BIM Chilean Social Housing Analysis

from the 70´s to 90´s

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This research based on education digs on the ``evolution'' of Chilean social housing between the period from 70's to 90's asking us the ``phylogenic'' relation between ``typos'' of designs that developed several problems in the urban fabric development during 20 years of intricate design just thinking in quantity but not quality in our country.The focus in this research is as the first step understanding the design behind dwellings between this time range, then its process of evolution and transformation by users, and then by BIM understand the virtues and defects of each design and rethink the typologies in a housing life cycle look for the next years.

Keywords: *BIM, Social Housing, Catalogue, Design, Intervention, Strategies*

INTRODUCTION

BIM as a design methodology inside the building life cycle can debug the existent problems not only in the new buildings that we are designing for our cities; it is a new opportunity to improve quality of existing buildings, regenerating our cities from the first cell of living, the housing as the engine of living transformation. From that point of view, the chance to work with existent building block by BIM is undoubtedly an excellent laboratory in which the operation factor in our designs and constructions has been put in the test during years, creating a scenario of possibilities from where we can learn about architecture and its evolution over years of use and transformation.

The time dimension was put in test in a set of 18 different cases at the Metropolitan Area of Santiago - Chile, in where our design teams proposed new solutions based on the family heritage protection plan of refurbishment from the Chilean government. We considered all the information available from study cases, simulated data and the speculative proposed solutions from our teams toward a new integration between housing programme, local-urban relations and the building as the mediator between scales.

RESEARCH QUESTION

-Is it possible to analyse pre-existent social housing by BIM and understanding in this process possible strategies to improve the quality of the study cases?

OBJECTIVES

-To generate a comparative study of Social housing typos between 1970 to 1990 as a primary database of knowledge that allows architectural and structural improvements in its life cycle.
-To create a catalogue of data building information

on Chilean social housing in three scales of intervention.
-To promote BIM and digital fabrication as the way to improve quality in pre-existent no optimised housing blocks versus traditional models of design and intervention.

BIM AS DESIGN TOOL FOR SOCIAL HOUSING RESEARCH

For the objectives of this research, we developed in the architectural design studio 6 at University of Chile a Lab for Multiscale Material Research (MMR) in the built environment. The students organized into research teams were detecting preexistences susceptible to be reconverted in new possibilities, through the inclusion of incremental strategies from the detail to the whole building.

We explored cases from the guidelines of intervention based on strategies of the Chilean Ministry of Housing and Urbanism (MINVU) and its housing refurbishment programme PPPF (Program of Protection of family heritage) integrating 3 scales of application from the whole (common spaces), programmatic enlargement (Housing) and thermal envelope (material detail).

In this direction, we promote the ability to generate simple codes, as project constraints, generating a language from the original structures as the base of multiscale formal systems, studying evolutionary or emergent processes with BIM and Digital Fabrication.

Under this logic (Smal, Medium, Large) the operations to be carried out at the micro level affects the following levels and vice versa, facilitating the feedback within this design process, integrating analogue and digital tools from simple elements like points, Vectors and surfaces, and also simple instructions, whose combination moreover, iteration generate different and "unexpected" results.

REBUILDING BIM FROM EXISTING BUILDINGS

The projects and products of this work are the conceptual base material for MINVU as a collaborative structure between the faculty and this Chilean public organization, delivering all the production by the end of 2019. For that reason, the first step of this work was the detection of iconic social housing typos from the '70s to '90s. around the metropolitan area of Santiago.

The starting point was to select 19 cases from areas defined in Santiago as "popular" neighbours that are marked in red from data developed by "Fundación Vivienda" in Chile. In all these areas, it is possible to detect social housing typos that were populated without differentiation from the north to the south of Santiago as well in the whole Chilean territory. (fig 1)

