CONSTRUCTION HISTORY

International Journal of the Construction History Society

Vol. 33 No. 2 (2018)

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CONSTRUCTION HISTORY Volume 33, No. 2. 2018

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International Journal of the Construction History Society

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CHS

CONSTRUCTION HISTORY
International Journal of the Construction History Society

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ISSN 0267-7768

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The development of prefabricated envelopes by GO.DB. Architects Studio for the construction of high-rise residential buildings in Valencia in the 1960s

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Abstract

In Spain, the construction of prefabricated modern architecture in the 1960s was not common and, in Valencia, was mostly associated with GO.DB. studio. Their work was published in national and International journals, such as Informes de la Construcción or Architecture d' Aujourd'hui. They experimented in designing modular elements for prefabricated residential buildings, both for social housing and for high-rise buildings. We have concentrated on the prefabricated façade elements because their proposals were of great design interest and because, implicitly, they represent their first prefabricated modules. These modular enveloping parts arose from extrapolating the hollow concrete boxes created to provide structural solutions for social housing and by reinterpreting modular elements for the building of high-rise prefabricated envelopes. The three-dimensionality and geometry of these components increases the interest in the volumetric treatment that these skins demonstrate. Various industrially manufactured materials were used in their design: asbestos cement, precast concrete and even plastics. This article details the building process, focusing on several significant examples of each type depending on the materials used, which provided them with the special constructional solutions designed to overcome the complexity of high-rise building.

Keywords

Prefabricated envelopes, high-rise residential buildings, precast concrete, plastics, Spain, 1960, GO.DB.Architects

Introduction

Until the 1960s, Valencian architecture was characterized by craft-built buildings using traditional techniques and finishes such as rendered or red brick facades. Technological innovation in construction was scarce. Arriving into this context was the **GODB** studio, whose architecture was to be characterized by the use of prefabricated constructional systems as the main tool for architectural renewal. The acronym GO.DB. is made up from the initials of the two founding architects of the studio, in 1958, Fernando Martínez **G**arcía-**O**rdoñez and Juan María **D**exeus **B**eatty. The company later grew to include the Valencian architects José Manuel Herrero Cuesta (1963), Julio Bellot Porta (1964) and Francisco Pérez Marsa (1967). Some members of this particular studio were Opus Dei[1] sympathizers, an organization that entered Spain at the end of the 1950s. At this time, some of their followers occupied high ministerial posts and important positions in public administration, law courts and public prosecutor's office, under the protection of the head of government, Carrero Blanco. His political, technocratic and authoritarian system was aimed at establishing a liberal economy that would put an end to autarchy with the implementation of the National Economic Stabilization Plan of 1959[2].

The founding architects of GO.DB. were archetypal of the Opus Dei affiliates in the post-war generation, which can be described as having the following characteristics: "man, from a Christian family, of middle to high social class, around 20 years old, University student and committed to living in apostolic celibacy" (Onésimo Díaz[3]). Throughout Carrero Blanco's career, the links between the Opus Dei and several members of the GO.DB. studio became closer; Fernando Martínez García-Ordoñez and Juan Maria Dexus Beatty becoming numeraries[4] of the prelature. His membership of that organization should come as no surprise given that, right from the beginning, Opus Dei focused on architecture and law students through the DyA academy, founded in Madrid in 1934.[5] This congregation provided Fernando Martínez with a series of privileges such as being able to travel to Europe and the United States, which allowed him to get to know the latest innovations in international architecture. Later, these influences were introduced into the studio, with a work dynamic inspired by the grand American studios. It should be said that the Seville office OTAISA[6] was also a point of reference for GO.DB.

The Valencia studio was set up with a business-like organisational structure, quite unusual among the architects of our country who were more used to working alone as specialists in small studios. In this context, the Valencian GO.DB. group adopted a challenging posture towards their immediate surroundings, presenting a rejuvenating attitude that was closer to European trends by reinterpreting housing programmes and incorporating new building systems in the interest of recovering a sense of modernity. Regarding the situation of industrialized construction in the national context, Pepa Casinello points out that:

> *"It was in the 1960s when the production of precast concrete elements really took off, due in part to the increase in manpower which had been holding back its development to a large extent, and to the overriding need to optimize completion times, especially in the case of housing."*[7]

Against this backdrop, this meant building social housing from prefabricated elements, and employing a specialised construction procedure that won the practice prestige on an international level. Their proposals, conceived as an architecture of processes based on standardization, modulation and industrialization, came into being in the Campanar set of prefabricated housing units, the only example of prefabrication of this kind in Valencia. To build these units, they developed a number of three-dimensional precast concrete Modular Elements.

Meanwhile, GO.DB. were also looking at building prefabricated facades and, in this field, their innovation consisted mainly of transferring the systems developed in prefabricated housing to prefabricated façades by reinterpreting those construction methods in order to function correctly on a different scale and with different materials. The influence of this process is reflected in several building envelopes, of a marked volumetric character, more appropriate to the structural systems of heavy prefabrication than the housing experiments they began with. Constructional innovation required implementing organizational systems that were different from the traditional compositions of urban façades, and their hierarchies and symmetries, by incorporating alternative, more versatile proposals based on serialization and fragmentation. The module façades were initially designed in fibre cement but, given the later-discovered toxicity of asbestos-cement, they abandoned this material and focused on the possibilities of using precast concrete and even plastics. Using these modular elements, also called boxes, they designed numerous building envelopes for high-rise housing. These undertakings can be found in various urban settings, both in freestanding buildings and in the Valencian Ensanche area, where they built one-off buildings for the middle-class, based on this characteristic modular system.

We shall now move on to analyse the references and concepts on which the theories of the GO.DB.

studio architects were based so as to set the context for the development of their work. The starting point for GO.DB. was the idea it developed in parallel with both the Modular Elements, which made up the "habitable box beams" employed in building prefabricated housing, and the Modular Boxes designed for undertaking the envelopes of high-rise buildings. The second consideration centres on the influence of the necessarily three-dimensional Modular Elements on the Modular Boxes; we can observe the unidirectionality of that influence, as the building of prefabricated housing represents the beginning of GO.DB.'s experimentation and its key objective. Our study methodology is to analyse both models of modular elements and modular box, their origin, dimensions and materiality. Later on we shall focus on studying the envelopes and will include the most significant examples, detailing the particularities of the different building skins depending on the material used, the design of the modules and composition solutions, as well as the constructional innovations made by undertaking these projects. The aim, is to understand the system of construction with which the building envelopes of the high-rise buildings typical of GO.DB. architects were built.

