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BIM methodology for unbuilt architecture. Louis Kahn's Parasol Houses

Although Kahn was mainly known for his public buildings, he also carried out a large number of residential projects. In 1944, along with Oscar Storonov, he submitted the Parasol Houses project to the "Equipment for Living" competition (Brownlee, 1998), which was never built. The project represents his dedication to the modern architectural language and diverges from the austerity present in his earlier housing designs and his later approaches anchored in history and tradition.
The main goal of this work is the recovery of the image, through current parameters, of the Parasol Houses project by means of the creation of a virtual model developed on the basis of BIM technology. This analysis aims to rescue and highlight the architectural memory of one of Kahn's unbuilt works, emphasizing the importance it had for his professional evolution and his contribution to the Modern Movement.
Based on the available documentation developed by the architect, a virtual 3D model has been elaborated that will make it possible to approach the "built" work, allowing different aspects of the project to be studied, such as the behaviour of light, the configuration of the spaces, the materials and the furnishings.
The dissemination of the model via immersive and interactive platforms also aims not only to vindicate the memory of a project that never came into the word, but also to make up for the sensation of experiencing and interacting with the work of a fundamental architect like Kahn, to the extent of the enormous possibilities that new technologies offer, sharing the historical and artistic transcendence of his creations.

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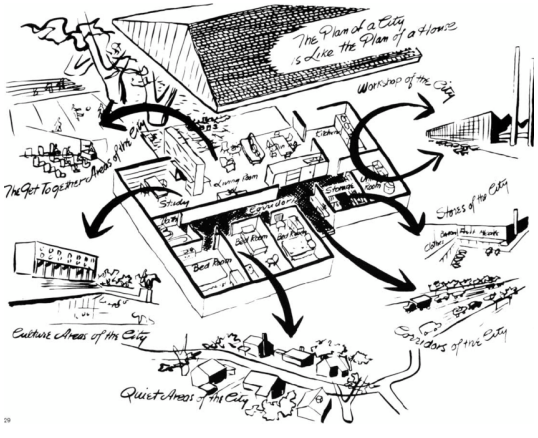
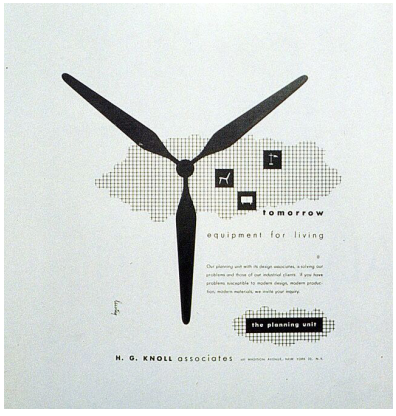
INTRODUCTION

After the Second World War, the United States experienced a period of unprecedented prosperity. In the field of architecture and urban planning, the adoption of laws such as the GI Bill in 1944 resulted in the development of a process of urbanization that colonized the peripheral areas of cities, creating the concept of the residential neighbourhood (Greenspan, 2008). This led to the emergence of a new suburban lifestyle characterized by the importance of the automobile, the growth of large shopping centres and the introduction of new consumer goods that generated a strong desire for prosperity in the domestic sphere, as opposed to the austere vision of the Modern Movement in architecture (Sudjic, 1999).

From that moment on, architecture was forced to adapt to the new requirements of society. To meet their expectations, architects began to imagine new typologies of post-war housing, shaping people's perception of the ideal suburban home and how they would live in it after the conflict (fig. 1).
Following the trend of many American architects, and in the face of a shortage of government projects, Kahn and Storonov immersed themselves in this culture of anticipation, participating in debates about architecture and post-war housing (Brownlee, 1998). Their aim was to redefine modern architecture in accordance with the rise of the consumer society. Through publications such as "You and Your Neighbourhood: A Primer for Neighbourhood Planning", promoted in 1944 by Revere Copper (Shanken, 2009), they set out their ideas about the housing of the moment. Using the analogy that, like a home, cities can be adapted to a variety of needs, the authors anticipate how the planning of the city as a whole can emerge from the design of each of its neighbourhoods. According to Kahn, "The project of a house is similar to the project of a city. The administrative buildings, museums, libraries and schools of the city are compared to dad's studio and office" (Kahn, 1944). Neighbourhoods, as the authors emphasize, are





intrinsically linked to the community, highlighting the importance of community spaces as catalysts for development and social cohesion (fig. 2).
In 1944, Hans G. Knoll Associates, a manufacturer company of office furniture, proposes a competition with the slogan "Equipment for Living" (fig. 3), to which eight architects were invited, including Serge Chermayeff, Charles Eames, Eero Saarinen, Ralph Raspson, Antonin Heythum, Joe Johannson and Kahn together with Storonov. The aim of the competition was to develop a planning unit that could meet the new demands of modern society. The idea was to create an architectural model in which the furniture was an integrating part of the project (Brownlee, 1998) and which the company intended to produce and sell to its clients. The proposals to be prioritized would be those aimed at revitalizing the classic American home by integrating the processes of design, manufacture and marketing.
Khan, along with Storonov, submits their proposal of the Parasol Houses to the competition. The

Fig. 1 - Advertising poster. 1943. Revere Copper Brass. Better Living no. 10.
Fig. 2 - Diagram You and your neighbourhood. Philadelphia, 1944. Kahn and Stonorov. Louis I. Kahn Collection, University of Pennsylvania and the Pennsylvania Historical and Museum Commission.
Fig. 3 - Poster for the "Equipment for living" competition. 1944. Hans G. Knoll Associates. Knoll archive.

