trends and needs*, (Carbondale: Southern Illinois University Press, 1963), VII.

6 Tomás Maldonado, *Design, Nature, and Revolution: Toward a Critical Ecology*, (USA, University of Minnesota Press, 1972), 141.

7 Vittorio Gregotti, "Modificazione", *Casabella* 498/9 (1984), 4.

8 Josep Quetglas, *Restos de arquitectura y de crítica de la cultura*, (Barcelona: Arcadia, 2017), 82.

These will then open future research perspectives, both relate to the rediscovery of Pierre Jeanneret's projects and to a reflection on the design as a tool for action within crises.

## Chandigarh: an opportunity to interpret the crisis

> *A city is an idea of life created out of life itself:*
> *A philosophy in four dimensions. If it does not offer a philosophy;*
> *if it is not in itself an end; it will perish.*
>
> Maxwell Fry[9]

After the independence of India in 1947, the country was divided in two in what is now known today as India and Pakistan. This division caused the displacement of more than 14 million people, among Hindus, Sikhs, and Muslims, creating a refugee crisis in the north-eastern area of the nascent country. As a solution to the problem arose the idea of building Chandigarh,[10] as the new capital of the eastern state of Punjab. It was designed as compensation for the loss of Lahore, the former Punjab capital now belonging to Pakistan, and proposed to recreate and strengthen the historical and cultural legacy in northeastern India that was affected by the division; Chandigarh would become the emblem of India's autonomous path towards modernization, and beyond, as Jawaharlal Nehru[11] points out, it would be the new Indian nation symbol,

> *Let this be a city that becomes a symbol of the freedom of India, unfettered by traditions of the past (...) an expression of the confidence of the nation of the future.*[12]

The Master Plan, initially commissioned to Albert Mayer[13] and due to fortuitous circumstances, would end up being developed by Le Corbusier, stipulated the construction of an administrative city of 150,000 inhabitants, in its first phase, and with its expansion in two successive phases, should reach 500,000 inhabitants, majority of which is made up of displaced people from the Pakistani Punjabi. The most notable feature of the plan is the urban form, based on a matrix generated by a primary rectangular module called Sector,[14] which confers the characteristic grid of the plan. (Fig.1)

Le Corbusier, as a planner and counselor, developed the general areas of the project, but it would not enter specifically to develop the sectors,[15] this work was delegated to the three Senior Architects in charge of the construction: Pierre Jeanneret, Maxwell Fry and Jane Drew, who would have to take, to a good resolution, the approaches, and guidelines dictated in the master plan.

The dimensions of the Sector were established by Le Corbusier from the beginning; a rectangle of 800m x 1200m. Each sector carries within it the four main functions stated in the Charter of Athens: to circulate, to work, to cultivate the body and spirit, and to dwell.

However, although the sector is born from a theoretical reflection, the public and residential architecture that conforms it, reflects on the architecture of the place, which responds to geographic and cultural aspects, as an example of these reflections, there is the intermediate scale of the sector, the village.

9 Maxwell Fry and Jane Drew, *Chandigarh Capital City Project*, (London: Elek Books, 1953), 56.

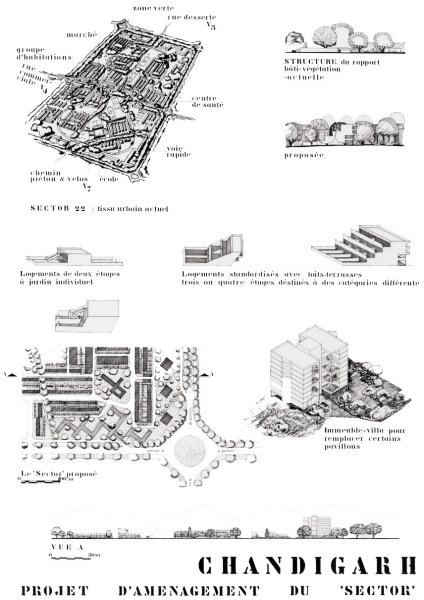
10 Chandigarh, in Hindi, means "the city of the goddess of war". Derived from Hindi 'Chandi', name of the goddess of war or Brahman's power and 'garh' meaning city or fortress.

11 The first Prime Minister of independent India, Jawaharlal Nehru, was the political engine behind the conception and making of Chandigarh. He played and essential role both in the decision to provide Punjab with a new capital and in securing steady funding through years of development. In, AA.VV., *Casablanca and Chandigarh: A report on modernization*, (Montreal: Park Books, 2014), 120.

12 Ravi Kalia, Chandigarh, *The Making an Indian*, City, (Zurich: Park Books 2014), 55.

13 Albert Mayer began his work in India well before the inception of Chandigarh. During World War II, Mayer was abroad in India where he worked as an engineer for the U.S. Army. He became enamored with Indian culture and proposed several new town schemes for rural, Indian villages.

