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Design to Thrive

From model to model: Lessons of perimeter in Jaime Sanfuentes' houses

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Abstract: The research proposes to study the work of the renowned Chilean architect Jaime Sanfuentes. The study is centered in his single-family houses, located in the commune of Vitacura in Santiago of Chile. These buildings stand out for its comprehensive work of the perimeter, incorporating interior courtyards, the rationality of its configuration and the extension of roofs and pergolas, which generate and qualify the spatiality of the houses. The exploration was proposed as an academic exercise for 2nd year students at the Architecture School of Universidad de Santiago de Chile. It begins with the evaluation of the houses' models in their original latitude with an heliodon in 3 dates (equinox, winter and summer solstice). The results revealed a language of architectural operations to control the entry of sunlight. The next step was to put the models into crisis, assigning new latitudes to the projects. These correspond to two of the most extreme cities in Chile: Arica and Punta Arenas. The main objective was to provoke a variation in the way the sunlight affected the houses. The problem presented to the students was to compare both evaluations and propose possible modifications to the projects' perimeter to recover the original sunlight control.

Keywords: heliodon, sunlight control, model, experimentation

Introduction

For architectural education, the integration of technical knowledge and design is a particular challenge. The objective of this process is not just implementing good practices to optimise energy or costs, but to incorporate these considerations in the design process, seeking to improve the people's quality of life in every aspect. This task implies giving the students theoretical and technical knowledge from architecture and construction, but, also, making and effort to facilitate its application to the tools developed in the Design Workshop.

Considering these requirements, the School of Architecture at the Universidad de Santiago de Chile includes a course that assists the Design Workshop to generate the transfer of theoretical knowledge to the students' projects. This is the Laboratory course, which is present throughout the curriculum. In the framework of the 2nd year of the program, the Laboratory works with structural and light comfort issues, essential characteristics for a good spatial quality.

In this context, we have developed an exercise based in the use of an heliodon, instrument that simulates the trajectory of the sun in the sky according to the latitude of the project's location. This allows us to analyse the influence of sunlight in a building and its context. In this exercise, the students work with architectural models and drawings in scale one to hundred, as a tool of analysis of the configuration of the built projects in relation to the control of sunlight that they articulate. In this case, we chose a series of single family

houses designed by Chilean architect Jaime Sanfuentes in the sixties. The development of the exercise put in evidence the shape resources used by the architect and its possible variations that could allow to control sunlight in the houses to respond to the needs that they present.

A singular case in Chilean modern architecture

The work by Jaime Sanfuentes is a faithful representative of Chilean modern architecture. Architect and Bachelor of Philosophy by the Catholic University of Chile, he traveled to the United States for three months, where he visited the bureau of Richard Neutra, Aero Saarinen and Skidmore Owens & Merrill (Altikes, 2013). Back in Chile, he works as an independent architect from 1963, developing most of his work until 1967, year in which he died. During this period, he designed 3 buildings projects and 34 single family houses. It is in this houses "where the Sanfuentes' style is more clearly shown", described by architect Helio Piñon as the most rabid modernity (Cousiño and Ubach, 1980).

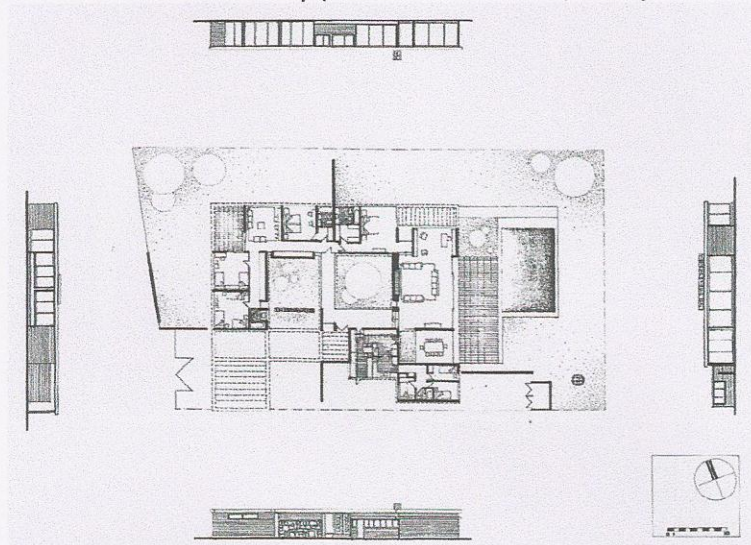


Figure 1. Drawings of the Fontaine house by Jaime Sanfuentes, 1966, built surface: 306,89 m² (Cousiño and Ubach, 1980).

