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DOMESTIC BIG DATA
Cluster Tool for the Analysis, Assessment, Diagnosis and Design of the Contemporary Collective Housing in Dense City Centres
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Abstract: The aim of this research is to create a tool which could be useful for architects as a methodology applied in projects. Said methodology would allow us to analyze the real state of the housing stock that, after the global crisis just passed, Spain suffered. To this purpose, we try to use the latest generation concerning in data field technologies. Therefore, the current achievement is to focus on the fact that BigData do not throw away any clue to solve by themselves any question, but through the use of the specific tool applied, the relation between data will help to move forward any research. We divide the development of this tool into five main categories: Urban Gradient, Energetic Optimization, Habitability, Adaptability, and Social.

Through this thesis the main target proposed is to visualize these categories, but highlighting the relation between the parts analyzed — in a topological way — in opposite to the usual methodology more extended through the state of art in the past, where plans, sections and axonometric, were mainly the support to transcribe those graphic analyses into information. Moreover, this is not a matter of form and calligraphy; the target will be to distill the tool in order to connect a maximum of conditions from the project to be analyzed and controlled just using a minimum of data from the beginning. That implies two spots: in one hand, the capacity of being able to compare the same parameters with two or more different projects; and on the other hand, to offer a boost in future improvements from architectural strategies.

Keywords: Big Data, Collective Housing, Parametric tool, Topological Methodology, Architectural Project.

1. Introduction
This is a must nowadays to generate tools which allow architects to update empty housing projects. To follow this path, it is important to look back into the concept on how a huge amount of data could be analyzed by latest technologies and refreshed in real time. This contemporary phenomena, known as Big Data, imply the existing rules that role the channels through these amounts of data have to go. Those rules are mainly subjects and under the command of political and socioeconomic vectors. Therefore, it is difficult to deal in a objective way with figures from Big Data (Mayer-Schoenberger y Cukier 2011). On the other hand, because of the fact that our research focuses on domestic spaces shared between users — collective housing — through a tool which could be able to tame Big Data — related to housing conditions —, we could offer both a new methodology on projects and, after this, a proper way to diagnose those housing projects which would need to be refurbished. What is more, daily conditions allow us to collect a more scientific and objective amount of data. So, in order to analyze collected data through parameters, our research purpose to classify from five different categories on each study case: urban, energy, habitat, adaptability and social.

2. Scientific analysis: improvement tool
First of all, we should define which are the current necessities to improve the collective housing projects nowadays, and also to find out the strategies in our parametric study purposes. To our mind, it is important to build our study based on the state of the art concerning to collective housing taxonomies, above all those texts and authors from domestic architecture tradition. After this, the main target should be to work with this huge amount of data from each project and to select — through the filter of contemporary — those which are more relevant. The strategy will be being able to tame Big Data available nowadays through contemporary tools as well.
2.1. To stare into: measured in a different way.

![Map created in 1855 by Doctor John Snow which wrote down cólera disease cases in Soho, London, 1854.](image)

The self-conscious about our own existence in the cities could bring us new capacities to observe around us in a new and unexpected way — above all related to our daily lifestyle, ruled by production results and globalized consume —. What is more, to develop the capacity to both stare into and analyze urban phenomena and citizen issues which surround us, will allow us to feel new realities never knew before. Learing how to adjust the sight — better said than the look —, became a challenge highly assumed by both Arts and Science fields nowadays. Concerning this, it is possible to go through texts as Manuel Lima, *Visual Complexity. Mapping Patterns of Information*¹ in 2011, where it is posible to have a brief look into this slow but complex evolution (Fig.01).

3. State of art: Collective Housing Taxonomy

After this, we proceed to define which parameters we decided to controlled in our tool; that implies to go through those texts which analyze and classify different aspects from collective housing projects in XX century. From there, we will try to sum up with our own list to create our five categories from our tool. The selection from this publication calls to the Collective Housing Research Group (GIVCO) criteria related to the Housing Cuaderns’ (CVI), where are included hundred of data measuring all aspects from the examples always from the same way; said database will be our starting point to create our parameters.