Figure 1. Site plans and elevations for a planning project for the 'Sector' in Chandigarh, India. ARCH268587. © Fondos Pierre Jeanneret collección Canadian Centre for Architecture, Montreal; Courtesy of Jacqueline Jeanneret.



## The Village: From the sector to the domestic scale

The discussions that took place around the conformation and relationship of the housing units, given the extension of the sector, were faced by Le Corbusier and the three Senior Architects, based on the delimitation of an intermediate scale, as a result of Le Corbusier's observations, and on the reflections made in the Pilot Plan of Bogotá and his trip to India, and which he would call Village.

> *I have recently observed on my trip to Punjab, that cities that date back to the beginning of time have a grid that draws neatly closer to the Spanish block. In the Chandigarh Master Plan, I distributed the neighborhood units —groups of horizontal rooms for a total of 750 people— in squares that approximate 120 meters on the side. This form of grouping, that I have called "village", allows solving in a simple way the problems of a population... In urban and architectural form, the essential conditions of life have been solved: the 'inside' and the 'outside'; the sun and shade in the summer, the sun and its penetration in the winter, etc.*[16] (Fig.2)

Observing the neighborhood, allows to focus where the scales interact,[17] in a framework between territory and architecture, recognizing the balance between built and open space. Indeed, the built fabric can be read as an urban fact itself, ultimately also architectural, assuming the semantic unity that identifies precise relational fields. Here it is revealed the sensitivity towards the resources of the territory, denoting the semantic unit of neighborhood as place of relation between nature, architecture and culture.

In this perspective, the focus of the fabric resides in the houses. With the growing population of workers and refugees arriving in the new capital, the urge to accommodate the diversity of families increased exponentially. Mainly the residences belonging to the government, which had to be designed, built and ready for the inauguration of the Capitol, were a priority for the Punjabi government. To address this task, the planners identified, initially, thirteen social types determined by the monthly salary income earning to government workers. Starting with the T-1 type corresponding to the single-family house for the First Minister of the state and ending with the T-13 type corresponding to row houses for workers with lower salary income.

Apart from the economic-spatial constraints determined by the government for the construction of housing, the three Senior Architects established some criteria that should be considered in the design of any of the residential types as a result of the low budget and looking for architecture of the site:[18]

- The architects must strictly follow the state guidelines on cost and type of housing, but without losing the architectural and spatial exploration of the houses.
- In order to reduce costs, houses intended for the lowest salary income category should be designed and aligned with a narrow front and a great depth.
- The simplest house must be proposed with at least two rooms, a veranda, a kitchen and a bathroom.

14 The Theory of the Sector is developed by Le Corbusier first in the pilot plan of Bogotá in 1947 and will continue in the development of the Punjabi Capital. See, Maria C. O'Byrne, "Bogotá en Chandigarh: El sector y la cuadra española", *Cuadernos de Vivienda y Urbanismo*, 5, 10 (2012): 309.

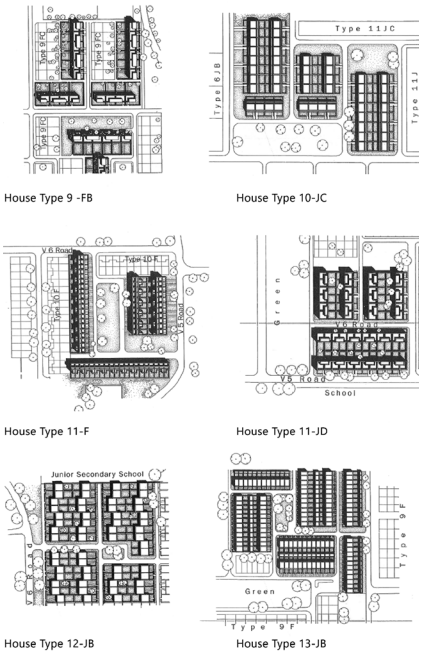
15 As we can see in the plans developed for the Master plan in the atelier of the *35 Rue de Sévres*, the interior of the sectors is always blank, except for the green structure that arises and traverses them. A call to the developer architects to fill them.

16 Interview by Luis Vera to Le Corbusier, Bogotá 1952. In, Maria C. O'Byrne, *Op. cit*., 312.

17 Kenneth Frampton, Architecture in the Age of Globalization, in de Baan C., Declerck J., Patteeuw V., (Eds), *Visionary Power. Producing the Contemporary City* (Rotterdam, Nai Publishers, 2007) p. 175.

18 Sarbjit Bahga and Surinder Bahga, specified and detailed the parameters, See Sarbjit Bahga and Surinder Bahga, *Le Corbusier and Pierre Jeanneret: Footprints on the sands of Indian Architecture*, (New Delhi: Galgotia Publishing Company, 2000), 45.

Figure 2. Village examples made by Pierre Jeanneret, Maxwell Fry and Jane Drew. Foundation Le Corbusier, © Kiran Joshi.