"The houses of Sanfuentes have orthogonal and simple lines. In general, they have a single storey and its low volumes set a complete horizontality. The vegetation covers this volumes in such way, that you cannot see them from the street. (...) Since we enter to the house nature is always present; in general, in almost every house the volumes shape an interior courtyard that faces the access and, through him, you can see the interior public spaces, like the living room and dining room. These possess big windows from floor to ceiling, that allow to see the house's backyard. This transparency in the public area gives continuity to the spaces, enabling a total control of them (...). To resume all of them show a simple and sober architecture, of great spatial richness, achieved through the integration of interior with exterior" (Cousiño and Ubach, 1980).

As a study object, the houses give us a limited repertoire of configurations that relate interior space with exterior: the interior courtyard, the beam courtyard, the paved courtyard and the wall courtyard (Cousiño and Ubach, 1980).

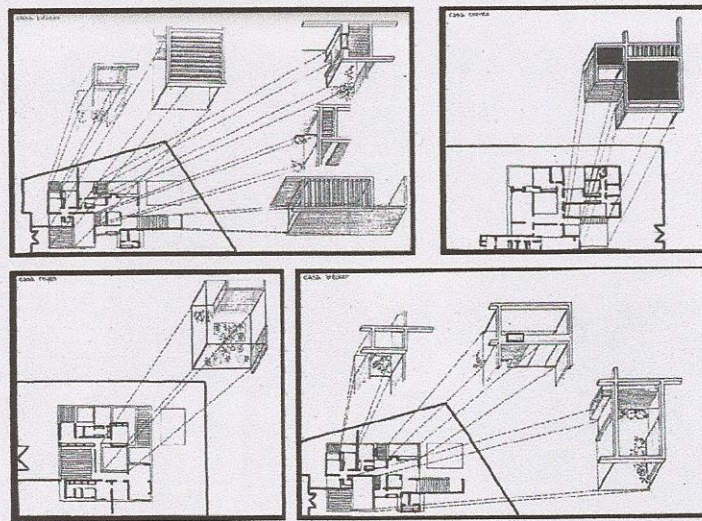


Figure 2. The different courtyards proposed by Sanfuentes. From upper left: pergola courtyard in Becker house, roof courtyard in Correa house, interior courtyard in Reyes house and beam courtyard in Becker house (Cousiño and Ubach, 1980).

The first step of the exercise is to model and draw the projects as accurately as possible. These are the work material to evaluate in the heliodon, identifying the virtues of Jaime Sanfuentes' architecture, to gain an understanding of its space and environment.

Models and heliodon evaluations

In science, an analog model is the material representation of an object or process to better understand its origin or functioning. It is used as a pedagogic tool to help students interpret abstract concepts (Gonzalez, 2005). In architecture, the models are scale representations of a project and are used as a study material or a design tool, they can assume an analytical role of resuming and reflecting, or a synthetic role of generating and producing (Vontrissi, 2015).

With the help of instruments, the architectural model can be used to test hypothesis, either related to the structural behaviour or environmental conditioning. Among these instruments, there is the heliodon, which gives us information about the sunning of buildings in different seasons, days and time. In a pedagogical context, the use of instruments and conducting tests with architectural models become an educational tool that allows students to analyse a specific phenomenon. This kind of experience results in a sensorial and perceptive support for the student, an inductive learning process about a particular subject (Vontrissi, 2015).