Influences

The prefabricated elements that the GO.DB. studio employed arose from the influence of ideas introduced by Spanish architects like Miguel Fisac[8], regarding the possibilities of concrete and its formwork, and Rafael Leoz, with regard to studies on modulation for forming spatial networks and rhythms. The architect Miguel Fisac, one of the founders of Opus Dei, was a spiritual reference for the members of the GO.DB. studio, especially for Fernando Martínez who worked in his office during his days as a student. Fisac's professional career was marked by the importance placed upon questions of constructional experimentation and the significance the architect placed on material construction as a key factor in the creation of architecture. Outstanding among his constructional systems were the 'bones' (1961) of precast concrete, designed for the building of wide-span structural elements or 'bone' beams using post-tensioned concrete segments.

GO.DB. interpreted Fisac's idea of the hollow space employed in small-scale structural pieces, the hollow elements that Fisac called 'bones', and transformed it into the concept of the habitable hollow. Furthermore, their spatial volumetric compositions took as reference the theories of Rafael Leoz[9], an architect who had achieved wide international acclaim for his geometric and compositional ideas based on the use of three-dimensional elements to form compact networks with the variation of one module, by union and repetition. In his book "Redes y ritmos espaciales"[10], Leoz explains that from a cube, as a basic unit, other networks can be obtained, the one offering the greater advantages being that of the Hele module[11]. This is a constructive module in the shape of the letter L formed by four cubes for housing construction. His investigations were aimed at finding simple solutions to the problems involved in undertaking social housing. Without arriving at the special complexity of the Hele module, the emphasis placed on the volumetric composition of space, developed in GO.DB. proposals, would come close to the theory put forward by Rafael Leoz. (Fig.1)

GO.DB. research followed both directions and, moreover, linked up with the thinking of Mies Van der Rohe on "creating the form from the essence of the epoch". Under these premises GO.DB. sought to distance themselves from conventionalism and build in harmony with their age, that of industry. In the spirit of that age, it is worthy to note the proposal presented by the GO.DB architects in the technical brief for the fundación March, drawn up in 1967-68. In it, they present a housing Project undertaken with habitable beams, a proposal with references to Moshe Safdie's well-known Habitat model, recently constructed for the Universal Exposition of 1967 in Montreal. Safdie's proposal consisted of a stack of concrete boxes as the basic unit, the same system that GO.DB. would chose for their precast housing

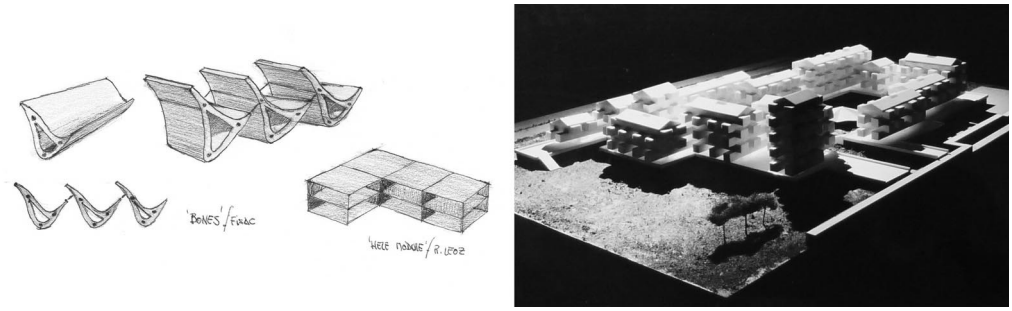

Figure 1. Fisac. Photomontage that shows the references of GO.DB.: Fisac's 'Bones', design, dimensions and their manufacture; volumetric composition of Rafael Leoz' Hele Module, and a proposal for "habitable box beam" residences. (Photo collage copyright of the authors)

projects. In his book *Existencia, Presencia, Arquitectura*[12], Dexeus Beatty stated that only industry could provide a new, enveloping space with a continuous form built of precast concrete, an artificial material. From his point of view, by incorporating industrial materials into the building of the modern habitat, one could define a new relationship between form and function, hence the interest of the GO.DB. studio in the technology of architecture and their experimentation with new materials coming from industry.

Elements for a prefabrication: from Modular Elements to Modular Boxes

The history of the Modular Elements employed by GO.DB. for the building envelopes of high-rise buildings originated in the idea of the "habitable box beam". Its evolution began in 1957 when the Great Flood of the city of Valencia took place, the disaster finally led to the diversion of the river Turia. To do so, a Technical Office was created that was commissioned to draw up the South Plan[13]. The Asturian architect Fernando Martínez García Ordoñez, a recent architecture graduate, was brought to Valencia to form part of the technical team, made up of engineers, economists and architects. Besides re-routing the riverbed, the plan required other infrastructures such as the creation and location of new bridges to link the new riverbanks of the Turia with the city. Precast prestressed concrete segments, i.e. structural elements of hollow section, were then considered. This experience with engineers and their techniques added to the ideas learnt in Fisac's studio; and influenced the future research of GO.DB. into industrial construction systems. This is reflected in the report that Fernando Martínez drew up between 1967-1968 to raise funds from the March Foundation for research into prefabricated systems. Entitled *S.I.C. Proceso investigativo*, it describes the experiments undertaken by GO.DB. and explains the strategies adopted to design the *ModulArch*[14] prefabrication system for building social housing. (Fig. 2 right) of the project shows a bridge undertaken using segments. It is the Castejón bridge built in 1966 by Fernandez Casado, a renowned engineer and pioneer in the building of precast pre-stressed concrete segments, who had also been involved in the South Plan Technical Office. Casado got to know of the advantages of the methods employed by engineers in building bridges (Fig.2 left) using precast concrete segments. This experience undoubtedly had an influence on his investigation into systems of prefabricated construction, where the idea of the "habitable box beam"[15] based on the effectiveness of the hollow profile came about. Hence, the architectural space constituted the gap around which the resistant material was placed, just as Dexeus Beatty had argued in his previously cited book *Existencia, Presencia, Arquitectura*.

To build a habitable beam it was necessary to assemble a set of Modular Elements that would make up a space similar to that produced inside precast segment bridges. In this solution, concrete was employed

with the dual function of support and casing. The mechanism of a simple joint with anchorage plates was employed to join various Modular Elements together (Fig. 2 right). The hollow beam concept was the inspiration for the prefabrication of Modular Elements for housing and for the hollow Modular Boxes employed used in facades of high-rise buildings.