- The architecture of the houses has to adapt to the tropical climate of northern India, considering the strong monsoons and the strong summer heat.
- The light and natural ventilation must penetrate through small openings, instead of large glass facades.
- Search for housing architectural language in harmony with the identity and culture of the place.

As a result of the parameters above, it is established that the architectural research for the residential solution of Maxwell Fry, Jane Drew and Pierre Jeanneret, starts from an economic and technical problem, but always in search of architectural solutions with a formal and aesthetic character that respond to the needs of its inhabitants.

## Pierre Jeanneret residential solutions

Pierre Jeanneret worked on all types of housing in the city (Fig.3), his research into the search for a local character of architecture, coupled with his curiosity, led him to interpret the needs of the people for whom he designed the houses. Although India did not possess modern technology, he was able to adapt and found the necessary resources for the design and construction of Chandigarh. This pushes him to study and use local construction techniques and materials, establishing as a goal the creation of symbiosis between nature, materials, and the needs of its inhabitants. Therefore, building houses that were modern, functional, and accepted by Indian people was the core of his work.

Figure 3. Chandigarh plan with the houses projected by Pierre Jeanneret between 1951-1965.
© Author: Oljer Cardenas Niño.

From this sensitiveness to the Indians lifestyle, and having understood the centrality of the outdoor spaces for people's activities, Jeanneret hierarchically treated the open space, working this aspect in the different groupings and scales: in the single-family house, in the block of houses and the conformation of the "villages". In this way, he generates a system of open spaces that range from the private gardens of the houses, whether front or rear, to the green spaces in the villages. These spaces, protected by trees, act not only as focal points but also recreate life in the villages, producing at the same time levels of intimacy and community.

On the other hand, for Pierre Jeanneret the economic aspect becomes his greatest challenge, due to the low budget that has been established for each type of salary, often having to simplify their designs, P. Jeanneret referred to the limited budget he had in a letter to his cousin Le Corbusier:

> *I have 4 types of houses that ought to begin, for which I have had to constantly remove and then remove again various elements that were to me of some satisfaction, and it's like that all the time. The garden walls have almost totally disappeared, the verandas too. Your minimum size houses, which I think perfect, are too expensive by 60%... One thing you should know: all prices were established by engineers before our arrival, and in spite of my hopes, there is no way can they be topped.*[19]

19 In Letter from Pierre Jeanneret to Le Corbusier dated Chandigarh, February 22, 1952, Foundation Le Corbusier, Paris, P1-20-41-001 / 012.

Even so, the houses designed by Pierre Jeanneret contain a visibly modern exploration, with rigid geometries, which only break with sun protection elements on their facades, cracks and deep protections, perforated walls and open terraces.

Pierre Jeanneret explored and gave rhythm to the facades through a combination of simple diversified materials such as clay brick, river stone, reinforced concrete and a variety of prefabricated elements. (Fig.4)

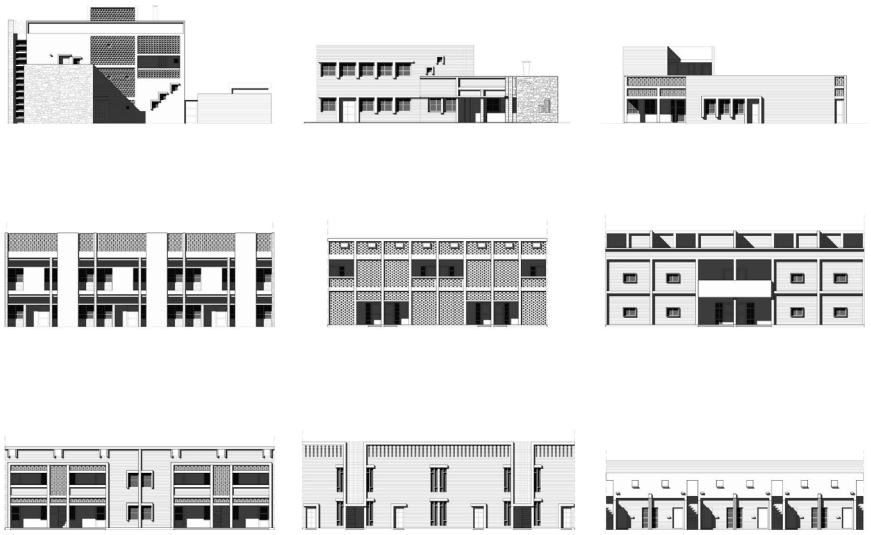


Figure 4. Pierre Jeanneret, some examples of the government houses designed between 1951-1965, the cases mixed different typologies and social categories.
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This use of few materials contributes to the formal and constructive autonomy of all the elements outside the structure, favoring the compositional balance of the whole.[20]

In the same way, he looked for solutions adapted for the Indians life, solving through a design perspective the elements to control the sun, the wind and the heat inside the room. So, the design of *brise soléis, jallis, barsatis,* perforated walls and other solutions, become the architectural core of the, defining the essence of the domestic spaces.