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project represents the author's dedication to the modern architectural language, keeping away from the austerity present in their designs for emergency housing and their later approaches more anchored in history and tradition. The result of his proposal reveals a more modern Kahn, who works with new advances in construction systems and materiality (Juárez, 2006).

THE PARASOL HOUSES

The Parasol Houses project has its genesis in the philosophy that Kahn was developing until then, focused on the family and the community, in search of a new housing typology, where the needs and the way of life of its inhabitants had to be taken into account from the very conception stage of the project. With the aim of resolving the shortcomings of contemporary architecture, Kahn and Stonorov attempted to provide a social response to the housing design based on prefabrication, strengthening the social links to be established in the house, between the family itself and the community. The proposal consisted on the development of a series of houses arranged in rows under a large continuous flat roof of very thin thickness, as if it were an infinite plane, which sheltered the habitat of each of the families. The design of the roof provided areas for social gatherings and communal spaces that connected the street with the access to the dwellings. Instead of resorting to a recreation of known models from his previous projects or to simple designs of functionally correct floor plan layouts, Kahn opted in the Parasol Houses project to reduce the construction to its most basic components: walls, pillars and roof. These elements would be capable by themselves of satisfying the needs of shelter, support and enclosure (Juárez, 2006).
The most unique element of the project, which gives its name to the slogan submitted to the competition, is the prefabricated roof module or "Parasol". The ensemble, made up of the slab and a central pillar, is resolved by means of a new system that consisted on the arrangement of prefabricated pieces in a grid of 3.60 m. (12 feet) on each side. These pieces were made up of a grid slab with metal ribs that converged on a slender cylindrical pillar (fig. 4). The configuration of the roof was carried out by means of a system of aggregation of modules, allowing the pieces to be assembled together to form a longitudinal system of row houses. The roof module is flexible and can be adapted to a serial organization of households, rather than being limited to a single residence (Galván, 2012).
This structural system has some precedents in projects such as Richard Neutra's Diatom series of houses (fig. 23) or the dendriform columns that Frank Lloyd Wright used in the Johnson Wax offices in Racine, 1936 (McCarter, 2009). There is also a certain link with Buckminster Fuller's Dymaxion, whose supporting system consisted of a central mast that supported the entire structure of the house. Although the reference to the central column of Fuller's futuristic house is tackled in a more Miesian way in the Parasol houses (Lamprecht, 2004).
Through Kahn's preserved sketches (1944) it is possible to follow the design process, starting from the urban planning in the general aerial perspectives, to the distribution of the dwellings, showing the relationship between the general idea and the architectural concretion, as well as the relationship between the structural system and the distribution of the spaces on the ground plan.
The design of the Parasol houses represents the synthesis between the structural rigidity with which the building is organized, based on a grid of metallic pillars, and the flexibility of its functional and spatial program. Analysing the various housing typologies proposed by Kahn, we can, as has been said, perceive that the walls, which do not fulfil a supporting function and do not always follow orthogonal lines, are arranged under the roof on the fringes of the structural mesh. The free plan thought up by Le Corbusier is manifested in the Parasol houses as a design that can be customized to meet the individual needs of each dwelling and its residents. As a result of being released from their structural function, the interior and exterior walls adopt a plan layout that folds to

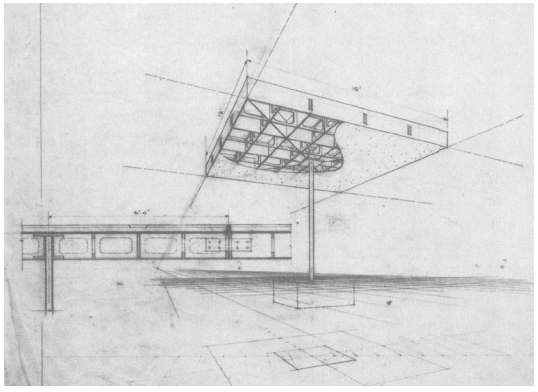
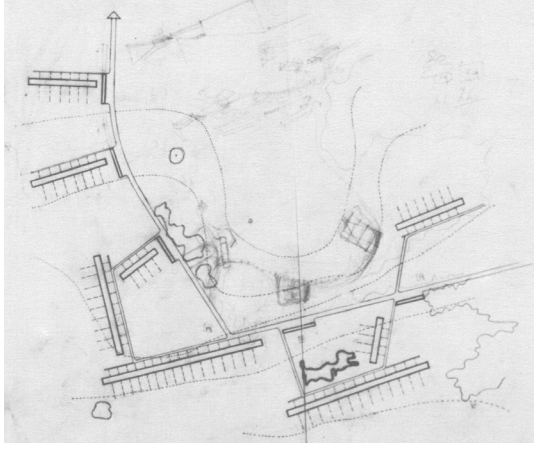


Fig. 4 - Structural system of Parasol Houses. 1944. Kahn and Stonorov. Louis I. Kahn Collection, Architectural Archives, University of Pennsylvania.

Fig. 5 - Urban implementation of row housing. 1944. Kahn and Stonorov. Louis I. Kahn Collection, Architectural Archives, University of Pennsylvania.