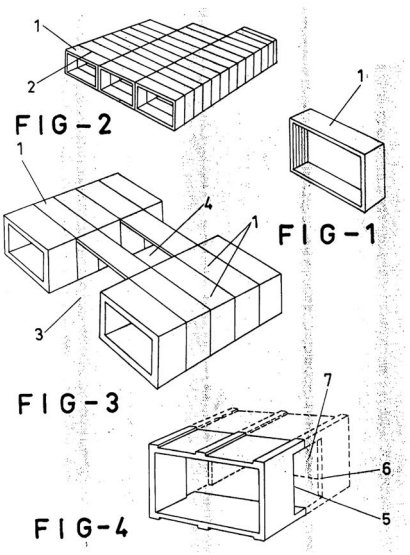

Figure 2 left. Building bridges with precast concrete segments. Originals from Foundation March Archives. Designed by: Vicente Blasco, 2016. (Private Archives of Vicente Blasco.)
Figure 2 right. The EM-III. Industrial model. A habitable beam composed of EM-III Modular Elements. The numerous joints required to build a habitable beam (FIG-2) using EM-III (FIG-1) can be observed. (Thesis Maite Palomares)

Modular Elements

During the 1960s various Modular Elements (EM) prototypes were designed before arriving at a definitive one. The first were EM-I and EM-II, and then EM-III, a ring-type with the dimensions 3.2 m x 2.5 m x 0.8 m metres in depth that enabled 'habitable box beams' to be formed by joining several precast components. Its reduced dimensions were a result of the tight budget that limited the dimensions of the formwork, smaller being cheaper due to ease of handling. Despite this, the experiment was a considerable success. The M series with its prototypes M-I, M-II, and M-III, were the models for M-IV (Fig. 3) an improvement that was 2.5 metres in depth with a single module, made possible thanks to the use of more costly panel elements, so reducing the number of joints necessary to form a habitable beam as only three EM-IV would be needed to compose the beam.

The dimensions of the Modular Elements were by no means random. From the start, the inspiration for the prefabricated elements was the golden rectangle. The measurements of the M-III were 3.2 m x 2.5 m x 0.8 m. If we take Le Corbusier's Modulor as a reference, we see that the dimensions of the M-III are close to those of an ideal rectangle based on the human body, i.e. 3.224 m x 2.526 m. Taking the limitations imposed by serial production into account, it is necessary to simplify this and work with a single decimal for the centimetres, so obtaining 3.2 m x 2.5 m. With regard to depth, as we said, in order to obtain rectangular based unit (3.2 m x 2.5 m) four modules were required that, with a height of 2.5 m,

would enable the groupings of modular housing to be formed. This dimension of 3.2 m was also related to 2.26 m (the height of the Modulor human figure with hand outstretched), through the square root of 2. GO.DB.'s Modular Elements were clearly inspired by Le Corbusier's blue series.

Figure 3. M-IV Modular Element. Mounting the panels and special elements required for the joints. Raising an M-IV for positioning on site and the composition of three M-IV to form a habitable beam, of rectangular proportion. In this case, the building of housing in Camapanar is shown with the lower number of joints compared to the EM-III. (Photo collage copyright of the authors.)

Modular Boxes

The Modular Boxes for the construction of prefabricated facades were pieces of a lesser size, more manageable and so more appropriate for that task. In the same way as in the Modular Elements, their design was linked to the concept of the hollow, taken from the ideas of Miguel Fisac. Added to this idea was the three-dimensional character of the experience of the Modular Elements which, in this case, was only employed for resolving the building envelope. The Modular Box elements were also hollow, and used to improve the insulative value of the enveloping elements. These hollow sections also incorporated window boxes. It must not be forgotten that these architects were designing housing for the Valencia middle class and one of the project aims was to provide space for vegetation, reflecting the health principles of the Modernist Movement.

Dimensionally, in this instance, Le Corbusier's red series of the Modulor was taken as the starting point: 1.13 m x 0.864 m x 0.266 m or 0.432 m, which when simplified resulted in 1.1 m x 0.9 m x 0.2 m or 0.4 m in depth depending on whether they were purely enclosing elements or if they also housed the much-desired window boxes. (Fig. 4)

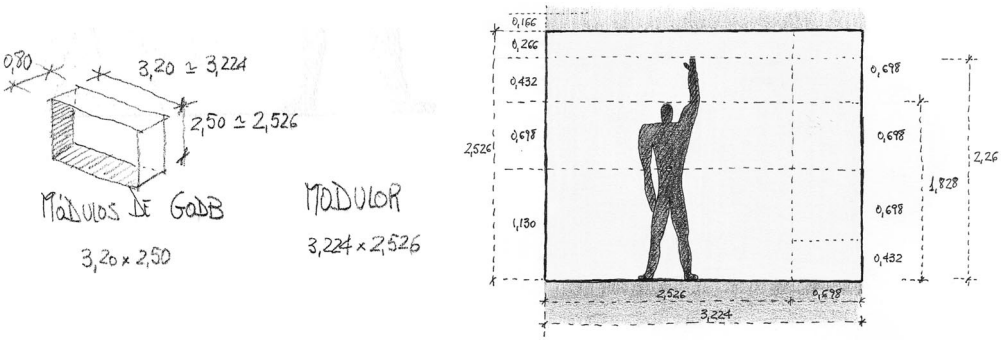

Figure 4. Comparison between the dimensions of the EM-III Modular Element and the Modulor blue series of Le Corbusier. Designed by: Vicente Blasco, 2016. (Private Archives of Vicente Blasco.)

Development of materials for GO.DB. facades

In Valencia, in the 1950s, the Madrid architect Luis Gutiérrez Soto burst onto the local scene with his use of traditional, but quality red brick finishes that earned him international recognition. In the 1960s the GO.DB. studio were keen to find a contemporary outward appearance that employed construction techniques, and thus distancing themselves from the traditional craft processes based on brick and stone. In prefabricated materials, they believed they had discovered a distinctive characteristic identifiable with a quality finish and capable of replacing stone facings and provide a new aesthetic for Valencian architecture.