20 Gero Marzullo, Luca Montuori, *Chandigarh: Utopia moderna è realtà contemporanea*, (Roma: Edizioni Kappa, 2004), 133.

## Climate and culture as construction material

As already mentioned, architecture of Pierre Jeanneret's houses, was influenced by the materials chosen for the construction, which must be readily available within the construction site, which limits the number of alternative forms of construction. If we refer to traditional constructions, the types of building construction in Punjab are, by necessity, based on the natural products of the soil. In this way, materials such as clay and stone are evident in the construction of houses in the areas where Chandigarh plans to build. (Fig.5)

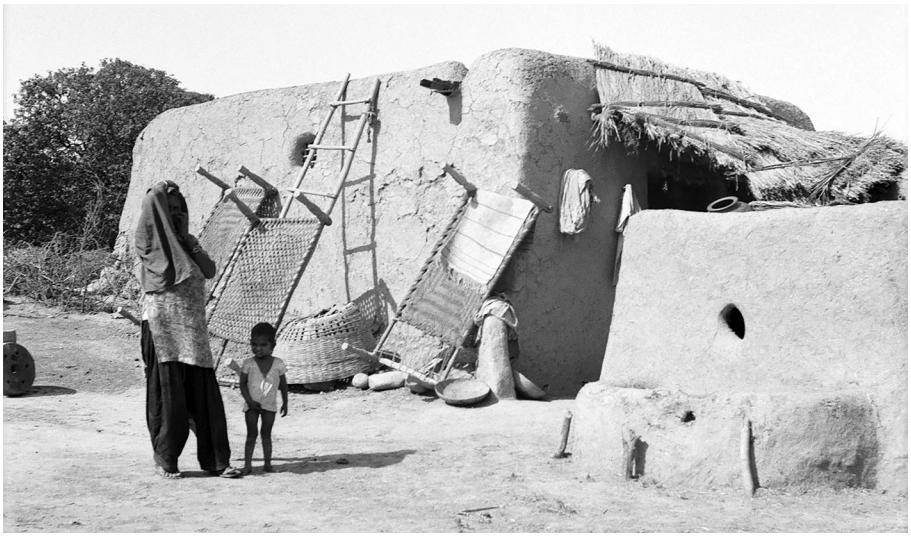

Figure 5. Pierre Jeanneret, Woman and child in front of a rural house in the Chandigarh area before its construction, 1950_1953, ARCH280621.
© Fondos Pierre Jeanneret colección *Canadian Centre for Architecture, Montreal*; Courtesy of Jacqueline Jeanneret

These materials are used in a variety of ways, especially in walls and floors. However intelligent these construction methods may be, they can only be considered temporary. They rarely remain airtight, and although they can be maintained almost continuously, they have only a limited life against the effects of climate. Pierre Jeanneret showed his interest in such systems. But, because of the above, he had to look for other materials and techniques:

> *J'aurais souvent voulu faire des maisons économiques en argile, mais l'entretien aurait dépassé les budgets, car un paysan soigneux colmate lui-même deux fois par année sa maison: après la mousson et après les pluies d'hiver.*[21]

For this reason, added to the economic situation of the project, make the use of brick and river stone are the most sensible decision for the construction of houses. Making use in this way of the traditional techniques of the place. Pierre Jeanneret himself said:

> *La brique est le matériau approprié à Chandigarh. Ce n'est pas une brique surcompressée, mais cuite au four, de belle couleur et d'une texture ridée comme la paume de la main, à mon avis très belle.*[22]

At the side of this technical and material reasoning, it is clear how the climate had a central role in the design process of the project definition. Indeed, the intense warm weather of Chandigarh during most of the year, makes the problem not only to be protected from the sun, but also to be kept in a cool environment.

However, without refrigeration systems that can keep indoor temperatures regulated, the problem must be addressed in a different way:

> *Lorsque l'on parle de la protection contre la chaleur, trop souvent l'on oublie qu'il n'y a pas apport de frigories artificielles, tandis que pour la protection contre le froid, il y a toujours apport de calories artificielles. Si ces deux protections pouvaient être traitées dans les mêmes conditions, c'est-à-dire apport de frigories artificielles pour l'une et apport de calories artificielles pour l'autre, le problème pourrait se résoudre à peu près de la même façon. Mais sans apport de frigories artificielles (les frigories sont plus chères que les calories), le problème est absolument différent.*[23]

In this way, the problem in Chandigarh is to create favorable conditions that allow its inhabitants to carry out their activities normally in a comfortable space that ensured lighting and ventilation.

With this perspective, the architectural project shows a profound sensitivity in the construction of an environment that establishes a relationship between material and culture,[24] actively dialoguing with local issues such as the climate and the cultual system. Indeed, the housing project highlights the design type response to a series of issues and problems. First, the climatic design was needed to be able to define living spaces, in which the climatic conditions were, therefore, addressed not through technological solutions, but rather design.