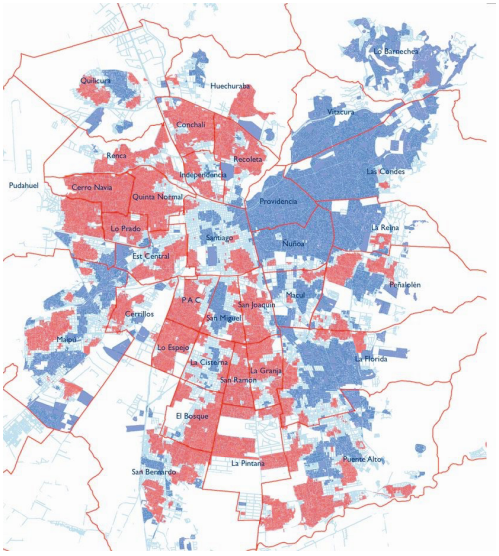


Figure 1
Map of social housing areas in Santiago, source "Fundación Vivienda"

After this field search, the teams selected the following cases: Marta Colvin, Andalucía, El Pinar 2, Los Troncos, El Refugio, El Cobre, San José, Pablo Neruda, Los Quillalles, Villa O'Higgins, San Rafael, Villa Navidad, La Faena, Matta Echaurren, Las Dunas, Alonso de Ercilla, Los Poetas,Alberto Larraguibel and Mi Casa.

Figure 2
Sample from case "Andalucía" about space and regulations, source by the authors

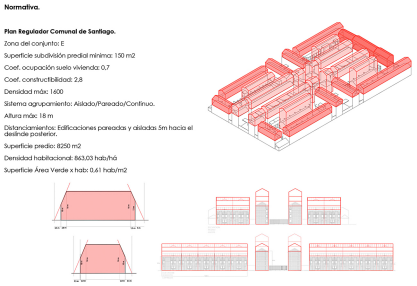


Figure 3
Sample of visual connectivity about space and regulations, source by the authors

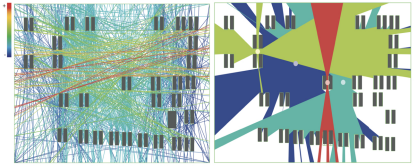
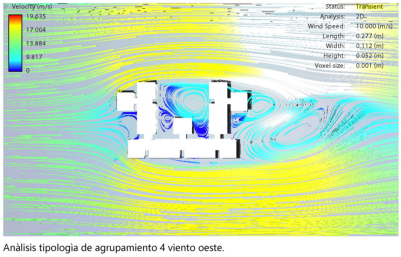
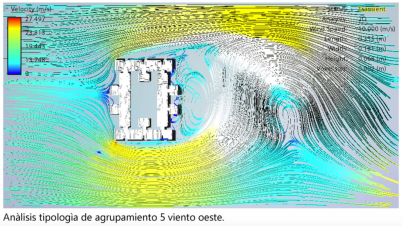


Figure 4
Sample of wind tunnel applied to housing blocks in the case "Alonso de Ercilla", source by the authors



Análisis tipologia de agrupamiento 4 viento oeste.


Análisis tipologia de agrupamiento 5 viento oeste.

PUBLIC SPACE

The first data collection was all related to public space and regulations over each study case, including the percentage of building versus space on the ground floor. (fig 2)

After the full reconstruction of each case, the design teams modelled graphically in 2d and 3d the restriction volumes from the building regulation of each site. From that analysis, it was possible to define for all the cases the available space now instead of the original existent buildings. All the data collected in this first step generated the base constriction of each new design over the pre-existent social housings, keeping in mind that the first improvement in each study case is the increment of square meters, and over that growth could be possible to re-develop strategies of operation and sustainability.

Some discoveries in this step were a comparison in connectivity at public space level as well as relations between public space and radiation and ventilation from wind models over the BIM reconstructions. (fig 3)

Other approaches over the cases were the relation of original orientations in some cases and turbulences that rejects possible appropriations in public space from the users due to the wind speed, and spiral air movements created areas with extra complexity for regular usage. In other cases, closer distances between housing block developed lack of ventilation (fig 4) as well as projected shadows from one building to public space, creating in this process under radiated areas. (fig 5)

This first stage of studies allowed to develop BIM basic models of each case, running several performance tests over the pre-existent housing blocks, being a highly explorative research scenario that built a dense framework of performative information, that proved to be consistently a co-reading system of the real situation for these unsuccessful living models between the 70s to 90s.

INTERIOR SPACE

This study will bring to the design teams closer to new production processes, from the outside scale to the interior space, from formalities of non-standard architecture to the sense of equity closer to the logic of gene (variation, mutation). This process allowed improvements by variations of the percentage of voids and glassing in facades, increasing square meters of each original floor plan in parallel.