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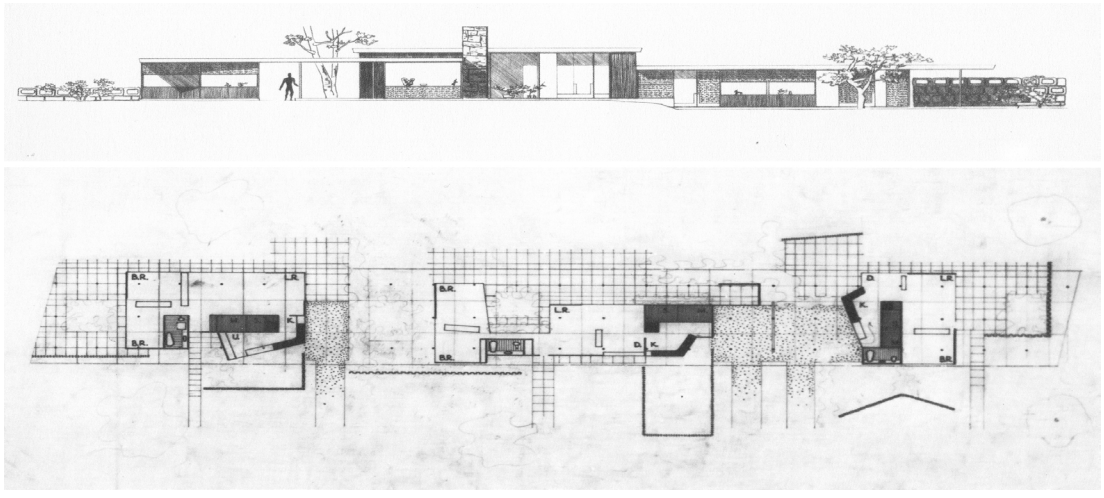

shape the domestic spaces independently of the grid structure.
The project develops both the definition of the dwellings and the grouping arrangements, which allow for social relations and interactions between the families. The road and pedestrian circulation patterns are adapted to the topography (fig. 5), the streets that give access to the residential units are integrated into a space plenty of vegetation, seeking balance and permeability between the house and the site. Between the houses, attractive communal spaces appear under the roof, generating a relationship between the road and the private garden of each plot and allowing nature to be integrated into the house itself.
The competition proposal includes several housing typologies (fig. 6). Although each of them is different, there is a common aspect to all of them: the different spaces are distributed around a courtyard, generating to a greater or lesser extent a U-shaped floor plan that adapts to the needs of each family unit or to the topography. This patio is generated by removing one of the prefabricated modules from the parasol, creating an opening in the roof. In this way a stronger relationship between the houses and the exterior is achieved, allowing at the same time a more flexible relationship between public and private space.
The layout of each dwelling is established according to three units determined by their use and configuration: the day area, the night area and the service area. Despite the apparent rigidity that these three differentiated uses seem to confer on Kahn's proposal, they are diaphanous distributions, where the organization of the spaces is carried out not only through the layout of the walls, but also through the furniture units (Juarez, 2006). These are elements designed specifically for the competition and which should be produced by the sponsoring company. These units, depicted in dark tones in the project plans, are what the architects call "cleaning and food processing unit", "food storage unit", "bathroom unit" and "object storage unit" (fig. 7).
It is important to highlight the importance of the design and layout of these "units" in the project as a whole. It should not be forgotten that Knoll was a company dedicated to the manufacture of furniture and therefore Kahn and Storonov devoted a large part of their efforts to their design. This is why they are represented in the plans as heavy and immobile elements, though indispensable, in contrast to the lightness and flexibility of the walls and structure.
Kahn's proposal for the Knoll competition can be considered as a transitional project, where the spatial tension of the dwellings, which seem to be on the verge of breaking down into multiple spatial units, is already visible (Juarez, 2006). With the Parasol Houses project, Kahn not only addresses the architectural shortcomings of the time, such as the lack of open spaces or the organization of the layout, but also anticipates the changing needs and lifestyles of modern society, where aspects such as social connection, advances in construction systems and materiality are essential to the design.

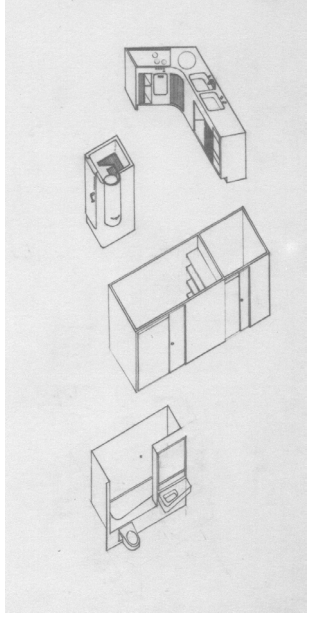

Fig. 6 - Elevation and plan view of the Parasol row Houses. 1944. Kahn and Stonorov. Louis I. Kahn Collection, Architectural Archives, University of Pennsylvania.
Fig. 7 - Sketches of the furniture sets for the Parasol Houses. 1944. Kahn and Stonorov. Louis I. Kahn Collection, Architectural Archives, University of Pennsylvania.

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METHODOLOGY

In order to develop this research, a workflow has been established that aims to integrate the study process of the building, considering its geometric, stylistic and material aspects. In this way, the stages summarised in the following table have been considered (fig. 8).
One of the main challenges we face when dealing with the virtual restitution of a model that, as in our case, has not been built, is to establish its dimensions (Lillo, 2021). Current restitution techniques, based on methodologies such as photogrammetry or laser scanning applied to existing buildings, allow us to obtain very accurate virtual models in terms of dimensions and geometric representation (Dore and Murphy, 2012). In our case, however, there are no material elements that can be used as a reference, and therefore it must inevitably fall on graphic or written documentary sources to provide the necessary information for the elaboration of the model. In this process, we have to highlight different recent researches that have aimed to create methodologies for the restitution of unbuilt or missing architectural elements (Apollonio et al., 2023; Di Mascio et al., 2016). Other works that can be considered as a reference focus on the elaboration of virtual models of projects that, as in our case, were never executed, such as Carlo Mollino's Theatre in Cagliari (Spallone & Capaldi, 2019) or Hutter's Kursaal in San Sebastián (Vitali et al., 2022).