21 Pierre Jeanneret, Incidences des techniques locales et du climat sur la construction à Chandigarh", *L'Architecture d'Aujourd'hui* 67- 68 (1956): 180.
Translation by the authors:
"I often wanted to make economical houses out of clay, but the maintenance would have exceeded the budget, because a careful farmer seals his house himself twice a year: after the monsoon and after the winter rains".

22 Ibidem.
Translation by the authors:
"Brick is the appropriate material in Chandigarh. It is not an overpressed brick, but kiln-fired, with a beautiful color and a wrinkled texture like the palm of the hand, in my opinion very beautiful".

23 Ibidem.
Translation by the authors:
" When we talk about protection against warm weather, we too often forget that there is no contribution of artificial refrigeration, whereas for protection against cold, there is always a contribution of artificial heat. If these two protections could be treated under the same conditions, i.e. contribution of artificial cooling for one and contribution of artificial heat for the other, the problem could be solved in much the same way. But without the use of artificial refrigeration (refrigeration is more expensive than heat), the problem is absolutely different".

24 Adam Caruso, *The feeling of things*, (Barcelona, Ediciones Polígrafa, 2008), 15.

**On-site placement**

The way of orienting the house within the site where it is going to be built, has a lot of influence if we are talking about climatic comfort. Therefore, much of the work of the architects in Chandigarh was to arrange the buildings in such a way as to take maximum advantage of the value of the sun for the thermal effect. Pierre Jeanneret took different conditions into account in the designs for the city's residences such us:

- The ideal orientation for the main facades is from northwest to southeast.
- Surfaces located to the north may remain open, while those oriented to the south should contain the least number of openings.
- Surfaces that deliberately face south must have solar protection systems that allow the entry of light rather than solar radiation.

**Floor Plan: Orientation and internal organization**

Following the theme of orientation, a building can be more energy efficient by designing its layout in such a way that the order of the rooms follows the daily path of the sun according to the activities carried out in them, so that its energy is used in the best possible way. In addition, or as an alternative to the exposure of the rooms to direct solar radiation, intermediate zones can be organized, conveniently oriented to promote the regulation of the internal temperature.

In this way, the different rooms that make up the house must be arranged with respect to their activity and their orientation to ensure the greatest comfort inside the house. An example of this is the T4-DM house model, where the layout of the rooms helps the thermal control of the room. (Fig.6)

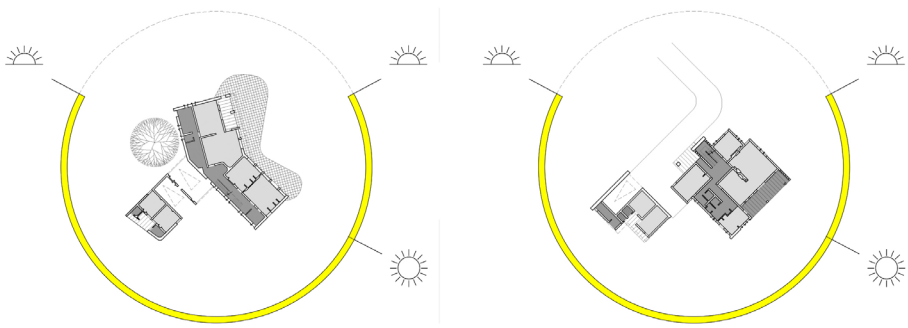

Figure 6. Pierre Jeanneret, House T4-DM and T5-J. The organization of the internal spaces is a result of the movement of the sun because of the orientation plan.
© Author: Oljer Cardenas Niño

First, the climatic design was needed to be able to define living spaces, in which the climatic conditions were, therefore, addressed not through technological solutions, but rather design.

Looking at the floor plan of the house, we should look at its orientation. The house is arranged from northeast to southwest, following the orientation conditions described above. This indicates that the predominantly south-facing façades should be more closed, as can be effectively observed. To this condition is added the criterion of distribution of the spaces on the ground plan. In it we can observe that spaces such as bathrooms, corridors and dispensations are located on the walls that receive the greatest amount of solar radiation. This distribution helps the spaces of lesser use to function as a filter to the main spaces of the house, delaying the heating of the rooms, living room or dining room, in summer and its loss of heat in winter.

## Passive ventilation systems

Ventilation, like radiation, will be affected by the orientation of the houses, but, unlike the arrangement with respect to the sun, ventilation is verified from the section and facade of the houses. This is because the arrangement of the openings in high —and low— pressure areas, added to the directional effect of the openings for the windows can improve the situation of air currents inside the room.