Dexeus Beatty reflected upon the new building envelopes in his book, saying that the traditional materials employed for that purpose were running out and so it would be a good idea to find an appropriate enveloping form for those building skins. Only industry could, artificially, provide an ideal material for providing that envelope. GO.DB. studio suggested that prefabricated parts would have the advantage of allowing them to mould and industrialize parts so solving the problems of traditional construction. The studio chose to work with three materials: fibre-cement, precast concrete and plastic. These materials were chosen for their lightness and their ease of moulding as this would positively effect the economy of means and, together with the three-dimensional shape, could provide stiffness and strength, with economy of material. Firstly they experimented with asbestos fibre-cement but, on finding that it was toxic, they shifted their research to precast concrete. The first versions of their pieces were rudimentary, lightweight panels. Over time, however, these developed into three-dimensional boxes that allowed them to take advantage of the increase in inertia strength caused by increasing the constructional section without the need to add thickness to the material, i.e. without making the final product more expensive. With the precast concrete parts, their experimentation focused on the design of different finish treatments, such as those used in the walls of the Ciudadela block. In order to increase the strength of the section without increasing the amount of material used, they incorporated several flutings or vertical grooves that also accentuated the height of the building in contrast to the horizontal composition of traditional facades. These were given shape by the hollow boxes containing the window boxes.

A notable case-study in the studio's use of precast concrete parts is provided by the building of the Ausias March Avenue (1970), where the format of the blocks was a tightly patterned and textured triangular concrete relief forming a very expressive building façade. As far as plastic modules are concerned, the innovation resided in their convex section that increased the rigidity of several parts where the material used needed to be of reduced thickness. Together with the ease of moulding, the plastic material formed distinctive façades without increasing the associated weight and keeping building costs down. Another advantage would be the impermeability of the new element, avoiding water absorptions of rain and aiding the self-cleaning of the façade. The only requirement was to find a system of anchorage for controlling stability. As a result of Fisac's influence, the expressiveness that both the material and forms transmitted were of great importance to GO.DB. Juan Antonio Cortés, referring to the pioneering attitude of this architect commented that:

> "*The world of forms that Fisac invents is not that of abstract forms, but that of forms linked to the forming capacity of each material and to the functional, structural and spatial purpose of the pieces obtained with those materials.*
>
> *This assessment of the material is a repeatedly demonstrated aspect of his work. In the architecture of Fisac, architectural expression resides to a large degree on the characteristics of the materials, on their textures and on the effects of light and shade on them.*

> *Fisac handles the materials in such a way as to exploit their capacity for generating forms that constitute new and unexpected solutions, so justifying the use of the term inventor. But for Fisac, these forms must be indebted to the specific properties of each material and truly express those properties, i.e. the architect emphasizes the coherence of the use of the material in accordance with their own conditions and their way of being and being produced."*[16]

High-rise buildings. Their construction

It is well known that the open prefabrication system or prefabrication of modular elements was the procedure most used in most countries where industrialization was well developed[17]. It consisted of factory made building components, such as walls, enclosures, partition walls, etc. mainly made of reinforced concrete that were then transported to the building site. The weight of those constructional elements was a determining factor for their transport and placing, any excess weight having a negative influence on their use. Once on site, large cranes would be used to mount them, standardization being required for all the elements employed.

In Spain, most Spanish industries were small and lacked the machinery and technical training to assimilate the standardization process that such prefabrication required. Nevertheless, some attempts were undertaken using concrete elements for constructing prefabricated facades. One such example is the Beatriz building situated in Madrid (Arq. Eleuterio Población Knappe, 1964-75).

Their construction solution to high-rise building envelopes distanced itself from tradition at a not excessively higher cost, as the prefabricated parts employed were very light boxes that were simple to make. The effectiveness of the system was based on the fact that these parts are made from material that is neither very thick nor heavy. The architects of GO.DB. understood how to take advantage of the hollow section of the pieces. It provided them with volume and, therefore, high rigidity and strength, reduced the load on the floors –by employing a light material, as is asbestos-cement- and increases the usable surface, given that, with the module developed by GO.DB., the outside brick enclosure layer of the traditional system was replaced. These prefabrication systems were novel both nationally and internationally because of their lightness and the fact that they differed widely from those habitually employed that consisted, generally speaking, of heavier elements that formed the incipient curtain walls.

Luz Buildings (1966). Experience with asbestos-cement

GO.DB's experimentation with asbestos-cement began in 1958 in the Virgen del Carmen housing project, where they employed fibre-cement panels for the building envelope. However, we shall focus on the Luz buildings due to the greater interest of the solution developed. Firstly, some reference should be made to the location of this set of buildings. It is situated in a residential area, close to Viveros Gardens area, which is characterized by open spaces. Added to the good location is the fact that most of the buildings have private gardens that provide a good environmental quality to this area of the city. In the case of the Luz building (Fig. 5), there are six towers of 11 storeys set aside for housing.

The towers rise up from a basement used as a garage and ground and mezzanine floors for commercial premises and offices, so forming a continuous base with the street, as a façade. The roof of the base constitutes a usable terrace so that the life of the community takes place on a level of 6.71 m, and, therefore, isolated from the traffic. All the buildings are similar in that their access is gained through internal passageways arranged at level 0, between the commercial premises of the base. These passageways repeat their route on the mezzanine floor and are lit by means of various sized courtyards, the most characteristic being circular with perimeter walkway, like a cloister, with a central garden.

Figure 5. Recently built Luz building. Image from promotional leaflet, 1969.

According to the promotional leaflet of GO.DB., this circular courtyard constitutes "a grand central plaza from which everything emanates, designed as a centre of attraction for its light (as mankind likes to walk towards that) and gardens". Moreover, as mentioned before, the architects also sought to incorporate vegetation throughout the façade by designing modular boxes to form the enclosing elements. (Fig. 6 left)

The modular boxes were prefabricated from hollow components, a novel and lighter type of envelope that, as well as adding comfort – thanks to the better insulation that a hollow piece provides – offered advantages when applied to high-rise buildings, due to their lightness. To design the prefabricated facade elements (Fig. 6 right), both the appropriate location and their foreseen support points were taken into consideration. On the one hand this required a connection with anchorage points capable of resisting the

vertical loads of the weight of the material itself, and, on the other hand (at the top), a fixing system to prevent toppling. Likewise, the modules also had to be capable of absorbing the horizontal loads arising from the action of the wind or any other source. A solution was therefore required that would offer sufficient guarantees of stability to the whole building structure. The other decisive factor were the joints, which necessarily had to absorb building construction tolerance and the possible movements caused by inherent expansions of the material. The supports for the boxes in the Luz buildings were undertaken taking these considerations into account, but, to be totally effective, it was necessary to include the stanchions and the flashings of the aluminium framework. The stanchions braced the envelopes through upper and lower anchorage points and separated each of the hollow boxes that, in turn, were connected to sub-frames, which the windows were fixed into.