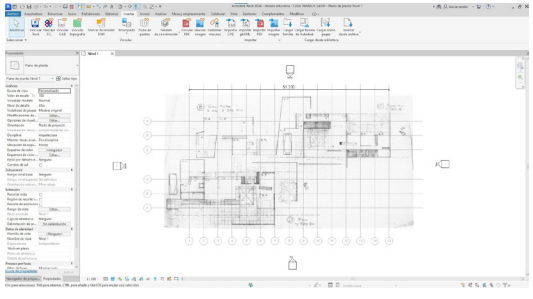

Fig. 9 - Process of importing the floor plan into the BIM software and creating the grid.

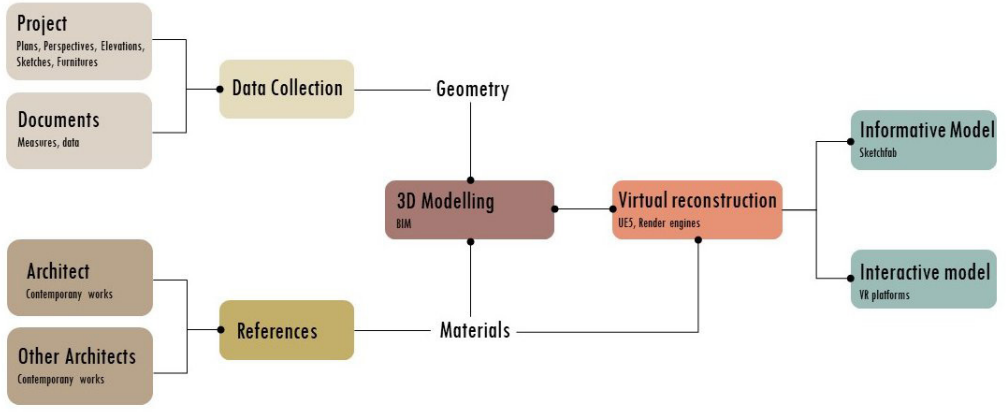

Fig. 8 - Conceptual map of the methodology.

On the other hand, we must take into account that the plans and documentary information provided with the proposal for the Parasol Houses do not include numerical or graphic scales. Nor are there any measurements to establish floor plan dimensions or height. Only one exception will be the key to allow the task to be carried out with the necessary precision: two dimension lines in the conical perspective representation of the parasol roof (fig. 4), indicating its dimensions: 12x12 feet (3.65 x 3.65 m.). This dimension is corroborated in the attached section detail, which indicates the distance of 6 ft from the end of the canopy to the supporting pillar. Indeed, based on these dimensions we will be able to establish the measurements of the grid on which the structure is based, formed by the overlay of the Parasol roof module and its corresponding pillar. When importing and scaling the plan in our BIM software, the most efficient procedure will consequently be to create this grid (fig. 9), bearing in mind that the pillar structure is represented in plan with small dots that will allow us to use this reference. In order to minimize errors, our grid and, therefore, our import reference, will not be limited to a single module but to fourteen (51.2 m), which cover the total length of the structure of dwellings types B, C and D.
Once the scale of the plan has been determined, it will be necessary to establish the levels with their corresponding heights. To do this, and given that the conical representation of the parasol does not specify its height dimension, we have to refer to the section detail which, although it corresponds to a later project, uses the same structural system based on the parasol module (fig. 10). In this way, based on the distance between pillars of 3.65 m., we can set a scale of representation and establish a free height of 2.40 m., much lower than current

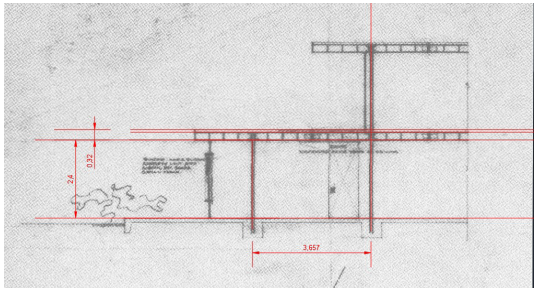

Fig. 10 - Process for defining heights based on the 12 ft. module.

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standards, and a slab thickness of 0.32 m. Having determined these parameters, we can start to model the different elements that make up the building, using the floor plan as a template in the same way as we would proceed from a point cloud. The modelling procedure using BIM systems has, among other advantages, compared to traditional CAD methodology, the fact that it makes unnecessary the task of transposing plans based on the original graphic documentation, which is, as has been said, our direct reference.

At this point it is necessary to specify the level of definition (LOD) that we should reach for the correct definition of our model, based on the objectives we have set. The LOD, published for the first time in 2008 by the American Institute of Architects in the document AIA E202-2008 Building Information Modelling Protocol (AIA, 2008), describes the level of precision with which an element of the model has been developed. It is an indicator that specifies the level of development that in each case has or has to be executed in the BIM model of any building or infrastructure. The BIMforum platform defines in its Level of Development (LOD) Specification document, in its updated edition 2023 (Reinhardt, 2023), the features of the model elements of different building systems at different levels of development. This specification allows BIM authors to define the level of accuracy of their models, and downstream users to clearly understand their usefulness and limitations. The aim of this standard is to help explain the LOD framework and normalize its use to make it more useful as a communication tool.