This effect can be seen in the planimetry of single-storey houses of the salary type 11, houses T11-J, T11-JB and T11-JC. In all three cases, the section of the residential unit, together with their respective facades, has simple and studied solutions to the aspect of the movement of air inside the houses. But first, a common characteristic of all houses is the height between floors, which varies between 14 ft and 15 ft in height. This dimension of the ceiling is fixed to allow the circulation of air and to avoid the accelerated heating of the space. The higher the height, the greater the volume of air inside the room the longer it takes for the room to warm up. Additionally, a higher height favors cross ventilation, the heavier cold air enters, displacing the lighter hot air, to the top of the room. So, if there are openings in the lower part and an opposite one in the upper part, the air will move naturally. (Fig7)

Figure 7. The house is oriented in the direction of the prevailing winds to allow cross ventilation system.
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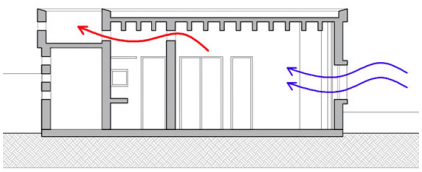

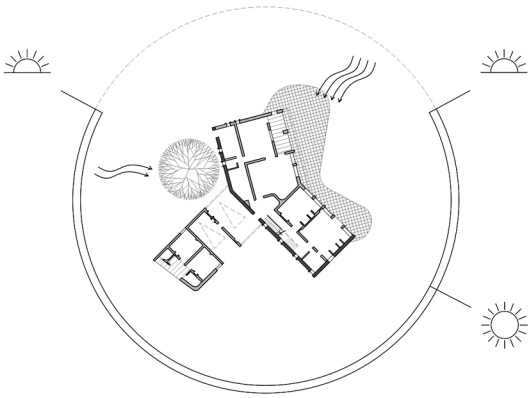

## Sun protection elements

As a complement to the previous determinants of orientation of the houses, different systems of solar protection were designed, which help the thermal efficiency of the interior of the residence.

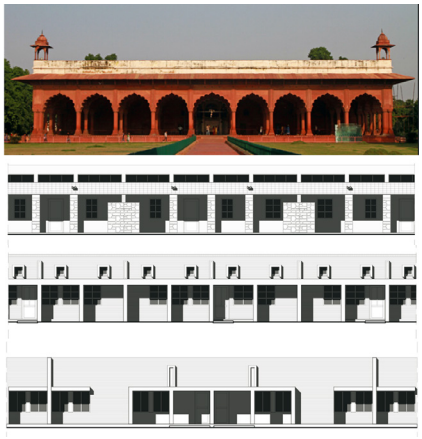

Figure 8. Diwan-I-Am Red Fort and the Houses T-10 single storey.
© Author: Oljer Cardenas Niño

## The porch: —Diwan-i-am—

The escape from the sun is an essential feature of the built environment of the Rajasthan area and the Punjab in northern India, a sample of which can be seen reflected in its architecture, where the urban houses that form the old fabric of cities have a deep shaded courtyard, the Chowk. In addition, the architecture of the early sultanates and the Mughal period introduced a vocabulary of shaded porches and arcades into all the city's palaces and mosques. An example of the use of this system are the Mughal palaces and fortresses, such as the Red Fort or the Agra Fort, where the use of porticoes over time was transformed into shaded pavilions, where public or private hearings would be held. Pierre Jeanneret visited one of these spaces at the Diwan-i-Am of the Red Fort in New Delhi. This traditional structure was interpreted by Pierre Jeanneret for the projection of the residences of Chandigarh. He applied it in the houses of the salary type 10, where different models of the structure were built. (Fig.8)

**Verandah**

Another traditional structure, used by Pierre Jeanneret was the Veranda. A long enclosure, open on at least one of its sides and with a roof. It is located mainly in front of the houses, as it is captured in some of the photographs taken by Pierre Jeanneret of the traditional houses and is associated with the main spaces of the house:

> *The social verandah is usually placed at the front of the house so as to be welcoming to visitors and to give the occupant a good view. It should be a social shape and not, as often built, a passage shape. It should give a sense of comunity without being so Deep as to destroy the open-air feeeling.*[25]

25 Jane Drew, Maxwell Fry, *Village housing in the tropics*, (London: Lund Humphries, 1947), 33.

The structure would be used in the design of both isolated houses and row houses, creating different versions of this element. It will fulfill two functions, as shadow projections to the main spaces to avoid the entrance of solar radiation and as habitable spaces to spend the hot summers. An example of this structure can be seen in the T6-JB house. Where two verandas were projected. The first, at the entrance of the house as a transition element between the outside and inside, and the second, attached to the living room, in the north corner of the house. In the case of the verandas projected for the row houses, as we can see in house T13-JB, they are in the rear part of the residence, in direct relation with the rear garden. The veranda in this case will also have two functions, that of solar protection, but additionally that of *Barsati,* as a covered sleeping space on hot summer nights. (Fig.9)