The independence of the system allowed a serialized construction of the envelope, regardless of the height of the building and stability was ensured by anchorage to the framework elements and the inertia strength itself provided by the volumetry and section of the box.

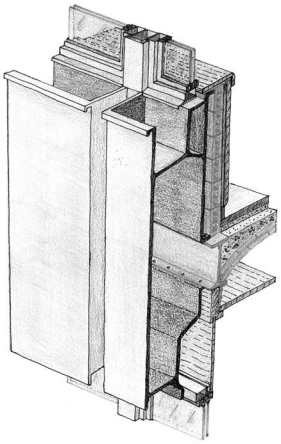

Figure 6 left. Detail from prefabricated facade elements. Asbestos-cement Modular boxes. The vegetation integrated into the facade can be clearly seen. Luz building. Valencia. Architect, GO.DB. Architects. (Photo: Maite Palomares, 2009. Private Archives of Maite Palomares.)

Figure 6 right. Detail from prefabricated facade elements. The hollow section reflects the concept of strength and lightness. In the hollow habitable beam of the Modular Element, the hollow space, because of its dimensions, becomes a habitable space. Luz building. Valencia. Architect, GO.DB. Architects. (Designed by: Vicente Blasco, 2016. Private Archives of Vicente Blasco.)

Ciudadela Building (1963). Experience with precast concrete

In 1963, the Ciudadela building (Fig. 7), located in a historically important part of the city, was built. Its location was due to *urban renewal* scheme developed in the historic centre of the city. Originally, the land was occupied by various buildings at the centre of which was the Casa de les Armes, a defensive building that historically had protected the city. According to Fernando Gaja[18], it is "a space of great urban value due to its position in the urban structure as a whole. The areas for renewal are chosen carefully, not because of the objective state of degradation, but for the economic feasibility of their reuse". The site has various views onto the Alameda promenade and the former river Turia riverbed, now public gardens.

In this building, as in the previous one, the ground and mezzanine floors are for commercial premises and form the base and the tower has 14 storeys for housing with an accessible roof terrace, where the services of the building are housed.

Figure 7. General view of Ciudadela Building. Office platform, modular composition and distinctive roof characterize the silhouette of the building. Each compositional unit corresponds to a House. Valencia. Architect, GO.DB. Architects. (Photo: Maite Palomares, 2009. Private Archives of Maite Palomares.)

The resolution of its façade with precast concrete elements was the result of an accumulation of tests to decide on how best to build high-rise buildings. They experimented with the compositional system, the finishing material, and how to crown the building. This set of details was of great importance due to its corner site, which presented a singular façade to the Jardín del Turia. The structural layout was exhibited outwards in the treatment of the elevation plan, so projecting the image of a fragmented volume, very distinct from the uniform and continuous planes that the façades of the Valencian Ensanche area presented. It displayed the new domestic programmes to the outside by replacing traditional hierarchical composition with an individualized treatment that differentiated the various family units, at the same time as encompassing them in the one same container. This approach clearly reflects similar proposals made by Moshe Safdie as far as reinventing the monolithism of residential housing.

This new compositional system also introduced the material aspect as the differentiating element, apparent in elevations through the presence of different types of precast concrete pieces that formed a brutalist envelope. A rough finish was used on the walls in the form of fluting that accentuated the verticality of the building. On the main facades, the prefabricated hollow boxes were of ground white quartz stone and cement of the same colour with a hollow portion at the top to house the window boxes with the same intention as those developed in asbestos-cement (Fig. 8). Their sloping section was particularly designed to individualize each of the cells, so enhancing the compositional system employed in the elevations. For positioning them, the boxes were placed, supported by and covered the floor to which they were attached on both the top and bottom sides. As a retaining element, another profile fixed to the inner face of the envelope acted as an abutment. In this way resistance to their own vertical loads and the horizontal actions, caused mainly by wind, was ensured. The solution for the top of the building consisted of a parapet of curved beams clad with asbestos-cement plates and crowned with a concrete carcass of strong section, similar to the lower profile. The result formed a recognizable silhouette in the urban context of the city.

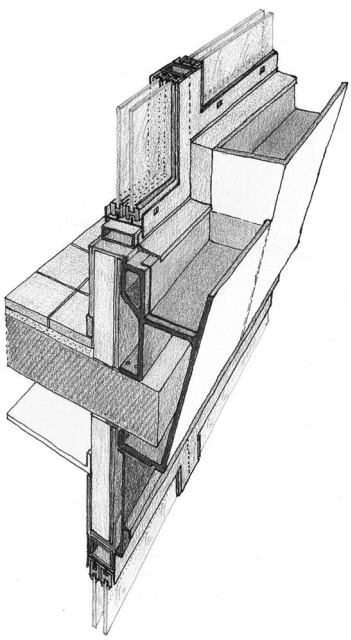

Figure 8. Detail from prefabricated facade with the retaining elements of the modular boxes. Ciudadela building. Valencia. Architect, GO.DB. Architects. (Designed by: Vicente Blasco, 2016. Private Archives of Vicente Blasco.)

1st November 2018, Cambridge

To whom it may concern

We can confirm that the article below:

The development of prefabricated envelopes by GO.DB. Architects Studio for the construction of high-rise residential buildings in Valencia in the 1960s.

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has been accepted for publication in the peer reviewed *Construction History Journal* vol 33. No. 2, 2018. This edition of the Journal is currently in production and will be published late November.

Yours faithfully,

Dr. Christine Wall
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Sorní Building (1967). Variations in precast concrete modules

Its situation in the Ensanche area of Valencia, in the Plaza de America, is a privileged and unique one, as it constitutes the entry and departure point from the city to the sea. This plaza, in the form of a semi-circle has a radial arrangement of roads that all meet there and so is of great importance to the urban development plan of the city. This plan proposed a new urban model to give direction to growth, in line with the middle-class spirit, in a setting characterized by an incipient industrial development and the economic boom due, to a large extent, to the exportation of agricultural products.