In this way, five LODs are established in the first instance, from LOD 100 to LOD 500, to which LOD 350 was later added, according to which we can know the level of data, parameters and geometry with which a BIM model is provided. Of these, the first two (100-200) include almost exclusively geometrical information, and their elements are represented in the model with their approximate size, quantity, shape, location and orientation. The LOD 400 and 500, on the other hand, are able to graphically represent the model in sufficient detail for its manufacture, assembly and installation.

Based on this, it would be ideal to aim for a LOD 300, whereby the model should contain precise information regarding dimensions, units, layers and thicknesses, materials, as well as physical, chemical and/or mechanical and regulatory data. However, given the starting conditions of the project and the data available, a combined solution of LOD 200 and LOD 300 elements appears to be the most feasible option.

Effectively, in addition to the fact that the project documentation does not include many of the data necessary to achieve a higher level of detail such as dimensions, materials, technical specifications, etc. of walls, carpentry or structural elements, there is the circumstance that the goal of our work does not require the definition of certain features beyond their own geometry or material solution. This allows us to avoid, among other things, the elaboration of construction components in elements that do have a higher level of definition, as happens, for example and exceptionally, in the case of the roof module.

We therefore proceed to the modelling of the walls, carpentry, floors, roof and furnishings. Regarding the former, we can notice the coexistence of two different types: the walls that delimit the spaces within the dwellings, which are more slender, and the exterior walls that make up the courtyards and communal use areas, with freer and more organic layouts, thicker and probably built in stone (fig. 6). Although these dimensions are not exactly defined in the original documentation, we have been able to identify them with relative precision thanks to the line weight in the plan view. According to the scaling and overlaying of the original plans with the redrawn ones (figs. 11 and 12) we obtain, in the case of the walls of the dwelling itself, thicknesses of 15 cm, dimensions which logically must be larger for the aforementioned stone walls. These parameters, which obviously do not comply with current regulations and which are possible thanks to the Parasol system that releases the enclosures from their structural function, are also found in such emblematic works by the same author as the Fisher House or the contemporary Roche House.

This reduction in wall thickness, which was one of the main characteristics of the modern movement, was nevertheless perceived by Kahn as a limitation that could weaken the integrity of the

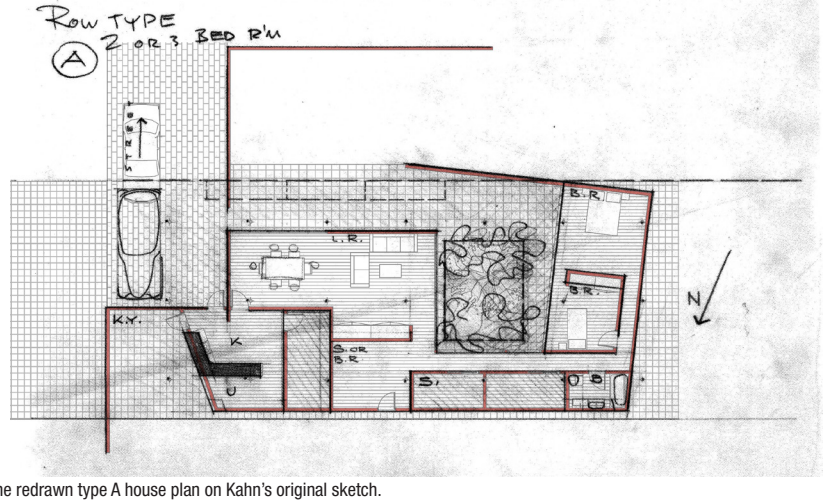

Fig. 11 - Overlay of the redrawn type A house plan on Kahn's original sketch.

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architectural form. To counteract this effect, he explored several strategies in projects such as the Parasol or the Oser House, incorporating thick walls that lacked structural function or the inclusion of disproportionate chimney cores that emphasized and densified the plan of the house (Frampton, 1996).
Regarding the doors, current standard measurements of 90 cm have been adopted. In the case of the external carpentry, we have considered heights of 2.10 m. divided into modules of 1 m., for the hinged windows in the living room 1.80 m. wide by 1.80 m. high, while those in the bedroom would have dimensions of 1.60 m. wide by 1.00 m. high. The different types of windows and their dimensions are taken approximately from the original elevation since, as mentioned above, the documentation does not include their exact measurements. Another aspect to highlight is the resulting corridor widths of 80-82 cm, dimensions that currently do not comply with the CTE (Spanish) regulations, where the prescribed minimum is 90 cm.
For cylindrical columns, a diameter of 15Ø cm has been considered. In any case, thanks to the BIM methodology, which allows the parameterization of families and model elements, all these specifications can be updated in possible subsequent revision stages.
Another of the relevant issues that must be considered when approaching the elaboration of the virtual model is the characterization of the materials. Once again we are facing the circumstance of the lack of definition of a project developed only in its earliest stage, where we only rely on the signs that some textures represented in elevations and conical perspectives may suggest. In these circumstances, we have to resort to new sources that allow us to obtain the data we need to complete the virtualization process, trying to be coherent with Kahn's architectural philosophy and ensuring that the finishes harmonize with the overall vision of the project.
Once the competition was over, Kahn and Stornonov continued working on a new version of their project, based on the two-floor superposition of the Parasol structure, which they illustrated with drawings (fig. 13) in which the different types of patterns suggest the use of lattice walls, wood panelling and lightweight materials, combined with continuous cladding and large glazed openings. On the other hand, earlier built projects such as the Jersey Homesteads or the Oser House, on which Kahn began to work alone, can also be used as a reference. With regard to the former, one of the most noteworthy aspects is the implementation of technological advances and the language of the international style adapted to the construction system, using prefabricated materials and white surfaces with flat roofs. The walls were built with slag concrete blocks, still in an experimental phase, while the floor was built with uninsulated concrete slabs. In the Oser House, on the other hand, a combination of wood and stone cladding was used on the elevations and flat surfaces, which was a milestone in the architect's style. In the interiors, ceramic and wooden furniture and flooring delimit the dining, study and living areas. The fireplace area, with wood panelling, ceramic mosaic finishes and steel carpentry that frees the envelope, is particularly interesting, as it combines Kahn's exploration of materials, light and the integration of the environment, while recovering the Nordic and American tradition of the "fire space" (Saito, 2003).
Through the developing process of the Oser House, Kahn established and consolidated several of the fundamental characteristics that will influence future residential projects such as the Parasol Houses. Elements such as the integration of design with structure, the reinterpretation of materials, the incorporation of the natural environment and light through the windows, as well as the revalorization of the space around the home, will be crucial factors in the design of many of his dwellings throughout his architectural career. In any case, these are projects in which Kahn abandoned his traditional conception in which he emphasized the importance of weights and supports to transmit the lightness and openness of the spaces towards the exterior, incorporating