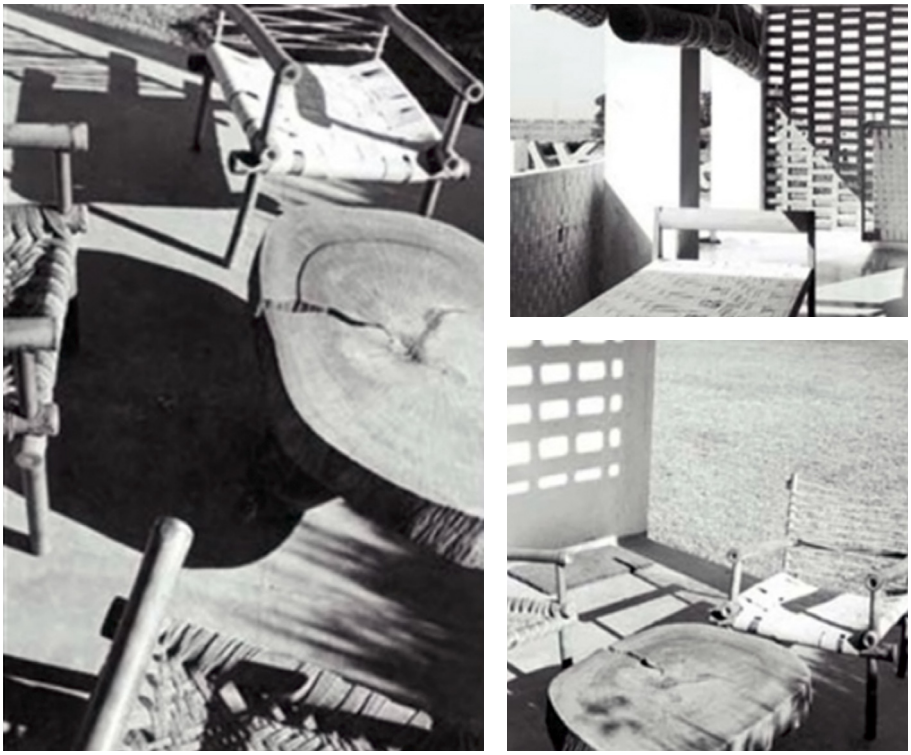

Figure 9.Pierre Jeanneret, Furniture in the Verandah House T4-J, Pierre Jeanneret's house in Chandigarh. © Lucien Hervé.

**Solar protection wall**

The construction of walls, with special bond, also functioned as solar protection elements for the houses. These include the rigging of houses T11-JB, T11-JC and T13-J (S.S.). This type of brickwork is one of the elements that authors such as Helen Cauquil and Maristella Casciato retain characteristic of Pierre Jeanneret's architecture in the residences of Chandigarh.

However, the outstanding arrangement of the bricks in the construction of a facade texture, in addition to having an aesthetic character, had mainly a climatic function. This is because the elements protruding from the façade generate shade on the wall surface, avoiding overheating it, in other words, the surface that receives direct solar radiation is smaller when compared to a flat brick surface. Additionally, the protruding elements increase the thickness and therefore the mass of the wall, so that the thermal inertia of the wall is greater. Avoiding this way, that the temperature inside the house increases. (Fig.10)

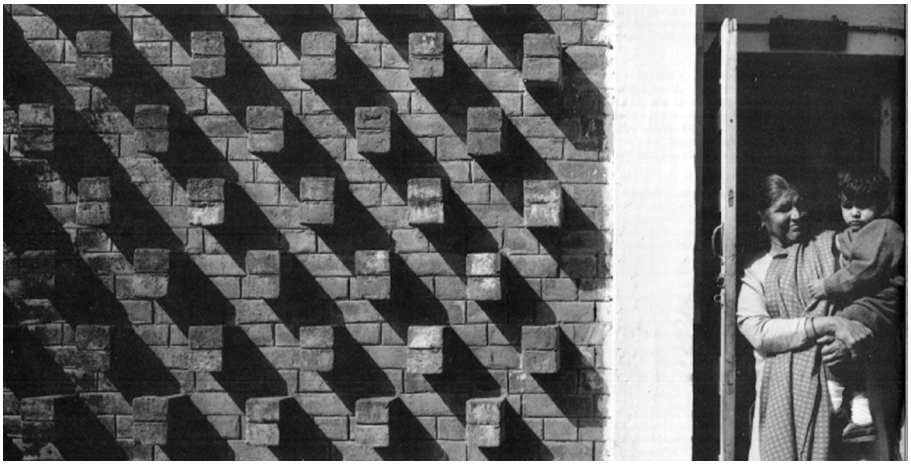

Figure 10. Pierre Jeanneret, House Type 11-JB. Solar protection Brick bond system. Foundation Le Corbusier. © Kiran Joshi

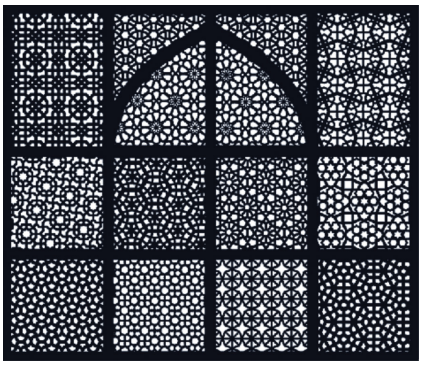

Figure 11. Mugal Jali in the Diwan-i Khas comparison with House Type 10-JB, Sector 22, Chandigarh, India. © Fondos Pierre Jeanneret colección *Canadian Centre for Architecture*, Montreal; Courtesy of Jacqueline Jeanneret