One of the high-rise buildings that best sums up the versatility of hollow boxes for the construction of light façades was that situated in Sorní street (Fig. 9), consisting of several large residences for the Valencia middle-class, already seduced by the now well-known formalist solutions offered by this team of architects. It is necessary to point out the value of this building as an alternative to the traditional types of the Valencia urban plan and construction – using prefabrication as a quality finish for façades. Moreover, the building is characterized by concentrating services and installations and freeing the perimeter, so permitting a more flexible treatment of the façades. The building has a basement and lower-ground floor for parking, ground floor access, 10 storeys of housing and a penthouse floor.

Figure 9. General view of the front of Sorní Building. Roof topped with a pergola of a section similar to the Modular Boxes of the Curved façade. The balcony ledges of variable section characterize the main façade. The horizontal composition predominates as a whole despite the verticality of the Modular Boxes. Valencia. Architect, GO.DB. Architects. (Photo: Maite Palomares, 2009. Private Archives of Maite Palomares.)

In the Sorní building, the hollow prefabricated boxes took on a variety of formats aimed at providing several well-differentiated elevations. The organizational system of GO.DB. was clearly apparent in this work, composed of two different bodies: the central, symmetrical part overlooking the square and the sides of circular ground plan design. The former was characterized by several spacious terraces composed of cantilever trays and topped by prefabricated parts that, grouped together, conferred the necessary rigidity without employing greater thicknesses of material. In this Sorní street example, the novelty lay in the variable section of the prefabricated boxes. On the terraces, they gradually diminished in size to form small window boxes at one of the ends and at the other increased in size to form the support for the wooden sliding shutters. Just as in the previous cases, the tops of the units were hollow so that the window boxes could fit inside. In the side façades, the variable section of the boxes was appropriate for following the overall curved line of the design but, unlike the central body, they were closed on top. Frontally, they formed horizontal bands between which the carpentry, consisting of a roller blind shading system, was housed.

Both in the central and in the side sections, the boxes were supported and anchored to the floors by means of several metal profile retention points. (Fig. 10) To prevent toppling and support the horizontal forces, several angular points that connected the prefabricated boxes to the inner face of the envelope were incorporated on the upper part of the parapets. These retention points were especially important in high-rise buildings due to the strong force of the wind and the low but existing risk of seismic action in the Valencia area, which became increasingly important as buildings got higher and because there were very few examples to take as a reference. It is, therefore, important to note that the activity of the GO.DB. team also focused on resolving the details that arose in the new constructional systems for using prefabricated envelopes, as the buildings continued to rise in height. Their contributions facilitated the task of introducing modern industrialized construction into the city of Valencia. Owing to the fineness of the details and finishes, the prefabrications of GO.DB. came to be identified with a building seal of quality that sought to represent the middle class.

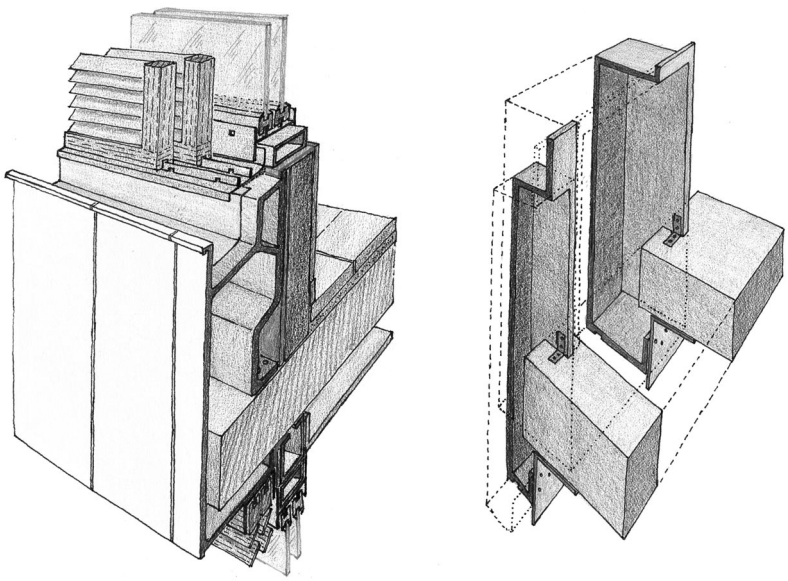

Figure 10. Detail from prefabricated facade elements and angular points. The anchorage of the Modular Boxes reflects an improved system compared to that of the Ciudadela building. Sorní building. Valencia. Architect, GO.DB. Architects. (Designed by: Vicente Blasco, 2016. Private Archives of Vicente Blasco.)

Paz y Seguridad Buildings (1969). Experimentation with plastic materials

At the end of the 1960s, the architects of the GO.DB. studio once again made changes to their tectonic register by incorporating plastic elements in the facades of the buildings of the "Paz y Seguridad" housing cooperative (Fig. 11). This was a set of 279 residences distributed in a grouping of various blocks.

Figure 11. General view and detail of the front of the Paz y Seguridad Building. The earlier composition of the Ciudadela Building is repeated in the image of this group. The bulging polyester profile of the modular boxes provides lightness and distinguishes it from the earlier building. It can be seen that the plant boxes are free-standing outside the Modular Boxes. Modulares. Valencia. GO.DB. Architects. (Photo: Maite Palomares, 2009. Private Archives of Maite Palomares.)

The use of new, slim but highly resistant, materials was very appropriate for the façades of high-rise buildings, but special moulds were required to manufacture polyester pieces reinforced with glass fibre. The architects took advantage of this large-scale project to experiment and without incurring high costs as these were distributed among many residences. They designed a convex section module that increased the rigidity of these thin parts, so thus transforming them into unbreakable pieces that would keep their shape. In this way, they could build with new materials that suited the reduced budgets associated with a social housing project.

The format of these new prefabrications differed from the previous ones. They were formed horizontally as this made the matrices more profitable, unlike all the previous examples where vertical parts had been used. Despite this, the three-dimensional characteristic of the parts designed by GO.BD. was maintained through the convex section, as this was necessary for achieving strength in a material of practically no thickness (Fig. 12). The effectiveness of the parts acquired greater interest the higher the building envelope reached, as the significant load of the wind increased the inverse movements of pressure and suction affecting the detachment of the prefabricated parts, which, therefore, required larger sized anchorage points. For that reason, the modules were anchored in pairs forming several horizontal bands that defined continuous parapets throughout the whole, their repetition being the strategy for one of great expressiveness that provided the characteristic image of the whole building. The numerous anchorage points were fixed from the front, but they hidden in the recessed bands, reinforcing the horizontal composition and giving an exceptionally structural stiffness. On this occasion, as a result of the lightness of the envelope, the plant boxes could not form part of the inside of the Modular Box. However, the presence of vegetation on the façade was not to be forsaken and so special parts were designed, separate from the envelope, but of the same material.