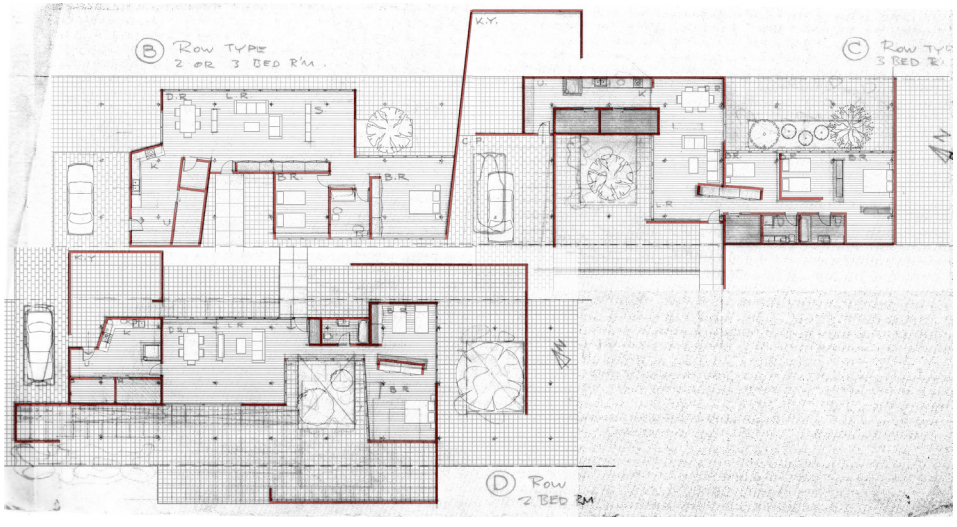

Fig. 12 - Overlay of the redrawn floor plan of housing type B, C and D on the original Kahn sketch.

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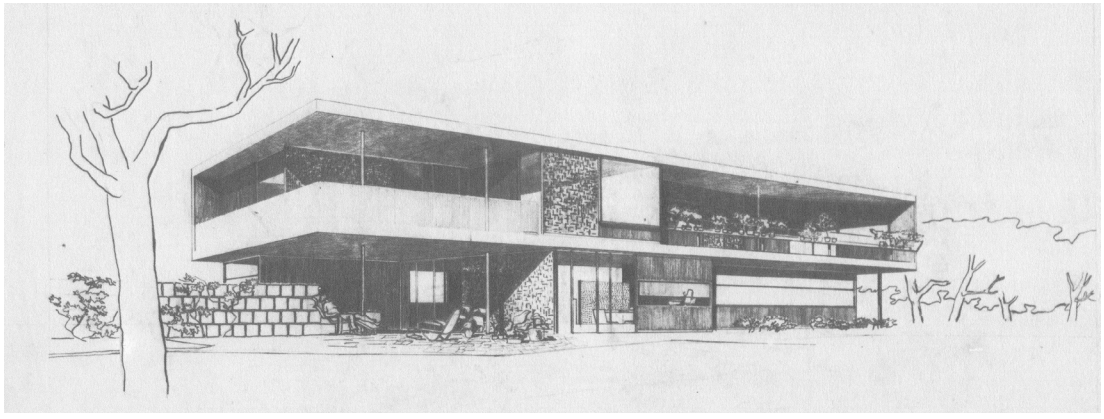

Fig. 13 - Parasol houses. Two-floor typology. 1944. Louis I. Kahn Collection, Architectural Archives, University of Pennsylvania.