In the framework of the exercise presented in this paper, the evaluation of models in the heliodon becomes the base of a reflection about the perimeter of the analysed houses and the components that configure them. The main objective is to identify and evaluate these components that determine the control of sunlight inside the houses. The selected projects are located in the same commune of Vitacura in Santiago of Chile (33°27'70"S) and were all built by the end of the sixties. The first evaluation locates each house in its original latitude to observe and analyse the characteristics of the project in terms of sunning and natural lightning. It is in this moment that the students can establish the perimeter components that define these characteristics. Later, they perform a second test, this time changing the original location of the houses, putting it in a sort of crisis by relocating them in an extreme latitude of Chile. To the north, in the desert, or to the south, in the Patagonia,

the particularities of sunlight are very different to the initial ones and alter the requirements of sunning and natural lightning. Thus, the components identified previously are put to test under new conditions, urging the students to take the corresponding decisions to avoid losing the initial characteristics.

Building the model / 1st understanding

To start the exercise, the students were introduced to the subject of sunning and its associated concepts in the first session. Furthermore, each group was assigned a house by Jaime Sanfuentes to analyse. The first analysis was based in the architectural drawings of the project and building its model in scale one to hundred. In this process, the students recognise the organisation of the program in the project, observed the rooms that were more opened to the exterior and defined the different ways that terraces and courtyards were shaped. The relevance of this stage was putting in evidence the relations between interior spaces and exterior and those intermediary spaces that contributed to configure the perimeter of the houses.

The manufacturing of the model helped the students see elements and details of the projects, like the interior courtyards in the various types designed by the architect. The material for the models was white cardboard, to better emphasise the components by its shape and also accentuate the shadows during the heliodon tests.

Evaluating the model with the heliodon / 2nd understanding

The second step was evaluating the model in the heliodon, in this occasion, with the original latitude. The students received the instructions of the heliodon's use to begin the tests. Hence, we could observe the lighting and sunning characteristics of the house, according to the design proposal of Sanfuentes. The students drew the influence of sunlight inside the house and in its surroundings, using the model as a board, where they marked the shadows generated in each solstice and the equinox in three times of the day: 8AM, 2PM and 6PM. The result showed the path of the sunlight in the project and enhanced the analysis related to the interior organisation of the rooms with more or less time of direct natural light in each season of the year.



Figure 3 and 4. Left, students working during the heliodon test. In the right, the use of the models as a board (picture by the authors).

With this evaluation, the students defined the components that determine the sunning and sunlight aspects of the project. To do this, they diagramed and related them to the projected shadows, graphing its dimensions. Thus, each group was able to identify the functioning and objective of these elements.

Choosing Jaime Sanfuentes' houses was not a random decision. As described by Cousiño and Ubach (1980), they configure an imbricated relation between interior and

exterior through their intermediary spaces and courtyard types. Highlighting this connection with a modern alphabet of pure volumes, open or transparent spaces and the extension in plant, directly related with the work by Richard Neutra, gives the student a specific plastic repertoire to approach and grasp the notion of the perimeter in architecture. A mediator perimeter that closes and opens links with the surroundings and, at the same time, shade and articulate from its own language without additional elements.

Models in crisis: change of latitude

As a way of testing the limits of the model and the perimeter components identified by the students, we take them to a critical location with a change of latitude. This operation modifies the situation of the house in a radical way, altering the arrival of sunlight and, in consequence, the conditions generated by the perimeter.

We chose two latitudes for the new location: half of the projects would be in the city of Arica (18°28'30"S) and the other half in the city of Punta Arenas (53°09'00"S). Both cities represent the most extreme regions of the north and south of Chile, with completely opposite sunlight conditions, the first in the Atacama desert, almost 700 km to the north of the tropic of Capricorn, and the second one in Patagonia, more than 4000 km to the south of the same point. Thus, the sunlight characteristics differ greatly from the original ones and between them.

This exercise allowed us to analyse the information obtained in the first evaluation and gain a better understanding of the control over sunlight offered by the perimeter components. With the change of location, the shadows and natural lightning was modified inside the house and its surroundings. Once more, the students drew the new projected shadows in their models, comparing them to the first drawings from the initial evaluation. In this way, the function of the identified components and the importance of their configuration were put into evidence.

Due to the new latitudes, the perimeter components did not produce the same lightning conditions. By examining the new results and contrasting them with the initial results, the students analysed which shape aspects of the components determined these outcomes and estimated possible alternatives of modification.