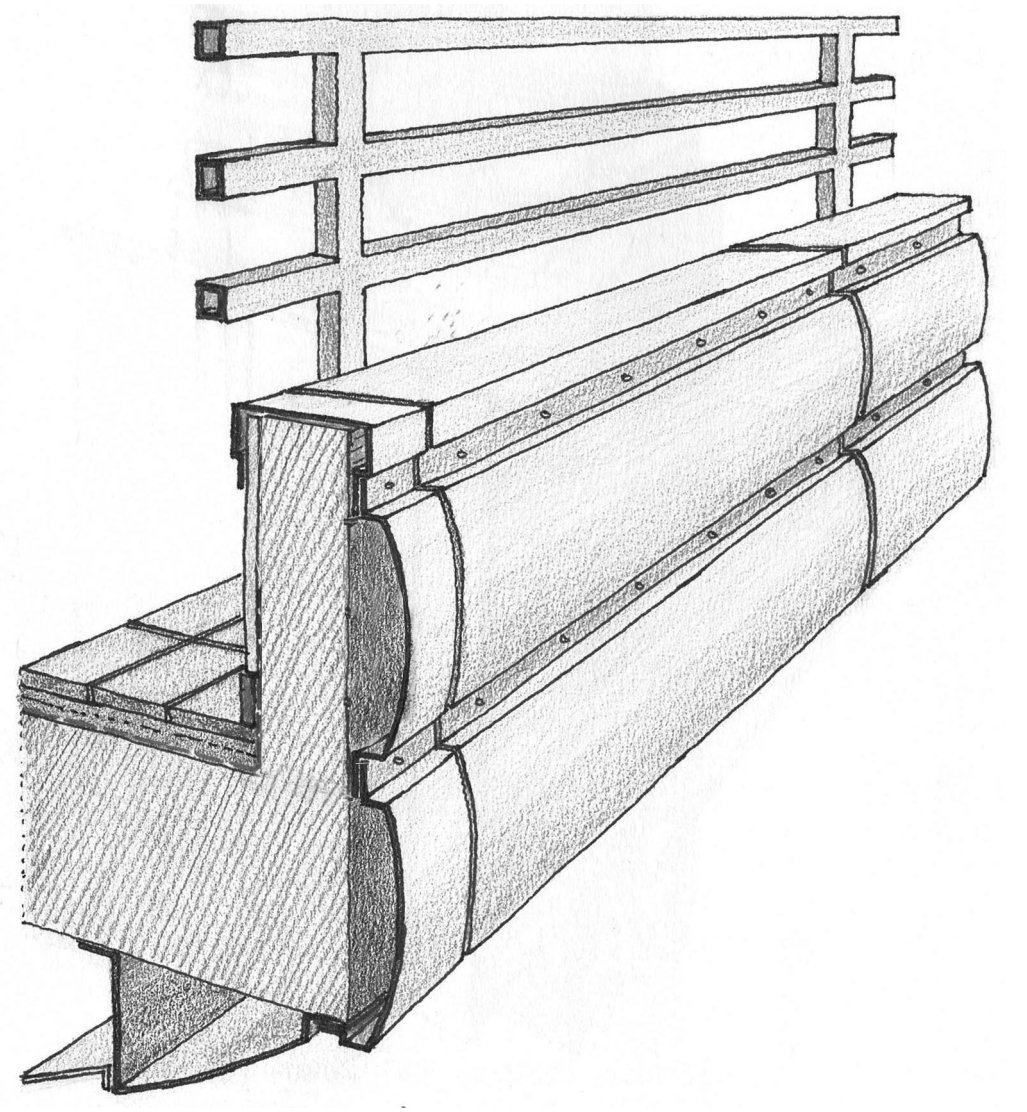

Figure 12. Detail of convex-profile prefabricated facade elements of the Paz y Seguridad Building. The horizontal joints are protected, being located on a posterior plane. Valencia. GO.DB. Architects. (Designed by: Vicente Blasco, 2016. Private Archives of Vicente Blasco.)

Conclusions

The study of the system employed by the Valencian GO.DB. team of architects increases our awareness of a chapter in the history of Valencian construction that took place in the 1960s concerning prefabricated architecture. The interest of their contribution to constructing envelopes resides in their use of a modular system, Modular Boxes, the origin of which dates back to the Modular Elements that they were trying out for the building of social houses. It is for that reason that Modular Boxes have a three-dimensional design. Their studied geometry offers a wide range of possibilities, highly appropriate for enveloping high-rise buildings because of their lightness and expressiveness. It is important to note the confidence

that GO.DB. placed in harmonious proportions for the dimensions of their models, taking the anthropomorphic series of Le Corbusier's Modulor as a reference. Their appropriate measurements were characteristic of several envelopes that built up a recognizable urban landscape of middle class residences in Valencia.

GO.DB. experimented with various materials: asbestos-cement, precast concrete and plastics. In every case, using the concept of the hollow that allowed them to design several modules of low material consumption, but with great rigidity and that facilitated the construction of various envelopes whose execution became more complicated with greater height. Their design was adapted to the particularities of each material without abandoning three-dimensionality, thus projecting a distinct section in terms of form, but always providing space to house the vegetation that associated these buildings skins with modern theories of a high-rise green city.

The constructional details were developed specifically to resolve the technical difficulties that arose from the verticality of the prefabricated facades, adding quality to the solution through a modulated characteristic of the spirit of the age. With the difficulties imposed by an incipient construction industry that had just begun in the 1960s in Spain, GO.DB. managed to achieve prefabricated constructions in line with European trends, although remaining far from the grand technological claims made in wider Europe for prefabricated systems. So, their achievements are due to a combination of economy of means and effectiveness in the results of their application in high-rise buildings.

The national references of GO.DB. Fisac and Leoz, and international ones such as Moshe Safdie, are a guarantee of the interest in their prefabrication production. The publication of their work in prestigious national and international journals such as *Informes de la Construcción* and *L'Architecture d'Aujourd'hui*, as well as their appearance in Registros DOCOMOMO Ibérico, bear witness to that.