the landscape into the interior space of the home (Büttiker, 1995).
As has been said, the furniture units are particularly relevant in the Parasol Houses project, as corroborated by the design of the dwellings itself, whose spaces are articulated around these prefabricated elements and the attention that the architects paid to their design, accompanied by sketches with details of materials and finishes. The specific modelling process for the food preparation and storage, object storage and bathroom units was carried out using the Rhinoceros 7 software, which allows the generation of organic shapes in a more intuitive way than the BIM environment (fig. 14). Given that the dimensions of these elements are not specified in the sketches, we have taken as a reference approximate measurements of contemporary furniture, following the proportions and ergonomic design in accordance with the human scale that, years later, would be collected and treated by Le Corbusier (1948) in "The Modulor".
The last stage of the BIM model development process consists of the distribution of the different housing typologies according to the urban layout proposed by the authors of the project, with the aim of recreating the experience of the relationships that are established both at the level of the dwellings each other, according to their arrangement in rows, and with the public road and the environment of the communal outdoor spaces.
Once the modelling phase has been completed, we can proceed to the elaboration of the "photorealistic" virtual model with the aim of obtaining a product that allows the end user to experience the sensation of visiting and getting to know the architectural space as closely to reality as possible. Since this process has been considered as complementary to the fundamental objective of our study, we will briefly describe the methodology adopted. In this sense, it is pertinent to point out some relevant works carried out in this same line of research that can be considered as a reference, such as the virtual reconstructions of the oil market in Valencia (Llopis et al., 2024), the Roman villa represented on a marble slab (Rossi et al., 2021) or the Fontivegge station in Perugia (Bianconi et al., 2023).
We therefore proceed to export the model to the virtual reality and rendering platform, in our case, Unreal Engine 5, through the Datasmith plugin, which allows us to carry out the process of generating a compatible file with a minimum of errors. Unreal Engine is not only a rendering engine but, mainly, a platform developed for the creation of video games whose use has also become popular for architectural visualization and which makes it possible to generate interactive virtual environments based on geometries imported, in our case, from BIM environments. In UE5 the work will be developed in several stages. Firstly, technical aspects must be resolved, such as the generation of collisions (relationship of the character with the floor elements, enclosures, etc.) or the creation of blueprints, which establish interaction elements and increase realism and immersion in the virtual model. Secondly, the assignment of materials will be carried out according to the parameters established in BIM, which, as mentioned above, are based on the analysis of the project documentation and the study of the author's contemporary works. The third phase has to do with the generation of environmental elements such as vegetation, background landscape, etc., which are fundamental in a project such as this in which the interior-exterior relationship is a fundamental aspect. Lastly, the atmosphere of the dwellings is set, applying decorative elements and furniture that are contemporary to the project, also including the pieces designed specifically for the competition.

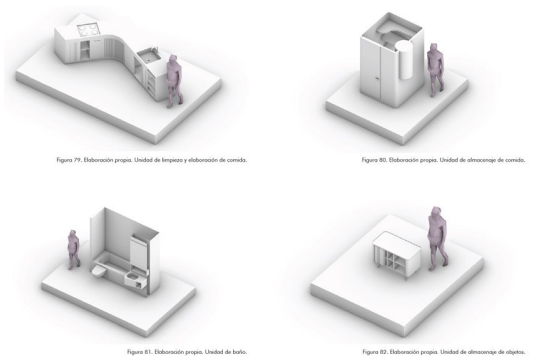

Fig. 14 - 3D models corresponding to the food processing and storage, toilet and object storage units.

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Fig. 15 - Axonometric representation. QR access to Sketchfab model.

CONCLUSIONS

There have been numerous architectural projects that, throughout history and due to various circumstances, never took shape in reality. Many of these unbuilt works, although they belong to the theoretical or experimental realm, have a transcendental value, since they represent the courage of their creators in exploring new ideas and approaches in the architectural field. The application of information technologies and the production of virtual models to unconstructed architecture has proved to be an effective tool for broadening the parameters of analysis applied to the project under study. Advances in means of digital graphic expression, thanks to the development of interactive virtual and augmented reality platforms (VR and AR), have made it possible to increase the realism of virtual models, enabling a more direct and sensorial approach to the idea that the architect has sought to express in his projects and facilitating precise studies of constructive and typological methods. This is why virtual and augmented reality are still being developing fields of research in the digital cultural heritage sector (Banfi, 2021).

In our case, through the virtual recreation of the Parasol Houses, it has been possible to establish a closer vision to the project, in accordance with current technologies and the multimedia world of our time (figs. 15-19). Rendered images transmit some of the key factors of the project to the user in a more direct, immediate and effective way than traditional graphic resources (López-Tarruella et al., 2016). Virtual tours allow a perception of the architectural space in which it is possible to recreate the sensations that the built work could transmit, the way in which the senses perceive the materials, the relationship between exterior and interior space, the circulations in a free space articulated around the furniture elements, the interaction with the physical objects, etc. (Sender et al., 2023).

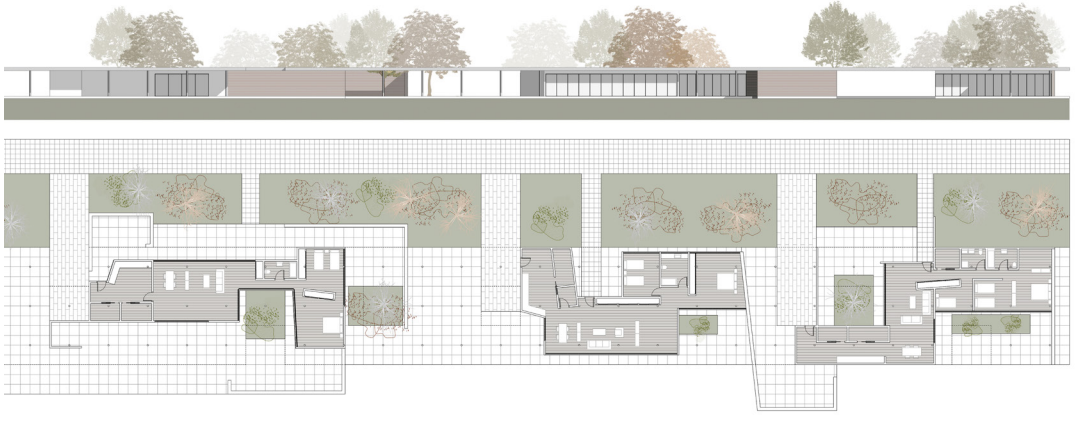

Fig 16 - Plans and elevations.