***Jalis***

Continuing with the rigging of the walls, as elements of solar protection we find the *Jalis*. This is a traditional element of Mughal architecture and Hindu temples, characterised by being a perforated stone or grille, generally with an ornamental pattern built using calligraphy and geometry. The *Jalis*, like the special bond walls, has two functions. The first and main one, of climatic character, helps to lower the temperature compressing the air through the holes, what generates that when the air passes through these openings, its speed increases giving a deep diffusion. The second one, of aesthetic character, represents geometric or natural figures according to the culture or religion that implements them.

Jeanneret reproduced in a more rustic way this type of systems and applied them in the houses of Chandigarh. This is the case of the T10-JB house, where its main façade basically consists of a large Jail, made of brick. These surfaces cover totally or partially the loggias of the room and allow the flow of the air in the residential units. Examples of these elements of the Mugal tradition can also be observed in isolated houses, in the T4-J house it is used in verandas, it changes the brick rigging, but it maintains its fundamental function of ventilation to the room and space. (Fig.11)

## Conclusion

Starting from what is exposed it is important to compare the design process that occurred in Chandigarh, specifically regarding the dwellings as a response to the specific socio-economic crisis and post-colonialist change, with some of the current global phenomena. Nowadays, the polycrisis that we are experimenting frames a condition of increasing fragility of the world, in which it is possible to note an overlap of risks related to the climatic issue, provoking environmental imbalance and then socio-economic uncertainties.[26]

26 Edgar Morin, *On Complexity*, (Cresskill, NJ: Hampton Press, 2008), 37.

Due to this, in various parts of the world, similarly to what happened during the second half of the last century in Chandigarh, it is possible to find a growing heterogenous pressure —social, political, economic, demographic— in which a correlation among them contributes to defining a state of increasing instability. In this general framework, the migratory phenomena seem to sharpen, revealing a poor ability to interact with this problematic issue. What follows is the proliferation of the so-called refugee camps, namely centers of centralizing/sorting of migratory flows, in which a coordinated spatial design seems to be almost absent.

Indeed, the theme of migration is assumed as an emergency issue, so subordinated to a temporary logic, directly connected with the design of spaces of provisional and transitory living space. Moreover, the main goals of current camps are mainly to give the basic human needs and to address a quantitative issue resulting from the large number of refugees to be accommodated. Nonetheless, these features are contradicted by the

> *Protraction over the time of the emergency, (implying that) refugees' camps should be considered more as urban settlements than as rows shelters.*[27]

Here, in fact, in the face of a hypothetical short duration of the artefacts as domestic spaces, a long stay of people produces a poor and inadequate spatial response.

This approach brings two main issues: the first refers to the lack of a planning and architectural reflection for these places, in which a reasoned approach on local needs and the theme of duration should be necessary. The second emphasizes instead how the vision on the climate crisis is associated with a temporary emergency logic; what instead seems to be central is the need to face the change in progress as a change of paradigm, where the reference system in which we operate and live has changed irreversibly.[28]

Therefore, all this brings out a consequent gap between project and crisis, in which the latter is not often interpreted as a project opportunity but as a problem to be remedied. Indeed, although fragility and crisis are considered sources for a design perspective, a lack of project is highlighted in the contemporary.

In this horizon, the reflection concerning Chandigarh, and specifically the presented work by Pierre Jeanneret, underline the capacity at the various scales to respond systemically to the initial fragility, in which, similarly to today, the project had to be a spatial response to the need to accommodate a lot of refugees. So, the analysis of Pierre Jeanneret's works shows a high sensibility, where the project is the result of the interpretation of architectural, economic, cultural, and environmental issues. His approach stresses how the answer to climate and humanitarian crisis can be tackled from an architectural perspective, in which reflection on the tools of the project and the reinterpretation of the site can lead to identifying a useful approach also in the contemporary world. Indeed, the project, and architects with it, should perhaps summarize an ethical role, making a bearer of a design hope,[29] clearly placing the project as an answer to the crisis, framed as an opportunity.

27 Rania Aburamadan, Claudia Trillo & Busisiwe Chikomborero Ncube Makore, "Designing refugees' camps: temporary emergency solutions, or contemporary paradigms of incomplete urban citizenship? Insights from Al Za'atari", City, Territory and Architecture 7, 12 (2020). Source: https://doi.org/10.1186/s40410-020-00120-z (Accessed April 30, 2022)

28 Mattia Bertin, Denis Maragno, Francesco Musco, "Pianificare l'adattamento al cambiamento climatico come gestione di una macro-emergenza locale", *Teritorio* 89, 2 (2019): 138-144.

29 Tomás Maldonado, *Design, Nature, and Revolution: Toward a Critical Ecology* (New York: Harper and Row, 1972), 141.

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