Speculation from the perimeter

After the previous analysis, the students identified the parameters of the components' configuration that defined the lightning conditions of the houses. These were related to dimension and disposition, in other words, they recognised the plastic alphabet of the houses in a relative way and not just as a geometric language, articulating precise operations to modify the sunlight characteristics. First, the students formulated hypothesis of possible variations of the registered parameters with the objective of recovering the original conditions of the model related to sunlight. This meant a rethinking of the perimeter of the models, with concise and rigorous adjustments that did not alter the original language of the house, but generated a new version of it, without transforming its plant.

With the new version of the model, we performed a new evaluation with the heliodon to note the effectiveness of the proposed modifications. Even though in most of the cases the original situation was not completely achieved, the changes generated a difference that approached the objective. The importance of this last test was to make evident that handling the components helped control the sunlight in the projects. Thus, they were

confirmed as tools of light control with the potential to be extrapolated to other projects and contexts.

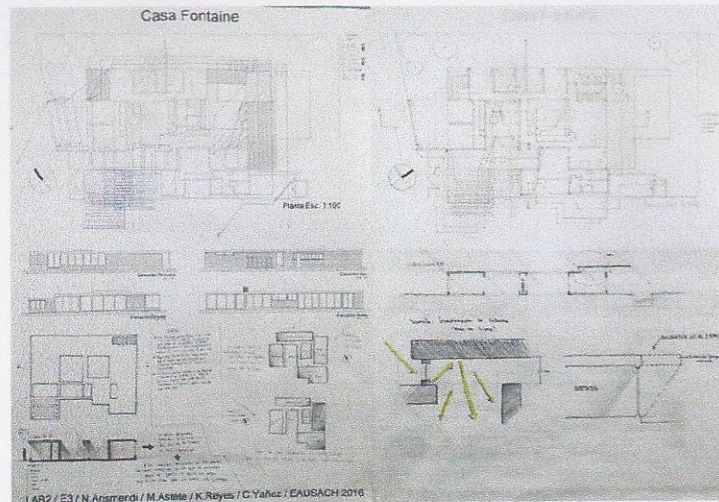


Figure 5. Students' work, analysis of the perimeter components and sunlight control (picture by the authors).

Thoughts about the applied methodology

The presented exercise was the first of its kind in the Architecture School of Universidad de Santiago of Chile. It was also the heliodon's debut and the first time the students worked with this instrument. This pilot experience helped us note the advantages and disadvantages of the instrument's use and the work with architectural models as a method of analysis. At the end of the exercise, the students answered a poll about their experience, composed of three questions. Here, we present a selection of their answers.

Perception of the utility of the heliodon as a pedagogic tool

In this question, the students were faced with five phrases which they needed to assess among four alternatives: Completely agree, Agree, Disagree or Completely disagree. This were the presented phrases:

1. I understand how the heliodon works with the instructions given by the professors.
2. The heliodon is a useful resource to understand the sunlight and its influence in a project's lightning.
3. The heliodon is a resource that helps me make decisions and generate design criteria for the Design Workshop and Laboratory course.
4. Integrating this type of instruments improves the courses dynamics.
5. The incorporation of the heliodon as an asset meant a support for the learning experience of the course contents.

The results are presented in the chart below:

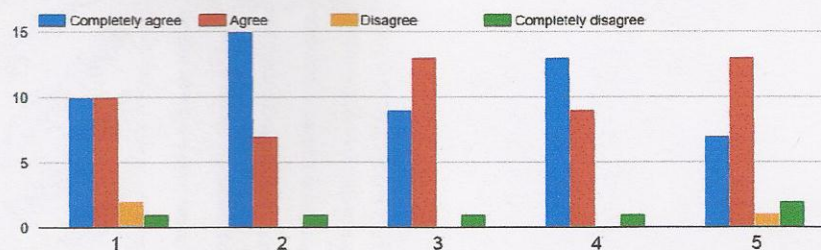


Figure 6. Chart of answers (picture by the authors)

What does the use of the heliodon contribute to your learning experience?