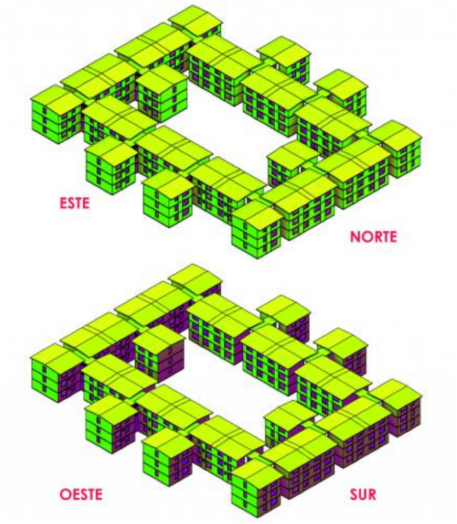


Figure 5
Sample of solar radiation applied to housing blocks in the case "Alonso de Ercilla", source by the authors

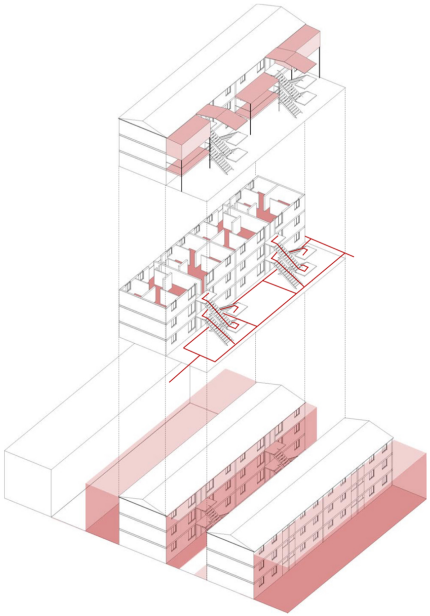


Figure 6
Sample of space capabilities from existing transformations, source by the authors

Understanding the possibilities of each case, the analysis in this step was ruled by circulation mapping, interior space capabilities, square meters available in each variation as well as module combinations as air cube from rooms typology (fig 6).

In the same process, all the regulations are visualized inside each existent sample, as well as the predominant materials involved in the cases, creating a database of general aspects from structural to finishing and self-construction possible aspects. This "deconstruction" BIM process allows developing in the proposal stage new strategies of flexible and transferable designs with different levels of details.

With the focus of facilitating the technologic migration, form one study case to another, as well as generating synergy between the different proposals and orders, all the material and performance analysis were run in individual housing units instead of housing blocks, with the KWh value for each unit and an estimative operation value along a full year (fig 7).

In all the studied cases, the teams detected the same patterns as design problems: the original government focus was at the beginning finding solution to housing just in term of quantity, for that reason the use of cheap raw materials overall in facades and exterior walls. That key factor affected the final energetic performance dramatically during a year operation, with almost the double of energy consumption versus an optimized model. Another critical aspect was the lack of space in the interior of each unit, producing a growing phenomenon over the facades, creating dark voids in the interiors of each unit (fig 8).

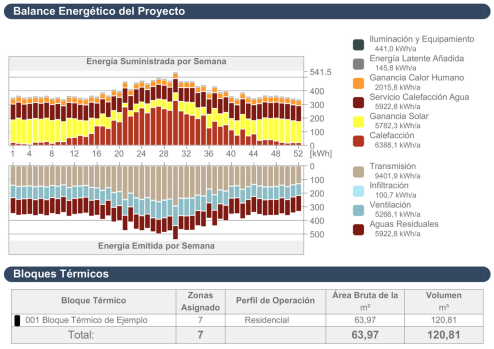


Figure 7
Sample of energy consumption by year from existing housing units from BIM model, source by the authors

Figure 8
Sample of lux provided in existing housing units from BIM model, source by the authors

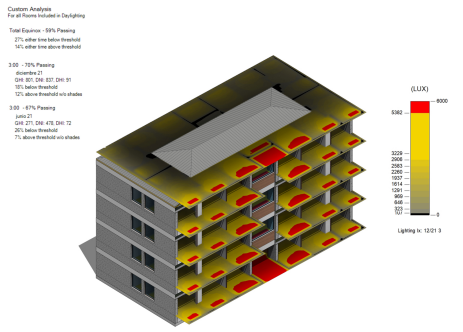


Figure 9
Sample of interior ventilation of a housing sample unit, source by the authors