**Context and analysis methodology:** United States of America, 1913. This is one of the early texts published concerning homework and how to classify them in terms of efficiency — in matters of time

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¹ We can see here medieval graphics from *The tree of the Two Advents* by Joaquín de Flore, in 1202, to *The net of life: Reconstructing the microbial phylogenetic network*, by Victor Kunin and others examples in the magazine Genome research 15, number 7, July 2005.
and space — to measure and improve those processes. Women’s roles in Nort America started to be published, at the end of nineteenth century, from moderate sectors in high class society and seen as an exclusive responsibility of the female sex\(^2\). The text includes some plans explaining different spacial configuration of livings, talking about proximity, ventilation, natural light or heating spots. That allows readers how to compare those different configurations. Therefore, the aim of this book is to offer a more efficient control of the time wasted and make it becoming useful to women daily homeworks. What is more, through the pages of this publication we can find different instructions about how to place objects and pieces of furniture — considering them Beyond simple decoration — to create a more efficient house, which would imply an improvement on homework routines for women but also in spatial configurations for every member of the family.


Context and analysis methodology: Germany, 1928. In this case, the frame which surrounds the works from Alexander Klein came from the housing subsidies which activated the production of those buildings in Weimar Republic between 1924 and 1930\(^3\). The intention to measure and classify the type of housing was supported from Berlin with the appearance, in 1924, of the GEHAG coop by Martin Wagner, Ernst May — who did the same in Frankfurt\(^4\), where placed the New Frankfurt from 1925 to 1930, building the figure of 15.000 units —, Walter Gropius and Bruno Taut. Therefore, we find easier conditions to go forward in proper housing studies. What is more, through the so-called “Graphic methodology for assessment in small housing” we can see how parts of that graphic study about usable area and the gross floor area is based on Doctor Leo Adler studies. Klein takes this data into graphical representation in three different ways:

1. Connecting location and connection between spaces. It represents the borders of all rooms, any windows, and with arrows and line connections between the main entrance and the rest of room with usable program — living, bedrooms, bathrooms, and kitchen —.
2. Free area concentration per floor. It draws following the silhouette of any type, the exterior and interior, to show the thickness of façades; then it highlights the surfaces of furniture free spaces.
3. Shadows thrown on the floor plant. Once again, it represents the silhouette of the type, but this time drawing also the edges of the furniture and its shadow thrown on there at different time-lapse — evening and morning —.

![Fig. 2. Plan drawings showing connections between spaces, program, free floor area and thrown shadows. Alexander Klein, 1928.](image)


\(^4\) When Ludwing Landmann was elected Mayor of Frankfurt in 1924 Ludwing Landmann, Ernst May created the Building Office Frankfurt am Main, with Wilhelm Schütte, Max Celto, Adolf Meyer, Eugen Kaufmann, Margarete Schütte-Lihotzky —who created the Frankfurt kitchen—and Ferdinand Kramer. They built, between 1926 and 1930 around 15.000 units and also funded the magazine Das Neue Frankfurt, implying the diffusion of all this work to the rest of Europe, with Ernst May at the head, until 1930. See chapter “Margarete Schütte-Lihotzky 1897-2000. El esplendor del compromiso ético” in Espegel, Carmen. Heroínas del Espacio. Mujeres arquitectos en el Movimiento Moderno. Ediciones Generales de la Construcción, Valencia, 2006, pp. 165-188.
Following to this (Fig.02), the author established links to each typology a primary order to follow. This analysis came from general concepts to reach specific data — taken from statistics —:
1: Technical aspects.
2: Scientific principals.
3: Building and sanitary issues.
4: Maximum and minimum program.
5: Graphic method of comparison.
6: Unification of all projects to the same scale and graphic style. Selection of the best ones.
7: After those results, they proceed to verification of selected projects.