Biography
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Notes and References

1. The Opus Dei is a prelature of the Catholic church founded in 1928 by the Spanish priest Jose Maria Escriva de Balaguer. In the beginning, it was aimed mainly at training young university students to spread the message of the Opus Dei among young people in general, hence its great influence during the Franco period.
2. A. Cotorruelo, *La Política Económica de la Vivienda en España*, Madrid: CSIC, 1960. According to Cotorruelo, on the Stabilization Plan of 1959, it can be said that it was a set of economic measures adopted by the Spanish state to liberalize the economy after the industrial recovery of 1950. The energy and equipment required by industry for its expansion would have a negative effect on the Spanish trade balance and so the aim of the Plan was to promote economic growth.
3. O. Diaz, *La difusión del Opus Dei en España (1939-1945): cronología, prosopografía, redes de sociabilidad y vida cotidiana*, Anuario de Historia de la Iglesia, vol.13, 2014, p.549
4. The prelature of the Opus Dei is constituted by three categories of affiliates: prelature priests (numeraries or assistants) diocesan priests (assistants or supernumeraries) and lay women and men (numeraries, assistants or supernumeraries). There are differences in their way of life: the assistants are members with a commitment to living a celibate life in their own private homes. The numeraries are also committed to celibacy but live in an Opus Dei centre. Finally, the supernumeraries have no commitment to celibacy and have family and professional obligations. Some data of Opus Dei's well-known organisation can be seen at his entry in the website https://opusdei.org (Consulted on 3th June 2018)
5. C. Anchel, *Fuentes para la historia de la Academia y de la Residencia DYA*, SetD, 4, 2010, p.47.
6. OTAISA, acronym of the Oficinas Técnicas de Arquitectura e Ingeniería is a point of reference in Seville architecture. It was founded in the 1940s by Felipe and Rodrigo Benjumea, Luis Gómez Estern and Alfonso Toro Buiza. The outstanding feature of this office was the ability to undertake teamwork projects with a group of professionals made up of various generations.
7. P. Cassinello, *Razón científica de la modernidad española en la década de los 50*, p.36 in J.M Pozo (Ed.), Procedings of the International Congress Los años 50: La arquitectura española y su compromiso con la historia, Pamplona 2000, Pamplona: T6 ediciones SL, 2000. Author's translation.
8. F. Arqués, *Miguel Fisac (1913-2006). An experimental aim*, Informes de la Construcción, Vol. 58, 503, Jul-Sep 2006, pp 5-9. The architect Miguel Fisac showed an early interest in precast pre-stressed concrete systems. The expression "Bone beams" arose from their similarities to animal skeletons, but made of concrete. It was a very innovative solution that was based on the strength of hollow elements. It was applied in the enveloping elements of the Vich and Montmeló factories (1968).

9. Rafael Leoz. Exposición homenaje. Madrid: Ministerio de Cultura. Dirección General del Patrimonio Artístico, Archivos y Museos, 1978. pp.5. The figure of the architect Rafael Leoz is interesting in that the aim of his investigations sought to propitiate the transition from craft architecture to industrialized architecture. His objective was to achieve a fully social architecture and, to do so, he sought to conciliate architecture with the new possibilities of industrialized construction that modern technologies were beginning to offer.
10. R. Leoz, *Redes y ritmos espaciales*, Madrid: Ed.Blume, 1969.
11. J. Lopez Diaz, *El módulo hele de Rafael Leoz. Una historia de contradicciones: del éxito internacional a la difícil relación con la arquitectura española*, Ra. Revista de Arquitectura, 14, Nov. 2012, p.37. The "L" module was presented at the Sao Paulo Biennial of 1961. It was received with great enthusiasm, especially in Latin America and enjoyed the support of architects such as Le Corbusier or Jean Prouvé, whereas in Spain, its reception was much more critical.
12. J.M. Dexeus Beatty, *Existencia, Presencia, Arquitectura*. Valencia: Bello, 1976.
13. R. Gut, 'Plan Sur de Valencia', Nueva Planta, núm. 7, May-Jun. 1964, p.35. Something had to be done about the problem of flooding in the city of Valencia, especially after the enormous damage caused by the 1957 Flood. A Technical Committee was set up to find a solution. That Committee came up with three solutions called the North, Central and South Plans referring to their position in relation to the River Turia. The plans attended to the problems of city access, road and rail systems, urban planning, port reforms and, as the central aspect, the course of the river in the city.

14. M. Palomares, *La experimentación en GO.DB. arquitectos* (Ph.D. thesis, Universitat Politècnica de València, 2010), p.357. Modul Arch was the industrialized construction method proposed by GO.DB. Arquitectos. It was a system of modular architectonic elements, i.e. three-dimensional components from which elemental habitable spaces of the architectural system were defined. This constuctional system took advantage of the qualities of precast concrete as a material for industrialized construction and its possibilities for providing a type of construction that sought to promote renewal through industry. The Modul-Arch system propose using the "hollow habitable beam" to define the architectural space. It consisted of assembling a certain number of these beams to create greater spaces. The idea provided a different concept to construction breaking down the living space into "habitable beams".
15. Palomares, thesis, p. 372. The hollow habitable beam was the basic element which habitable space was broken down to according to the Modul-Arch System. It was formed by joining together the basic hollow elements of the "M series". The configuration of the basic element of habitable space was a volumetric piece, which, due to its dimensions and geometry, would require the joining of various elements to achieve a "habitable beam" or architectonic space.
16. J. A. Cortés, Miguel Fisac, el último pionero. Valladolid: COACYLE, 2001, p.35. Author's translation
17. A. Del Águila, *La industrialización abierta y su situación en Europa*. Madrid: Comisión de Asuntos Tecnológicos. Servicio de publicaciones del Colegio Oficial de Arquitectos, 1980. p. 7. See also W. Meyer-Bohe, *Prefabricación. Manual de la construcción con piezas prefabricadas*. Barcelona: Blume, 1967, p. 7.
18. F. Gaja, *Planeamiento y transformación de Ciutat Vella de Valencia: 1939-1957,* in Ayuntamiento de Valencia (Ed), Proceedings of the I Congreso de Historia de la Ciudad de Valencia (s. XIX-XX,) Tomo II, Valencia: Ayuntamiento de Valencia,1998.