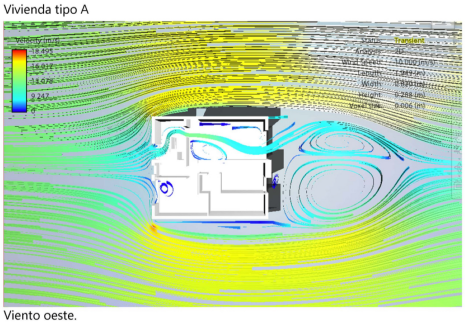


Figure 10
Sample of skin deconstruction in housing block from BIM model, source by the authors

Figure 11
Sample of solar radiation in the "external skin" from BIM model, source by the authors

In terms of interior ventilation, the performance of each existent unit was reduced due to the ratio of windows and walls in the facades usually avoid a better result thanks to cheaper solutions designed in the period (fig 9).

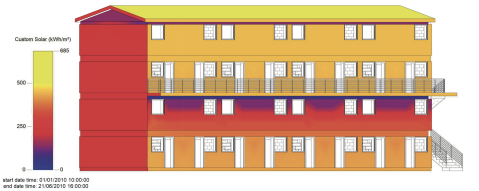
EXTERNAL SKIN

In the full process, the design teams emulate conceptual models from the real study cases, towards the construction of visual architectural models with embedded information, allowing modifications at any point in the process for the final transformation step, promoting the incorporation of ideas during the same development. By the recognition of an "external skin" that allows radical refurbishments, this study migrated from rational to experimental simultaneously, democratising the design process and opening the black box inherent in its structures.

The idea behind this stage was the detection of supports that allows transformation and reconnection between public and private space. By definition, the skin is "a thin layer of tissue forming the natural outer covering of the body", understanding this meaning applied to a building like an interface between inside and outside (fig 10).

It was necessary again to run tests of energy consumption, living cost, radiation and illumination for each specific skin, generating a database of information which is the base of all the transformations, creating a catalogue of possible solutions from existent problems (fig 11).

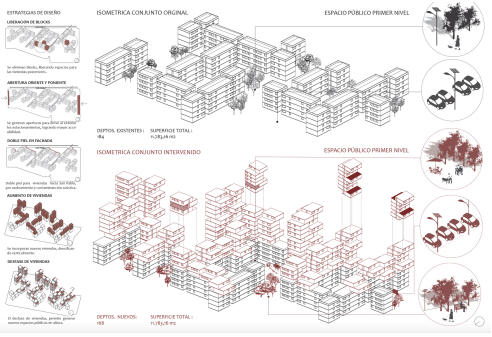
At the end of this process, it was possible to develop a comparison from different models, integrating new designs with old developed structures in a political context that radically changed between the years the 70s to 90s.



RESULTS

The results of this research are on the one hand a link between technology and design, in an incremental strategy of architecture development in real cases, that are part of a formative model of architectural research based in education, promoting a systematisation in the creative process, from data to real space and vice versa. On the other hand, it creates a critical analysis about what we develop before as country in the social housing field for the studied period and what we need to do over those unsuccessful models of habitable blocks.

After the isolation of half of the cases, we applied to existent blocks an optimised housing models like design restrictions/opportunities by using rules and regulations of the Program of Protection of family heritage (PPPF). As a result of this operation, we generated a new catalogue of projects and strategies.



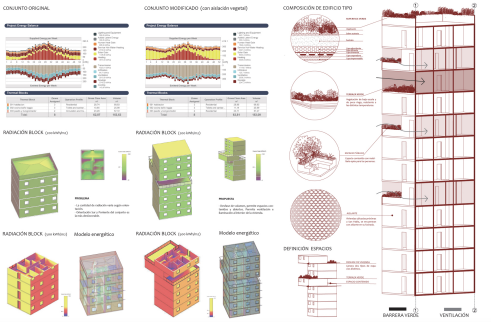


Figure 12
Sample of densification in "Alberto Larraguibel" from BIM model, source by the authors

Figure 13
Catalog of transformations over "Alberto Larraguibel", source by the authors

The final stage of this research was based on the second half of the study cases, as BIM densification process by which each case increased its capacity and density in a ratio between 200 to 300 per cent. This new restriction opened the possibility to visualise a possible new design scenario, pushing the base density to a higher level of square meters per inhabitant.In all these three stages, we used the same process: an integration of the whole public space, the house and the building block, and thermal envelope as the mediator between booth scales (the public and the private) in a proposed scale of habitability (fig 12)(fig 13).