This early effervescence about rational and minimum dwelling implied the undoubted thrust which was necessary to make studies from Alexander Klein real. Therefore, Klein presented in 1928 his Rational studies Kleinwohnungen at the Housing Exposition on the occasion of the International Congress for Housing and Planning in Paris, where was possible to find that methodology to determinate objective ways to evaluate and optimize the minimum dwelling (Sherwood 1983).


Context and analysis methodology: The appearance, on late 60’s from the twenty century, of a comprehension of the housing based on a minimum structure which allows dwellings to develop and offer countless possible configurations, it is certain to be owed to the book Supports: an Alternative to Mass Housing by N. John Habraken⁶. For this author, the adaptability on housing would be easier to appear when it is possible to divide the space in bands, allowing the existence of a permanent structure with other parts from architectural aspects which would appear or disappear related to the occupancy and the necessities of the users living there. According to this, in this text those projects are divided into different programmatic stripes meanwhile the structure appears permanent. Those stripes are, in order: entrance, connecting corridor, storage, beds and terrace on the frontage (Bosma, Hoogstraten y Vos 2000). Through the text, there exist different ways to classify those bands, but always based on this gradient which establishes, from one façade to the other, the configuration for open space buildings — wall-to-wall blocks, galleries on façades, double air circulation on the frontage, and this will produce a system based on horizontal bands, divided a specific measure of each other depending on each case —. What is more, we can find through the publication anthropological, social, and phenomenological studies related to data which would allow us to measure the stripes according to the flexibility needed by each user, but always with the same permanent structure (Fig.03).

Fig. 3 Band drawings, related to gradients, from spaces classified on dwellings. N. John Habraken, 1962.

⁵ Translated into Spanish as Soportes, una alternativa al alojamiento de masas (Madrid, Alberto Corazón, 1975)

3.4. [1963] Victor Olgyay. Climate and architecture

Context and analysis methodology: On early 1950’s, brothers Victor y Aladar Olgyay⁷ started a series of researches about bioclimatic performance in buildings, setting the basis for this field. They were the pioneers to face thermodynamic performance in buildings as a system balanced, measurable through macro-climatic conditions — solar radiation, temperature, humidity, precipitation, and wind —, and also micro-climatic ones — properly regulated by humans control, the authors said — that affect to dwelling construction⁸. Based on four principals — biology, climate, technology, and architecture — Victor Olgyay is capable to face a flawless taxonomic study concerning energetic aspects related to housing construction: not only the body influences and necessities on daily inhabiting but also climatic and atmospheric phenomena — which influence said inhabiting —. Following to this, we can find out in the text pioneer graphics in both humidity and air studies, where we should remark the well-known graphic about atmospheric confort⁹. What is more, the author continues developing through the text showing another huge amount of graphics, which drill down to further levels of details on solar control, wind, position of materials and openings in façades. That scientific argument emerged as the foundations for bioclimatic analysis for the next decades, being the starting point for future scientists on thermodynamic field. In order to include this text in our research, we highlight the next Olgyay’s way for analysing:

1. Site
2. Solar orientation.
3. Solar control by environmental conditions and constructive frames.
4. Wind effects and air flow.
5. Thermic effects on materials.

Trying to offer an applied consequence of their studies, Olgyay brothers created a tool to measure on real models, made with scaled proportions and conditions, the effects in real time. This tool allowed them to test thermodynamic effects on buildings, on real time. This tool was called Thermoheliidan¹⁰. Because of that, it is possible to say that it was a pioneer parametric tool for the scientific world¹¹. From this, after Victor Olgyay works, it will appear energetic classification to control housing several effects of climate, but always bringing the influence of Olgyay’s work.


Context and analysis methodology: In 1976, the critic Peter Reyner Banham wrote this text¹², crucial for the understanding towards a change in paradigm those years, focused on infrastructures as a new topic — minded as another layer in the city — related to urban issues (Garcia-Germán 2012). Therefore, in the text, the borders between urban infrastructure and mass equipment started to vanish. According to this, it is possible to start thinking about the chance to measure invisible aspects from the

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⁷ Both brothers studied architecture in Hungary under Modern Movement influence. After this, they moved as immigrants to the USA after II World War. They were teachers at MIT and Princeton. Then, Victor Olgyay could test his studies about climate performances on housing throughout Southamerica working at Universidad del Valle de Cali, Colombia, in 1967 and also Argentina in 1969, as a United Nations consultant.