The answers to this question were positive in general. Here, we transcribe some of them:

- *In relation to the last project, it helped me see the sunning phenomenon and in an empirical way, more than just in a computer, move the pieces so the design made more sense.*
- *Keeping in mind the importance of the sun to create spatiality, even if this was also seen in first year, with the use of the heliodon it becomes evident and creates a real consciousness of the interaction of the models with the sun.*
- *Even if software of sunlight analysis exists, the heliodon allows me to see it in a more real perspective.*

Write down strengths and weaknesses you found in the process of the heliodon's incorporation to the laboratory course.

This question presented more critical answers, pointing specifically to the pedagogical implementation of the heliodon, which needs to be improved in the future. Here, we present some of these answers:

- *It was a great support for the Design Workshop project, specially at the end. The modifications part was unnecessary, because we lost time in something that was not directly applied in Design Workshop (...).*
- *The only bad thing I saw was that, since we only had one heliodon, it took a long time for everyone to use it (...).*
- *It is a useful tool to understand the relevance of the sun in the spaces and how to organise the project's program. The exercise of changing the latitude of a house in Santiago and see the transformation it provoked (...) was interesting. As a weakness, it would be the great amount of students that made the use of the heliodon very slow.*

The professors' impression

The faculty in charge of the exercise was composed of three professors: Hugo Pérez, Ginnia Moroni and Carmen Melo. The development of the exercise and the final results allowed us to observe the strength and weaknesses of the experience, besides showing the possibilities that the heliodon's use offers for future academic work. The observations are divided in three areas.

Firstly, about the use of the heliodon as a tool, we could notice the enthusiasm of the students during the evaluations, since it gave them the opportunity to examine, in a reliable way, the influence of sunlight in the studied projects. This facilitated the understanding of this aspect and the qualities it offered to the project. However, by the end of the experience, there were still some students who presented doubts about its use. We believe that reinforcing the associated concepts of sunning and sunlight during the exercise, i.e. azimuth or solar angle, could be a possible solution.

Secondly, concerning the work with models, their potential as a method of analysis was confirmed, no longer being just a method of representation. The use of the models as a board where the shadows were drew, transformed them in study material that later became a reference for the students to create their proposals. In the words of Olafur Eliasson (2007): "What we are witnessing is a shift in the traditional relationship between reality and representation. We no longer progress from model to reality, but from model to model while acknowledging that both models are, in fact, real. As a result we may work in a

very productive manner with reality experienced as a conglomeration of models. Rather than seeing model and reality as polarised modes, they now function on the same level. Models have become co-producers of reality”.

Finally, regarding the applied methodology, the firsts analysis of the model in its original and new latitude was effective to recognise the components that created the sunlight control of the houses. Nevertheless, the final stage of the students' proposals was too short to fully analyse the possibilities these variations really offered. In the future, we would like to perform more than one evaluation to the new versions or maybe continue with a second exercise that allows to go deeper into this aspect.

Discussion

The experience obtained with the exercise shows the potentiality of using models and analog instruments of evaluation as a pedagogical tool in the education of architecture. On one hand, the experimentation gives the students new work methods, confirming the architectural model as a tool of analysis. The model is no longer a simple form of representation, but an artefact that enables the observation of a specific phenomenon.

Furthermore, the tests as a learning method enhances the understanding and assimilation of theoretical concepts by the students, not only as an abstract knowledge, but also empirical. This facilitates the extrapolation of these acquired notions to other pedagogical concepts, i.e. the Design Workshop. Nonetheless, the design proposal and modifications to the models was not properly realised, remaining pending for future experiences to improve this part of the methodology.

Light comfort is very important for the optimisation and efficiency of projects. There are several digital tools that helps analysing buildings to optimise this aspect. However, the sensibility regarding this issue has to be acquired during the years in architecture school, where students become aware of the impact their design decisions have in this essential characteristic. Therefore, we see in experimentation a method to achieve this sensitisation in future architects.

Lastly, working with a renowned architect was a great method to put in value an important representative of Chilean modern architecture. It also allowed us to study a body of work focused in the relation between interior and exterior and sunlight control, through the development of simple components. The students could analyse and codify them, creating a repertoire of tools for the configuration of the perimeter that can help regulate these aspects and could be extrapolated to their own projects.

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