NEXT STEPS

For the next steps, the Ministry of Housing and Urbanism wants to develop with us the same process but taking existent models from other Chilean regions. From the north to the south of our country we will develop a new design restriction: different latitudes over the building, creating a new set of results, due to the differences between regions are tremendous in terms of climate, energy and ways to use the space by the users.The catalogue of transformation from each study case will be the base of the phylogenic study that we are developing with all the cases from the year of research running in the Design studio six at the University of Chile. (fig 14) (fig15).

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Figure 14
Full transformation process study case “Marta Colvin” based on the typology from the 90s, source by the authors

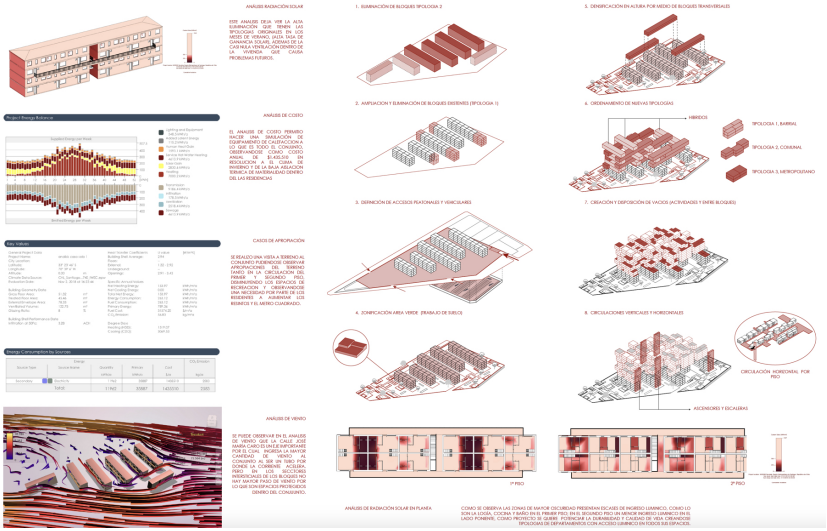
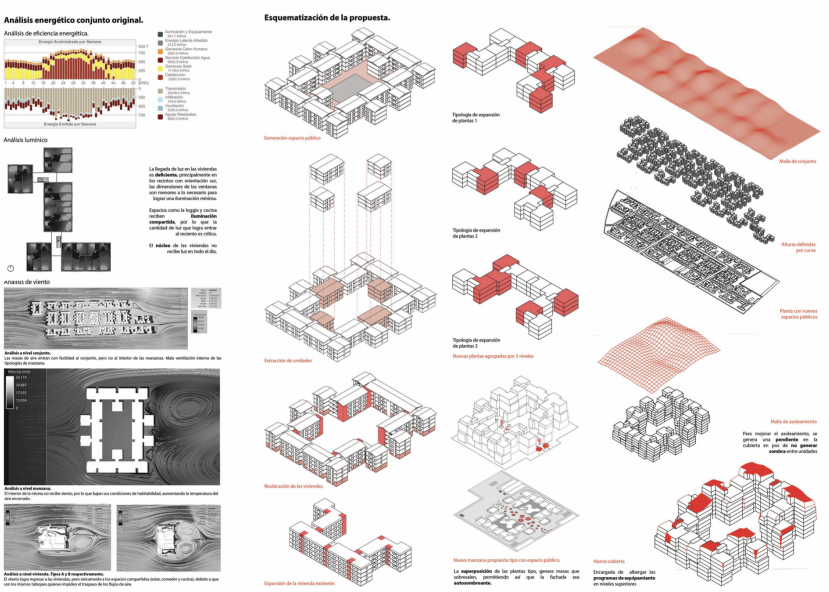


Figure 15
Full transformation process study case “Alonso de Ercilla” based on the typology from the 80s, source by the authors



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