⁸ All these studies, released on articles as The temperate house (1951), Solar control and orientation to meet bioclimatical requirements (1954), Environment and building shape (1954) and finally in the book Solar Control and Shading Devices (1967) help Victor Olgyay to publish in 1963 Design with climate. Bioclimatic approach to architectural regionalism. It represented eight years working at Princeton University, thanks to the support from the Federal Founding Agency of Housing, USA, through a Grant from Solomon R. Guggenheim Foundation.

⁹ See the influence on several thermodynamic works after them as Baruch Givoni’s — as the Psychometric Diagram published in 1969 on Man, climate and architecture, or Koeningsberger, Mahoney and Evans works — Mahoney tables, published in 1971 —.

¹⁰ See article from Barber, Daniel “The Thermoheliidan. Climatic architecture at the end of calculation” in ARPA Journal n. 01, Test Subject. Columbia University Graduate School of Architecture. May 2014, online.

¹¹ In 1957, parallel to the Thermoheliidan appearance at the Princeton Architectural Laboratory, Geiger was developing The Meteorological Project — computer based approach to climate — also at Princeton University’s RCA, using John von Neumann’s studies called Computer Project.

¹² See Guy Debord, Constant, Archigram, Yona Friedman or Cedric Price works, also the experience in Montreal Exhibition in 1967, compiled by Banham in this text.
4.1.3.2. Thermic flows [gU.03.02].

4.1.4. Urban frame.
   4.1.4.1. Urban compactness [gU.04.01].
   4.1.4.2. Empty plots [gU.04.02].

4.2. Energetic optimization [oE]. Analyzes the exchange from elements and between mediums related to thermodynamic factors:

4.2.1. Solar factor.
   4.2.1.1. Light amount [oE.01.01].
   4.2.1.2. Correction through solar orientation [oE.01.02].
   4.2.1.3. Solar contribution [oE.01.03].

4.2.2. Thermodynamic factors [oE.02].

4.1.3. Thermic factor [oE.03].

4.1.4. Form factor.
   4.1.4.1. Height correction [oE.04.01].

4.1.5. Waste storage [oE.05].

4.3. Habitability [Hb]. Concerning: confort, hygiene and sanitation:

4.3.1. Privacy factor. [Hb.01].

4.3.2. View expositions[Hb.02].

4.3.3. Hygiene [Hb.03].
   4.3.3.1. Healthy height [Hb.03.01].
   4.3.3.2. Environmental noise [Hb.03.02].
   4.3.3.3. Atmospheric comfort [Hb.03.03].

4.3.4. Accessibility [Hb.04].

4.3.5. Interior air conditions [Hb.05].

4.4. Adaptability [Ad]. Those parameters where time is crucial to understand flexibility as a real condition for inhabiting:

4.4.1. Structure support [Ad.01].

4.4.2. Infrastructure support. [Ad.02].

4.4.3. Enlargement of the cell [Ad.03].

4.4.4. Enlargement of the unit [Ad.04].

4.4.5. Occupancy. [Ad.05].
   4.4.5.1. Cell [Ad.05.01].
   4.4.5.2. Unit [Ad.05.02].
   4.4.5.3. Block [Ad.05.03].

4.4.6. Adaptable volume [Ad.06].

4.5. Social [Sb]. It analyzes spaces where it is possible to share as common uses and configurations, even between users:

4.5.1. Common space available [Sb.05].
   4.5.1.1. Roof [Sb.05.01].
   4.5.1.2. Façade [Sb.05.02].
   4.5.1.3. Per floor [Sb.05.03].
   4.5.1.4. Ground floor [Sb.05.04].