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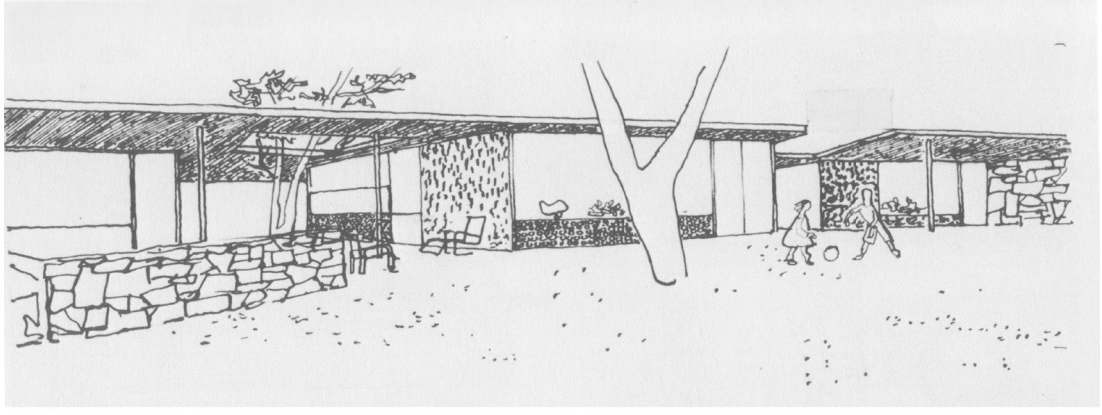
Fig. 17 - Virtual model. Aerial view.
Fig. 18 - View of the exterior space in communal areas. 1944. Kahn and Stonorov. Louis I. Kahn Collection, Architectural Archives, University of Pennsylvania. Virtual model. Exterior view.

Thanks to the use of the BIM methodology, the process of creating the virtual model is speeded up, in which the graphic documentation produced by the architects is used as a direct source of reference, dispensing with prior restitution processes. The parameterization of the project's own construction elements and its properties makes it easier to generate the different housing variants, making the process more agile and automatic, as well as allowing geometric properties to be updated, data to be reviewed and options to be suggested. In addition, thanks to the phased development system, the BIM model can be completed with a higher LOD, adding detail elements, physical and mechanical properties, etc., which becomes it a product that can continuously evolve if necessary for potential new stages of the work.
The use of virtual reality applications such as Unreal Engine has transformed architectural representation, providing advanced tools for the creation of realistic and interactive visualizations. Its accessibility and versatility for integration with 3D design software has facilitated workflow, allowing the easy importation of existing architectural models. The ability to create complex virtual environments and the integration of virtual and augmented reality technologies have expanded the possibilities for communicating and presenting architectural designs.
The incorporation of social, educational and entertainment platforms as allies in the dissemination of architectural heritage opens up new possibilities for bringing the work of essential architects such as Kahn to the public. Platforms such as Sketchfab, a website used to visualize and share 3D content online, operate as catalysts for knowledge, allowing 3D models to be played on both mobile and desktop websites. Through them, it is possible to reach a wider audience thanks to the use of accessible formats and intelligible and universal languages. The aim is to offer knowledge in an immediate and attractive way so that soci-



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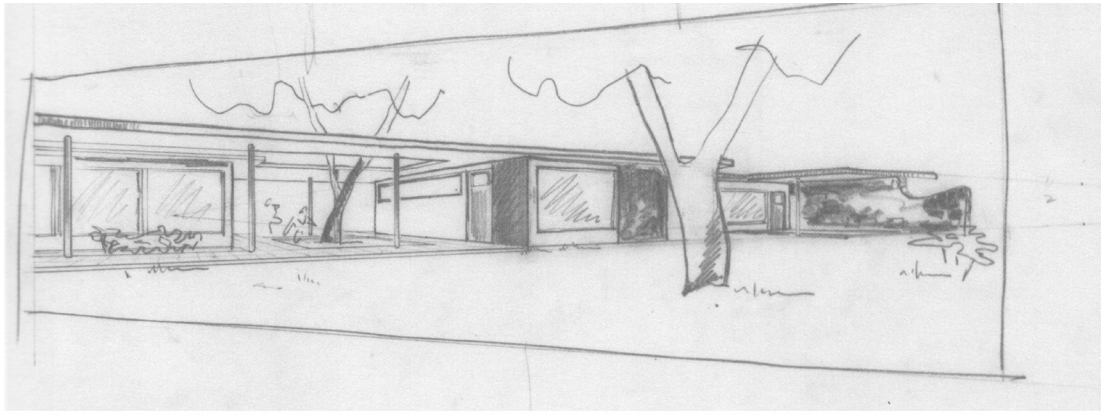

Fig. 19 - View of the exterior space in communal areas. 1944. Kahn and Stonorov. Louis I. Kahn Collection, Architectural Archives, University of Pennsylvania. Virtual model. Interior view of dwelling type D.

ety appreciates their history and heritage and be aware of the need to protect it. In short, it is about making the immaterial material, about highlighting a heritage by sharing the historical and artistic significance of creators like Kahn, and thus inspiring current and future generations of architects to explore innovative ideas and ways of building.

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