4.4.2. Vision and Visual promiscuity [Sb.02].

4.4.3. Negotiations between green spaces [Sb.03].
5. Methodology: topological devices

The main target is to find out the proper tool to focus on bringing from Big Data — which is by itself an amount of data unclassified\(^\text{16}\) —, which allows us to solve contemporary problems on housing issues. Another step would be knowing where and how to apply this tool into urban realities (Harris 2013). This research tries to create said an applied tool, not only basic research. That means to jump into the relation between the objects — data — more than trying to describe by never-ending classification the best house ever.

Therefore, our methodology puts their heart and soul on making explicit the relationship, in a graphic way, between the parameters labeled before. It is important to highlight that our study goes beyond the Cartesian way of representation only by plans, sections or axonometric, closer to typologies. To generate this methodological tool, the starting point will be to create relationships from data, which means, from local and specific to global or abstract. Then, the essential will emerge to established a proper criteria which describe the parameters to analyse the projects (Fig.04).

\[\text{Fig. 4 Specific graphics from Urban Gradient category [gU]. Authors.}\]

We called to these tools, \textit{devices} — better called \textit{gizmos} in IT specific vocabulary — because they make explicit those relationships we are looking for from spacial indicators — data — from the buildings where analyzing. These devices are generated by codes which allow them to be open systems. For each categorie, we create a different device. Each \textit{gizmo} will have to connect data in a different way, such a smart cluster capable to use minimum data from the beginning to create as much as possible relations to fulfill each category. To visualize those gizmos we create a proper graphic which include all parameters in a spider graphic: Cluster Tool. Besides, using an example created in our studies, we can show some results through several sheets (Fig.05).

\[\text{Fig. 5 Urban Gradient study case sheets. Authors.}\]

6. Results and discussion: capacity to compare
Criteria to choose models\textsuperscript{17} came from the Research Group in Collective Housing (GIVCO) which hold this research. The criteria under which we selected these models has been given by the research guidelines for research project stems from. These guidelines are: 

\textit{Atlas de Vivienda Colectiva Española del Siglo XX} and \textit{Atlas de Vivienda Colectiva Contemporánea Europea}, which represent the main route currently followed by GIVCO.

\textsuperscript{17} We have selected 100 buildings as models from European collective housing. They range from the beginnings of the 20th century, revising Le Corbusier's Unités, Atelier 5's Hagensiedlung, Ralph Erskine's Byker Wall, Alvaro Siza's Quinta da Malagueira in Evora, amongst others. As well as more contemporary examples such as MGM's Europan 5 in Ceuta or AMC's Housing in Coslada, both of them from the 21st century.
After this, we have divided the graphic called Cluster Tool into the already mentioned main five categories. Then we proceed to assign parameters to the definition of each category. Said parameters will be the result of crossing data in our domesticated Big Data, meaning, our database. The calculation of the parameters will be represented by a scope that ranges from zero to one hundred (Fig. 06), placing its admissible value in between that range — both its maximum value (ν) as well as its minimum (ν) value — which will be a product of introducing a sample from our model cases into our database. The values of each main category will be arithmetically correlated to the corresponding parameters.

To sum up, this research project aims to generate a tool that transforms the analysis, diagnosis and assessment of potential in the improvement of existing housing. It is important to focus on the fact that by using this tool we can come up with new solutions to answer to contemporary user’s necessities. This is an aspect that has traditionally been perceived as non-transparent and subjective. Instead of coming across as a partial party, with the help of new technologies and the multiple knowledge supported by Big Data, architects now can have an updated role in the city’s future. One that is more universal and interested in the so-called “greater good”. Cluster Tool is a useful application not only for analysis, but also for designing and proposing better conceived spaces that citizens can inhabit from now onto the distant future.

7. References

Books, by authors


Fernández Per, Aurora; Mozas, Javier; S. Öller, Álex (2013) 10 historias sobre vivienda colectiva. Análisis gráfico de 10 obras esenciales. a+t architecture publishers, Vitoria-Gasteiz.


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Tesis

